COGNITION AND CONSCIOUSNESS: DEVELOPING A CONCEPTUAL FRAMEWORK

by

DAVID JACOBUS FRANCOIS MAREE

Submitted in partial fulfilment of the requirements
for the degree
DOCTOR PHILOSOPHIAE
Psychology
in the Faculty of Arts

University of Pretoria

PROMOTER: PROFESSOR W.J. SCHOEMAN

August 1995

To Maryke

ACKNOWLEDGEMENTS

- My family for their constant and patient support
- Professor Schoeman for his excellent guidance
- Carole Welman for her diligent language editing
- Helene Le Roux for proofreading
- Tinie Scheepers for his superb binding of the manuscript

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CHAPTER 1
PRELIMINARY CONSIDERATIONS ON THE STUDY OF COGNITION AND CONSCIOUSNESS

1.1 INTRODUCTION

The study of consciousness in the history of theoretical and experimental psychology has been neglected or avoided to a great extent. Only recently has the interest in consciousness in scientific studies flared up and the interest is gathering impetus daily. Various reasons have been cited for this neglect. Usually the impact that behaviouristic paradigm has had on psychology, especially from the United States, is held responsible for this neglect. Another prominent reason is the nature of consciousness itself. Although humans, and scientists for that matter, are conscious beings, no real experimental grip on consciousness was found. The result was that consciousness was regulated to certain branches of psychology, such as phenomenological psychology and variants concentrating on therapy, where consciousness is taken for granted as an integral part of human experience. Cognitive psychology, where one would expect at least attempts to relate consciousness to the working of the mind, was virtually silent on the subject.

The recent flurry of interest in consciousness may, amongst others, be ascribed to the development of new non-evasive brain scanning techniques and the great strides in development of computer hard- and software. For instance, articles on the ability of scanning techniques to perceive the activity in the brain of persons while engaging in cognitive activities in real-time, appeared in magazines such as Newsweek, Discover,[1] National Geographic,[2] Scientific American[3] and New Scientist,[4] giving prominence to the fact that the mysteries of the working of the brain and possibly consciousness were about to be solved. Although some progress has been made in studying cognition by means of these techniques, the problem of consciousness as such and its relation to cognition has not been accounted for yet. Theories on what consciousness is and what cognition is, abound, but not much has been done in the field of cognitive psychology regarding the place of consciousness in cognition.

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[1] What is consciousness? (1992), Freedman (1994).

[2] Swerdlow (1995).

[3] Raichle (1994), Fischbach (1992), Hinton (1992), Crick & Koch (1992).

[4] Lewin (1992), Collins (1992), Humphrey (1994).

1.1.1 Aim of the study

This study starts from the premise that the human mind is the apparatus for both cognition and the place where consciousness shows its effects or is experienced. So much of what is consciously experienced is somehow related to the cognitive working of the human mind that ignoring consciousness when studying cognition can only lead to an impoverished understanding of cognition. The aim of this study is then **to develop a conceptual framework within which the relation between cognition and consciousness can be studied**.

The study is thus restricted to the formulating of a conceptual framework as the starting point for further research. This study will therefore be mainly theoretical with the hope that this conceptual framework eventually will lead to a full fledged theory and empirical experimentation. The particular conceptual framework to be developed is a conceptual model, which means that its explanatory power and function is much more restricted than a theory (see Chapter 5 for a discussion of these issues). Although the model will be developed fully in Chapter 5 of this study, it must be noted that the aim of a conceptual model is to provide a framework within which the relationships between phenomena under investigation, the causative mechanisms involved, and the structure and function of phenomena, can be specified. A conceptual model functions as a rudimentary explanatory tool and has a heuristic function in terms of indicating further avenues of research. This study aims at providing such a framework.

1.1.2 The structure and argument of the study

In order to develop a conceptual model, this study will follow a particular course. It can be specified as an argument starting from specifying the principles to the eventual development of the conceptual framework. In this chapter, the philosophical assumptions underlying the approach of this study will be specified. These assumptions involve a systemic emergentist perspective, and the eventual conceptual model will be called a systemic emergentist model (what *systemic* and *emergentist* mean, will be clarified in the discussion below). It is thus assumed that a systemic emergentist perspective provides a new and fruitful way of conceptualising the relationship between cognition and consciousness, and the study is devoted to clarifying this perspective.

Thus, after the philosophical assumptions have been specified, certain principles involved in a systemic emergentist approach will be identified with reference to systems and Gestalt theory (these principles include, amongst others, emergence, structure, function, the constitution of systemic wholes, etc.). These principles will be further clarified by means of two examples. The first example is the hermeneutic theory of Gadamer which illustrates the principle of emergence. The second example is that of an interactionist theory of cognition developed to explain the understanding of metaphor. This theory will be used to illustrate the principles of interaction and structure. This chapter concludes with a precursory model that includes all the systemic emergentist principles identified.

The second chapter analyses the phenomenon of consciousness in order to refine the systemic emergentist principles. It will be seen that the concepts of structure and function play an important role in the study of consciousness. Structure and function are normally utilised as separate principles and it is hypothesised that this separation is responsible for the difficulty of theories of cognition to account for consciousness. It is also hypothesised that a fusion between these two principles makes a systemic emergentist approach possible and facilitates the understanding of consciousness and its place within cognition. In Chapter 2, the role of intentionality as a characteristic of consciousness, will be discussed. Intentionality will be utilised in the final chapter as the principle of emergence applied to consciousness.

The systemic emergentist principles will be applied to various cognitive theories to determine how these theories are able to incorporate them. Simultaneously, the ability of theories to account for these principles will provide additional refinement of the principles. The theories of cognition were divided into four broad approaches (or paradigms). They are the information processing approach represented by Neisser's (1967) initial cognitive theory. The second approach represents a move beyond the information processing approach. The theories of Neisser (1976) and Jackendoff are discussed in this regard. The third paradigm is the symbolicist approach which views cognition as being similar to the architecture of the modern computer. The last approach represents a more recent development in cognitive studies, namely the connectionist paradigm. It is assumed that the four broad categories of theories represent the mainstream of cognitive psychology. The description of the various representative theories entails determining the place of consciousness within the different approaches. In the last chapter, it will be indicated that the ability to account for consciousness within cognition depends on the ability to incorporate and utilise systemic emergentist principles. Chapters 3 and 4 are thus devoted to the analysis of the various cognitive psychological approaches.

In the last chapter the systemic emergentist principles will be clarified against the background of General Systems Theory and the emergent interactionist theory of Roger Sperry. The results of the analysis of Chapters 2 to 4 will be taken into account in the description of a systemic emergentist model. The characteristics of a conceptual model will also be identified, and along with the characteristics of cognition and consciousness, be used to test and evaluate the systemic emergentist model. In the course of the discussion, the relationship between cognition and consciousness will be viewed from a systemic emergentist perspective.

Since much of the recent interest in consciousness and cognition is related to brain or neurophysiological studies, the following section will discuss certain levels of explanation within which cognition as such can be studied. This will be done in order to demarcate the current study's focus from other related areas. Thereafter, the different views on the mind-body problem will be discussed in order to narrow the field further and to give some sort of indication of the philosophical underpinnings possible within the study of mind. Finally, the rudimentary concepts involved in the development of the conceptual framework will be discussed with reference to explanatory illustrations.

1.2 LEVELS OF ANALYSIS

It is generally assumed that cognitive phenomena can be described and studied on various levels ranging from the "lowest" biological level to the most abstract level that may be found in cognition, namely, the conceptual level. Different scientists describe these levels differently, sometimes using confusing terminology.

1.2.1 Four levels of analysis or explanation

Basically four levels can be described when studying cognition. The lowest level is that of the *biological* functioning of the brain (see Table 1 under *Anderson*). Neuroscientists study this level and at this stage knowledge about the functioning of the brain at a neuronal level is still incomplete and, in principle, reasonably inaccessible to cognitive studies (Anderson 1990:22). The level usually studied by cognitive psychologists is the *computational level* where theories try to account for the cognitive processes such as memory storage, retrieval, and problem solving. What the information processing approach describes as processing of information is thus researched. The computational level consists of symbol structures representing knowledge structures and consists of operations to manipulate the symbols (cf. Anderson 1990:18). The computational level presupposes an *implementation level* which accounts for how the computations can be made possible. The implementational level is still not the biological level but somehow abstracts the structural constraints from the biological level. Anderson (1990:18) calls it *an approximation to the biological level*, which we need in order to calculate the cost for the computational level in terms of temporal and other constraints posed by the biological level. Anderson (1990:18) is not convinced that the implementation level corresponds to anything psychologically real. The implementational and computational levels stand to each other as the hardware and software stand to each other in terms of computer technology. The last level can be termed a conceptual level that specifies the goals a cognitive system must attain in order to claim it as human (cf. Anderson 1990:22). It does not correspond to the computations in the mind but specifies what the computations must attain.

Table 1 Levels of cognitive theory/explanation (various cognitive scientists) (Anderson 1990:4)

Marr	**Chomsky**	**Pylyshyn**	**Rumelhart and McClelland**	**Newell**	**Anderson**
	Competence				
Computational theory		Semantic level		Knowledge level	Rational level
Representation and Algorithm	Performance	Algorithm	Macrotheory/ rules	Program symbol level	Algorithm
		Functional Architecture	Microtheory PDP models	Register transfer level	Implementation
Hardware implementation		Biological level		Device	Biological

1.2.2 Comparison between cognitive theorists

Each theorist uses terms which can be very confusing since some use computational level to indicate something else while others use algorithm level to indicate the computational level. Anderson (1990) provides a comparison between the opinions of different cognitive scientists to clarify the situation (see Table 1). Anderson's (1990) comparison with some alterations will be discussed in order to clarify the discussion of various theories later on in this study. Table 1 refers to the first six opinions to be discussed below. In addition, the views of Jackendoff and Flanagan will also be discussed.

1.2.2.1 Marr

Marr (1982) is often quoted for his three levels of explanation. He distinguishes between the computational, representational and algorithm levels and the hardware implementational level. The computational level states the goals of the computations to be carried out by the cognitive system (cf. Anderson 1990:5-6). This level, although inappropriately named the *computational level* according to Anderson (1990:6), requires the problems under study to be clearly stated (Marr 1982:27-28). The point Marr wants to make is that a study of either the computations involved in cognition or the biological functioning of the brain without understanding the problems or goals involved in a particular process, unnecessarily restricts investigations at lower levels.[5] The algorithm and representation levels are the actual computational level where the problems stated at the first level

[5] *...trying to understand perception by studying neurons is like trying to understand bird flight by studying only feathers: It just cannot be done. In order to understand bird flight, we have to understand aerodynamics; only then do structure of feathers and the different shapes of birds' wings make sense* (Marr 1982:27-28).

are to be solved by means of specific computations (cf. Jackendoff 1987:168). The lowest level is then the hardware implementation. In terms of cognition it will then be the level where the biological functioning of the brain is studied, but always in connection with the particular problems that mind must solve.

1.2.2.2 Chomsky

According to Anderson, Marr likened his computational level to the competence level Chomsky (1965) developed in terms of linguistics. Chomsky made a distinction between competence and performance in linguistics. Competence seems to involve the knowledge of a particular language a speaker-hearer has and competence involves the actual use of the language. According to Anderson (1990:8-9), the similarity between Marr's computational (goal level) and the competence level is only apparent, since the competence level is not concerned with the goals of the system (language use in this case). Anderson thus renders the competence level apart form the other levels.

1.2.2.3 Pylyshyn

Pylyshyn (1984) distinguishes three levels that are quite similar to Marr's (cf. Anderson 1990:9). A distinction is made between the algorithm and architecture. The algorithm level specifies the programming (software), while the architecture specifies the hardware requirements for running the software (Anderson 1990:10). Anderson (1990:11) refers to Pylyshyn's principle of *cognitive impenetrability* which states that *the operations at the functional architecture level are not influenced by the organism's goals and beliefs.*

1.2.2.4 Rumelhart and McClelland

The two levels proposed by Rumelhart and McClelland (1986), reflect their work on connectionist models. The connectionist modelling of the brain is essentially a computational level; a level above the actual biological functioning of the brain. The connectionist system, according to Rumelhart and McClelland (1986:125), gives rise to the macrolevel rules which specify the programming procedures relevant to certain cognitive functions. In effect, according to Anderson (1990:11-12), all that is needed is the microlevel computations, while the emergent macrolevel is a useful description of what is going on at the microlevel.

1.2.2.5 Newell

Newell (1982) delineates knowledge, program symbol, register transfer, and device levels. The *program symbol* level corresponds to the computational level described above, while the *register transfer* level corresponds to the implementation level. The device level refers to the biological level. The interesting level Newell proposed was the knowledge level. In fact, *few until Marr and Newell had suggested that it was possible that there was a useful level of analysis above the symbol level* (Anderson 1990:14). Newell's analysis was initially focused on computer systems but, according to Anderson (1990:14), he extended it to the human situation. The knowledge level is characterised by *knowledge as the medium and the principle of rationality as the law of behavior* (Newell 1982:99). The principle of rationality states that if someone knows that one of his actions will lead to a particular goal, then he will perform that action. Behaviour is then explained in terms of knowledge and goals. Newell thus makes provision for goal orientated behaviour. According to Anderson (1990:16), this knowledge level has predictive force since one is able to predict behaviour if one knows what a person's goals and knowledge are. However, more important is the fact that the knowledge level, by allowing ... *an analysis of human behavior abstracted away from the assumptions about the symbols or processes in the human head* (Anderson 1990:16), assigns something human to the otherwise formalised nature of computational studies on cognition. Anderson (1990:23) says as much:

> *Cognitive psychology would be a rather unreal science if we worked only at the algorithm level. Our minds are not abstract algorithms left to compute away but have significant temporal and reliability properties.*

1.2.2.6 Anderson

Anderson's concession above voices the concern recent theorists have about cognitive psychology as such. His statement is remarkable since his theory of the architecture of cognition is widely taken as a paradigm for symbolic systems (cf. Anderson 1980). It seems as if a dissatisfaction with cognitive psychology, in terms of the fundamental restriction to computational and implementational issues, is slowly starting to arise within the ranks of the staunch supporters of the symbolic paradigm of cognition. This is more apparent in the way Anderson (1990) takes Newell's *knowledge level* a step further. He describes this level explicitly as the *rational level*. The assumption underlying this level is the belief that the human cognitive apparatus did not develop in an arbitrary fashion, but in some way is evolutionary optimised (Anderson 1990:26-27). In some way (we do not really know how) the evolutionary adaptation of the human mind, to some constraints (we also do not know what these constraints are and how complex these constraint are), resulted in an optimised mechanism and can explain why the human mind functions in the way it does. Anderson (1990:28) explores the hypothesis that *the cognitive system operates at all times to optimize the adaptation of the behavior of the organism*. He takes rationality to mean that human behaviour is optimal in terms of achieving human goals. The rationality principle leads him to explicitly specify the goals of the cognitive system and then develop a model of the environment to which the system is adapted. The environment provides the constraints within which the system must function. From there on the computational theory can be developed. The assumption is that one does not start from proliferating computational theory by supposing what must be in the human head, but that one studies the constraints the environment places on the cognitive system first. Anderson tries to answer the question of what the purpose of cognition is in the first place. The upshot is that cognition must be studied within a real environment, which echoes Neisser's (1976) plea for the ecological validity of cognitive studies (see Chapter 3 of this study). To illustrate with Anderson's own example:

> *... human memory is often criticized because it cannot easily perform simple tasks, like storing a list of 20 words. However, human memory did not evolve to manage a list of 20 words but rather to manage a data base of millions of facts and experiences* (Anderson 1990:37).

1.2.2.7 Jackendoff

Jackendoff (1987) explicitly tries to relate the phenomenon of consciousness with a computational theory of mind. Although his theory will be discussed later, it is worth noting that his views of cognition can be assigned to the information processing/symbolic approach to cognition. The merit of his work lies in his attempt to account for consciousness within this computational paradigm. He distinguishes two broad levels of enquiry, namely the phenomenological level and the computational level. The relationship between these levels will be discussed in Chapter 3. The phenomenological level describes the phenomenological experience with regard to consciousness. Thus, our experience as conscious human beings in our interaction with the world must therefore be described. For instance, experiencing objects as *out there* (or external to ourselves), or experiencing the quality of awareness such as the blueness of blue, must be described at a phenomenological level and be accounted for on the computational level (cf. Jackendoff 1987:12-13).

The computational level can further be divided into the processing stage (similar to what is called the computational or algorithm level)(cf. Jackendoff 1987:168), and the informational structure level. His main concern is that the structure of information determines actually what processes are going on in the mind. Indeed, by focusing on the structure of information or on the content of the mind, answers to the problem of consciousness can be more readily given.

In Jackendoff's (1987:29-33) motivation for speaking about the computational mind, it follows that he does not envisage an implementation level between the computation and biological levels. It is rather the nature of the biological level which allows him to speak of computations going on in the brain. It may be argued that the informational structures yield the architecture for processes to take place, but it seems that the information structures are dynamic and intimately intertwined with the computational process. Rather, the brain consists of separate units (neurons) and only by virtue of their combinatory interactions yield computations in a way very similar to a computer (Jackendoff 1987:30). Although Jackendoff uses the computer analogy, he is aware of the differences between computers and the brain (cf. Jackendoff 1987:33-36). The brain is not a mass-action device (such as the stomach or an electric motor) where the sum or average of the parts describes the action of that device (cf. Jackendoff 1987:30,32). Only the combinatorial properties of the microlevel units, which can be very complex, describe the function of the brain.

With Jackendoff, the knowledge level is enriched by the phenomenological level. This level allows descriptions of the goals of cognition as with Newell's and Anderson's levels, but widens it sufficiently to allow conscious awareness within the field of analysis. In fact, it is only within this level of analysis, where consciousness plays a definite role, that goal directed behaviour within a particular environment has its force. Human beings normally interact with their environment in a conscious way, and much of what a person is aware of, such as the appearance of objects and bodily states, needs to be explained in a cognitive theory. The interaction between the environment and the embodied brain is made possible by awareness. This is a contentious statement since the senses usually provide the information for cognitive processes and one may argue that the interaction between the mind and the environment is the function of the senses. But, what is the sense of functioning within a world without awareness?

1.2.2.8 Flanagan

Flanagan (1992:11) is of the opinion that the best way to study consciousness is to use, what he calls, the natural method. This entails integrating three domains of study, namely, the phenomenological, the psychological and the neuroscientific. It allows each field to describe consciousness from its perspective, precludes exclusive preference of one perspective above another and continually sifts and refines the resultant theory. According to Flanagan (1992:12) each theory on its own cannot explain consciousness fully: *Phenomenology alone has been tried and tested. It does not work. But all we know is that taken **alone** it does not work.*[6] The same goes for cognitive psychology and neuroscience. Cognitive psychology can provide descriptions of and explanations of mental functioning, but must be constrained by the way the brain actually works.[7] However, *...the study of the brain alone will yield absolutely no knowledge about the mind unless certain phenomena described at the psychological or phenomenological level are on the table to be explained* (Flanagan

[6] Emphasis Flanagan's.

[7] *Cognitive psychology alone also does not work. Explanations at the psychological level can provide illuminating models of mental activity. But psychological explanations need to be constrained by knowledge about the brain* (Flanagan 1992:12).

1992:12).[8] Flanagan therefore argues for an interaction between three levels of analysis. While studying cognition, the one cannot do without the other in terms of the constraints they place on each other. While the focus in this particular study is on cognition and cognitive psychology, it seems important to incorporate the constraints from lower and upper levels of descriptions.

1.2.3 Summary: the levels of analysis

Figure 1 summarises the results of the discussion on the levels of analysis, with necessary adjustment to the initial description. There are three broad levels of analysis, namely the phenomenological, the psychological and the biological. Cognition is analysed on the psychological level and the theories of cognition consist mainly of proposals how various cognitive functions may operate by means of describing the structure of knowledge and the procedures or computations involved.

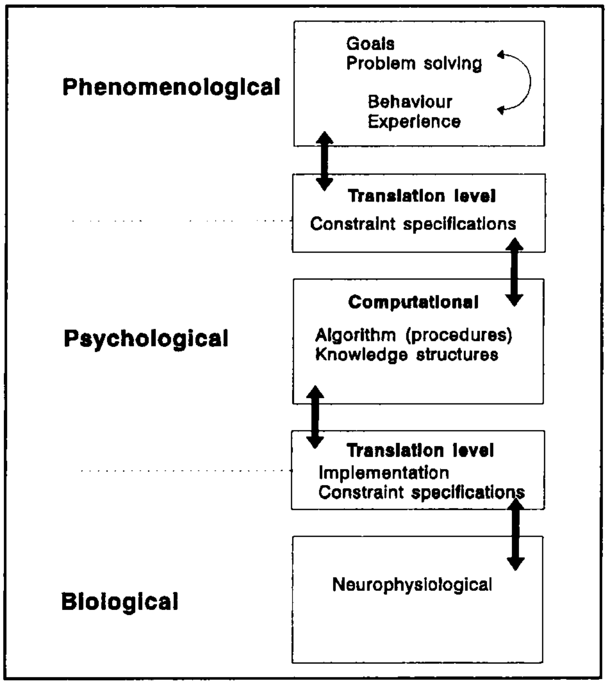

Figure 1 Levels of analysis

The phenomenological level provides the descriptions of what is to be described in terms of behaviourial data, but it is much more than this. It incorporates a description of the goals of

[8] *... there is nothing about the phenomenological concept of consciousness that renders it incompatible with the terms and concepts of a science of mind. The best strategy is one that promotes the search for relations among the phenomenological, information-processing, and neural levels ... In practice, the search for relations will require give-and-take in various places, especially in our commonsense characterizations of mental events. There are a host of possible relations that might be discovered to obtain among the different levels* (Flanagan 1992:19).

cognitive behaviour. The goals of cognitive behaviour specify the problems cognition must be able to solve, and in fact does solve, within an experiential environment. Experience includes both the subjective experience of the cogniser and the objective demands of the environment, while the environment includes the world within which cognition takes place. This means that a person's body and experience of it, is as much part of one's world as the external environment. The phenomenological level provides a description of what we see and experience. This data allows the researcher to infer what the problems to be solved are and what the purpose is of cognition (as will become clear later, it is possible that multiple goals and problems exist, since the problems visual perception must solve differ somewhat from the problems other senses, such as auditory perception, must solve).

The biological level provides information on the biological functioning of the senses and the brain. This level of analysis lies outside the scope of this study but, where necessary, it will be taken into consideration.

The most important aspect from the model in Figure 1, is that interaction takes place between the different levels. Each level provides constraints for its adjacent level(s) so that theorising for a particular level takes place within specific parameters. For the purpose of this study the focus is on the psychological level, with reference to the phenomenological level. What was described as an independent *implementation* level, is posited as a bridging level between the biological and computational levels. This level translates the constraints from one level to the next. It is called a translation level since it formulates the constraints and information of one level in terminology appropriate to a particular level. For instance, from a biological analysis it is apparent that neurons are slow processors. This means that a time constraint is placed on the cognitive model in terms of the number of steps required for a particular computation. One cannot therefore devise a model which in practice will not comply to the time constraint placed upon it by the actual functioning of the brain. A similar translation level is posited between the phenomenological and psychological levels. This implies that a phenomenological experience such as experiencing objects external to the mind, or the experience of the unity of consciousness, must be somehow translated into terms compatible to the model of cognition.

It is clear then, when trying to relate consciousness and cognition, that the different levels of analysis be kept in mind. Both the observable data of cognition and consciousness can be described at the phenomenological level and it is at this level where the purpose of cognition and consciousness will be formulated. The description of phenomenological data and formulation of goals and problems influences the psychological analysis at the next level of analysis. In some way, the model of cognition developed at this level must account for the formulations at the phenomenological level. What is aimed at is then a development of a conceptual framework encompassing both the phenomenological and psychological levels, which hopefully could guide the development of a model of cognition and consciousness, which in its turn could provide the biological analysis with certain constraints (see Chapter 5).

The following section discusses the philosophical assumptions underlying cognitive research in order to provide a deeper understanding of the problems involved in this study.

1.3 PHILOSOPHICAL ASSUMPTIONS OF COGNITIVE STUDIES: THE MIND-BODY PROBLEM

The experience of consciousness is so intense that it seems to have independent existence or substance apart from physical substance. Indeed, in mankind's endeavour to understand itself, the positing of minds or incorporeal substance distinct from physical matter is constantly discussed in terms of the mind-body problem. Flanagan (1992) expresses this observation as follows:

> *Whereas the brain seems suited to processing information, it is harder to imagine the brain's giving rise to consciousness. The very idea of consciousness materializing, of subjectivity being realized in the activity of a physical organism, is puzzling. The rich phenomenology of the conscious stream and complex neural activity appear to belong to two entirely different orders: the subjective and the objective* (Flanagan 1992:xi).

The mind-body problem is the subject matter of a philosophy of mind, and the various statements of the problem can be divided into monism and dualism (Bunge & Ardila 1987:7). Monism states that there is no distinction between body and mind, while dualism makes a distinction between body and mind. Bunge and Ardila (1987:8) summarised the various views of the mind-body problem (see Table 2).

Contrary to Jackendoff (1987:10) who equates materialism and monism in contrast with dualistic theories, it is worth noting that, according to Bunge and Ardila (1987:8), the monism-dualism distinction in Table 2 does not correspond to the classical materialism-idealism dichotomy, since one can be a materialist while having a dualist view of the mind-body relation. For instance, Flanagan (1992) is a materialist, but argues for the possibility to develop a theory of consciousness:

> *There must be truths about consciousness, since consciousness exists, is a natural phenomena, and is in need of explanation. So there can be a theory of consciousness* (Flanagan 1992:220).

He brings in another distinction within the materialist position, namely that of constructive and nonconstructive. However, the term "constructive" designates the possibility of formulating a theory of consciousness and does not refer to the relation between body and mind.

Table 2 Ten major views on the mind-body problem (Bunge & Ardila 1987:8, adapted from Bunge 1980).

Psychophysical monism		Psychophysical dualism	
M1	*Idealism, panpsychism, and phenomenalism:* Everything is mental (Berkely, Fichte, Hegel, Fechner, E. Mach, the later W. James, A.N. Whitehead, Teilhard de Chardin, B. Rensch).	D1	*Autonomism:* Body and mind are mutually independent (Wittgenstein).
M2	*Neutral monism, or the double aspect doctrine:* Body and mind are many manifestations of a single unknowable neutral substance (Spinoza, W. James, B. Russell, R. Carnap, M. Schlick, and H. Feigl).	D2	*Parallelism:* Body and mind are parallel or synchronous (Leibniz, R.H. Lotze, W. Wundt, J.H. Jackson, the young Freud, some Gestaltists).
M3	*Eliminative materialism:* Nothing is mind (J.B. Watson, B.F. Skinner. A. Turing).	D3	*Epiphenomenalism:* Body produces or causes mind, which does not react back upon body (Hobbes, C. Vogt, T.H. Huxley, C.D. Broad, A.J. Ayer).
M4	*Reductive or physicalist materialism:* Mind states are body states (Epicurus, Lucretius, Hobbes, La Mettrie, d'Holbach, I.P. Pavlov, K.S. Lashley, J.J.C. Smart, D. Armstrong, W.V. Quine).	D4	*Animism:* Mind animates, controls, causes or affects body, which does not react back upon mind (Plato, Augustine, computationalist cognitive psychology, according to which people are run by immaterial programs).
M5	*Emergentist materialism:* Mind is a very special biofunction (Diderot, S. Ramón y Cajal, T.C. Schneirla, D. Hebb, A.R. Luria, D. Bindra, V. Mountcastle, J. Olds, H. Jerison).	D5	*Interactionism:* Body and mind interact, the brain being only the "material basis" of mind (Descartes, W. McDougall, the mature Freud, W. Penfield, R. Sperry, J.C. Eccles, K.R. Popper, N. Chomsky).

Flanagan (1992:2-3) advocates a constructive naturalistic (materialistic) perspective of consciousness, which means essentially that a theory about the nature, forms, and origins can be constructed *by blending insights from phenomenology, psychology, cognitive science, neuroscience, and evolutionary biology* (Flanagan 1992:xi). Against nonnaturalist (idealistic) perspectives which believe either that consciousness is a nonphysical substance, or that it is miraculous, and against the agnostic belief that it is too difficult to relate consciousness and the brain, Flanagan believes that the existence of consciousness in the natural world can be made intelligible by taking both the phenomenal descriptions of consciousness and the study of the brain seriously. He (1992:1-2) then argues against anticonstructive naturalism, which holds naturalism to be true but consciousness as cognitively closed to human beings (cf. McGinn 1991), and against eliminativist naturalism (or materialism) which also regards naturalism to be true but requires the elimination of consciousness-related concepts (cf. P.M. Churchland 1981 and P.S. Churchland 1983). One of the most dominant philosophical perspectives in cognitive science is that of computational functionalism.

Computational functionalism goes hand in hand with what Flanagan (1992:5) calls *conscious inessentialism*, which entails the perspective that consciousness is not essential to intelligent mental activity. Cognition can take place without consciousness. The role of consciousness in cognitive science is further curtailed by the *epiphenomenalist* belief that, although some cognitive processes are accompanied by consciousness, consciousness does not play an integral part in the successful execution of those processes (Flanagan 1992:7; cf. Jackendoff 1987:8-9). The question therefore remains as to what the function of consciousness is. Parallelism is also not a viable alternative since this position entails that body and mind are distinct domains (substances). Although they are allowed to interact, it is only more apparent than real (cf. Jackendoff 1987:9-10). Interactionism allows brain states to influence mental states, and the other way round, but it still holds body and mind to be two separate domains (cf. Jackendoff 1987:8).

According to Bunge and Ardila (1987:10), *emergent materialism* is probably the best position in terms of scientific research. Emergent materialism does not deny the phenomenon of consciousness, or the mind, as is the case with eliminative materialism or physicalist materialism (comprising the various unconstructive positions Flanagan complains about) (Bunge & Ardila 1987:10). However, unlike dualism and idealistic monism, emergent materialism does not posit the mental domain as having separate substance subjected to its own laws and not open to scientific investigation (Bunge & Ardila 1987:10). Emergent materialism allows psychology within the scientific domain, and allows the mental to be scientifically studied. The position of constructive naturalism espoused by Flanagan, is then an emergent materialist view [one suspects that Flanagan wanted to avoid the pejorative meaning attached to the term *materialism*]. Behind this materialist theory lies the identity theory or hypothesis,[9] which specifies that *all mental events are (identical to) brain events* (Bunge & Ardila 1987:12; cf. Jackendoff 1987:10-11). The identity hypothesis comes in two forms, the *strong or emergentist* hypothesis, and the *weak or levelling* hypothesis (Bunge & Ardila 1987:10). The emergentist hypothesis states that mental events correspond to neural events but cannot be explained only by physics or chemistry, while the weak hypothesis holds that mental events are just physico-chemical events occurring in the brain, and physics and chemistry should be sufficient to explain them (Bunge & Ardila 1987:10). Although many psychobiological researchers object to the emergentist identity hypothesis due to the obscurantist notion of emergence, the weak identity hypothesis cannot find mental events in the functioning of single cells. The emergentist hypothesis finds mental events in larger groups of cells in brains (Bunge & Ardila 1987:13). Although Jackendoff (1987:24) is careful not to commit himself wholly to the identity theory, his theory is clearly based on the emergentist hypothesis (see Jackendoff 1987:29-33 and paragraph 1.2.2.7 above).

To summarise: in order to study the relation between cognition and consciousness, it is best to start from a philosophical position enabling one to study both cognition and consciousness scientifically.

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[9] Bunge and Ardila (1987:12) call it a hypothesis rather than a theory since it functions as a heuristic hypothesis rather than as a fully developed theory (cf. Bunge & Ardila 1987:15).

This means that the phenomena under discussion are open to scientific explanation and empirical analysis. The aim of scientific investigation is to explain phenomena and explanation is done by means of theory formulation. The explanatory power of a theory, in the end, is tested empirically. Therefore it is best to avoid, at this initial stage, philosophical assumptions such as dualism (which ascribes independent substance in some form to mental phenomena)[10] and various forms of monism which deny the existence of the mental (eliminative materialism, and physicalist materialism), or affirms only the mental (idealism). The assumption underlying this study is then constructive (in Flanagan's sense), which confirms the interactional levels of analysis above. The assumption underlying this constructive model is thus the emergent or identity hypothesis which states that the mental corresponds to, or emerges from, the combinatory function of biological units.

1.4 FORMULATION OF HEURISTIC PRINCIPLES

Discussion up to this point has all the elements of a systemic or systems-theoretic approach. This approach proceeds from an ontology stating that the world is a system consisting of subsystems belonging to different levels (Bunge & Ardila 1987:46). The systemic epistemology allows one to study systems theoretically and empirically in terms of the analysis and synthesis of systems components, the interactions among components, and the interactions between the components, the system and the environment (Bunge & Ardila 1987:46). A systemic approach is contrasted with atomism and holism. Atomism studies the individual behaviour of single units, but cannot account for the emergent properties of whole units (Bunge & Ardila 1987:46). Holism (such as Gestalt psychology), on the other hand, studies wholes as such without regard for the processes constituting the wholes.[11] The systemic approach avoids the restricted emphasis and problems associated with atomism and holism by focusing on their positive aspects: systemism *studies both the whole and its parts, and it admits the occurrence of emergence, or qualitative novelty, as well as the possibility of explaining it* (Bunge & Ardila 1987:46).

A system, according to Bunge and Ardila (1987:46-47), consists of its composition, the environment, and the structure of the system. The composition is the collection of the system's parts. The environment is a collection of "things" which is not part of the system and which acts upon the system and is influenced by the system. The structure is defined as ... *the collection of relations among components of the system (**internal** structure) as well as among these and items in the environment (**external** structure)* (Bunge & Ardila 1987:47). The system, with its composition, environment and structure is always analysed/described at a specific time, which implies that the components may change over time. It is also important to note that the level of analysis for a particular system must

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[10] Cf. Dennett (1991:37) and Searle (1992) for a further discussion on why the dualist position precludes scientific inquiry of the mind.

[11] Marx and Cronan-Hillix (1987:189) point out that the Gestaltists were not opposed to analysis in general.

be specified since the composition, structure or environment can change for the same system depending on the level it is analysed. A description of perception at the neurophysiological level, entails analysing subsystems of neurons, particular firing patterns etc., while a description at the psychological level will involve subsystems of memory, retrieval procedures etc.

Despite the fact that Gestalt psychology was mentioned above as an example of holism, it must be pointed out that Gestalt theory provides some interesting perspectives on the problem under discussion. The phenomenological description of experiential wholes is generally accepted by Gestalt theorists (Marx & Cronan-Hillix 1987:191; cf. Koffka 1935; Köhler 1920, 1938, 1947, 1969; Wertheimer 1923). This means that the validity of direct experience is taken for granted rather than basing descriptions on an analysis of elements of that experience. Indeed, by focusing on atomistic elements of experience, the experience as such ceases to exist (cf. Marx & Cronan-Hillix 1987:195). The necessity to preserve the essence of a whole phenomenon or experience, gave birth to the well known dictum: *the whole is more than the sum of its parts*. This slogan tries to emphasise that there is a *difference* between the sum of the parts and the whole. Marx and Cronan-Hillix (1987:198) quote Wertheimer and points out that he refers to both the structure of the whole and to the logical priority of the whole with respect to the given in experience:

> *The given is itself in varying degrees structured (Gestaltet), it consists of more or less definitely structured wholes and whole-processes with their whole-properties and laws, characteristic whole-tendencies and whole-determinations of parts. Pieces almost always appear as parts in whole processes* (Wertheimer 1938:14).

What Wertheimer refers to here as wholes, and the structure and properties of wholes, are the three senses in which *Gestalt* can be understood (Bunge & Ardila 1987:100):

(a) the whole or system (*Ganzheit*),

(b) the structure or configuration (*Struktur*), and

(c) the emergent or systemic property (*Gestalt-qualität*).

The relationship between the parts and the whole is of course determined by its structure, but it seems as if Wertheimer is asserting the logical priority of the whole. This means that the whole determines the parts. Figure 2 illustrates the relationship perceptually. The two squares, although objectively identical, are first experienced as different appearing wholes and not as parts making up a whole.

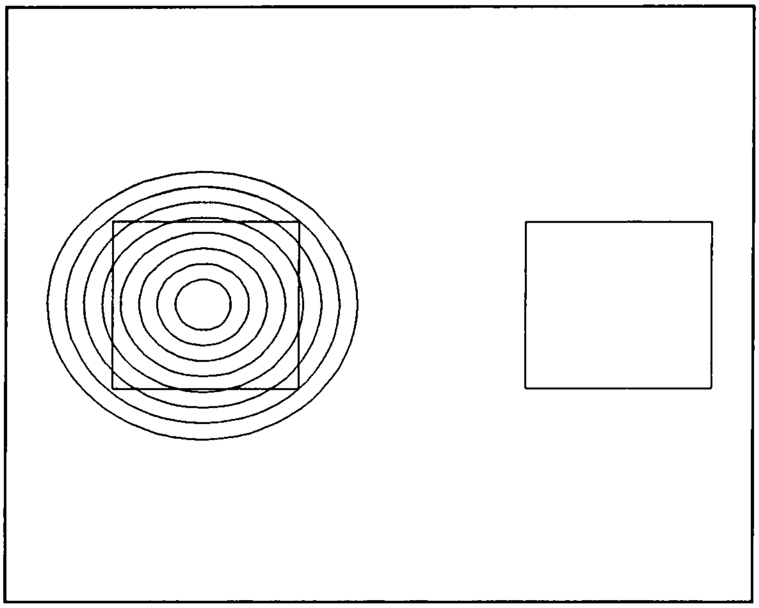

Figure 2 Perception of the part and the whole (adapted from Marx & Cronan-Hillix 1987:198)

The appearance of a whole cannot be inferred from the properties of its elements or parts, as is the case with the square on the left in Figure 2. Only by configuring the elements in a certain way does the whole appear in the way it does. In some way the relationship between the parts in the particular structure of the whole, gives rise to its appearance as a whole.

Thus the slogan, *the whole is more than the sum of its parts*, is paraphrased by Bunge and Ardila (1987:101) as follows: *Every system has some global or systemic properties that are emergent relative to those of its components, that is, that the latter lack.* Emergence or *Gestalt-qualität* is then the mechanism - if it can be called a mechanism at this stage - that accounts for the novel properties a whole has by virtue of its structure.[12] The fact that the elements of the whole lack the emergent property, does not imply that emergence as such cannot be explained. According to Bunge and Ardila (1987:102), knowledge of the preceding constituents of a system is sometimes sufficient to explain the emergent properties such as is the case with chemical reactions. The impression might be given that the configuration of elements or the structure of the whole is static in some way but, as expressed by Piaget (1918, 1952) in connection with the stages of development of children, it is the *interactions* among parts which give rise to a new whole (cf. Chapman 1988:344).

For the purpose of this study, the assumption that certain phenomena constitute systemic wholes will guide the formulation of a conceptual framework within which cognition and consciousness can be studied. A system consists of elements related to each other, and by virtue of the configuration

[12] Compare the following description of emergence: *"emergentism" is a label for all the theories which assert the presence, in the realm of living beings and organic life, of elements which are not continuous with what went before and which are therefore "emergent", or irreducible to the already known elements* (Egidi 1987:157).

of elements it is said to have a certain structure. This structure determines the emergent properties of that particular system. It is possible that the properties of the system and the elements cannot be reduced to each other. By calling the configuration of elements a structure does not imply a static structure, since the relation between elements can be dynamic in terms of interaction taking place between the elements.

The thesis posed in this study is that consciousness must be described systemically. In fact, the only way consciousness can arise is within the relations between certain structures. It is my contention that these structures are of a cognitive nature since it seems to me that consciousness is an integral part of *thinking* human beings (at least for the moment, since we do not have the ways and means to determine whether animals or other objects in nature are in fact conscious or thinking for that matter). The terminology to be used in describing and explaining consciousness will be hammered out in due course. The relationship between consciousness and cognition will also be made clearer as the discussion progresses.

Certain principles can be identified from the discussion thus far. The philosophical assumption underlying the approach to be followed in this study is that of emergent materialism or naturalism. This assumption implies that all the levels of analysis come into play when discussing the relationship between cognition and consciousness. The approach to be followed in this study entails a systemic perspective. This means that a system has a structure, a particular appearance as a whole and a mechanism involving emergence of certain properties.

In the following section, emergence, structure and interaction will be examined with the help of two theories. The two theories illustrate the principles identified above from the perspective of understanding when using language. The context of language was chosen since emergence of meaning forming a *Gestalt*, is clearly illustrated within this context.

1.5 EXAMPLES OF SYSTEMIC EMERGENT THEORIES

In the following paragraphs, two theories will be discussed as examples of the principles needed to be incorporated in a conceptual framework for cognition and consciousness. The principles are closely connected to the systemic emergentist approach. The first theory is that of the hermeneutical theory of Gadamer which illustrates emergence in connection with the constitution of meaning when trying to understand a text. In this particular context, it will be seen that the emergence of meaning in the process of understanding reveals something of the conscious process. Aspects surrounding the emergence of meaning will play a fundamental role in the concept of intentionality discussed in Chapter 2, and again in Chapter 5, when the final conceptual model will be developed. The second theory to be discussed below is that of Indurkhya's interactionist theory of cognition. Indurkhya developed this theory to explain the understanding of a certain type of metaphor. Thus, although the emergence of meaning when trying to grasp a metaphor also features in his theory, it is explained in terms of the interaction between knowledge *structures*. This theory provides systemic principles, such as structure and interaction, which must be included in the eventual conceptual model of cognition and consciousness.

1.5.1 The phenomenon of understanding in the philosophical hermeneutics of Gadamer

The work of Gadamer on hermeneutic understanding serves as a first example of emergent properties of a system due to the structure of the elements within the system. Gadamer reacts against the view of science as a presuppositionless and objective enterprise by which one is able to pinpoint truth by way of following a certain methodology. In this view, the scientist can understand phenomena without involving himself in his methodology or in the phenomena. To illustrate the falsity of this view, Gadamer explicates the phenomenon of understanding as such. It becomes clear that understanding *is* being human and understanding takes place linguistically (cf. Gadamer 1972:449-450). In fact, the medium by which understanding or being human is realised is language itself (Gadamer 1972:451).[13] By defining understanding ontologically, a person's past and present experiences become intertwined (cf. Gadamer 1972:289). The traditional problem of hermeneutics was the understanding of past experiences usually embodied within texts. For instance, one is acutely aware of the gap between one's own situation and that of another culture when trying to understand a text written 2000 years ago (cf. Gadamer 1972:364). One way of bridging this hermeneutic gap is to suspend one's own situation and in an ahistorical manner analyse the text objectively. This method underlies the scientific attitude Gadamer views as illegitimate. The only way to understand the text, is to become involved in the process of understanding. One cannot suspend one's own prejudices[14] as a scientist. It is part of the scientific process. This means that one must realise that what one has become, is part of a certain history and tradition (Gadamer 1972:289-290). This history or tradition, with its beliefs and prejudices, forms one's own current being made up of various kinds of experiences, knowledge, beliefs, commitments and prejudices. By trying to suspend one's own historicity, one denies one's fundamental existence as a human being and one severs the link between oneself and the past and thereby the possibility of understanding the past. This effect of the past on forming present understanding is called *wirkungsgeschichtliche Bewußtsein* (Gadamer 1972:324).

So much for the ontological grounding of understanding. How does understanding take place? Gadamer (1972:361-362) illustrates the emergence or the happening of understanding with the

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[13] *Vielmehr ist die Sprache das universale Medium, in denn sich das Verstehen selber vollzieht* (Gadamer 1972:366).

[14] Cf. Gadamer (1972:250-275) on the role of prejudice in understanding.

phenomenon of a conversation.[15] We take part in a conversation: it is a process in which we are involved. Although the elements are readily identified (for instance two or more partakers and a topic), the final truth of the conversation is something which is only eventually established during the conversation. A game has the same emergent property not reducible to the elements of the game. For instance, only by playing the game, by becoming involved in the game, does the game have its effect as a game and is it constituted as a game.[16] It is not possible to constitute the game by being an onlooker. In fact, the game as phenomenon is destroyed by removing oneself as a player or by not keeping to the rules of the game. In the same way understanding takes place by becoming involved in the process of struggling with a text. Understanding takes place by letting the horizon of the text and one's own life horizon merge in some way (cf. Gadamer 1972:366). This involves letting one's own experience be changed by the text. What one understands and the truth one appropriates, becomes part of one's history and lifeworld. Any subsequent struggles with other texts will be coloured by past hermeneutic processes.

Understanding is thus not a denial of one's history and the effect this history has, but it calls for a *fundamental openness* towards experience (Gadamer 1972:343-344). The openness of experience, according to Gadamer (1972:344), has the structure of a *question*. A question always implies a certain openness towards a possible answer. Although a question implies openness, it is simultaneously limited by what Gadamer (1972:346) calls, *its own horizon*. Its horizon is the establishing of a body of background knowledge and presuppositions, in terms of the origin of the question and the expectations it establishes for a possible answer. Asking a question implies a certain lack of knowledge and it is precisely the acknowledgement of this fact that leads one to expect an answer. The structure of question and implied answer characterises phenomena such as a conversation which was mentioned above. Hermeneutical understanding, more than anything else, has the structure of question and answer since the conversation one has with a text, commences first of all from an openness towards the text in letting it question oneself. Understanding the text is to understand the question of the text (Gadamer 1972:351). This interplay between text and interpreter - this "conversation" which has the structure of question and answer - does not happen or proceed aimlessly but has a definite direction or "sense". This direction is fundamental to the

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[15] *Vielmehr ist es im allgemeinen richtiger zu sagen, daß wir in ein Gespräch geraten, wenn nicht gar, daß wir uns in ein Gespräch verwickeln. Wie da ein Wort das andere gibt, wie das Gespräch seine Wendungen nimmt, seinen Fortgang und seinen Ausgang findet, das mag sehr wohl eine Art Führung haben, aber in dieser Führung sind die Partner des Gesprächs weit weniger die Führenden als die Geführten. Was bei einem Gespräch 'herauskommt', weiß keiner vorher. Die Verständigung oder ihr Mißlingen ist wie ein Geschehen, das sich an uns vollzogen hat. So können wir dann sagen, daß etwas ein gutes Gespräch war, oder auch, daß es unter keinem günstigen Stern stand. All das bekundet, daß das Gespräch seinen eigenen Geist hat, und daß die Sprache, die in ihm geführt wird, ihre eigene Wahrheit in sich trägt, d.h. etwas 'entbirgt' und heraustreten läßt, was fortan ist* (Gadamer 1972:361).

[16] *For what reveals itself as most characteristic of the phenomenon of playing is that the individual player is absorbed into the back-and-forth movement of the game, that is, into the definable procedure and rules of the game, and does not hold back in self-awareness as one who is "merely playing." The person who cannot lose himself in full earnest in the game or give himself over to the spirit of the game, but instead stands outside it, is a "spoil sport," one who cannot play. ... The real subject of playing is the game itself* (Linge 1976:xxiii).

nature of the question. Its sense is the direction in which a possible answer must be given in order to be meaningful. Gadamer (1972:345) puts it quite clearly:

> *Im Wesen der Frage liegt, daß sie einen Sinn hat. Sinn aber ist Richtungssinn. Der Sinn der Frage ist mithin die Richtung, in der die Antwort allein erfolgen kann, wenn sie sinnvolle, sinngemäße Antwort sein will. Mit der Frage wird das Befragte in eine bestimmte Hinsicht gerückt. Das Aufkommen einer Frage bricht gleichsam das Sein des Befragten auf. Der Logos, der dieses aufgebrochene Sein entfaltet, ist insofern immer schon Antwort. Er hat selbst nur Sinn im Sinne der Frage.*

This direction towards a possible meaning characterises understanding. In the process of understanding phenomena such as texts, meaning comes into being or emerges. It is this directional mechanism or structure underlying emergence within a systemic structure, which must be incorporated in this study's description of the systemic structure.

Although the above description of Gadamer's hermeneutic theory uses his philosophical terminology, it is important to realise that he does a phenomenological analysis of a very real human phenomenon. The phenomenon of understanding is described as a systemic process having emergent properties not reducible to the elements involved. Indeed, the way the various elements interact by virtue of their structure leads to the emergence of understanding. Gadamer's theory was used to illustrate the systemic emergence structure we wish to use. More importantly, it seems as if an additional factor informs the process of emergence, namely that of directionality towards meaning. To my mind, it is this factor that must be incorporated into a description of whole systems: it is fine to say that certain properties emerge from a systemic whole, but what drives the emergence? Why do certain properties emerge in the way that they do? Tentatively, we may state that emergence is driven by a mechanism called the directionality of meaning. Although this can be a very subjective judgement of what happens with systemic wholes, it is my contention that certain properties arise in order to be meaningful in the end (one may ask "meaningful to whom?" but this mechanism will be more fully discussed later on). One may visualise this mechanism as either meaning having a certain attraction which pulls a system in a certain direction or as a drive towards meaning which is inherent in the system.

1.5.2 An interactionist theory of metaphor and cognition

Some of the concepts and ideas under discussion here are found in the work of Indurkhya (1992), who tries to explain the working of metaphor by developing a particular interactionist theory of cognition. In the following section the work of Indurkhya (1992) will be broadly discussed with a view to explicating some concepts relevant to the current study. The reason his theory is chosen is because it also moves in the sphere of language and interpretation, as does the theory of

Gadamer, but Indurkhya tries to explain certain linguistic phenomena in terms of a theory of cognition which is closer to the subject matter of this study.

1.5.2.1 The problem of metaphor

What Indurkhya (1992:64) tries to explain in his theory of metaphor, is the problem of the *creation of similarity*. Indeed, Indurkhya (1992:64) is of the opinion that this is the main problem of any theory of metaphor. In order to explain this problem, it is necessary to quickly look at some definitions of metaphor. The phenomenon of metaphor - which usually is discussed as a linguistic phenomenon though non-linguistic metaphors, as are found in art and religion, play a very important role in the theory of metaphor (cf. Indurkhya 1992:21-26) - must be distinguished from simile, analogy, and models, although these phenomena are related to metaphor (Indurkhya 1992:13, cf. also pp. 26-35). Indeed, the distinguishing mark for Indurkhya (1992:20) between a simile, analogy and model and metaphor is the unconventionality of the interpretation of the particular phenomenon: while a simile, analogy, model and metaphor are based on similarities between a target and source (to be explained hereafter), only a metaphor entails an unconventional interpretation.[17]

A linguistic metaphor *is a description of an object or event, real or imagined, using concepts that cannot be applied to the object or event in a conventional way* (Indurkhya 1992:18,246). In the metaphor "the sky is crying", "sky" is the target of the metaphor while "crying" or the action "to cry" is the source which applies unconventional concepts to the target (Indurkhya 1992:18). The metaphor is made meaningful by means of interpreting the unconventional source in the target. Usually an unconventional interpretation is facilitated by finding some similarity between the source and the target. Indurkhya (1992:18) is of the opinion that most metaphors do have similarities before they are understood but that some metaphors *create* similarities between the source and the target only after they are understood. Metaphors based on underlying similarities, are called *similarity-based metaphors*, while the last mentioned type of metaphor is called *similarity-creating metaphor* (Indurkhya 1992:37). Similarity-creating metaphors present a particular paradox. On the one hand, similarities are made apparent which were not present before the metaphor was understood. On the other hand, the similarities are not arbitrarily created but are somehow constrained (Indurkhya 1992:65,90).[18] The interaction theory of metaphor in particular was developed, amongst others, to try and resolve this paradox and to explain the creation of similarity (Indurkhya 1992:65-66). Simply stated, the interaction theory claims that similarity is created, and simultaneously constrained, by means of the interaction between the target and the source of the metaphor (cf.

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[17] Indurkhya (1992:21) is well aware that his characterisation of metaphor as entailing unconventional interpretation and his taking this as the distinguishing feature of metaphor from similar phenomena, is contentions.

[18] ... *the creation of similarity seems to work in mysterious ways. Sometimes it works, and sometimes it does not. It is as if every domain had a mind of its own, and it would do unpredictable things when juxtaposed with another domain* (Indurkhya 1992:64).

Indurkhya 1992:68). After discussing various interaction theories,[19] Indurkhya (1992:90) concludes that none of these theories are able to fully resolve the paradox between creation and constraint. The solving of paradox *per se* is not as important to this study as is the direction in which Indurkhya moves with his discussion of interaction theory. Furthermore, the conclusions he draws from the various interaction theories bear upon this study.

1.5.2.2 An interactionist theory of cognition

To explain the working of a metaphor and, more specifically, to resolve the paradox of similarity creating metaphors, Indurkhya (1992) develops a theory of cognition since *(T)he problem of creation of similarity becomes a problem of cognition* (Indurkhya 1992:90). To Indurkhya (1992:90) the problem of metaphor is a problem of cognition since, when trying to understand a metaphor, new attributes and structures can emerge due to changes in (perceptual/cognitive) perspectives.[20] The issue of the creation of attributes is a cognitive problem, but stated simply, understanding as such, is an issue for cognition.

Indurkhya's (1992:93) interaction theory of cognition is based on the view that ... *our concepts do not reflect some pre-existing structure in the environment, they create the structure.* This *conceptual organization cannot be arbitrary, and is somehow constrained by reality* (Indurkhya 1992:93). There is thus an interaction between the cognitive agent and his environment. In order to know or perceive something, the cognitive agent's internal representational structure - called a concept network - structures the environment, but at the same time, the environment constrains these structures in some way (Indurkhya 1992:131-132). This interaction establishes links or a relation between the concept network and reality (Indurkhya 1992:132). It is this establishment of a relation which constitutes cognition. The concept network must represent the environment as coherently as possible (the structure of the environment and of the concept network must be the same) (Indurkhya 1992:133). Indurkhya (1992:132) maintains that reality in itself cannot be known directly, but also maintains that it is this reality that constrains cognition in some way in order for cognition not to degenerate into a pure subjectivistic and arbitrary exercise.

> ***EXCURSION: Interaction between reality and representation***
> At this point, it is necessary to indicate a fundamental flaw in Indurkhya's (1992) theory. Interactionist theory is based on the assumption of an interplay between subject and object or between the

[19] Indurkhya (1992:65-91) discusses the interaction theories of metaphor of Max Black (1962, 1979), Paul Ricoeur (1976, 1977, 1978, 1982), Carl Hausman (1983, 1984, 1989), Wheelwright (1962) and Kittay (1987).

[20] ... *in changing perspectives on an object (event, situation, etc.) new attributes and structures can emerge. Thus, the creation of similarity essentially becomes the creation of attributes. But this is a cognitive claim. The problem of creation of similarity becomes a problem of cognition* (Indurkhya 1992:90).

cognitive agent and its environment. Furthermore, the structure and meaning a person finds in the environment can be attributed to the constructive role the cognitive agent's mind plays in this interactive process. To counter a wholesale relativistic capitulation, cognition's constructive role must be constrained in some way. According to Indurkhya (1992) this constraint must be attributed to reality - in fact, his theory of metaphor hinges upon the attribution of constraint. Indurkhya (1992:158) steadfastly maintains that reality has a *mind-independent autonomous structure that cannot be specified or known* and that it is not *an unstructured mass.* It must have structure in order to constrain our perceptions. But how do we then bridge the gap between the Kantian *ding an sich* and ourselves? In fact, according to Indurkhya (1992:159)[21], the cognitive agent can interact with this reality. In order for the interaction to take place, Indurkhya (1992:159) posits a second level of reality through which knowledge of the first unknowable level can be obtained: ... *it is only by interacting with this reality* (the first pure and unknowable level) *that the cognitive agent can partially receive evidence of its autonomous structure* (Indurkhya 1992:159). The second level corresponds to the world of sense impressions which Indurkhya (1992:159) calls the *sensorimotor data set.* Furthermore, *(T)his level of reality is* ***created***[22] *by our sensory and motor apparatus interacting with the world of things-in-themselves* (Indurkhya 1992:159). The sensorimotor data set is constructed, not arbitrarily, but by the structured nature of the stimuli impinging on the senses. Certain sets of stimuli occur together and therefore make structured impressions on the senses. In this way, the sensorimotor data set, although rather raw, is already structured by means of a constructive and creative process. Although Indurkhya (1992) argues for a multi-layered cognitive system which consists of various levels of abstraction ranging from the sensorimotor data set to the highest level of abstract conceptual networks, the point is that it is still the cognitive agent who does all the constructing between levels. A particular level supposedly constrains its upper level in terms of what it is able to construct from the available information - and this is probably the purpose of Indurkhya's (1992) multi-layered system - but the question still remains how reality is able to constrain what is formed in the sensorimotor dataset especially if reality is unknowable. Indurkhya (1992:158) probably overstates his case by assigning unknowable status to reality rather than only affirming its *mind-independent* nature. What he wants to say is that the cognitive agent does not construct reality as such, but only his/her experience of it. The problem is, however, that Indurkhya (1992) in his argument, holds the cognitive interaction to be between the cognitive agent and the sensorimotor data set as if it is reality itself, even though this level of reality, by his own concession, is constructed by the cognitive agent.

For Indurkhya (1992), cognition is the interaction between different representational[23] levels, each differing in level of abstractness. A higher level either incorporates some of the information or structure of a lower level, or imposes its own structure on the lower level (cf. Indurkhya 1992:181). In this way relations, or links, between the cognitive agent's networks and reality are formed. Only by establishing a correspondence between a conceptual network and real objects does cognitive relations become meaningful and can reality be grasped, known, or understood Indurkhya

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[21] Indurkhya (1992:158-159) refers to Krausser (1974).

[22] My emphasis

[23] Cf. Indurkhya (1992:176-178): ... *objects in the environment acquire a description only by being represented in a concept network and via the operational structure of the concept network.*

(1992:161).[24] The formation and maintenance of a link between reality and the conceptual network is achieved by means of the tendency of cognitive relations to be coherent (cf. Indurkhya 1992:163).[25] Incoherency, disparity or mismatches between concept networks and reality (or between other levels of representation), prompts the cognitive mechanism to restore coherency by means of two processes, namely accommodation and projection:

> *Accommodation works by keeping the correspondence between the concepts and the environment invariant, and then altering the structure of the concept network ... Projection works by keeping the structure of the concept network invariant, but changing the correspondence between the concepts and the parts of the environment* (Indurkhya 1992:165).

A cognitive relation may be *concept* or *environment driven* (cf. Indurkhya 1992:165), i.e., it may be mainly formed by projection where the concept network determines the eventual structure of the environment, or it may be formed by accommodation where the structure of the environment determines the eventual structure of the concept network. A relation may of course be formed by means of a combination of both processes.

Indurkhya summarises the process as follows:

> *The mechanisms of projection and accommodation work between adjacent layers to organize the 'lower level' representations or 'raw-data' of the lower layer into the 'higher-order' categories or concepts of the upper layer. Since the 'lower-level' representations at the lower layer have their own autonomous structure, the process is essentially interactive. Projection works in a 'top-down' fashion by forcing the 'lower-level' representations, as far as they can be forced, to fit the concepts and categories of the upper layer. ... Accommodation works in a 'bottom-up' fashion by first grouping the 'lower-level' representations in some way, and then reorganizing the concepts and categories - creating new ones, if necessary - of the next layer above to reflect the structure of the groupings* (Indurkhya 1992:184-185).

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[24] *A cognitive relation is a link between a concept network and reality. It is a cognitive relation that makes a concept network meaningful, and it is a cognitive relation that brings reality within the cognitive grasp of the cognitive agent. Moreover, it is by forming a cognitive relation that environments are created out of the world of things-in-themselves (a process that is mediated by the sensorimotor data set)* (Indurkhya 1992:161).

[25] *Coherency refers to the property of certain cognitive relations in which the structure of concept network reflects the autonomous structure of the environment* (Indurkhya 1992:188).

1.5.2.3 Solving the problem of similarity-creating metaphor

How does this relate to the problem of metaphor? The main point of this interactionist theory is its ability to describe the formation of different interpretations for the same set of data. This is accomplished mainly by projection where the concept network is kept stable while new relations between the concept network and objects in the environment are found (Indurkhya 1992:167). Although one is not able to change the structure of reality itself (cf. Indurkhya's insistence on maintaining the independence of reality as discussed in the *Excursion* above), with each new set of relations found between a particular concept network and reality, reality is experienced differently. Reality allows for different sets of groupings between objects - this is what makes different projections possible - but simultaneously *restricts* the possibilities by virtue of its own independent structure. Indurkhya 1992:167) summarises this point as follows:

> *... the structure of the environment does not actually conform, what this means is that the cognitive agent is asserting its formative power in changing the experiential ontology of the environment so as to be able to see the structure of the concept network reflected in it. And, of course, reality, which determines the structure of any experiential ontology created by the cognitive agent, asserts itself by limiting the possible ontologies that do end up reflecting this structure, if at all.*

Therefore, by positing different layers or levels of cognitive representation - the two most important being the environment (as a representation of reality) and the concept network - and mechanisms of interaction (accommodation and projection) between the levels, Indurkhya (1992:245) is of the opinion that the paradox of interactionist cognition is solved.[26] Indeed, this interactionist structure provides Indurkhya with a way to explain the paradox of similarity creating metaphor.

Metaphor is described as an example of projection taking place between two levels of representation. For instance, understanding a metaphor in a poem involves forming a relation between a concept network (the text of the poem) and the environment or reality (the real or imagined experiences/objects described by the poem)(Indurkhya 1992:247). As soon as disparate concepts or descriptions are found, the interpreter can either consider the description anomalous, use accommodation to change the description or use projection to *instantiate the troublesome concepts in a nonconventional way* (Indurkhya 1992:251). Since a metaphor consists of a target and a source, both have associated concept networks and environments.[27] To interpret the target in

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[26] *In my framework of cognition, the paradox of interactionism is resolved by pointing out that while it is the cognitive agent who gives an ontology to the external world by instantiating concept networks, the structure of the world, as seen from this ontology, is determined by reality* (Indurkhya 1992:245).

[27] The terms 'concept network' and 'environment' are used here for the sake of consistency and understandability. Indurkhya (1992:253) uses the terms 'domain of interpretation' and 'realm' instead of 'environment' when referring to metaphor.

terms of the source (e.g., in the metaphor 'the sky is crying' the sky is interpreted in terms of crying), the target environment, i.e., that real or imagined experiential data set which is both less abstract and more detailed than the concept network (Indurkhya 1992:251), is interpreted in terms of the source concept network (the more abstract representation on a higher level than the environment level). The metaphorical relation or understanding is formed by projecting a 'foreign' concept network (that of the source) on a lower level of description (that of the target). The mechanisms and structures involved are the same as with forming cognitive relations or understanding conventional text for instance. The novelty is that two levels of different domains are being related which allows the creation of new interpretations, meanings and perspectives. Since both the target and source structures remain stable or invariant in the process of projection, it is these independent and stable structures that constrain interpretation (cf. Indurkhya 1992:252). A person understands the metaphor, or sees the target differently, not due to the target or source being transformed, but by virtue of a changed relation or the creation of a different perspective (Indurkhya 1992:275). This perspective has the effect of one seeing the target differently than before.

1.5.2.4 Summary

From the discussion above it is clear that the explanation of what happens with a similarity-creating metaphor, is based on Indurkhya's interactionist theory of cognition. This interactionist theory states that a cognitive relation is established by means of interaction taking place between representational levels. The interaction is described as accommodation or projection, depending on the starting point of the interaction. Each level consists of various structures and interaction regroups or reconfigures the structures on each level. The reconfigurations lead to a changed perspective on perceived data and therefore changes the meaning arising from the reconfigured structures.

(a) The eventual meaning gleaned from a particular interaction is then the result of the regrouping within a structure on a particular level. The configuration of the elements (in Indurkhya's terminology this is the concepts within a concept network) in a structure is then important. For Indurkhya, meaning lies within the regroupings of elements.

(b) The mechanism driving the reconfigurations is the interaction between levels. Stated more carefully: the interaction does not imply a simultaneous bi-directional movement. If the movement starts from one's environment (data-driven), then the mechanism is called accommodation (bottom-up processing), while concept-driven movement is called projection. Both directions of movement establish a relation and it is this relation which gives rise to cognition, understanding or finding meaning.

(c) The aim of this interactionist process is for the cognitive agent to experience his/her environment in a meaningful way. Supposedly the movements or interaction between levels will continue until the cognitive agent makes sense of the perceived data.

(d) From Indurkhya's discussion of the creation of similarities in metaphor it is clear that a cognitive mechanism is involved. The juxtaposition of two different structures (or systems), enables the establishment of a different perspective on the perceived data. The resulting interaction (projection/accommodation) leads to the reconfiguration of structures and the emergence of new meaning (or stated differently, in the case of similarity-creating metaphor, perception of novel similarity). Indurkhya summarises this point as follows:

> *... in changing perspectives on an object (event, situation, etc.) new attributes and structures can emerge. Thus, the creation of similarity essentially becomes the creation of attributes. But this is a cognitive claim. The problem of creation of similarity becomes a problem of cognition* (Indurkhya 1992:90).

(e) The problem of similarity-creating metaphor accentuated the importance of constraints on the process of emergence. Similarity is not created arbitrarily, but is constrained by the structures involved in the process of interaction. This means that the structures do have some stability. This stability is the result of the nature of a particular level of representation which imposes a restriction on the possible reconfigurations that can take place below and above a particular level. Thus, certain higher level abstract conceptual structures impose restrictions downwards, while lower level structures from reality to the sensorimotor dataset impose restrictions upwards. Reconfigurations within levels are possible but cannot take place arbitrarily due to upper and lower level constraints.

1.5.3 The principles involved in a systemic emergentist approach

The aim of this study is to provide a conceptual framework for viewing cognition and consciousness. As will be seen in Chapter 5 of this study, the conceptual framework in this instance, is a conceptual model. A model is not a fully developed theory, but identifies the basic principles involved in explaining the phenomena under investigation. This model can be termed a systemic emergentist model. The basic principles expected to be included in the model can be specified at this stage. Although the model will be described in the final chapter of this study, the principles specified here will be used to analyse various theories of cognition and consciousness, and in the process of analysis, be refined.

1.5.3.1 From Gadamer's theory follows the principle of emergence, conceptualised as a mechanism aimed at consitituing meaning or meaningful wholes. Indurkhya's theory strengthens the idea of emergent properties of a system due to the relationship between the elements of a structure. It also strengthens the idea of meaning directionality as a mechanism driving the process of emergence. His theory also provides some additional perspectives in order to refine this model.

1.5.3.2 It seems as if cognition involves multiple levels of representation ranging from the structures formed at the sense perception stadium to the more abstract conceptual levels of knowledge. It therefore seems necessary to make provision for levels of systems and subsystems interacting with each other.

1.5.3.3 The mechanism of interaction Indurkhya proposed between levels and between the cognitive agent and his/her environment provides a way of accounting for different emergent properties in terms of reconfigurations of elements. This means that as soon as elements in a system are reconfigured, or the system is restructured, other properties emerge.

1.5.3.4 The interaction between structures (i.e. systems) must not be confused with the emergent mechanism of a particular system or structure. It seems as if accommodation and projection, which establish a relationship between systems, are responsible for the reconfiguration between elements, and this reconfiguration or new structure gives rise to new systemic properties. The relationship between the process of interaction between systems or levels of structures and the emergent mechanism will be clarified later on in the study. Suffice to state at this stage that both processes or mechanisms involve the mechanism of direction towards meaning in some way, since both processes involve establishing properties which are meaningful to the cognitive agent.

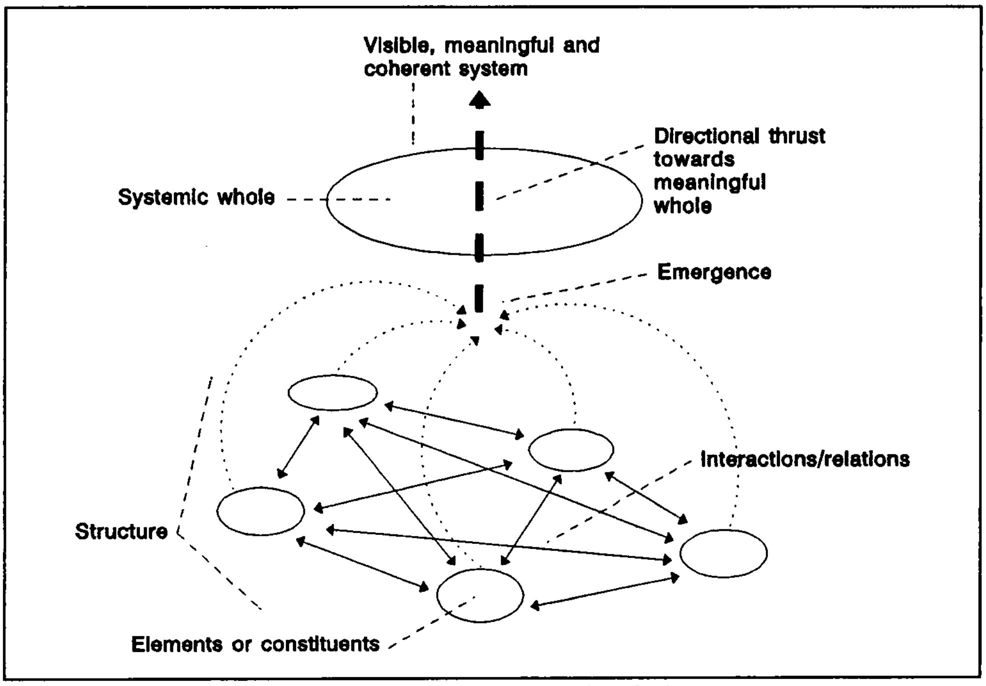

Figure 3 Schematic representation of a systemic whole

The various elements identified, namely a system, a structure, interactions between elements, emergence and the directional thrust towards a meaningful whole are represented in Figure 3. In this figure it can be seen that a systemic whole is constituted by an underlying structure consisting of elements interacting. The particular nature of these aspects and principles will be clarified in due course. The final model will be described in Chapter 5 of this study.

1.6 SUMMARY AND CONCLUSION

The particular problem this study addresses is the neglect of consciousness within theories of cognition. The recent interest in consciousness, the mind, the brain and cognition necessitates a new perspective from which the relationship between cognition and consciousness can be studied. This implies the developing of a conceptual framework from a particular perspective, namely a systemic emergentist perspective, which could prove fruitful in establishing the relationship between cognition and consciousness. The conceptual framework to be developed in this study is a conceptual model functioning as a rudimentary framework enabling one to indicate the relationship between certain phenomena, the causative mechanisms involved and the structure and function of the phenomena (cf. Chapter 5).

The principles involved in the systemic emergentist model will be clarified and analysed in the following chapters. Additional principles will be identified. For instance, in the following chapter it will be seen that consciousness was studied from a structural and a functional perspective. It will be made clear that these two aspects are separated illegitimately, since both functional and structural principles are involved in an intimate way in a systemic perspective. The first step is to analyse the phenomenon of consciousness with reference to its place in cognitive studies. The refined systemic emergentist principles gleaned from the analysis of consciousness as a phenomenon, will be used to discuss various theories of cognition. These theories are roughly divided into the information processing approach, theories moving beyond the information processing approach, the symbolicist approach and the connectionist approach. The discussion of these approaches involves the following strategy:

(a) *Analysing the theories by means of the heuristic principles.* It will be determined to what extent theories of cognition incorporate the principles of function, structure and other systemic emergentist principles (such as emergence, interaction, systemic wholes, etc.).

(b) *Refining the systemic emergentist principles.* The way some principles feature, or do not feature, in certain cognitive theories, provides additional information to refine the principles. In the final chapter, these principles will be further refined in a discussion of General Systems Theory and Sperry's emergent interactionism.

(c) *Determining the place of consciousness within the theories of cognition.* Each approach provides a different perspective on the role and place of consciousness. This analysis will provide one with the means to evaluate the final systemic emergentist model.

The aim of this chapter is to provide the heuristic principles in order to analyse theories of cognition and consciousness, and to provide the framework for the final systemic emergentist model. The discussion in this chapter can be summarised as follows.

1.6.1 This study aims at developing a **conceptual framework**, specifically a conceptual model, within which cognition, consciousness, and the relationship between both can be studied.

1.6.1.1 One reason for starting at a conceptual framework rather than a fully developed theory is that the phenomenon of consciousness in cognitive psychology has been neglected for many years and the battle for the rehabilitation of consciousness within cognitive studies started only recently.

1.6.1.2 Another reason for starting off with a rudimentary theory is that a full explanation of the relationship between consciousness and cognition will eventually call for empirical testing. Starting off too boldly could preclude the possibility of a theory encompassing consciousness and cognition since it could flounder in the face of such empirical procedures. The major impact behaviourism had on psychology attests to the fact of how easily phenomena such as the mind and consciousness can be regulated outside the sphere of valid science.

1.6.2 The first step in developing a conceptual framework is to be clear about **the levels of analysis** or description. A distinction is made between the phenomenological level, the psychological level and the biological level.

1.6.2.1 It is important to distinguish between these levels since certain phenomena such as consciousness can be (and indeed were) analysed only at the phenomenological level with no bearing on other levels of analysis or explanation. A disregard for other levels of analysis can lead to reductions and inadequate explanations. The diversity of the body-mind theories attests to this fact. While the biological level lies outside the scope of this study, it is assumed that explanations of cognitive phenomena can eventually be enhanced by biological studies. This study focuses on the phenomenological and psychological levels and takes phenomenological descriptions of certain phenomena, such as cognition and consciousness, as data to be explained on the psychological level.

1.6.2.2 The levels of analysis as explicated above, interact with one another.

1.6.2.3 Each level specifies certain constraints for the other levels in terms of possible explanations.

1.6.2.4 These constraints are mapped onto the other levels by means of a translation or bridging level.

1.6.3 The problem of relating cognition and consciousness is further amplified by the various possible positions on the **body-mind** problem. It is of no use trying to study consciousness while holding a philosophical position which denies the existence of consciousness.

1.6.3.1 This study assumes an underlying philosophical view which enables one to study cognition and consciousness scientifically.

1.6.3.2 This means that cognition and consciousness can be described and explained theoretically and eventually be tested empirically.

1.6.3.3 This position can be described as emergent materialism (or naturalism) which entails that certain phenomena are the result of emergent properties of other structures. For instance, the coherent interaction between cell assemblies gives rise to certain properties such as visual perception.

1.6.4 The next step was to formulate a basic framework, or model, based on the background hypothesis of emergent naturalism. This model may be called a **systemic emergent model**. After discussing the systemic approach, Gestalt theory and using examples from the philosophical hermeneutics of Gadamer and the cognitive interactionist theory of metaphor of Indurkhya, the following properties of the systemic emergent structure may be stipulated:

1.6.4.1 A whole or system consists of elements configured in a certain way. Due to this configuration or composition it is said to have a structure.

1.6.4.2 Certain properties of a system emerge from the structure.

1.6.4.3 Emergence is posited as a mechanism of the system.

1.6.4.4 Emergence is said to have direction towards meaning and this directionality is also posited as a mechanism.

1.6.4.5 Systems are organised hierarchically and interact with each other.

1.6.4.6 The mechanism of interaction between systems is bi-directional and for the time being, must be distinguished from the emergent mechanism.

1.6.4.7 Interaction between systems results in a reconfiguration of structures.

1.6.4.8 This reconfiguration gives rise to new perspectives, meaning and understanding of one's environment.

Some of these principles, such as emergence, will only be finalised in the last chapter, while others will stay intact, although the subsequent discussion will provide further clarification of their nature. The specific relationship between these principles will also be indicated in Chapter 5. In the next chapter, consciousness as a phenomenon will be discussed in order to clarify some of these principles and introduce the problem of structure and function (process). It will be seen that the problem of structure and function plays a fundamental role in the difficulty of relating cognition and consciousness.

CHAPTER 2
CONSCIOUSNESS

2.1 INTRODUCTION

To determine the relationship between cognition and consciousness it is necessary, along with the groundwork laid in the introductory chapter, to come to grips with the phenomenon of consciousness. The aim is not merely to define consciousness, although a definition will be provided at the end of this chapter, but to arrive at an understanding of consciousness from a certain perspective. This perspective will be obtained by looking at the history of psychology in its endeavour to study human consciousness or in its fervour to eliminate the mental from the study of human behaviour. The study of history on its own is very valuable, but in the case of consciousness in this chapter, each historical phase or school of thought under consideration will provide conceptual elements contributing to the final understanding of consciousness as a phenomenon. In some cases, only certain representatives of a school of thought or approach will be contemplated since it is believed that restrictions in such cases is justified in terms of their contribution to the argument of this chapter.

The two main perspectives from which consciousness will be discussed are structuralism and functionalism due to their respective emphasis on, on the one hand, the structure and the elements of consciousness and, on the other hand, the dynamic or process nature of consciousness. Certain subthemes will also be addressed that will recur in other chapters. Intentionality plays a very important part in the particular view of consciousness explicated in this study and will be discussed in depth, especially as it occur in the phenomenological theory of Brentano and Husserl. The historical demise of the study of consciousness will be briefly referred to, since the recent interest in consciousness, especially in cognitive studies, is a reaction against this historical trend due to a rediscovery, of some sorts, of the issues relevant almost a hundred years ago. The role of consciousness in recent cognitive psychology will be discussed, keeping some of the results of the previous chapter in mind. As a final point, some definitions of consciousness will be considered, and an own definition will be provided in the light of the discussion thus far. It should be stated at the outset that the final view of consciousness will be a systemic emergentist one and the argument in this chapter is aimed at substantiating this view. Some of the results in this discussion will also be used to clarify certain aspects in the systemic emergentist model developed in the first chapter, such as the principles of emergence, structure and function. At the end of the discussion it will be seen that these principles play an important role in defining consciousness, and in providing the basis for further investigation and development of the conceptual framework for cognition and consciousness.

2.2 CONSCIOUSNESS AS COMPONENTIAL: THE STRUCTURAL VIEW

The first issue under consideration is the structural view of consciousness. In this section the structural psychology of Wundt and Titchener will be discussed in order to emphasise certain important components in the structural view which are relevant to the current study of consciousness. Its historical importance in setting psychology on its modern course and in raising certain issues are acknowledged.

2.2.1 Wundt

According to Boring (1950:316), Wilhelm Wundt (1832-1920) can be viewed as the principal psychologist in the history of psychology. For Wundt, psychology was *Erfahrungswissenschaft*: in as much as physics can be viewed as a science, so can psychology. In fact, in stressing psychology's anti-metaphysical nature, Wundt emphasised the importance of empirical experimentation (Wundt 1894:10; cf. Boring 1950:331-332). Since both physics and psychology deal with experience, it is important to demarcate the two sciences. The difference lies in the way experience is viewed: psychology's concern is with immediate experience, and not with "inner" experience as opposed to "outer" experience. This distinction obscures the fact that psychological experience deals with both since, for instance, the experience of feelings (inner experience) and perception of objects (outer experience) are immediate: ... *a perception does not have to be perceived in order to be a perception; it has only to occur* (Boring 1950:332). Physics, on the other hand, deals with mediate experience since ... *its elements are inferred and are not given immediately as the phenomena in experience* (Boring 1950:332).

For Wundt, the subject-matter of psychology (immediate experience) determines its method, which he called *Selbstbeobachtung* (Boring 1950:332). Self-perception/observation or introspection ... *signif(ies) nothing more than that having an experience is the same as observing it* (Boring 1950:332). For Wundt the problem of psychology is (a) *the analysis of conscious processes into elements*, (b) determining the connections between these elements, and (c) determining the laws of connection (Boring 1950:333). Psychology aims therefore at identifying and distinguishing the simple elements of mind and determining the *form of their ordered multiplicity* (Boring 1950:333). Therefore, according to Marx and Cronan-Hillix (1987:72) the impression one gains from Wundt's position is that

> *... psychology was to be a kind of **chemistry of consciousness**.*[1] *The primary task of the psychologist was to discover the nature of elementary conscious experiences and their relationships to one another.*

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[1] Emphasis mine.

The problem with defining mind as consisting of elements is that elementism creates the impression the elements are static. The fact is that experience is constantly changing. To counter this impression, Wundt described the elements as *mental processes* in order to convey the fact that mind consists of active and changing processes (Boring 1950:334). According to Boring (1950:334), the ambiguity created by combining two concepts, the one susceptible to elementist and substantialist interpretation and the other having actualist import, led to Wundt being held responsible for the subsequent interpretation by later psychologists of mind consisting of *static bits of consciousness*. Wundt regarded the mind as actual - it is immediately phenomenal and therefore not substantial (Boring 1950:334). Sensations, images and feelings are combined to form perception, ideas, and higher mental processes (Pekala 1991:14). Since the mind is in constant flux, the elements of the mind were described by Wundt as mental processes. A mental process such as a sensation is not a substantial element as is the case with elements in chemistry (Pekala 1991:15). Wundt's approach can be described as structural since a certain structure between the elements of experience is said to exist, which in turn forms the more abstract structures such as the higher mental processes (cf. Marx & Cronan-Hillix 1987:72). His method was introspection consisting of training observers to the nature of the elements of experience and making them aware of what was occurring during consciousness (Pekala 1991:15).

2.2.2 Titchener

Titchener (1867-1927) introduced structural psychology to America. Just as it is necessary in biological science to describe the structures of an organism in order to understand its functioning, it is necessary to describe the structure of consciousness in order to understand its nature (Pekala 1991:15).[2] Titchener (1899:12) defined consciousness, or mind, as the sum total of a person's experiences at a given time. The structural elements of mind according to Titchener (1898:459) are sensations, images and affective processes (cf. Marx & Cronan-Hillix 1987:92; Lundin 1991:88-89). Sensations included "sensation" (which is percepts from the external world) and "ideas" (which is percepts derived from internal processes)(Pekala 1991:15; cf. Marx & Cronan-Hillix 1987:92). Later on Titchener eliminated feelings as an element of consciousness (Marx & Cronan-Hillix 1987:91,93).

The structuralist direction of Titchener's thought is strengthened by his view of the aim of psychology:

> *(1) to analyze concrete (actual) mental experience into its simplest components, (2) to discover how these elements combine, what are the laws which govern their combination,*

[2] According to Marx & Cronan-Hillix (1987:85), Titchener's view on the importance of functionalism as related to structuralism, is unclear, since it seems as if his primary focus was on structure and not the function of structures (see Watson 1968:393).

> *and (3) to bring them into connection with their physiological (bodily) conditions* (Titchener 1899:15).

According to Marx and Cronan-Hillix (1987:96), Titchener was mainly concerned with elucidating the structural elements, and not so much with the principles of connection between the elements, although he did posit a *principle of association* (Titchener 1910:378-379). This principle broadly states that if a certain element (image or sensation) occurs in consciousness, the elements associated with its occurrence at a previous occasion are also likely to occur again. Thus elements are successively connected, which means *item A tends to elicit item B immediately afterward* (Marx & Cronan-Hillix 1987:96). The principle of successive connection does not, however, solve the problem of the constitution of a conscious experience: the elements must somehow be synthesised to form a unitary experience. Titchener realised the difficulty of the problem of synthesis. The reconstruction of an experience would be easy if the elements were static components, but according to Titchener (1910:17), the elements are more like processes which overlap and interfere with each other. According to Marx and Cronan-Hillix (1987:96), Titchener never completed the task of developing an account of synthesis.

EXCURSION: The problem of synthesis - associationism and the principle of association

Associationism suggests that complex ideas or behaviour consist of the association between atomistic ideas/elements.[3] In psychology it is more a principle than a school of thought since the principle of association is found in various theories of learning (Marx & Cronan-Hillix 1987:40) and memory (Voss 1979). Associationism has its roots in philosophy and particularly in the empiricism of Hobbes, Locke, Berkley and Hume. The empiricists took the three principles of association of Aristotle (Lundin 1991:26-27), namely, similarity, contrast and contiguity, as starting point and in various ways elaborated or criticised the principles (Marx & Cronan-Hillix 1987:42-43). Hume (1992:255-256) added a fourth principle, namely that of causality. The principles involve the following: two ideas or elements are associated if they are similar in some way (similarity), if they are opposite ideas (contrast), experienced closely in time (contiguity), or if one item was the effect of another item (cause and effect). The idea of association influenced the subsequent development of psychology. Brown (1778-1820) focused on secondary principles of association: the selection of a particular idea in thought is based on its associative strength with related ideas. The strength of association is governed by the frequency of association, recency of association, vividness of the original idea, duration, and number of connections with other related ideas (Marx & Cronan-Hillix 1987:48; cf. also Mill 1992:257). John Stuart Mill (1806-1873) held the origin of complex mental ideas to be the result of some kind of "mental chemistry", where the association between simple ideas formed complex ideas, but the association led to some of the simple ideas to loose their original properties:

> *... the Complex Idea, formed by blending together of several simpler ones, should, when it really appears simple (that is, when the separate elements are not consciously distinguishable in it) be said to* ***result from****, or be* ***generated by****, the simple ideas, not to* ***consist of them****. ...* ***These are cases of mental chemistry: in which it is*** *possible to say that*

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[3] *Were ideas entirely loose and unconnected, chance alone would join them; and 'tis impossible the same simple ideas should fall regularly into complex ones (as they commonly do) without some bond of union among them, some associating quality, by which one idea naturally introduces another* (Hume 1992:255).

> *the simple ideas generate, rather than that they compose, the complex ones* (Mill 1843/1956:558).[4]

Mill based his theory on his father James Mill's theory, who stated that consciousness itself was associative. In consciousness ideas and sensations follow each other incessantly (Boring 1950:223). James Mill rejected two of Hume's principles of association, namely causality and similarity. The only valid principle remaining was contiguity (Boring 1950:224). However, James Mill explicitly stated that associations operate on ideas and not on sensations, since sensation concurs with ideas (Boring 1950:223-224). This emphasis on the pure ideational nature of associations changed with subsequent developments in psychology. The movement towards physiological experimentation started with Alexander Bain (1818-1903) (Boring 1950:236). Bain held contiguity and similarity to be valid principles of association and applied them to the association between actions and sensations (Boring 1950:238). Herbert Spencer's (1820-1903) evolutionary associationism must also be mentioned as an attempt to counter the elementism[5] implied by associationism (Boring 1950:242). Certain associations, by being repetitive, become cumulative in subsequent generations. In terms of cognition, for instance, simple cognitive elements *evolve* to become more complex later on (Boring 1950:242).

With Pavlov ((1849-1936), the association between ideas was transformed into the association between observable behaviourial components in terms of the stimulus and response (S-R). The ideas of Pavlov were incorporated and elaborated by behaviourism. Indeed, the roots of the first fully developed associationistic theory, namely that of Thorndike (1847-1949), can be traced to the behaviourism of Watson and Skinner (Marx & Cronan-Hillix 1987:54; cf. also Lundin 1991:136-143). Psychology, for Thorndike, was the study of the stimulus-response connections. Associations or connections do not exist only between the elements of thought, but also between wholes, and between elements within situations and between situations and brain states (cf. Thorndike 1949:81). Thorndike's law of reinforcement stipulated the nature of associations between behaviourial components: the association between stimulus and response is strengthened by reinforcement or rewarding successful behaviour (cf. Marx & Cronan-Hillix 1987:58-59).

Although William James strengthened the movement towards relating physiology and psychological phenomena, he criticised the so-called laws of association severely. According to James (1890:566) all laws of association, namely contiguity, contrast and similarity may be reduced to the *law of neural habit*. This simply means that if two processes occur in the brain simultaneously or successively, then those two processes tend to become neurally associated. The classical law of association states too much while explaining too little: It states too much since it implies that in the ordinary flow of thought all associated items are recalled at the same time and as a whole. This is certainly not the case since certain selections are always taking place: if one thinks about a certain experience or object, thought tends to go on certain side paths (see the example in James 1890:573). The laws of association cannot therefore explain why thought tends to select certain paths not associated with the initial object or experience. It cannot account for the richness of actual experience happening in conscious thought (cf. James 1890:565-566). For James (1890:572) the *law of interest* governs association since those items which appeal to one's interest tend to be selected (cf. the discussion of the role of *interest* on p.41 of this study).

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[4] Emphasis Mill's.

[5] Or *atomistic* (cf. Henle 1985:117).

What is interesting to note is that Titchener excluded any reference to meaning in reports on conscious experience, since questions of meaning lie outside the scope of psychology (Pekala 1991:16; Marx & Cronan-Hillix 1987:96). He, however, gave an answer to the question how meaning becomes attached or connected to sensation.[6] By using the context theory of meaning, Titchener viewed the meaning of a sensation as the context within which it occurred in consciousness. A sensation (element) does not have meaning but acquires its meaning from other sensations or images associated with it (Titchener 1910:367-369; Marx & Cronan-Hillix 1987:96). Meaning is thus the result of past experience with a particular sensation: *The meaning is the result of associations between past sensations or images. What we call meaning is simply the totality of sensation accompanying the meaningful sensation* (Marx & Cronan-Hillix 1987:96)

2.2.3 Conclusion

2.2.3.1 The main focus of structuralism was on the *analysis* of elements and the relationship between the elements. Thus consciousness or mind is said to consist of structures of elements.

2.2.3.2 The elements of mind are not static bits or components, but it seems as if the elements are defined as processes.

2.2.3.3 Due to structuralist difficulty in accounting for the synthesis of elements involved in conscious experience or in experiential wholes, the main criticism (especially from the Gestaltists)(Lundin 1991:94; Goldstein 1989:22) levelled against structuralism was its focus on analysis (Marx & Cronan-Hillix 1987:100).

2.2.3.4 Structuralism is mainly of historical interest and functioned as a system against which other schools of thought, such as functionalism, behaviourism and Gestalt psychology, reacted (cf. Marx & Cronan-Hillix 1987:103; Lundin 1991:85). However, the greatest influence of structuralism on psychology still prevalent today, was its emphasis on the experimental method (Lundin 1991:95).

2.2.3.5 Consciousness, mind and sensations as objects of scientific investigation after Titchener received less attention, as the focus of psychological studies shifted to observable phenomena such as behaviour. Boring (1933) tried to salvage structuralism by trying to correlate conscious and physiological processes (cf. Marx & Cronan-Hillix 1987:101-102).

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[6] *A further kind of connection for Titchener to explain was the problem of meaning. How does meaning become connected to sensation? He regarded this question as belonging outside of psychology but decided to answer it anyway* (Marx & Cronan-Hillix 1987:96).

Although Boring also tried to retain consciousness for scientific investigation, a mere four years later he abandoned the project altogether:

> *Having understood, tough-minded rigorous thinkers will, I think, want to drop the term* ***consciousness*** *altogether. A scientific psychology is scarcely yet ready to give importance to so ill defined a physiological event as awareness of an awareness* (Boring 1937:458).

2.3 CONSCIOUSNESS AS PROCESS: THE FUNCTIONAL PSYCHOLOGY OF WILLIAM JAMES

According to Pekala (1991:17) the reason that structural psychology never made a lasting impression on American psychology, was the Americans' emphasis on functionality and practicality. Functionalism was mainly concerned with the purpose and utility of behaviour. Stated more specifically, it was ... *concerned with the uses of the organism's behavior and consciousness in its adaptation to its environment* (Marx & Cronan-Hillix 1987:107).[7] The main proponents of functionalism were John Dewey (1859-1952), J. R. Angell (1869), R. S. Woodworth (1869-1962), and Harvey Carr (1873-1954)(cf. Marx & Cronan-Hillix 1987:124-135 for a discussion). William James (1842-1910), however, founded functionalism as a system and not so much as a school of psychological thought (cf. Marx & Cronan-Hillix 1987:112). Since the functional theory of James had a lasting influence on American psychology, and especially since he had much to say on consciousness, it will be discussed as an example of the functionalist approach.

2.3.1 The function of consciousness

James (1890:1) saw psychology as the science of mental life, *both of its phenomena and their connections*. The main difference between James's functional theory and structural psychology is in the way consciousness is studied (Pekala 1991:17). For James, consciousness is a process - he emphasised the stream of consciousness[8] which refers to the changing nature of consciousness *over time*, while the structural psychologists studied the elements and contents of a single moment or segment of consciousness (Pekala 1991:17). For James, the pragmatic nature of psychology and the study of behaviour and consciousness was important. This implies that ... *the validation of any knowledge must be in terms of its consequences, values, or utilities* (Marx & Cronan-Hillix 1987:115). The functionalist assumption underlies this pragmatism: psychology must study functions (cf. James

[7] Cf. also Pekala (1991:19): *A functionalist approach ... addressed itself to how the mind mediates between the environment and the needs of the organism*.

[8] *The first fact for us, then, as psychologists, is that thinking of some sorts goes on* (James 1890:224).

1890:10-11), which means that human behaviour must be seen as adaptational behaviour within a specific environment. The survival value of behaviour and other psychological phenomena determines their purpose and function (cf. Marx & Cronan-Hillix 1987:115-116; cf. James 1890:141). This view firmly weds biological functioning and psychological phenomena and James constantly referred to biological functions when explaining psychological phenomena (cf. James 1890:4,5 & 1992). Even consciousness must have had some biological use to have survived (James 1890:141). Consciousness therefore has a purpose (cf. James 1890:129,136): ... *consciousness is at all times primarily* ***a selecting agency*** (James 1890:139; cf. also James 1890:144).[9]

> *Its function is to make the human being a better-adapted animal*[10] *- to enable humans to choose.*[11] *Conscious choice is to be contrasted with habit, which becomes involuntary and non-conscious.*[12] *Consciousness tends to become involved when there is a* ***new*** *problem, the need for* ***new*** *adjustment* (cf. Marx & Cronan-Hillix 1987:117).[13]

According to James (1890:139), the reason consciousness selects a certain item ... *is always in close connection with some* ***interest*** *felt by consciousness to be paramount at the time.*[14] Certain items are selected while others are suppressed, and the emphasis placed on the selected information is congruent with the interests consciousness created.[15] In this context, according to James (1890:141), *survival* dictates the interests of the organism's consciousness. It may be argued that the concept of survival, especially in human beings, is certainly more subtle since some or most everyday behaviour is not directly concerned with "raw" survival as such (it certainly depends on which segment of the society one focuses). Stated in more general terms, one may say that consciousness is concerned with problem solving or levels of adaptation. When James discussed the association of elements within conscious thought, he stated that when remembering a past event or experience, not all associated items are equally recalled, but only those which ... *appeal most to our interest* (James 1890:572). In the ordinary flow of thought, a person then focuses or selects the thought or an item of interest. According to James (1890:577), the interesting item is then, that which is formed by *habit* (items are selected which are associated with each other due

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[9] Emphasis James'.

[10] *But what are now the defects of the nervous system in those animals whose consciousness seems most highly developed? Chief among them must be* ***instability****. ... But this very vagueness constitutes their advantage. They allow their possessor to adapt his conduct to the minutest alterations in the environing circumstances ...* (James 1890:139).

[11] For example: *Where indecision is great, as before a dangerous leap, consciousness is agonizingly intense* (James 1890:142).

[12] Cf. James (1890:114).

[13] Authors' emphasis.

[14] Emphasis James'.

[15] *... just such pressure and such inhibition are what consciousness* ***seems*** *to be exerting all the while. And the interests in whose favor it seems to exert them are* ***its*** *interests and its alone, interests which it* ***creates****, and which, but for it, would have no status in the realm of being whatever* (James 1890:140)(author's emphasis).

to frequency of associated use), which is most *vivid* (an item is selected due to the vivid impression it made in the original experience), most *recent* (due the recency of experience, certain impressions are more likely to be remembered than impressions of distant experiences), or emotionally congruent (items which occurred within a certain emotional frame of mind are more likely to recur in a similar mood than others not associated with that mood).

Two important aspects follow from this account of the purpose of consciousness. First, it could be that consciousness evolved under pressure of its survival value, but most importantly, its function seems to be selection, and *conscious* selection at that. By conceptualising consciousness as an instrument for selection, the basis of its functioning may be broadened considerably. Thus, secondly, the selection function seems to have developed to a point where interests govern the process of selection. "Raw" survival then also becomes an interest of the conscious mind. That interests include more than mere survival,[16] seems to be what James tried to convey when he discussed the role of interests in associations in the free flow of thought (cf. James 1890:604). As was suggested above, the selectional nature of consciousness may also be called a problem solving process which also broadens its function. The central role of *interest* also applies then to voluntary thought (cf. James 1890:583-584). In voluntary conscious thought, selections take place in order to solve certain cognitive problems, and the problems constitute the interests which govern the selectional process (for instance, trying to remember a forgotten fact constitutes a problem or interest which guides the process of conscious selectional thought)(cf. James 1890:584-585).

To summarise: consciousness seems to be directed towards certain interests which, in the end, determine the content and process of consciousness. It seems as if the purpose of consciousness, according to James, is to cope with the survival problems/interests posed by the environment. Its purpose is, of course, intertwined with the physiological structure of the brain, or at least its plasticity, since with humans a tight fit between biological functioning and environment did not take place. On a psychological level, this openness or freedom of adaptive behaviour finds its fullest expression in a conscious focus on diverse interests.

2.3.2 Characteristics of consciousness

James (1890:225) distinguished five characteristics of consciousness[17]: it is personal, changing, continuous, intentional and selective (cf. Pekala 1991:17).

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[16] The phrase *mere survival*, does not intend slighting the immense importance of survival as a functionalist principle. One must realise that survival in the modern world means something else than survival some million years ago. Nowadays, survival as a principle comes in many forms, such as Anderson's and Newell's rationality principle discussed in Chapter 1 of this study. See also Popper (1979) for an account on how evolutionist principles can govern the modern scientific mind in doing science and forming theories.

[17] James (1950:225) actually uses the term "thought" in this context but treats "consciousness" and "thought" synonymously when he speaks about the process of thought.

2.3.2.1 First, thought is part of a **personal** consciousness (James 1890:225). This means that thought is localised within *particular I's*; therefore *(A)bsolute insulation, irreducible pluralism, is the law* (James 1890:226). James emphasises the existence of *personal* consciousness rather than absolute or *universal* thoughts: *The universal conscious fact is not 'feelings and thoughts exist,' but 'I think' and 'I feel.'* (James 1890:226).

2.3.2.2 The second characteristic of thought is that it **changes** constantly over time (James 1890:229-230). This means that no thought or conscious state which occurred once, *can recur and be identical with what it was before* (James 1890:230). Of course, one may have a second thought about the same object, but these two thoughts about the same objects are in no way similar (James 1890:231). Nothing objective or unchanging - which was regarded by philosophers as the essence of ideas (cf. James 1890:230) - can be distilled from similar thoughts or conscious states. The feeling of similarity between thoughts is caused by the same object and some cognitive mechanism fooling[18] us into thinking that it is the same object[19] since even objects change their appearance with a change in perspective or lighting (cf. James 1890:232). Consciousness is moulded by experience (James 1890:234) and it is a process taking place over time (James 1890:233). Therefore, even when a similar fact appears in the mind, one views it from a (even slightly) different perspective and is sometimes even surprised that such a fact was thought about differently at an earlier stage (James 1890:233).[20]

2.3.2.3 Thirdly, consciousness is **continuous** (James 1890:237-271).[21] This means first of all, that despite breaks in consciousness, a person has a sense of personal unity over time (James 1890:237,238). Consciousness is experienced as continuous, despite periods of unawareness. James (1890:238) likens this aspect to the eye's ability to fill the gap of the blind spot.[22] Furthermore, parts of one's personal experience are experienced as a whole: this common whole is the "I" or one's experience of personal unity (James 1890:238).

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[18] *The realities, concrete and abstract, we believe in, seem to be constantly coming up again before our thought, and lead us, in our carelessness, to suppose that 'our ideas' of them are the same ideas* (James 1890:231).

[19] *The sameness of the things is what we are concerned to ascertain; and any sensations that assure us of that will probably be considered in a rough way to be the same with each other.*

[20] *When the identical fact recurs, we must think of it in afresh manner, see it under a somewhat different angle, apprehend it in different relations from those in which it last appeared. And the thought by which we cognize it is the thought of it-in-those-relations, a thought suffused with the consciousness of all that dim context. Often we are ourselves struck at the strange differences in our successive views of the same thing. ... From one year to another we see things in new lights* (James 1890:233).

[21] *Consciousness, then, does not appear to itself chopped up in bits. Such words as 'chain' or 'train' do not describe it fitly as it presents itself in the first instance. It is nothing jointed; it flows. A 'river' or a 'stream' are the metaphors by which it is most naturally described.* ***In talking of it hereafter, let us call it the stream of thought, of consciousness, or of subjective life*** (James 1890:239). Cf. also James (1890:248).

[22] Cf. James (1950:264 footnote *).

2.3.2.4 Fourthly, consciousness is **intentional**, i.e, it is the ability to think about objects. In James' (1890:271) own words, consciousness deals *with objects independent of itself*. It is this characteristic that makes consciousness *cognitive*. Being able to think about an object is what usually is characterised as *intentionality*. For James (1890:273) the consciousness of an object is primary. Self-consciousness seems to be a derivative of this primary state:

> *A mind which has become conscious of its own cognitive function, plays what we have called 'the psychologist' upon itself. It not only knows the things that appear before it;* ***it knows that it knows them****. The stage of reflective condition is, more or less explicitly, our habitual adult state of mind. It cannot, however, be regarded as primitive. ... Many philosophers, however, hold that the reflective consciousness of the self is essential to the cognitive functioning of thought. They hold that a thought, in order to know a thing at all, must expressly distinguish between the thing and its own self* (James 1890:273-274).

Being conscious of oneself holding a thought, according to James (1890:274), is just having another object. Philosophers elevate the new object, i.e., knowledge about me thinking about a tree, as the object *par excellence* (James 1890:274), and fail to see that *thought may, but need not, in knowing, discriminate between its object and itself* (James 1890:275).

An important aspect James (1890:275) emphasises is the nature of the *object*. Usually the object of consciousness is taken to be identical with the grammatical object (or subject) of the verbalised[23] thought.[24] It is however true that such a designation usually underdetermines what is meant by the object of a thought. For instance, the object of the thought "Columbus discovered America in 1492" is neither "Columbus" nor "America" but, according to James (1890:275), "Columbus-discovered-America-in-1492". It (the object) is the whole thought (James 1890:276); not parts of it, but every constituent intimately related. The implication is that a thought (and its object) exists only in this totality of relationships - destroying a part destroys the whole. In fact, James (1890:277) puts it emphatically that an object - however complex - does not consist of an association or a fusion of many parts or ideas which only *appear* as a whole, while still being readily separable: *(T)here is no manifold of coexisting ideas. ... Whatever things are thought in relation are thought from the outset in a unity, in a single pulse of subjectivity, a single psychosis, feeling, or state of mind* (James 1890:278). This "undivided unity" of thought (or consciousness) happens over time. Consecutive segments of time may be distinguished within a single thought, but in no way

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[23] Cf. James (1950:276).

[24] *It is a vicious use of speech to take out a substantive kernel from its content and call that its object; and it is an equally vicious use of speech to add a substantive kernel not articulately included in its content, and to call that its object. Yet either one of these two sins we commit, whenever we content ourselves with saying that a given thought is simply 'about' a certain topic, or that topic is its 'object'* (James 1890:275).

does a single segment capture the thought itself (James 1890:279-280). The object of thought is captured, or even anticipated in the intention to utter a phrase[25] (James 1890:280). After the thought is spoken, its object is even more fully realised than at the start (James 1890:280). Stated otherwise: its meaning is "felt"[26] more fully at the end. But at this stage the point is that a thought cannot be separated into parts. One may distinguish aspects of thought, probably due to it *taking place over time*, but a thought is primarily a unity. James (1890:283) uses a very interesting final illustration: a thought moving from its beginning to its end may be likened to a bulge on an elastic diaphragm (made by a ball underneath it), moving from one to the other side. The bulge represents the focus on a specific aspect of the thought within a specific time segment while the slight stretches between the beginning and the end of the thought and the bulge represent the continuity of the whole thought.

2.3.2.5 In the last place, consciousness is **selectional** and thus able to direct its attention to certain aspects of its object and reject other aspects (James 1890:284).[27] Consciousness is therefore selectional (cf. James 1890:286,287) and it manages this by means of attention.[28] The selectional function of consciousness (or attention) is to emphasise certain aspects: it is quite impossible to attend to the multitude of impressions bombarding one's senses (cf. James 1890:284). While choosing to tend to certain data, consciousness ignores others (James 1890:284).[29] A multitude of "possibilities" exist for the individual mind, and *(C)onsciousness consists in the comparison of these with each other, the selection of some, and the suppression of the rest by the reinforcing and inhibiting agency of attention* (James 1890:288).

2.3.3 Conclusion

Against the associationists and structuralists and the atomistic/elementist implications of their theories, James emphasised the holistic and dynamic nature of consciousness. Furthermore, he

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[25] James (1890:279-280), in his explanation of the stream of consciousness (which is about the undivided unity of thought), uses the way a phrase is verbalised to illustrate this seamlessness of thought. One gets the impression that he confuses the verbalisation of a thought with the thought itself, a mistake he himself warns against (James 1890:275). A better perspective probably is to view his discussion of speaking a sentence not as a metaphor or an illustration of the stream of thought, but as an explanation of what goes on in thought whilst one speaks a sentence.

[26] James uses the term "feeling" to express the understanding of the meaning of a sentence or thought: ... *the final way of feeling the content is fuller and richer than the initial way* (James 1890:280); *Now I believe that in all cases where the words are understood, the total idea may be and usually is present not only before and after the phrase has been spoken, but also whilst each separate word is uttered .... We feel its meaning as it passes ...* (James 1890:281).

[27] *It (consciousness) is always interested more in one part of its object than in another, and welcomes and rejects, or chooses, all the while it thinks* (James 1890:284).

[28] *Consciousness, from our natal day, is of a teeming multiplicity of objects and relations, and what we call simple sensations are results of discriminative attention, pushed often to a very high degree* (James 1890:224).

[29] *Attention ... out of all the sensations yielded, picks out certain ones as worthy of its notice and suppresses all the rest* (James 1890:285).

emphasised the purpose of consciousness within a functionalist framework. What is important in his account of consciousness is the relational nature of the content of consciousness: the relation between elements constitutes a whole thought and not so much the elements themselves. At this stage, a distinction must be made between intentionality or the ability to think about objects and interests governing the process of consciousness. Interests determine the "attractions" or direction of thought while intentionality enables one to focus on what these interests point to. The following discussion will focus on an analysis of intentionality.

2.4 THE ROLE OF INTENTIONALITY IN CONSCIOUSNESS: ORIGINS IN PHENOMENOLOGICAL THEORY

The analysis of intentionality as a concept integral to the phenomena of human subjectivity and consciousness, found its clearest expression in phenomenological thought. Subsequent philosophical and psychological phenomenological thought built upon the foundations established by Husserl. Since intentionality is regarded as a fundamental feature of consciousness, an overview of the relevant work of Husserl and Brentano, as it pertains to consciousness, will be given in this section.

2.4.1 The transcendental study of subjectivity and consciousness

One of Husserl's (1928a:7,12-13,16) main aims was to study logic purified[30] from the confounding influence of psychologism (Husserl 1928a:50-60; cf. p.60-61).[31] He (1928a:114) took Frege's account of psychologism and logic as his starting point: for Frege it was necessary to distinguish between *what is true in itself and our regarding something as true*[32] (Pivčević 1970:34). Logic studied what is true in itself while psychology studied the empirical judgemental acts localised in space and time (cf. Pivčević 1970:34). The same goes for Husserl's view: the psychological analysis of logical and mathematical[33] concepts was inadequate (cf. Husserl 1928a:123-125, 169-173; Spiegelberg 1969:95). Husserl's position, however, departed radically from that of Frege (cf. Pivčević 1970:44). Although Husserl agreed with Frege that psychologism blurred the distinction between *fact* and

[30] *Dazu gehört vielmehr - soll von einem Wissen im engsten und strengsten Sinne die Rede sein - die Evidenz, die lichtvolle Gewißheit, daß ist, was wir anerkannt, oder nicht ist, was wir verworfen haben; eine Gewißheit, die wir in bekannter Weise scheiden müssen von der blinden Überzeugung, vom vagen und sei es noch so fest entschiedenen Meinen, wofern wir nicht an den Klippen des extremen Skeptizismus scheitern sollen* (Husserl 1928a:13).

[31] Psychologism (at least for Husserl), according to Spiegelberg (1969:94) is the view that psychology is both the necessary and the sufficient foundation of logic. The term was later used by Husserl with a wider meaning: it then refers to the attempt to establish any object (such as ethics or theology) on psychological experiences (Spiegelberg 1969:94).

[32] *Aller menschlichen Wahrheit Maß ist also der Mensch als solcher* (Husserl 1928a:115).

[33] Cf. Husserl (1928a:170).[179]

belief (cf. Pivčević 1970:41), his work aimed at revealing the nature of subjectivity in order to *clarify the presuppositions of logic and provide a true philosophical understanding of science* (Pivčević 1970:43). To establish a pure logic or a true objective logic, it is therefore necessary to clarify the nature of the activity which lies behind the logic of science (cf. Pivčević 1970:43).[34] Husserl wants to understand knowledge as the *active, meaning-giving, object-constituting subjectivity* by means of his phenomenological analysis (Pivčević 1970:43). Husserl's *subjectivity* is however not "psychological subjectivity" or the mental events studied by psychology but rather subjectivity *as such*, unattached from the subjectivity of one person or a group (cf. Husserl 1928b:347-348; cf. also Pivčević 1970:43; Spiegelberg 1969:103).[35] Husserl's aim is to provide a method of philosophical analysis with which one may discover or expose the objective conditions of knowledge and truth (cf. Pivčević 1970:64-65). By exposing the true nature of phenomena one may find the essences of knowledge and thereby escape the relativistic epistemological conclusions inherent in every form of subjectivism and psychologism (cf. Spiegelberg 1969:94). The method he uses is called the phenomenological reduction whereby one transforms (or reduces) one's phenomenological experiences and consciousness into a transcendental consciousness within which the "eidetic structures", or the true nature (the essence), of experiences are revealed (cf. Pivčević 1970:65,66; see Husserl 1928:350 footnote 1). Putting it more simply: Husserl wants a suspension of subjectivist judgements concerning the meaning or truth of ordinary, everyday experience[36] (cf. Pivčević 1970:68,69,70). The truth of phenomena cannot be found within ordinary subjective consciousness - if this was the case, truth will still be relativistic and not objective or valid (cf. Pivčević 1970:70). Husserl (1950:6,73)[37] therefore introduces the concept of transcendental consciousness as opposed to (empirical) consciousness of the (empirical) subject (cf. Husserl 1928:350-351; cf. Pivčević 1970:70).

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[34] In order to explain the aim of his theory of science, Husserl (1928:169-172) compares logic to mathematics. Of course, one needs the individualised or empirical subject to do the counting, but this does not mean that mathematical concepts may be reduced to psychology (Husserl 1928:170). The number five is neither my, or any one else's, counting or representation of five. In the following elaboration, Husserl (1928:171) reveals the main thrust of his work: *Vergegenwärtigen wir uns klar, was die Zahl Fünf eigentlich ist, erzeugen wir also eine adäquate Vorstellung von der Fünf, so werden wir zunächst einen gegliederten Akt kollektiver Vorstellung von irgendwelchen fünf Objekten bilden. In ihm ist das Kollektivum in einer gewissen Gliederungsform und damit ein Einzelfall der genannten Zahlenspezies anschaulich gegeben. In Hinblick auf dieses anschaulich Einzelne vollführen wir nun eine "Abstraktion", d.h. wir heben nicht nur das unselbständige Moment der Kollektionsform am Angeschauten als solchen heraus, sondern wir erfassen in ihm die Idee: Die Zahl Fünf als Spezies der Form tritt in das meinende Bewußtsein. Das jetzt Gemeinte ist nicht dieser Einzelfall, es ist nicht das Angeschaute als Ganzes, noch die ihm innewohnende, obschon für sich nicht lostrennbare Form; gemeint is vielmehr die ideale Formspezies, die im Sinne der Arithmetik schlechthin Eine ist, in welchen Akten sie sich auch an anschaulich konstituierten Kollektiven vereinzelnen mag, und die somit ohne jeden Anteil ist an der Zufälligkeit der Akte mit ihrer Zeitlichkeit und Vergänglichkeit.*

[35] ... *Husserl's intent was a description of the ideal types of logical experience corresponding to the ideal logical laws* (Spiegelberg 1969:102).

[36] Also called the *existential* conditions of an experience since an empirical experience is situated within time and space (cf. Pivčević 1970:68).

[37] *Die Psychologie ist eine Erfahrungswissenschaft. ... Demgegenüber wird die reine oder transzendentale Phänomenologie nicht als Tatsachenwissenschaft, sondern als Wesenswissenschaft (als "eidetische" Wissenschaft) begründet werden; als eine Wissenschaft, die auschließlich "Wesenserkenntnisse" feststellen will und durchaus keine "Tatsachen"* (Husserl 1950:6).

2.4.2 Brentano's conception of intentionality

A central concept to Husserl's phenomenology is that of intentionality. The term's introduction to modern philosophy is usually ascribed to Brentano (cf. Pekala 1991:19; Pivčević 1970:45; Spiegelberg 1969:39).[38] In trying to differentiate between physical and mental (or psychological) phenomena,[39] Brentano (1924:124-125) found that mental phenomena distinguished themselves from physical phenomena by means of the *"intentional inexistence"*[40] *(of the intended object)* (Pivčević 1970:46; cf. Spiegelberg 1969:39).[41] In other words, a mental act is characterised by its intentionality, or by its relation to a content (Brentano 1924:124,125,137).[42] It is directed towards an object, but this "intended" object is also "immanent objective"[43]: it exists as an object but only subjectively[44] - it may have its empirical counterpart,[45] but as such it exists in the relation

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[38] According to Spiegelberg (1969:40-41) at least the concept of the *reference to an object* as one of the characterisations of mental phenomena may be ascribed exclusively to Brentano. "Intentionality" and related concepts was seemingly borrowed from scholastic philosophy (see Spiegelberg 1969:40 footnote 2; see also p.41 footnote 1). In scholastic philosophy the term "intentio" refers to *the peculiar image or likeness formed in the soul in the process of acquiring knowledge, thus representing, as it were, a kind of distillate from the world outside* (Spiegelberg 1969:40 footnote 2). This usage of "intentio" has its roots in Aristotle's theory of perception: the form of an object is received without its matter. Brentano's (1924:125 and 269 footnote 10) concept differs from the scholastic one in his referral to intentionality as "the directedness to an object" (cf. Spiegelberg 1969:40 footnote 2).

[39] Cf. Brentano (1924:120-124, especially p.121) discussion of the inadequacy of distinguishing between mental and physical phenomena in terms of defining mental phenomena negatively as "the absence of extension" (*... den Mangel der Ausdehnung*).

[40] "Mental (or intentional) inexistence" (*...die intentionale (auch wohl mentale) Inexistenz*)(Brentano 1924:124) *... literally implies the existence of an "intentio" inside the intending being, as if imbedded in it ...* (Spiegelberg 1969:40). The term "inexistence" does not mean "not existing" but rather *existing in* and this is what is implied by "immanent objectivity" (cf. Brentano 1924:124, footnote ***). This concept (mental inexistence) is, according to Spiegelberg (1969:40) a scholastic or more specific a Thomistic view (cf. Spiegelberg 1969:40, footnote 38; also Brentano 1924:125, footnote *).

[41] *Jedes psychische Phänomen ist durch das charakterisiert, was die Scholastiker des Mittelalters die intentionale (auch wohl mentale) Inexistenz eiens Gegenstandes genannt haben, und was wir, obwohl mit nicht ganz unzweideutigen Ausdrücken, die Beziehung auf einen Inhalt, die Richtung auf ein Objekt (worunter hier nicht eine Realität zu verstehen ist), oder die immanente Gegenständlichkeit nennen würden* (Brentano 1924:124-125).

[42] *Reference to an object is thus the decisive and indispensable feature of anything that we consider psychical ...* (Spiegelberg 1969:41). Cf. also Brentano (1924:125): *Diese intentionale Inexistenz ist den psychischen Phänomenen ausschließlich eigentümlich. Kein physisches Phänomen zeigt etwas Ähnliches. Und somit können wir die psychischen Phänomene definieren, indem wir sagen, sie seien solche Phänomene, welche intentional einen Gegenstand in sich enthalten*.

[43] The concept of the immanence of the object in consciousness - or its "mental inexistence" - was eventually dropped by Brentano (cf. the editor's remarks in Brentano 1924:125 and 269 footnote 10) - in favour of the meaning of directedness to an object - along with the term "intentionality" (Spiegelberg 1969:107). Brentano (1924:137), in fact, tries to clarify "mental inexistence" as reference to an object: *Wir fanden demnächst als unterscheidende Eignentümlichkeit aller psychischen Phänomene die intentionale Inexistenz, die Beziehung auf etwas als Object* (cf. also Brentano 1924:137 and 271 footnote 20). Husserl rejected the concept of the immanency of the objects in the act of consciousness from the start (cf. Husserl 1928b:372-374). It is only with Husserl that "intentionality" refers exclusively to the directedness towards an object rather than that of the object's immanence (Spiegelberg 1969:107).

[44] The phrase "only subjectively" may be misleading since, for Brentano (1924:128-129), a mental object is subjectively or innerly apprehended (or perceived) (*durch innere Wahrnehmung*)(Brentano 1924:128). Subjective or *innere Wahrnehmung* (perception) is distinguished from other kinds of perception (Brentano 1924:128). Inner perception is characterised - and therefore distinguished from other forms of perception - by having mental phenomena as its object **and** by its *unmittelbare, untrügliche Evidenz* (Brentano 1924:128). Subjective perception is therefore the only perception that is immediately evident; in fact, *(D)ie innere Wahrnehmung ist nicht bloß die einzige unmittelbat evidente; sie ist eigentlich die einzige Wahrnehmung im eigentlichen Sinne de Wortes* (Brentano 1924:128). Inner perception is thus literally "**taking** mental phenomena to be **true**" (*Wahr-nehmung)* in contrast to the truth of external perception which cannot be proved (Brentano 1924:40-41,128-129; cf. pp.40-48 for Brentano's (continued...)

constituted by the mental act (cf. Pivčević 1970:47). What is more, the object does not only exist subjectively, its constitution presupposes the subject and in this sense deepens the notion of its subjectivity. The intentional relation as the characteristic of mental acts, is first of all a relation. Pivčević (1970:47) summarises this idea succinctly: *This relation involves a mental act, and while it does not imply the extra-mental existence of the object of such an act, it does presuppose the existence of a **subject** ....*

But what is the relationship between consciousness and intentionality? Brentano (1924:218) regarded every mental act as a conscious act. Since mental acts or phenomena are intentional, the same applies to consciousness. Having something as an object and the consciousness of having something as an object *are parts of **one and the same** mental phenomenon* (Pivčević 1970:48). Brentano (1924:218) distinguishes between "primary" and "secondary" objects.[46] For instance, he (1924:218) distinguishes between hearing a sound (the primary object) and being conscious of the sound (the secondary object).[47] It seems that consciousness, on the one hand, is the consciousness one has of the mental phenomenon apart from the (primary) object that gave rise to the mental phenomenon. On the other hand, it seems as if primary and secondary objects, as part of consciousness, are distinguishable but not separable. According to Pivčević (1970:49), it seems as if Brentano's concept of consciousness - with its distinction between primary and secondary objects - refers to consciousness and self-consciousness. Being conscious of an object and being conscious (thus self-conscious) of the fact that one is conscious of an object (thus having the former consciousness as a new object) could lead to an infinite regress[48] according to Pivčević (1970:48), but Brentano precludes this possibility by regarding these different forms of consciousness not as multiple acts but as different ways of being conscious (cf. Pivčević 1970:49).

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[44](...continued)
discussion of the difference between "inner observation" or introspection, and "inner perception"; cf. also Husserl 1928b:354-356 and 1928c:222-244, especially pp.231-233).

[45] *The "intentional inexistence of an object" is given here as a main characteristic of mental phenomena. The words "inexistence" and "immanent objectivity" are a reminder not to confuse the existence of intentional objects with extra-mental reality. The objects of presentation, desire, love, hate, etc., may, but need not, exist extra-mentally* (Pivčević 1970:46).

[46] Cf. Spiegelberg (1969:42,108).

[47] *Jeder psychische Akt ist bewußt; ein Bewußtsein von ihm ist in ihm selbst gegeben. Jeder auch noch so einfache psychische Akt hat darum ein doppeltes Objekt, ein primäres und ein sekundäres. Der einfachste Akt, in welchem wir hören, z. B. hat als primäres Objekt den Ton, als sekundäres Objekt aber sich selbst, das psychische Phänomen, in welchem der Ton gehört wird* (Brentano 1924:218). Cf. also Pivčević (1970:48)

[48] The infinite regress lies in the possibility of having a conscious act as an object in the next conscious act and so on ad infinitum (cf. Pivčević 1970:48). The possibility of a regress is opened up by making the distinction between a phenomenon and the consciousness of this phenomenon. This distinction should not be confused with the empirical object since it seems as if Brentano only distinguishes between the perception of an object and consciousness of the object, both of which are subjective phenomena and therefore regarded as *mental* phenomena (cf. Pivčević 1970:48)

2.4.3 Husserl's conception of intentionality

Although Brentano's contributed much towards understanding consciousness as intentionality (cf. Spiegelberg 1969:39, cf. Husserl 1950:211), his view of consciousness, according to Pivčević (1970:50), is criticised as being psychologistic, since Brentano derives objective knowledge from mental phenomena rather than delineating the transcendental conditions for knowledge and truth.

> However, according to Spiegelberg (1969:49) it seems that Husserl never explicitly accused Brentano of psychologism, at least not of attempting to *derive logical from psychological laws, thus converting them into merely probable inductive generalizations with the ensuing sceptical and relativistic consequences.* Brentano's interest was, amongst others, to devise an empirical psychology (although not in the sense empirical psychology is understood today)(cf. Spiegelberg 1969:36).

Husserl uses the concept of intentionality to explain the objective conditions for knowledge and deliberately avoids the empirical subject. Thus *(T)he intentional object is not an image or idea within a (psychological, empirical) consciousness* (Pivčević 1970:50). Contrary to Brentano's usage of the concept of intentionality, the intentional object and the act of intentionality is not situated within a real or material subject's consciousness: *It is what is intended in the act, no more and no less* (Pivčević 1970:51). As Husserl (1950:212-213) says: *Bewußtsein ist eben Bewußtsein "von" etwas....* Intentional objects are not mental or physical objects: *They are simply objects of certain signifying relations* (Pivčević 1970:51). However, intentional objects are given only through the empirical subject's stream of consciousness (Spiegelberg 1969:108). Intentionality "objectivates" the objects within an empirical subject's mind: *It is the function of the intention to relate these data to an object which is itself not part of the act, but "transcendent" to it* (Spiegelberg 1969:108). It should be remembered that Husserl wanted to obtain the essence of a phenomenon. This means that since the perception of a phenomenon or the consciousness of a phenomenon in normal empirical circumstances is always from a specific viewpoint or perspective (a total view is never obtainable - one for example, either sees the front or the back of a chair), the objectivating function of intentionality is to *identify* or synthesise various perspectives or aspects so that the essence of the intentional object may be revealed (cf. Spiegelberg 1969:108-109).[49] Intentionality does not only identify, it also *connects* or relates various perspectives of the intentional object. For instance, reference to the front view of chair immediately implies its back. Spiegelberg (1969:109) puts it quite accurately:

> *Each aspect of an identical object refers to related aspects which form its horizon, as it were. The frontal aspect of a head refers to the lateral aspects (profiles) and, least definitely, its rear. It gives rise to legitimate expectations for further experiences, which may*

[49] *A furhter step in the objectivating function of intentions is that they allow us to assign a variety of successive data to the same referents or "pole" of meaning* (Spiegelberg 1969:108).

or may not be fulfilled in the further development of our experience, yet are clearly foreshadowed in what is given.

The functions[50] of intentionality eventually have their consequence in the constituting[51] function of the intentional object.[52] At first glance, the intentional object is understood as referring to pre-existing referent to which the intending act refers - the intentional object is given before any intending act is concluded (Spiegelberg 1969:110). However, the fact that intentionality constitutes the intentional object implies that its "existence" is owed to the *act* of intending (cf. Spiegelberg 1969:110).[53]

Husserl makes a distinction between the *noesis* and the *noema* with regard to intentional experience. *Noesis* refers to the intentional and non-material component of an experience (Husserl 1950:210)[54] - it is the act of intending - while the *noema* refers to the content of the *noesis* (cf. Pivčević 1970:68). The *noema* is the "ideal content-correlate" or the meaning of the intention (see Husserl 1950: 218; cf. Pivčević 1970:68). Both aspects of the intentional experience must be distinguished from the actual empirical experience or its sensory content (Pivčević 1970:67). The difference between the sensory content of an act and the intentionality of an act is the same as the difference between a word and its meaning.[55] The word "pen" for instance, is merely a symbol for the "true" object and does not signify its true meaning. Any word, symbol or tag will do. This aspect may be clarified by Husserl's conception of language. He makes a distinction between sign and expression. A sign merely points to something without expressing its truth. Words on their own, point or link symbol and object, while language on the other hand expresses much more. Language, or rather speech, expresses truth or meaning. What is needed for a sign to express meaning is an intentional act (cf. Pivčević 1970:52).

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50 The functions of intentionality as discussed by Spiegelberg (1969:108-109) include objectivating, identifying and connecting.

51 Cf. Spiegelberg (1969:146-149).

52 One could actually try to relate the functions to each other more intimately by turning the sequence of functions around: firstly, intentionality constitutes the intentional object. The characteristics of "constitution" are then bringing into being (originating), objectifying, identifying, and connecting. However, according to Spiegelberg (1969:110), it seems as if some of the functions are reflected in Kant's analysis of experience (note the logical order of the functions) ... *in which the intellect (Verstand), with the help of its categories, synthesizes the sense-data supplied by the perception (Anschauung), thus constituting identical objects within the flux of our sensations.*

53 According to Spiegelberg (1969:109), this constituting nature of intentionality is acknowledged by Husserl only in the period after his *Logische Untersuchungen*.

54 *Diese Noesen machen das Spezifische des Nus im weitesten Sinne des Wortes aus, der uns nach allen seinen aktuellen Lebensformen auf cogitationes und dann auf intentionale Erlebnisse überhaupt zurückführt und somit all das umspannt (und im wesentlichen nur das), was eidetische Voraussetzung der Idee der Norm ist. Zugleich ist es nicht unwillenkommen, daß das Wort Nus an eine seiner ausgezeichneten Bedeutungen, nämlich eben an "Sinn" erinnert, obschon die "Sinngebung", die in den noetischen Momenten sich vollzieht, vielerlei umfaßt und nur als Fundament eine dem prägnanten Begriffe von Sinn sich anschließende "Sinngebung"* (Husserl 1950:210).

55 Cf. Spiegelberg (1969:110 footnote 1).

2.4.4 Phenomenological thought after Husserl

The transcendental (or a-empirical) emphasis in Husserl's phenomenology was later tempered by himself in his call *zurück zu den Sachen selbst* (cf. Luijpen 1976:101). The importance of the world within which human beings live gained prominence in the works of, amongst others, Heidegger and Gadamer. In later phenomenological works, the ideal of objectivity or rather of bracketing of subjectivity - of the empirical reality of human beings - was given up in favour of a fundamental analysis of human existence, an existence which is inextricably bounded to all inner and outer realities which a human being experienced or may experience. Heidegger named it *Dasein* and Gadamer termed it *wirkungsgeschichtliche Bewußtsein*[56] (which is in fact - as an analysis of existentiality - a step further than Heidegger's *Dasein*). Phenomenological thought, after Husserl, may be termed *existential phenomenology*,[57] which is a marriage between *existentialism* (entailing the analysis of human existence)(cf. Luijpen 1976:24,42; Spiegelberg 1969:411) and *phenomenology* (entailing the analysis of the essence of phenomena).[58] It aims in the end at a rehabilitation of both humanity and its world: both subjectivity and objectivity are rescued (or rather dissolved) by referring the one to the other within a relationship of *interaction*. Neither the subject (humans) nor its object (their world) can be thought about without the one immediately referring to the other (cf. Luijpen 1976:41-42)[59]: *... als de existensie-filosoof de mens existensie noemt, dan wil hij daarmee zeggen dat het bewust-zijn-in-de-wereld de essentie, het wezen van de mens uitmaakt* (Luijpen 1976:48).[60] They

[56] See Chapter 1 of this study.

[57] Luijpen (1976:23-26) explains *existential phenomenology* firstly in terms of the difference between Kierkegaard's existentialism and Husserl's phenomenology. Both react against an atomistic view of humanity although their reactions differ. Kierkegaard views human existence as the subject existing in a relation (specifically, in Kierkegaard's case, the relation to God). Husserl focuses on knowledge or (transcendental) consciousness as intentionality (which also implies a relational structure as against an atomistic view). A further difference between the two thinkers arises from the subjectivity of existence (Kierkegaard) entailing an almost personal and unrepeatable experience of existence, and from the objectivity of consciousness where Husserl aims at providing universally valid knowledge. According to Luijpen (1976:26), the differences between the two views are resolved within Heidegger's theory [however cf. Spiegelberg's (1969:409-410) remarks on Heidegger's view of existence as *fundamental ontology*]. The union between phenomenology and existentialism was much more evident in France (Spiegelberg 1969:410) than in Germany were the two schools of thought remained separate (Spiegelberg 1969:409-410).

[58] It is rather difficult to find one clear definition of phenomenology (cf. Spiegelberg 1969:xxvi-xxvii) since phenomenologists differ extensively in method and content (cf. Spiegelberg 1969:xxvii,1-3). Understanding phenomenology as an approach (therefore viewing it as a method) to grasp the essence of appearances (phenomena), probably comes closest to a generic definition (cf. Spiegelberg 1969:5-6,8).

[59] *De existensie-gedachte wil precies uitdrukken, dat de menselijke subjectiviteit niet is wat zij is, zonder wereld. Zij wil uitdrukken dat de wereld tot het wezen van de mens behoort, zodat met het 'weg-denken' van de wereld ook het subject niet bevestigd kan word* (Luijpen 1976:43).

[60] *De existensie is dan ook geen eigenschap die de mens heeft of niet heeft, die hij zich aanmeet of niet aanmeet. De mens is niet eerst mens om vervolgens een verhouding met de werled aan te knopen of niet. Existeren is een 'existentiaal', een wezenlijk kenmerk van het mens-zijn. de mens is een geïncarneerde-subjectiviteit-in-de-wereld* (Luijpen 1976:48).

can be distinguished but not separated. Separation involves negation.[61] In fact, the only way to understand either is to focus on their interaction.

2.4.5 Concluding discussion

2.4.5.1 Brentano defined intentionality as "aboutness" (cf. Dennett 1991:76), i.e., thought is always *about* something, or *aimed* at some object (cf. Dennett 1991:333). This *directed upon something* is taken as the standard definition of intentionality in philosophical and psychological discussions of the mind and consciousness (Bechtel 1988:40).

2.4.5.2 Brentano used intentionality as the distinctive attribute of *mental phenomena*, since natural or nonmental phenomena do not possess intentionality. Indeed, intentionality is the fundamental defining quality of consciousness.

2.4.5.3 Brentano's definition of intentionality in terms of *a relation* which presupposes an intending subject and an intended object, led to much controversy. How can one have an imaginary object in mind which does not exist or refer to a real (empirical) object, since having a relation with something means that it must be something real? Brentano said that intentionality was indeed characteristic of *mental* phenomena, and as such was subjective (i.e. within the subject), but the consequence is that a class of objects exists with no correspondence to real objects. Although it is obvious that we can imagine objects with no empirical counterparts such as unicorns, the problem is that intentionality can be ascribed to both imaginary mental objects and mental objects with empirical counterparts. How then are we able to distinguish between these two classes of mental objects? Brentano's student, Meinong (1960), tried to solve the problem by making a distinction between *Sosein* (the being or subsistence) and the *Sein* (existence) of an object. Objects that do not exist, such as unicorns, do have subsistence and therefore constitute the intentional object (cf. Bechtel 1988:42). However, Frege's (1892) distinction between *sense* and *reference* of an expression (sense represents the features of an object, while reference points to the real object), implies that if *sense* is viewed as the intended object (in the same way as Meinong's *Sosein*), then it must be applied to both actual and imaginary mental objects. According to Bechtel (1988:43), *(T)his leads to the unwanted consequence that all of our discourse is about senses or intentional objects and not about objects in the world*. To retain the concept of intentionality, it is necessary to be able to account for both classes of objects.

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[61] *Er is voor de mens maar een mogelijke wijze van zich terugtrekken uit de wereld: de dood. Maar daardoor houdt hij op mens te zijn. De mens kan zich uit deze of gene wereld terugtrekken, maar daardoor betreedt hij per se een andere wereld. Definitief zich terugtrekken uit de wereld is de mens slechts mogelijk door zijn mens-zijn op te geven* (Luijpen 1976:48).

2.4.5.4 Husserl's distinction between the *noesis* and the *noema* with regard to intentional experience may be viewed as an attempt to solve this particular problem. The act of intending and its ideal content must be distinguished, but this distinction is not enough to solve the problem of reference. As was said above, the word "pen" is merely a symbol/sign for the "true" object and does not signify or express its true meaning. In terms of Husserl's language theory, only by speaking, or in terms of mental acts, only by intending (or thinking), is truth or meaning expressed. To repeat: *What is needed for a sign to express meaning is an intentional act*.

How then, do we distinguish between mental objects corresponding to real objects and mental objects not having empirical counterparts? The implication of Husserl's theory is that we do not have to at the level where a distinction between sense and reference is usually made, since a word functions as a symbol/sign/token which sometimes refers to empirical objects (cat) and sometimes not (unicorn). The symbol does not express the truth of its reference (i.e., whether there really are unicorns or not). It merely points. But by thinking or speaking, the intended object's truth or meaning emerges. The implication is that the act of thinking establishes whether the object actually exists or whether it is merely imaginary. This emergence of meaning of the intended object is consistent with the synthesising and relational functions of intentionality discussed above (see page 50). When the meaning/truth of an object is grasped, then its essence is understood, i.e., all the perspectives on the object are realised and related to each other. The object as a whole, in all its relations, is constituted and grasped.

2.4.5.5 Searle (1990:587) called this the *aspectual shape* of intentional states, which means, perception or thought about anything is always under some aspects and not others. The object seen, or thought about, is not simply an object but is viewed from a certain perspective with certain features. This means that for a particular person, an object always has a specific aspectual shape despite the infinite possible descriptions of that particular object. Husserl's initial transcendental view of intentionality is thus tempered and reduced to the intentional object as it appears to the *empirical* subject.

2.4.5.6 To conclude: intentionality is a fundamental feature of consciousness. Indeed, intentionality constitutes subjectivity in the sense that it is a conscious subject that thinks. A conscious subject always thinks of something. Thought always has an object or content. Although intentionality was originally proposed to characterise thought as having content, the positing of a subject-object relationship led to the difficulties with reference discussed above. This problem can be overcome by focusing not on the static relationship between the subject and object (which is, of course, a necessary elaboration of the structure of consciousness), but on the act of thinking. Consciousness is not so much an intentional structure as it is a process. By focusing on the static structure of consciousness, the concept of intentionality is changed in such a way, which is not conducive to understanding the unique character of consciousness. The problems of reference and intentionality as mere content will be addressed below.

Intentionality must be seen as a process which expresses the directionality of thought, or rather, which expresses the directionality of consciousness. The unique character of consciousness is not that it has content, but that it is directed towards *meaningful* content. It will be seen below that the computational theory of cognition views intentionality as the problem of representation of the content of thought. The problem is that mechanical devices, such as a computer, also represent knowledge or content and accordingly may be viewed as intentional. Intentionality as the distinguishing mark between mental and nonmental states is therefore lost. By construing intentionality as directionality towards meaningful content, this distinction is maintained. Content is meaningful to someone. Meaningful content requires a personal conscious subject capable of appropriating content as meaningful. Stated simply, this is what consciousness is: *it is thinking meaningful thoughts*. It requires fundamental subjectivity. Thoughts or content could be senseless to the observer (from the third-person perspective), but the content of one's own consciousness is always meaningful to oneself (from the first-person perspective). And if it is not, then a struggle ensues to find meaning, since consciousness is a process which aims at finding meaningful content. The concept of intentionality seeks to express this struggle.

2.5 THE DEMISE OF CONSCIOUSNESS IN PSYCHOLOGY

In the history of psychology the increasing focus on behaviour, objective observation, quantification and physiological processes, contributed to the unpopularity of mentalistic phenomena in scientific psychological studies. As such, the flavour of science in the first part of this century was determined by positivistic conceptions of doing science, and the demise of consciousness as a valid object of scientific study must be seen against this background. In psychology, the increasing popularity of behaviourism contributed to the prevailing anti-mentalistic attitude. However, the simultaneous rise of psychoanalysis kept mentalism alive in some way but, as a prominent force in psychology, it also contributed to the unpopularity of consciousness due to its emphasis on the unconscious. The following section describes the role of both behaviourism and psychoanalysis in the process of regulating the inquiry into consciousness to the periphery of scientific psychological studies.

2.5.1 Behaviourism

The rise of behaviourism spelled the end for classical introspectionism and the study of consciousness in America (Pekala 1991:21). The founder of behaviourism was J.B. Watson (1878-

1958). Watson exorcised the concept of consciousness from psychology, since the focus of scientific study was on behaviour (Watson 1929:4). Consciousness and conscious process cannot be studied scientifically (cf. Marx & Cronan-Hillix 1987:158). Both functionalism and structuralism could not solve behaviourial problems, and kept themselves busy with speculative theory which could not endure empirical verification. Behaviourism, however, incorporated an empirical methodology which allowed for *adequate testing* of psychological problems (Pekala 1991:21; Bunge & Ardila 1987:116).

2.5.1.1 Methodological and radical behaviourism

Marx and Cronan-Hillix (1987:145) made a distinction between methodological or empirical behaviourism, and metaphysical or radical behaviourism. Methodological behaviourism emphasises behaviour rather than consciousness as the source of psychological data, while radical behaviourism rejects all mentalistic concepts such as consciousness, from the outset. Empirical behaviourism had a profound influence on psychology in terms of the emphasis on experimental method and the analysis of behaviour (cf. Kendler 1985:124,132). Its negative aspect, namely the rejection of mentalistic concepts as valid data for scientific scrutiny, can lead to the belief as stated by radical behaviourism that mentalistic data do no exist. It is from this denial which psychology and particularly cognitive psychology, struggles to free itself (cf. Kendler 1985:128).

2.5.1.2 The denial of the existence of consciousness

Radical behaviourism argued against the existence of consciousness in various ways. One argument goes that the gaps in consciousness, such as occur when sleeping, can only be explained in terms of behaviour. For instance, when sleeping, nothing measurable (in terms of consciousness) is lost, only behaviour differs in the waking and sleeping stages: *For the behaviorist, unconsciousness simply meant that neural pathways were blocked off so that no stimulation could be reported* (Marx & Cronan-Hillix 1987:161). The most important and most frequently occurring argument is the following: for the behaviourist the assumption that non-physical events can interact with physical events, violates the principle of conservation of energy (Marx & Cronan-Hillix 1987:161). The laws of physics state that energy is never lost, only transformed from one state to another. This means that *(I)f conscious events affected the body or its processes, they would have to do so by adding or subtracting energy or mass*, which is impossible according to the principle of energy conservation (Marx & Cronan-Hillix 1987:161). Mental events cannot therefore influence bodily processes such as making muscles move. If mental events, such as ideas, can influence muscular events (such as ideas verbalised), then ideas must be physical events occurring in the nervous system. Ideas must then be nonmental (cf. Marx & Cronan-Hillix 1987:161).

The radical behaviourist rejects any dualistic mind-body theory. Parallelism, interactionism or epiphenomenalism are not viable options. Interactionism (mental events can cause physical events) and epiphenomenalism (physical events can cause mental phenomena) cannot be true due to the principle of energy conservation, since in both cases energy must be spent to cause either physical or mental events (cf. Marx & Cronan-Hillix 1987:161-162). Parallelism cannot be true due to the nonexistence of mental phenomena. Behaviourism, according to the discussion in Chapter 1 of this study, is a version of monistic materialism which views mental phenomena as only another way of describing physical events (cf. Lashley 1923:351-352; Marx & Cronan-Hillix 1987:162).

2.5.2 Psychoanalysis

Proponents of psychoanalysis[62] made a distinction between consciousness and unconsciousness, while emphasising the unconscious, although there are great differences between the theories of the psychoanalysts. According to Munroe (1955), the varieties of psychoanalysis agree on the following four basic postulates (see Marx & Cronan-Hillix 1987:276):

(a) The psychic life is determined, i.e., it follows certain principles and is determined by these principles (cf. Lundin 1991:311; Marx & Cronan-Hillix 1987:250). For instance, Freud believed that items of dreams were determined by unconscious psychic forces (cf. Rosenzweig 1985:146).

(b) The unconscious has a dominant role in determining human behaviour.

(c) Behaviour can be explained by a single underlying motivational concept.

(d) Current behaviour is determined by the history of the person.

Freud (1961:15), as the founder of psychoanalysis, made a distinction between the conscious, preconscious, and unconscious. The preconscious was situated between the conscious and unconscious (see Figure 4). The unconscious played a major role in determining behaviour, but it was also the least accessible part of the mental apparatus (Freud 1953a:613). From the schematic representation of Freud's concept of the mental apparatus in Figure 4, it can be seen that the unconscious occupied a large part of a person's mind (cf. Freud 1957b:166-204). Freud devised various techniques for accessing the contents of the unconscious, such as free association and dream analysis (cf. Rosenzweig 1985:140-141). From the results with these techniques on various patients, Freud inferred the contents of the unconscious. It consisted of repressed memories from

[62] The best known proponents of psychoanalysis were Sigmund Freud (1856-1939), Alfred Adler (1870-1937), Carl Jung (1875-1961), Otto Rank (1884-1939), Karen Horney (1885-1952), H. Sullivan (1892-1949), Anna Freud (1895-1982) and Erich Fromm (1900-1980).

previous episodes in a person's life, and it was the source of psychic energy and the instincts (cf. Freud 1961:24). The mental apparatus consisted of three aspects called the id, ego and superego. Figure 4 shows the relationship between the id, ego and superego with the conscious, preconscious, and unconscious. It is clear the conscious part of a person's mind is very small compared to the unconscious.

The id was the most fundamental aspect of a person's personality and was wholly unconscious. The functioning of the id followed the pleasure principle which is primarily focused on the satisfaction of primary and basic needs. It served as the vehicle for the instincts and had no normative restrictions (cf. Freud 1957a:117-140).

The instincts, which Freud (1961:40) divided into life (Eros) and death (Thanatos) instincts, gave rise to psychic energy. The energy of the life instincts was called the *libido* (Freud 1953b:217-219). Freud (1964:95-96) viewed the instincts as biological instincts since they were in service of the person's psychological needs.

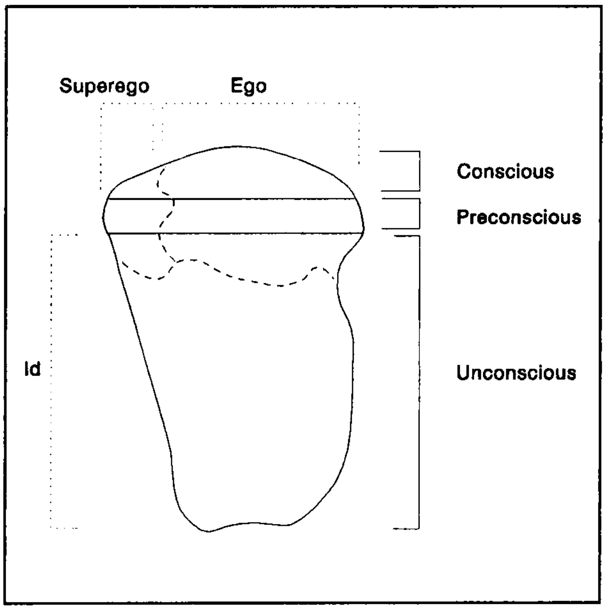

Figure 4 Schematic representation of Freud's mental apparatus (adapted from Lundin 1991:301)

The id was controlled by the ego since the id could not think but only desire. The ego became the executive of the person, since it controlled the demands of the id and the superego. The ego was governed by the reality principle. The ego's function was to find ways of keeping the demands of the id in place and of realistic ways to satisfy the demands of the id. The ego was partly conscious and unconscious, and in this way became the connection with the outside world. Its secondary function was to perform psychologically in terms of perceiving, remembering and interacting with the environment (Freud 1964:75), and according to Freud (1953a:615) this is the "small" role of consciousness. The superego developed as a pure normative mechanism. During a person's development from birth to adulthood, the id was present at first and thereafter the ego and the superego developed. All normative principles, learning right from wrong, were incorporated by the superego (cf. Freud 1964:60-64). The superego consisted of the conscience and the ego-ideal (Freud 1964:66). The conscience was a person's conception of what was wrong while the ego-ideal represented what was right. The superego functioned according to the morality principle. The superego punished the ego for perceived wrong deeds/thoughts in various ways.

In sum, psychoanalysis emphasised the dominant role the unconscious played in determining behaviour. Consciousness seemed to be equated with cognitive functioning but did not have an important role in terms of motivating behaviour. The importance of psychoanalysis, on the one hand, lies in the way it retained mentalistic concepts within psychological theory, concepts, of course, which behaviourism denied (cf. Sears 1985).[63] On the other hand, despite its mentalistic nature, psychoanalysis shifted the emphasis from the phenomenon of consciousness to other phenomena. Psychoanalysis found a strange partner in behaviourism, a partnership which virtually silenced any reference to consciousness in psychology since the 1950's, especially in cognitive psychology.

EXCURSION: Quantifying phenomenology - the empirical study of consciousness

Despite the behaviourist denial that mental phenomena cannot be studied empirically, some researchers recently employed the strong empirical and experimental legacy of behaviourism to study consciousness. Pekala (1991:1), for instance, studied consciousness by means of an empirical-phenomenological approach, which he called the *retrospective phenomenological assessment* (RPA). The method entailed the use of retrospective self-reports of subjects on their subjective or phenomenological experience. Subjects rate the intensity of various aspects of their experience using a self-report inventory (cf. Pekala 1991:1). Pekala devised various instruments to this effect. His aim was to enable psychologists and researchers to study consciousness (or the mind)[64] by means of these instruments (Pekala 1991:2). The questionnaires mapped so called "dimensions (and subdimensions)" of consciousness enabling the quantification of the *variations in subjective experience* (Pekala 1991:1-2). He further developed

> ***psygrams*** *(graphs of the pattern structures among dimensions of consciousness),* ***pips*** *[phenomenological intensity profiles or profiles of (sub)dimension intensity effects],* ***icons*** *[two-dimensional representations of (sub)dimension intensity effects], and* ***hypnographs*** *(graphs of the hypnoidal effects associated with a given stimulus condition),*

which enables one to diagram certain aspects (such as the intensity) of states of consciousness associated with a particular stimulus condition (Pekala 1991:2).

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[63] *What did psychology gain from these long and sometimes contentious efforts to integrate, verify, translate, and absorb. The net effect for psychoanalysis was minimal, I think. Its leadership withdrew behind a wall impervious to those who did not subscribe solely to that method and that theory. But the outcome for behavior theory was quite the opposite. Over the half century, psychoanalysis had opened a whole new world to behavioral research* (Sears 1985:217).

[64] "Consciousness" and "mind" are used as synonyms by Pekala (1991:2).

Pekala (1991:2,3) had particular faith in psychology's methods to understand human behaviour. In fact its past success is due to its attempt to ***quantify** and **statistically** assess that behaviour* (Pekala 1993:3). The success of Pekala's programme in making the structures of consciousness available to scientific scrutiny, will only be substantiated by future research. What is valuable from his attempt to study consciousness empirically, is that he takes the phenomenon of consciousness seriously (a trend becoming fashionable in psychological studies nowadays) and that he takes phenomenological description seriously. He then tries to wed inherently contradictory positions by quantifying subjective experience.

2.6 THE REHABILITATION OF CONSCIOUSNESS

Since the concern of this study is with cognitive psychology, it is important to determine a view of consciousness within this particular field. Cognitive psychology has very strong roots in the experimental psychology initiated at the turn of this century, with its focus on behaviour and measurable states. Indeed, its negligence of consciousness very much stems from the behaviouristic denial of consciousness and mental states. Some theorists did complain seriously about cognitive psychology's lack of interest in the phenomenon of consciousness (cf. Grof 1986):

> *At the time I wrote the article, I thought the major mistake we were making in cognitive science was to think that the mind is a computer program implemented in the hardware of the brain. I now believe the underlying mistake is much deeper: We have neglected the centrality of consciousness to the study of the mind. ... If you come to cognitive science, psychology, or the philosophy of mind with an innocent eye, the first thing that strikes you is how little serious attention is paid to consciousness* (Searle 1990:585).

In the past few years, since the nineteen-eighties, interest in consciousness as a neglected phenomenon became more prevalent. The increase in the number of publications shows this trend.[65]

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[65] The gradual emphasis on consciousness and aspects related to cognition is apparent from the following selectional survey of journal publications:

The relationship between cognition and consciousness: Andersen (1986), Hample (1986), Kydd & Wright (1986), Grof (1986), Dorpat (1987), Slife (1987), Pekala & Kumar (1989), Semenov (1989), Wertsch (1990), Spiegel (1991), Kihlstrom (1992).

Consciousness in cognitive studies: Maddock (1983), Taborsky (1985), Spendel (1985), Hunt (1985), Lucas (1985), Presnell (1986), Churchland (1988), Roberts (1989).

Unconsciousness and cognition: Conte & Gennaro (1983), Gardiner (1989), Reber (1989), Searle (1990), Spiegel (1991).

Consciousness in cognitive, affectional and behaviourial processes: Rychlak (1986), Toskala (1986), Boekaerts (1987), Gardiner (1988), Meuller, Haupt & Grove (1988), Wessler & Hankin-Wessler (1989), Gardiner & Parkin (1990), Gardiner & Java (1990), Shanon (1990), Roediger (1990), Kitayama (1990).

Consciousness and (cognitive) development: Gourova (1986), Karmiloff (1986), Donovan (1989), Keating & Crane (1990).

(continued...)

The importance of consciousness in cognitive studies is also reflected by the initiation of a journal *Cognition and Consciousness*, which started publication in 1992.

Despite the obvious neglect of matters concerning consciousness in cognitive psychology and cognitive science, Bechtel (1988:53,54) was of the opinion that cognitive science's development was due to its attempt to solve the problem of intentionality (thinking about/perceiving objects external to the cognitive agent; see paragraph 2.4.5). Since intentionality is characteristic of consciousness, the problem of consciousness was, actually, always on the table for cognitive science. How, then, does one explain Gardner's (1987) absolute silence on the subject of consciousness in his supposedly comprehensive account of the development of cognitive science? Bechtel's (1988) account does have some merit despite the fact that he construed the problem of intentionality as the problem of the representation of knowledge (cf. Bechtel 1988:49,78; cf. also Fodor 1981 for a discussion of this particular problem).[66]

To solve the initial problem initiated by Brentano, philosophers' developed *propositional attitudes*; which is, propositions representing intentional or mental states (cf. Russell 1940). Hopes, desires, fears, beliefs, etc., are all forms of mental states and, since they all are about something (i.e., they all have content or objects), they express intentionality or may be characterised as intentional states. An intentional state is represented by a proposition preceded by a verb expressing, for instance, hope, desire or belief, and the word "that." The sentence *David hopes that he will receive a toy for Christmas*, shows that the verb "hope" expresses David's attitude toward the content of his hope which is represented by the proposition.[67] This manner of representing mental states has become established as the most convenient way of objectively expressing subjective intentions.

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[65](...continued)
Consciousness, cognition and personality: Singer & Kolligian (1987), Lewicki & Hill (1987), Zlate (1988).

Consciousness and physiological studies: Wieder (1984), Sandman (1986), Miller (1986), Gillett (1988), Damasio (1989).

Consciousness, cognition and dream studies: LaBerge, Levitan & Dement (1986), Hunt (1986), Hobson, Hoffman, Helfand & Kostner (1987).

Consciousness and animal studies: Latto (1986), Domjan (1987).

[66] Bechtel (1988) probably derived his descriptions of the problem of cognitive science, representation and intentionality from Fodor's explicit views as summarised by the following statement:

> *If the representational theory of mind is true, then we know what propositional attitudes are. But the net total of philosophical problems is surely not decreased thereby. We must now face what has always been the problem for representational theories to solve:* ***what relates internal representations to the world?*** *What is it for a system of internal representations to be semantically interpreted? I take it that this problem is now the main content of philosophy of mind* (Fodor 1981:203)(Emphasis mine).

[67] It is a mistake to regard the proposition rather than what is expressed by the proposition as the object of the attitude. Although Bechtel (1988:49) points this out, his (1988:47) initial description of the *propositional attitude* leaves the impression that the attitude is the proposition itself.

2.6.1 The computational approach

The propositional form has been taken up by computational/symbolic cognitive psychology (see Chapter 4 of this study), as the paradigm for representing knowledge states since the propositional form corresponds to the propositional and symbolic nature of the knowledge structures of the mind (cf. Fodor 1981:26). According to Bechtel, knowledge representation in this particular form may then be regarded as an attempt to express intentionality in the sense that it is the *content* of thought and perception (cf. Fodor 1981:20). Indeed, Fodor (1981:27), as one of the main proponents of this representational theory of mind, states ... *that the postulation of mental representations provides for a theory of mental content ....*

The hallmark of the computational approach in cognitive psychology is its emphasis on the computational operations on formal mental representations (the propositions or symbols). The close connection between the computational approach and the propositional format of representation is best illustrated by the work of Fodor (1975), who proposed an internal language of thought underlying the processes of cognition. Fodor (1987) proposed three features of language which are also features of thought, namely *productivity*, *systematicity*, and *inferential coherence*.

(a) Language is productive since new sentences can always be constructed and it does not consist merely of an exhaustive lists of propositions. The same applies to thought: new thoughts are always produced over and above what has been thought.

(b) Language is also systematic since grammatically related sentences can be constructed, and in thought it means that if one can think about a particular proposition, a related proposition can also be thought.

(c) The coherence of inference refers to the ability to make appropriate inferences irrespective of the content of a particular sentence and given the syntactical structure of language. Thought exhibits the same coherence.

Thus, Fodor thinks that thought requires a language-like medium or a language of thought and that organisms that do not exhibit these features can simply not claim to be cognitive (cf. Bechtel 1990:275). In the end, Fodor (1981:23) takes the computer metaphor of cognition seriously. He (1981:23-24) views *mental processes as formal operations on symbols*, and since *the objects of propositional attitudes are symbols (specifically, mental representations)*, they are intentional.

2.6.2 The inadequacy of the concept of intentionality in the computational approach

In effect, intentionality may be ascribed to computational systems, such as computers, which have content as the object of their computations. It may be argued that the computer programmes are sets of semantically interpreted formulae and that their operations consist of transformation of sets of semantically interpreted formulae (Fodor 1981:23). Thus, intentionality and meaning are ascribed to unintelligent systems and mechanistic operations (cf. Fodor 1981:23). The implication is that any system, no matter how simple, expresses intentionality since its purpose defines its content and hence, aims at meaningful behaviour. A thermometer's purpose is to show temperature and thus its behaviour is both intentional (its purpose constitutes its content) and meaningful. Searle (1980) reacted vehemently against the idea that computational systems express intentional and meaningful behaviour and denied that this is at all possible. In fact, his famous Chinese room argument is taken as a refutation of computational theory as expressed by Artificial Intelligence studies (cf. Gardner 1987). According to this argument, it is impossible for a room full of operators receiving Chinese phrases from outside the room, not understanding Chinese, to deliver a meaningful conversation in Chinese by merely performing formal operations on phrases. According to Searle, formal operations are therefore not sufficient in explaining intentionality (cf. Bechtel 1988:69). The problem, according to Searle (1990:586-587), is that intentionality is ascribed to systems which do not have *intrinsic* intentionality. *Intrinsic* intentionality is the hallmark of mental life and consciousness. By not distinguishing between *as-if* intentionality and *intrinsic* intentionality, we actually anthropomorphise living and non-living organisms and systems and define a system's purpose in terms of what is meaningful to us (cf. Searle 1992:79-80; 1990:589). But, according to Searle (1992:84), intentionality is a fundamental feature of consciousness, and consciousness is, to him, a primary mental state.

The computational approach cannot account for mental phenomena such as consciousness, since the concept of intentionality is defined too broadly. Intentionality construed as being about some content, leads to the view that a theory of mental representation is sufficient to explain how thought can be about the world out there. By taking the concept of intentionality a step further as expressing purpose, all mental and non-mental phenomena may be regarded as "intentional." The distinction between mental and non-mental phenomena is thus thereby lost, *contra* Brentano's intention. Due to these difficulties with the concept of intentionality, some theorists deny intentionality and consciousness altogether while others maintain the distinction between mental and non-mental phenomena. These issues are discussed in the following two sections.

2.6.3 Denial of intentionality and consciousness as fundamental

Dennett (1978) calls Searle's *as-if* intentionality described above, the *intentional stance*, which we adopt in our view of people and things in order to explain and predict behaviour (cf. Dennett 1991:77). In fact, it is only a stance or a position humans adopt: there is no such thing as intentionality. According to Dennett (1991), intentionality supports the idea of a central executive responsible for a unified conscious experience. He (1991:106-107) rejects a unified view of consciousness or the *Cartesian Theater* view of mind, which implies that processing comes together at a central point to enable understanding to take place. Dennett (1991:111) proposes a *Multiple*

Drafts view of consciousness which entails parallel processes of interpretation and elaboration of sensory inputs:

> *There is no single, definitive "stream of consciousness," because there is no central Headquarters, no Cartesian Theater where "it all comes together" for the perusal of a Central Meaner. Instead of such a single stream (however wide) there are multiple channels in which specialist circuits try, in parallel pandemoniums, to do their various things, creating Multiple Drafts as they go. Most of these fragmentary drafts of "narrative" play short-lived roles in the modulation of current activity but some get promoted to further functional roles, in swift succession, by the activity of a virtual machine in the brain. The seriality of this machine (its "von Neumannesque" character) is not a "hard-wired" design feature, but rather the upshot of a succession of coalitions of these specialists* (Dennett 1991:253-254).

Information in the nervous system undergoes continuous revision. Although parallel processing, revision and reconstruction are recognised by most cognitive theories, the Multiple Drafts model is distinct from other theories in a fundamental way: feature detections or discriminations only have to be made once. As soon as a specialised portion of the brain makes a discrimination, the information becomes fixed and does not have to be sent to other centres to be synthesised in a meaningful whole. There is no central executive responsible for integrating various features: ... *at any point in time there are multiple "drafts" of narrative fragments at various stages of editing in various places in the brain* (Dennett 1991:113). According to Flanagan (1992:172-174), Dennett's view of consciousness must be rejected as a valid explanation for the phenomenological experience of the unity of consciousness. The stream of consciousness experienced as a unity by a single subject cannot be explained away. Intentionality which expresses the singularity of focus on meaningful content, likewise cannot be explained away. However, Dennett's account is a valid view of *nonconscious* cognitive processing, since newer developments in neurophysiological research (cf. Churchland 1989, Churchland & Sejnowksi 1992) and Parallel Distributed Processing (or connectionism; see Chapter 4) substantiate the parallel nature of cognitive processing (Flanagan 1992:174-175). According to Flanagan (1992:174), the Multiple Drafts view is also useful ... *as a way of describing how thinking, sizing things up, occurs* ***within*** *the stream of consciousness.*[68]

The rejection of Dennett's Multiple Drafts as a valid metaphor for consciousness, by no means implies acceptance of the Cartesian Theater metaphor: one does not have to accept the fact that somewhere in the brain a little man (homonculus) does all the perceiving, thinking and deciding. The acceptance of nonconscious processing as parallel need not imply a central processor or control centre somewhere in the brain which integrates information and processes in order to make it available to consciousness. Indeed, according to this view, there is no "I", ego, a mind's "I", or a

[68] Emphasis Flanagan's.

real self (cf. Flanagan 1992; Dennett 1991; Minsky 1985; Varela, Thompson & Rosch 1991). Although the experience of a personal identity is real, there is no substance named "me" in consciousness or the brain. The experience of personal unity is given in the stream of consciousness.[69] The point is that we are not endowed with an ego from birth: the sense of self and unity *emerges* in the development of the organism and with the accruement of experience (cf. Flanagan 1992:177-178). However, what emerges is not a static self, but a self that constantly changes and develops over time. Indeed, over time, one may speak of multiple selves when looking at the development of the self. It is perceived or experienced as a self at a particular time.

This idea of the multifariousness of the self and consciousness was expressed very clearly by William James nearly a hundred years ago, but was eventually eclipsed by the force of the computer metaphor in cognitive science and psychology (see Flanagan 1992; also page 43 above). According to this metaphor employed in cognitive science, something or someone - and it could just as well be consciousness - ought to be responsible for the integration of all the programmes running simultaneously in the brain. The serial nature of conscious processes left the distinct impression that, despite the parallel nature of underlying processes, a central executive was responsible for integrating the results of the parallel processes. Recently, with the impact parallel processing made on cognitive science, the central executive idea was also rejected (cf. Dennett 1991; see Chapter 4 of this study). As will be seen further on in this study, it is not necessary to reject consciousness (as an experience of a unitary phenomenon) because of the rejection of the central processor idea, since the emergent properties of a system can account for the phenomenon of intentionality and consciousness. The assumption of the emergent systemic model described in Chapter 1 of this study is that a system having parallel functioning elements does not need to have a central processor coordinating the interactions between the elements.

The following section discusses a view which holds consciousness and other mental phenomena to be real and irreducible to the processes underlying its causation. It enables us to do justice to both the underlying (nonconscious) processes and the phenomenon of consciousness.

2.6.4 The fundamental nature of consciousness

According to Searle (1992:1) mental states, such as consciousness and intentionality, *are caused by neurophysiological processes in the brain and are themselves features of the brain.* Searle (1992:93) espouses a naturalised view of consciousness, which means that consciousness and other mental states are the result of physiological processes. He (1992:27-57) defends his naturalism against other forms of dualistic and monistic materialism, contending that any form of materialism which

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[69] See Flanagan (1992) for a full discussion of William James' view of the unity of the self within the stream of consciousness.

either reduces the mental to the physical, or makes a distinction between the mental and physical as separate domains, is false and precludes the possibility of studying mental states scientifically (cf. Hardcastle 1991).

A naturalistic view may be confused with materialism, since both seem to explain certain phenomena in terms of ontological reductions. Ontological reduction implies that a phenomenon is then "nothing but" certain objective physical process (cf. Searle 1992:113). Searle grants the validity of ontological reductions in terms of describing and explaining underlying mechanisms causally (causal reductions). Causal reductions usually aim at ontological reductions (cf. Searle 1992:114-116). An example is the redefinition of a phenomenon such as heat in terms of underlying processes or states. For instance, *heat* is nothing but the kinetic movement of molecules. Invalid ontological reductions (or reductionism) are prevalent in the physicalistic materialism which denies the reality of the appearance of the phenomenon. Reduction must rather be viewed in terms of a causal explanation on the microlevel for a phenomenon on the macrolevel. Causal reduction or explanation/description of processes in terms of real entities and processes is part of the objective nature of modern science and its methods (cf. Searle 1992:116). Within this modern view of science, it is possible to explain, for instance, physical states causally on a macrolevel (e.g., water boils because of the stove I have switched on), and in a bottom-up micro- to macrolevel (water boils because of the kinetic energy of moving particles, etc.)(cf. Searle 1992:86-88). This micro- to macrolevel explanation is what Searle views as a valid causal reduction. Indeed, this bottom-up explanation enables one to view certain physical systems as consisting of elements. A rock, for instance, consists of a certain configuration of molecules (cf. Searle 1992:111). Furthermore, this configuration of elements gives rise to emergent properties not included in the initial description of the elements. The rock as a system has emergent properties. In the same way, the brain as a system of elements or neurons, gives rise to certain mental phenomena (cf. Searle 1992:112). Searle's naturalism is then a form of emergent materialism or naturalism, as was discussed in Chapter 1 of this study (cf. Searle 1992:111).

The history of science and philosophy showed that the study of objective phenomena was more accessible than studying fundamental subjectivity, a state of affairs which led to denying subjectivity ontological status (materialism, physicalism and related problems attest to this fact)(cf. Searle 1992:95). According to Searle (1992:97-99), despite the difficulty of studying subjectivity, or first-person subjective experience, by means of introspection, or from a third-person view, must not mislead us to think that subjectivity and, with that, consciousness and intentionality, are not ontologically real. In contrast to materialism, Searle (1992) does not deny consciousness and mental states/phenomena ontological status.

To summarise Searle's argument: Causal reduction, which aims at redefining phenomena ontologically (ontological reduction), is part of the method of science. This method includes the elimination of subjectivity. This state of affairs, on the one hand, leads to materialism's reductionism and the denial of the reality of subjectivity. Searle therefore rejects materialism. On the other hand, the valid reductions employed in science do not allow for the fundamental asymmetry which exists when studying subjectivity or mental states. When working with objective phenomena (the subject matter of natural science), causal reductions usually lead to ontological reductions. With mental phenomena such as consciousness this is not possible. It is possible to make causal reductions in terms of bottom-up micro- to macrolevel explanations (neurophysiological processes cause mental states), but subjectivity/consciousness/mental states cannot be reduced to these states ontologically. This is then the asymmetry Searle (1992:116) tries to point out, with regard to subjectivity.

Searle then holds consciousness to be both irreducible to other ontological phenomena and caused by neurophysiological processes (cf. Searle 1992:98). His naturalism allows for ontological reductions in terms of micro- to macrolevel explanations: neurophysiological processes cause mental states. But mental states such as consciousness are not reducible to these states, since the subjectivity of mental states (e.g., my experience of pain) is not mere appearance, but ontologically real. Materialism reduces these states to physical processes, since appearances are not real. How then, is it possible to hold a view that can explain mental phenomena in terms of microlevel processes and states and still affirm the irreducibility of mental phenomena to these states? How can mental phenomena be ontologically real? The answer is, that mental phenomena are emergent properties of certain biological systems.

Searle's view of emergent naturalism and his description of consciousness as causally dependent on biological process, while being ontologically irreducible, corroborates the systemic emergent model with its philosophical assumptions developed in Chapter 1 of this study. It allows us to view the model as imbedded within a valid scientific view and methodology. This model also allows us to view the properties of an emergent system as ontologically real without the need to make an ontological reduction. Although Searle (1992) emphasises the reality of subjective states such as consciousness, and points out the asymmetry between reductions of objective and subjective phenomena, the systemic emergent model developed thus far implies that emergent properties, mental or otherwise, are *as such* irreducible to the elements of a system. Searle (1992:116) is then mistaken to restrict this irreducibility to subjective mental phenomena (cf. Chapter 1 of this study). The distinction between mental and nonmental phenomena cannot be found in the irreducibility of consciousness to underlying processes (other nonmental systems exhibit the same properties) but must rather be found in the directionality towards meaningful content as expressed by intentionality.

2.7 DEFINING CONSCIOUSNESS

According to Pekala (1991:31) two general trends in the study of consciousness may be found. The two perspectives are similar to the functionalist-structuralist approaches described above. The "functionalist" perspective investigates the stream of consciousness, or consciousness as a process, while the "structuralist" approach investigates the states of consciousness. Although useful, this distinction is susceptible to misunderstanding (in the way Pekala uses it). This distinction will be used and clarified by looking at definitions of consciousness below.

2.7.1 Baruss (1987)

Pekala (1991:32) refers to Baruss (1987) who did a metanalysis on the definitions of consciousness found in Battista (1978), Bowers (1986), Helminiak (1984), Klein (1984), Merrell-Wolff (1973), Miller and Buckhout (1973), Natsoulas (1978), Pribram (1976), Savage (1976), Strange (1978) and Toulmin (1982). Baruss (1987) classified the definitions of consciousness in three groups:

Consciousness$_1$ — Defines consciousness in terms of potential cognitive functions that denote being alive. These definitions refer to the *characteristics of an organism in a running state which entails the registration, processing, and acting upon information* (Baruss 1987:325).

Consciousness$_2$ — Defines consciousness in terms of subjective awareness and intentionality (i.e., consciousness of something).

Consciousness$_3$ — Defines consciousness as *knowledge of one's existence as a concomitant of one's experience* (Baruss 1987:327).

It should be noted that each of these three groups can be viewed from a dynamic or structural perspective although the emphasis seems to be on the structural. Definition 1 views consciousness as consisting of cognitive states involving processes connecting the states. Definition 2 focuses on intentionality as a static structure as discussed above. Definition 3 seems to indicate a version of the Representationalist view, where knowledge of one's existence involves a static representational state at a particular time.

2.7.2 Natsoulas (1978)

Natsoulas (1978) discusses various definitions of consciousness taking the definitions as found in the *Oxford English Dictionary* (1933) as starting point:

Consciousness$_1$ — **Joint or mutual knowledge** (Natsoulas 1978:909-910). In this sense, consciousness is knowledge that is shared with others. It is an awareness of knowledge by more than one person. It seems as if Natsoulas is aiming at the concept of a societal consciousness: an awareness arising from the interaction between members of a group.

Consciousness$_2$ **Internal knowledge or conviction** (Natsoulas 1978:910). Consciousness is knowledge of oneself in the sense of being one's own witness or observer of one's own acts (Pekala 1991:33). It is standing in a *certain cognitive relation to oneself*. In the logical sequence of the definitions given by Natsoulas, this second definition of consciousness as internal knowledge follows quite naturally from the first (as its opposite) that describes consciousness as external knowledge or socially shared knowledge. Natsoulas (1978:910) hints that this definition is akin to the reflexive dimension of consciousness, i.e., that one is able to stand in a relation to oneself and one is able to know that one is busy with this "distancing".

Consciousness$_3$ **Awareness** (Natsoulas 1978:910). Consciousness is the ability to be aware of something. The emphasis is on both awareness and the object of awareness. Awareness is always of something - it is intentional (cf. Pekala 1991:34). Describing the *nature* of awareness is more difficult since in this definition consciousness is defined as awareness, a concept that needs further explanation. Natsoulas (1978:910) realises this and tries to define what he calls intrinsic character of awareness. The main question, it seems, is how it is possible for awareness to become constituted from the mere nerve impulses stimulated by perceptual signals or information (cf. Natsoulas 1978:911). It is obvious that the awareness one has of a tree, or rather the awareness that the tree is being represented in one's mind, is not the tree itself. The problem is to grasp the contents of awareness since an obvious distinction between stimuli (as external causes) and the contents, or the effects of, for instance perception, which constitutes awareness, must be made.

Consciousness$_4$ **Direct awareness**. This definition refers to the ability to be aware of one's own "acts or affections" (Natsoulas 1978:911). He (1978:911) qualifies this definition of consciousness as direct awareness as follows: *One exemplifies consciousness$_4$ by being aware of, or by being in a position to be aware of, one's own perception, thought, or other occurrent mental episode*. One is therefore directly, or "noninferentially" aware that a certain thought is occurring or has occurred. According to Pekala (1991:33) this, and the previous definition, is how consciousness is currently being defined. However, consciousness$_4$ is described by Pekala (1991:33) as reflective awareness which, according to him, is similar to Satre's (1971) reflective, thetic, or positional self-consciousness. The question is how the reflexivity of definitions 2 and 4 differ; is there a contradiction between definitions, is Pekala's interpretation wrong, or is Natsoulas's definition 2 wrong?

Consciousness$_5$ **Personal unity**. This refers to the totality of mental episodes that constitute a person's conscious being (Natsoulas 1978:912). He (1978:912) regards consciousness$_4$, or the unity of consciousness, as "a matter of degree that is responsive to our own efforts."[70]

Consciousness$_6$ **The normal waking state**. This is the most obvious usage of the term consciousness. It is then a *state* normally equated with being awake (Natsoulas 1978:912). In this general state of consciousness other "processes" of consciousness, such as consciousness$_4$, may occur.

2.7.3 Pekala (1991)

Taking Natsoulas' (1978) definitions as starting point (especially definitions 5 and 6 in which definitions 3 and 4 are implicated), Pekala (1991:34, cf. p.1) defines consciousness as

> *the sum total of one's awareness of (or attention to) one's stream of subjective experience. It includes what Husserl (1913/72) would define as the* ***noeses*** *(the subjective intentional acts of consciousness, i.e., perceiving, willing, imagining, etc.) and noema (the objects of consciousness, i.e., thoughts, feelings, visualizations, etc.) of that experience, including whatever awareness/attention is capable of being aware of, and also encompasses states and altered states of consciousness.*

Pekala thus tried to incorporate both the dynamic and structural aspects in his definition. The problem is that the mere mentioning of the *stream of consciousness* in the definition is not enough to substantiate consciousness as dynamic, since the processes underlying the stream are not accounted for. It seems as if Pekala views it both as a state and dynamic, or rather both as static and dynamic. It is a static state since at a particular time, attention focuses the flux of the stream in a sum total of awareness. It is also dynamic since it involves intentional *acts* which continuously go on. In terms of Pekala's definition, it seems that a confusion exists between what is meant by *state* as implied by the structuralist perspective and *state* as a result of attention or awareness. The structuralist perspective implies that certain elements or states underlie the phenomenon of

[70] Natsoulas' (1978:912) argument seems rather odd when describing consciousness$_5$. Reacting on the *Oxford English Dictionary*'s definition, Natsoulas follows: *One might say that consciousness$_5$ refers to the sum total to date, the whole set of one's mental episodes*. However, Natsoulas says that *such a construal would hide the problems involved in comprehending* ***how*** *the respective totality constitutes one's conscious being.*

consciousness, and this is certainly not what Pekala had in mind. Rather, his definition describes a conscious state as the momentarily static state of awareness as the result of the "freezing" capability of attention. The structuralist emphasis is of course on structure, a structure has a static overtone, but as was seen above, the structuralists did have a very clear atomistic structure in mind when they theorised about consciousness. In the next set of definitions the concept of state will be clarified further.

2.7.4 Bunge and Ardila (1987)

Bunge and Ardila (1987:234-235), in the process of defining consciousness, introduced five concepts (reactivity, awareness, self-awareness, consciousness and self-consciousness) which must be distinguished from each other since what is normally understood by the terms "awareness" and "consciousness" refer to these related but different concepts (Bunge & Ardila 1987:235). Their definitions are *hierarchical*, progressing from the most simple states to the most complex state of self-consciousness.

1. Reactivity or sensitivity — Reactivity or sensitivity means that a thing (whether it be a living or non-living object) reacts or responds (*always or with a certain probability*) (Bunge & Ardila 1987:235) when a certain stimulus (found either externally to, or partly within, the object) is applied to it (cf. Bunge & Ardila 1987:235). Examples of reactivity are photo-sensitivity, chemical sensitivity, and the ability to respond to social stimuli (Bunge & Ardila 1987:235). The ability to react upon or be sensitive towards stimuli is not, according to Bunge and Ardila (1987:235), a test for consciousness.

2. Awareness — Bunge and Ardila (1987:235) define awareness as follows: *If **b** is an animal, **b** is **aware** (or notices) change in **X** (internal or external to **b**) if, and only if, **b** feels (senses) **X** - otherwise **b** is **unaware** of **X***. Awareness requires sense organs.

3. Self-awareness — The difference between awareness and self-awareness is that an animal that is aware (i.e., senses changes in its internal or external environments) is not necessarily aware of what it is feeling and doing (Bunge & Ardila 1987:236). Self-awareness implies that one is aware *of oneself as something different from everything else* (Bunge & Ardila 1987:236). A self-aware being recognises that it is the subject of its own feelings and doings.

4. Consciousness	A further step beyond self-awareness is not only the ability to be aware of feelings and actions, but the ability to think about one's own perceptions and conceptions - this ability entails being conscious (Bunge & Ardila 1987:236). An animal is therefore conscious if it is able to think about its own or some of its own thoughts. According to Bunge and Ardila (1987:236) it is *(N)ot just feeling, sensing, and doing, but (it is) also thinking of what it perceives or thinks*. It is interesting to note that Bunge and Ardila (1987:236) qualify the nature of conscious thought: it may be in the form of images and need not be verbalisable. Furthermore, being conscious of a thought means to be conscious of the process of thinking something, but also of being conscious of what the process is about (or its contents)(Bunge & Ardila 1987:236).
5. Content of consciousness	Their fifth definition qualifies consciousness even further. Consciousness is always consciousness of *something*: *the content (or object) of a conscious state is the object being perceived or thought about while in that state* (Bunge & Ardila 1987:236).
6. Consciousness as a state	The consciousness of an animal is *the set of states of the brain* of the animal *in which (it) is conscious of some perception or thought* in itself (Bunge & Ardila 1987:237). The implication of this definition of consciousness as a state, is that it is not an entity (cf. Bunge & Ardila 1987:237). For that matter there is no such entity as unconsciousness according to Bunge and Ardila (1987:237) - *(I)nstead, there are simply some mental processes that remain nonconscious or preconscious....* It is clear from the implication of this last remark, and from the fourth definition, that they regard consciousness as consisting of mental processes. Just what these mental processes entail must be specified more fully.
7. Self-consciousness	A person (or animal) is self-conscious if *he has consciousness of his own perceptions and thoughts as occurring in himself* (Bunge & Ardila 1987:237). In other words, an organism knows who and what it is (Bunge & Ardila 1987:237).

Bunge and Ardila (1987:237) qualify self-consciousness by a last definition (8) since, according to them, one can only know who and what one is by having some memory of one's past. An individual is then *antero-self-conscious* if he can correctly recall some of his recent past. He is *pro-self-conscious* if he can imagine - not necessarily correctly - his own future. Finally, he is *fully self-conscious* if he is both antero- and pro-self-conscious (Bunge & Ardila 1987:237).

The problem found in Pekala's definition above with *state*, can now be clarified. State must not be seen from a structuralist perspective implying inertia (being static), but must rather be viewed in opposition to substance or entity. *State* is not an entity having substance in the same way a three-dimensional object, such as a teapot, has. It is rather a state which, in fact, is the result of a process. In this way, Pekala's reference to Husserl's act and content makes sense. Consciousness as a process is an act, and as such is a particular state. It can now be seen that Pekala does not incorporate the structuralist perspective at all, since no mention is made of the structure underlying consciousness.

The hierarchical progression of Bunge and Ardila's definitions implies increasing complexity of underlying systems. Although not stated as such, but implied by definition 6, consciousness may be viewed as an emergent property of a specific biological system, since biological processes give rise to a conscious state. All the definitions discussed in this section do have some elements of both the structuralist and functionalist views, but none expresses the relationship between elements or processes underlying consciousness and the process of consciousness clearly. The truth inherent in both perspectives, and the definition of intentionality developed thus far, may be incorporated sensibly by means of a *systemic emergentist* definition.

Consciousness may then be defined as

> *an emergent property of a particular system having a particular structure consisting of various interacting elements. The emergence of consciousness is governed by a process constantly aiming at finding meaningful content.*

It is therefore intentional. Although consciousness is caused by underlying processes, its direction is maintained by meaning. The underlying processes express both the system's dynamic (procedural or acting) nature and its structural nature. It is structural due to the configuration of the elements, and it is dynamic due to the interactions taking place, and again, that particular interactions take place due to the particular structural configuration. What these elements are, cannot be specified at this stage. It could be subsystems consisting of cognitive processes which in turn depend on pure biological systems, or it could directly be biological systems of cells. Similarly, it is difficult to specify the configuration of the elements (or subsystems). Further clues may be found in the following two chapters on cognition. The novelty of this definition lies not so much in relating structure and process, but in viewing consciousness as an emergent property aimed at meaning, or as a process of struggling to find meaning. Seen in this way, the function or purpose of consciousness is established. Indeed its function also determines its existence, and this is what intentionality wants to express: by being an act intending meaning, it comes into existence. No meaningful content implies no consciousness.

2.8 CONCLUDING SUMMARY

2.8.1 The structural psychology of consciousness dominated the last part of the nineteenth century, but the gradual emphasis on behaviour, physiology and function led to its demise. Furthermore, psychoanalytic theory, with its emphasis on the unconscious and on a motivational theory of thought processes, radically changed the subject matter (cf. Sears 1985:208). Even William James' view of consciousness could not halt the shift in emphasis. It could be argued that James' view of consciousness did not fit the psychological paradigms at that time and that it is only now that the relevance of his thought is grasped.

2.8.2 Psychology started off with a dualistic conception of body and mind. At first the emphasis was on mentalistic concepts and consciousness was regarded as a valid scientific subject. The gradual emphasis on physiology and observable/measurable behaviour denied the study of the mental its rightful place. Behaviourism reduced the dualism to a materialistic monism. Psychoanalytic theory operated as a prominent force beside behaviourism for many years in the twentieth century and despite criticisms levelled at both sides, psychoanalytic theory kept mentalism alive.

2.8.3 Structuralism focused on the elements of consciousness, and although it is certainly true that certain elements do underlie consciousness, structuralism's inability to escape from static elementism, analysis and the inability to account for the interactional processes underlying mental phenomena, discounts it as a valid account of consciousness.

2.8.4 James' functionalism is very relevant to the study of consciousness today. Much of what he said nearly one hundred years ago, can be applied to the phenomenon of consciousness as it is understood today. The sections below will refer to certain aspects of his views. Consciousness as a process, as intentional, as ever changing and as having a purpose or function is very relevant to the study of consciousness. Even his views on the relationship between physiology and mentality are relevant today. His view of the role of interests is important to the model of consciousness and cognition developed in this study.

2.8.5 The phenomenological approach was discussed from the perspective of intentionality since it was within this approach that the concept of intentionality was developed as the distinguishing aspect of consciousness. The concept of intentionality was refined slightly by means of certain features implicitly present in the theories of Brentano and Husserl. The dynamic nature of intentionality was emphasised: it is an act rather than a structure.

Intentionality usually refers to consciousness being about some content. It was proposed that intentionality refers to the ability of consciousness to be about *meaningful* content and not about *mere* content. Intentionality characterises consciousness as being a process (not a structure) that constantly struggles to find meaning. In this way intentionality as the distinguishing feature between the mental and non-mental is fundamentally retained.

2.8.6 Recently, consciousness as a phenomenon relevant to cognitive studies gained prominence. Some theorists argued that mentalistic concepts were implicitly present in cognitive science, especially in computational theory, through the problem of intentionality. The problem of the representation of knowledge in cognitive psychology was actually the problem of intentionality since it addressed the content aspect of consciousness. As was seen above, this is a very restricted view of intentionality. The representational problem will also be addressed in the next two chapters.

2.8.7 Current views on cognition and consciousness include two main perspectives, namely one that denies the standard view of consciousness, and one that affirms the reality of consciousness and its fundamentality. It seems that both views reject materialism in their dualistic and monistic forms. Both views assume a naturalistic stance acknowledging the importance of the biological level of analysis. The one rejects consciousness as a unitary phenomenon, while the other affirms consciousness as an ontologically real but irreducible phenomenon, both on grounds of the parallel nature of underlying processes. The rejection of consciousness as a unitary phenomenon implies the rejection of intentionality. The view espoused in this study regards intentionality as a fundamental feature of consciousness, while also acknowledging the diverse and parallel nature of underlying processes. Consciousness is thus an emergent phenomenon.

2.8.8 Various definitions have been discussed from the perspective of structuralism and functionalism. These concepts have been clarified in terms of what is meant by structure and process. The *actual* (being an act or a process) nature of consciousness has been emphasised, and it has been pointed out that both structure and process can be incorporated in an understanding of consciousness. The definition of consciousness at this stage is as follows:

> *an emergent property of a particular system having a particular structure consisting of various interacting elements. The emergence of consciousness is governed by a process constantly aiming at finding meaningful content.*

Consciousness may be viewed sensibly from the systemic emergentist model developed in the first chapter. Underlying this model is a particular philosophical view called emergentist naturalism. In the fist chapter it was called emergentist materialism, but it is felt that the pejorative nature of the term materialism must be avoided.

In terms of the systemic emergentist perspective being developed in this study, it seems as if, in addition to the principle of emergence, the two principles of structure and function (process) play an important role. The principles of structure and function influenced the investigation of consciousness in a certain way, and it seems that a fusion between the two principles is necessary in order to yield a complete view of consciousness. The specific relationship between these two principles needs to be established. In the following two chapters the two principles will function heuristically in order to determine in what way they function in the four main approaches to cognition. A link was made between emergence and intentionality in connection with the phenomenon of consciousness, and in the following two chapters, the various theories of cognition will also be analysed in terms of how the principles of structure and function support emergence in order to account for consciousness and related mental phenomena. The final chapter of this study will indicate the precise meaning of structure, function and emergence, and the relationship between these principles in order to formulate a systemic emergentist model within which the relationship between cognition and consciousness can be viewed.

CHAPTER 3
THE INFORMATION PROCESSING APPROACH TO COGNITION AND BEYOND

3.1 INTRODUCTION

The aim of this study is to relate cognition and consciousness by developing a conceptual framework or model. The model developed thus far is an emergentist systemic one. This particular model has a certain structure consisting of interacting elements. The result of these interactions is emergent properties which cannot merely be reduced to the elements of the system. Indeed, the only way the emergent property can come into being is for the system to be active. The properties arising from the system are also not arbitrary but are propelled or driven by a mechanism we called directionality towards meaning. In terms of consciousness, it was shown in Chapter 2 that consciousness may be viewed as an emergent property of a particular system. Intentionality may, on the one hand, be viewed as the distinguishing mark of mental phenomena such as consciousness but, on the other hand, it was argued that it in fact embodies the directionality-towards-meaning mechanism of emergentist systems. By viewing intentionality as some sort of mechanism, it reflects both the structural and functional nature of the system as a whole: it is both content and act. It was seen in Chapter 2 that the structural and functional perspectives functioned in opposition in the history of psychology. The systemic emergentist framework encapsulates both. In fact, the model developed here, needs both perspectives in order to account for emerging properties of a system. In this and the following chapter, the focus will be on cognition.

Four major approaches to cognition will be considered. In this chapter, the information processing approach and the approach moving beyond the information processing approach in some important respects, will be considered. The following chapter will focus on the symbolic and connectionist approaches to cognition. The various approaches will be examined to determine in what way they incorporate the systemic emergentist principles discussed thus far. The results of the analysis will also be used to shed more light on the systemic emergentist principles. The systemic emergentist principles under consideration in this and the following chapter are structure, function, the relationship between both, emergence and interaction between levels of systems. Simultaneously, the views of the various approaches on consciousness will also be specified. The relationship between cognition and consciousness and the way the systemic emergentist principles support this relationship will be explored.

Although the information processing approach towards cognition was widely studied and many different versions exist, the work of Neisser will be taken as a paradigm example of this approach due to his widespread influence in shaping the field of cognitive psychology in the 60's (cf. Gardner

1985:34,120). But there is another reason for including his work in this chapter. Neisser gradually expressed dissatisfaction with the information processing approach he helped to formalise, and later voiced concern about the exclusion of consciousness from cognitive studies. Both his views on cognition, within an information processing approach and within an approach *beyond* the standard paradigm, will be discussed to determine how consciousness can be accounted for.

3.2 NEISSER AND COGNITIVE PSYCHOLOGY FROM AN INFORMATION PROCESSING PERSPECTIVE

Ulric Neisser's first major work on cognitive psychology was published in 1967. Although his previous work clearly indicated the direction of his thought, it was in *Cognitive psychology*, that his main arguments and thought which would determine the main thrust of his later work, were set forth. His work, *Cognitive psychology*, comprises amongst others an overview of the state of cognitive psychology in the late 60's. He discusses various components of cognition and formulates a theory on cognition consisting of certain elements which influenced his later formulation of cognition significantly (Neisser 1976).

3.2.1 Introduction

Neisser's (1967:3) opening paragraph reveals the main thrust of his thought. Referring to the saying *beauty is in the eye of the beholder*, he states that despite the physiological inaccuracy of the saying, it points towards the central problem of cognition. He follows, ... *whether beautiful or ugly or just conveniently at hand, the world of experience is produced by the man who experiences it*. With this statement, Neisser separates himself from every philosophical or psychological position holding that knowledge of the world mirrors that world.

3.2.1.1 Neisser's view of cognition

Neisser's position reveals a fundamental break with the empiristic tradition which in fact inspired the science of psychology in the sixteenth century. Usually empiricism holds that perception is immediate, i.e., that objects being perceived are copied exactly or mirrored in the mind. Neisser (1967:3) rejects the theory of immediate access to the world. Cognition and perception according to Neisser, are constructive. The world of experience is produced by man. Cognition is, however, not regulated wholly to the subjective realm thereby severing its empirical roots. Cognition needs empirical and/or external stimuli but does not necessarily start at the stimuli. He (1976:4) distinguishes between visual and auditory cognition. Visual cognition

> ... *deals with the processes by which a perceived, remembered, and thought-about world is brought into being from as unpromising a beginning as the retinal patterns. Similarly, auditory cognition is concerned with transformation of the fluctuating pressure pattern at the ear into sounds and the speech and music we hear* (Neisser 1967:4).

Cognition then, as defined by Neisser (1967:4), refers to *all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used.* Even in the absence of relevant empirical stimuli, such as hallucinations, the same process of cognition takes place. According to Neisser (1967:4) cognition, in the face of his broad definition, is involved in every aspect of human experience. Despite this fact Neisser focuses his study on only certain aspects of cognition. Phenomena such as motivation[1] and emotions[2] certainly influence cognition (cf. Humphreys & Revelle 1984). Rather than trying to account for how such influences take place and to what extent, Neisser (1967:5) initially regards them as independent variables, keeping their existence in mind and acknowledging the fact that such variables do influence cognition.

Both stimuli and the constructive process come into play in his theory. His (1967:10,94-95) approach is related to that of Bartlett (1932, 1958)[3] and its roots can be found in the "act psychology" of the nineteenth century. The main thrust of his approach entails that ... *seeing, hearing, and remembering are all acts of construction, which may make more or less use of stimulus information depending on circumstances* (Neisser 1967:10). Act psychology refers to the view that psychology should study mental processes rather than mental contents, and the name of Brentano is usually associated with act psychology (cf. Marx & Cronan-Hillix 1987:81; cf. Neisser 1967:94). The constructive process has two stages, namely a fast, rather crude holistic[4] stage and a second deliberate, attentive and detailed stage (Neisser 1976:10). The mode of execution for the first phase can be described as parallel while the second phase is executed serially or sequentially.

3.2.1.2 Positioning the study of cognition

Neisser positioned cognitive psychology within psychology and related fields by implicitly specifying levels of analysis. He (1967:5) granted the validity of the view that neurophysiological events underlie cognitive processes and acknowledged the advances made in this field. He, (1967:6) however, chose not to focus on this level of analysis since it lies outside the scope of the

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[1] Cf. Fusilier, Gangster & Middlemist (1984); Nilsson (1987); Heckhausen & Gollwitzer (1987).

[2] Cf. d'Ydewalle (1984); Kanfer & Ackerman (1989); Isen (1987).

[3] Bartlett (1932) was of the opinion that remembering takes place by organising knowledge in terms of schemata. Schemata are defined as knowledge structures *or sets of expectations based on past experiences* (Saab, Trottier & Wall 1984:607).

[4] Neisser (1967:10) uses the spelling "wholistic" rather than the more contemporary "holistic".

psychologist's focus for the following reason: in the same way a person trying to understand the programming of a computer in terms of information storage and retrieval, can ignore for all practical purposes the hardware implementation, the psychologist can focus on the working of the mind without being too much concerned with the hardware of the brain. Neisser (1967:6) acknowledged that the computer analogy overstates the case a bit, since the hardware of the brain and the motor system do impose some limitations on information input and behaviourial outputs, but essentially the hardware is of *peripheral interest* to the psychologist. Neisser sympathised with the view of Newell, Shaw, and Simon (1958) who regarded theories on computer programming as having much in common with theories of cognition: *Both are descriptions of the vicissitudes of input information* (Neisser 1967:8). Focusing on a computer programme rather than on the hardware has several advantages over previous conceptions on how the mind works: *Although a program is nothing but a flow of symbols, it has reality enough to control the operation of very tangible machinery that executes very physical operations* (Neisser 1967:8). The computer analogy[5] also enables one to visualise cognitive processes as operating on information. Neisser (1967:9) thus embraced information processing as applied in programming concepts in his descriptions of cognitive processes. He (1967:7), however, rejected the information theory of Shannon (1948) who espoused information in terms of bits and binary choices since it is applied to unselective systems not similar to the dynamic nature of human reactive systems (cf. Baird 1984).[6] Neisser's (1967) level of analysis falls within the psychological level of analysis described in Chapter 1, with specific reference to the computational level. He regards the translation level or implementation (hardware) level as outside his field of study. In the following chapter it will be seen that the computer analogy as used by, amongst others, Newell, goes much further than mere programming and indeed takes the hardware level very seriously.

3.2.1.3 Summary

Neisser viewed cognition as fundamental to human functioning but restricted himself to a description and explanation of cognitive processes involved with visual and auditory cognition. His descriptions of processes were couched in informational processing terms drawing upon the insights provided by the computer (programming) analogy. He rejected the idea that the mind mirrors the world and views cognition essentially as constructive and not replicative. What construction entails, will be discussed below, but it draws heavily on what Neisser calls the "act psychology" of the previous century. Thus Neisser's cognitive psychology underscores the dynamic nature of mental phenomena which was discussed in Chapter 2 of this study. In the next sections an overview of Neisser's (1967) theory will be given.

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[5] Neisser (1967:8) preferred the term "program analogy" to emphasise the programme rather than the hardware.

[6] See also Shannon & Weaver (1962). For the application of information processing theory in the field of psychomotor performance see Hick (1952), Hyman (1953), Fitts & Posner (1967), Singer (1980), Schepers (1987), Schmidt (1988), and Maree (1995).

3.2.2 The higher cognitive processes

Neisser (1967) discusses visual (Neisser 1967:15-170) and auditory cognition (Neisser 1967:173-276) in two parts (Part II and III). The last part (IV) of his work is more tentative and discusses higher mental processes. Indeed this last part foreshadows his later 1976-work and in terms of boldness opens more interesting perspectives than the description of cognitive psychological research up to 1967 found in part II and III of his work under discussion.

It is sensible to start the discussion with part IV which deals with the higher mental processes, namely memory and thinking. In this way the difference and similarity between Parts II and III and the higher mental process can be discerned more easily. According to Neisser (1967:280) his discussion on visual and auditory cognition focuses on *the cognitive transformations of present (or very recent) input* while the higher mental processes presume the utilisation and transformation of stored information. The concept of transformation or construction is central to Neisser's cognitive theory and is based upon the hypothesis that information, or whatever is perceived or cognised, is transformed or used rather that replicated. This means in connection with the higher mental processes that what is found in memory in terms of storage of information is not duly a duplication of stimuli or information. Whatever is stored in memory is a transformed construction of information. Although Neisser's (1967) treatment of the higher mental processes such as remembering, thinking and problem solving, is cursory, he proposes a tentative theory of the higher mental processes based upon the basic structure of the primary cognitive functions of visual and auditory cognition. This structure consists of levels of processing and a description of what processing entails. The levels of processing include a fast, holistic and largely parallel phase and a sequential and more detailed phase. Processing itself is described in terms of construction which is mainly a process of synthesis even when it seems like an analytic activity (such as occurs when attention seemingly analyses objects or events).

3.2.2.1 The reappearance hypothesis

One important aspect central to the concept of higher mental processes is that the past is somehow preserved and used by the cognising subject (Neisser 1967:280-281). According to Neisser (1967:281) the question cognitive psychology has to answer is not how information regarding the past is stored neurologically, but how (stored) information is organised and used. Rather than asking how information is stored, one should ask what is stored and subsequently used in the higher mental processes. In this regard, Neisser (1967:281) is rather adamant about the fact that what is stored, or what is found, in memory is never a duplicate of what was experienced in the first place. According to Neisser (1967:282), the hypothesis that stored information consists of ideas that are simply reused or aroused at a later stage is false, although it is a hypothesis taken for granted in the history of psychology. What he (1967:281-282) then calls the "reappearance hypothesis" can be found in the influential account of memory of the empiricist philosophers, namely Hobbes, Locke, Hume and Mill. They assumed that ideas are copies of sensory experience which become associated in light of similar or successive recurrence of original experiences (Neisser 1967:281). When an idea becomes conscious, it is in the order of association of the original experiences. The conscious or remembered idea is then a copy of the original experience or sensation.

3.2.2.2 Reappearance and associationism

Remembering is therefore *only the arousal of something that already exists* (Neisser 1967:281). Interestingly, William James (1890:236) said of the reappearance hypothesis, or the idea that cognitive units exist permanently and disappear and reappear: *A permanently existing 'idea' or 'Vorstellung' which makes its appearance before the footlights of consciousness at periodical intervals, is as mythological an entity as the Jack of Spades* (cf. Neisser 1967:282). Neisser (1967:282) finds the reappearance hypothesis, despite James' view, in associationism, psychoanalysis, behaviourism and in Gestalt psychology. The reappearance hypothesis applies not only to "ideas", or rather to cognitive units, but also to behavioral units as is the case with behaviourism. The association formed between stimulus and response supposedly can be elicited at a later stage in light of appropriate stimuli. The strength of the reappearance hypothesis lies in its associationistic structure, since associationism as discussed in the previous chapter of this study (see the excursion: *The problem of synthesis - associationism and the principle of association*) implies relationships between invariant elements. The invariancy of elements, or its static nature, as found in the Gestaltists and structuralists and the empiricist history behind associationism, naturally lead to the doctrine of association. Neisser's view (substantiated by William James' actualist theory), accentuates the problem with associationism from the perspective of his constructionism. Neisser (1967:283) does not find it surprising that behaviourists and psychoanalysts continue to make the reappearance assumption on grounds of their roots in associationism. Historically, the Gestalt theorists oppose the behaviourists and psychoanalysts, but even they use the reappearance hypothesis: stored information consists of copies of earlier events which are linked, or associated, to form complex ideas. By means of these links events are aroused from time to time (cf. Neisser 1967:283 and Osgood 1953).

3.2.2.3 The constructionist principle

In view of his constructionist inclination, Neisser cannot accept the reappearance hypothesis and refutes it with reference to experience:

> *If Reappearance were really the governing principle of mental life, repetition of earlier acts or thoughts should be the natural thing, and variation the exception. In fact, the opposite is true. Precise repetition of any movement, any spoken sentence, or any sequence of thought is extremely difficult to achieve* (Neisser 1967:282).

In his discussion of visual and auditory cognition, Neisser demonstrated that adaptive variation is the rule rather than invariant repetition, and concludes that cognition's governing principle is construction rather than reappearance (Neisser 1967:282).

> One should be careful with this line of reasoning: does Neisser reject the reappearance hypothesis on grounds of contrary empirical evidence (i.e., evidence supporting the constructionist principle), or does he identify or use the reappearance hypothesis as a notion to support his constructionist hypothesis? The argument could easily become circular and the uneasiness regarding a circular argument is strengthened by his statement that *(I)n this view, mental processes are by no means " constructive"*, after he quoted Mill on the reappearance hypothesis: *Our ideas spring up, or exist, in the order in which the sensations existed, of which they are copies* (Dennis 1948:142, cf. Neisser 1967:281). It seems as if Neisser wants to show the absurdity of the reappearance hypothesis by means of invoking the construction principle, thereby subtly predisposing the reader to believe that the construction principle is in fact true. This concern of a circular argument can, however, be set aside as soon as Neisser's parts on visual and auditory cognition have been discussed and it is shown that experience or empirical evidence do, in fact, exist in support of the construction principle.

The above excursion does amplify the major, if not central, role the construction principle plays in Neisser's theory of cognition. It further indicates the way one could in fact interpret his theory: should one regard evidence in support of the construction principle as a refutation of the reappearance hypothesis, or should one regard lack of support for the reappearance hypothesis as support for the construction principle? Of course, it depends on the logical relationship between construction and reappearance, since an either-or mutually exclusive relationship between the two principles would indeed lead one to accepting one hypothesis if the other is untenable. The second question pertains to the centrality of the concepts to a theory of cognition: what happens to a theory of cognition if one of the concepts should be deemed false? If the construction principle is found to be untenable, in what way will it influence Neisser's theory? As a guiding principle it can be stated that if the construction principle is removed from Neisser's theory, either empirically or conceptually[7], and if thereby one reduces the explanatory power of his theory, the construction principle is then shown to be the basis of his theory (and by implication the reappearance hypothesis is then suspected to be a central concept to alternative cognitive theories if the reappearance and construction concepts contradict each other). In determining the role of the constructionist principle, two questions will be answered in due course: (a) The first question is whether the reappearance and construction concepts contradict each other? Are they mutually

[7] To remove the concept of construction empirically means that it could be refuted empirically. Removing it conceptually means that one engages in a thought experiment to see whether the theory still can perform adequately without the particular concept.

exclusive? (b) The second question is whether the construction principle is central to Neisser's theory?

3.2.2.4 Clarification of the constructionist principle: act and content

The appearance hypothesis entails that stored information consists of copies of dormant ideas, images or responses (Neisser 1967:284). Neisser's thesis is that perception (the starting point of cognition) and thought (higher mental processes which include recall of previously stored information) are constructive. He (1967:284-285) acknowledges that repeated recall of the same event seems similar, just as repeated perception of the same stimulus seems similar, despite the fact that both recall and perception construct, or use, stored visual information or stimuli. Repeated perception or recall thus is determined by the stimulus in each case leaving the impression that repeated recall of the same event, or perception of the same object, seems similar. Although Neisser uses the perception of an object, in which perception is determined by the stimulus in the constructing act, as an analogy to describe the nature of recall using the raw material of memory,

> *this is not to say that the stimuli themselves are copied and stored; far from it. The analogy being offered asserts only the role which stored information plays in recall is like the role which stimulus information plays in perception* (Neisser 1967:285).

Previous events, behaviour or stimuli are never themselves copied to the mind and do not enter awareness directly. Seeing an object does not take place directly, but the object seen is the result of a process of construction:[8] perception makes use of relevant stimulus information. In the same way, the recall of an event does not happen because traces of that event exist in the mind, but takes place only after an elaborate process of *re*construction, a process ... *which usually makes use of relevant stored information* (Neisser 1967:285). This last remark lets one wonder what "relevant stored information" is, if not traces of the original event? Trying not to fall into the trap of acknowledging that the relevant stored information somehow is related to the original event, he explains that *the only plausible possibility is that it consists of traces of prior processes of construction* (Neisser 1967:285). The traces left in memory then, is not directly of original events or images but traces of constructions (*...human memory stores information about processes rather than about contents*) (Neisser 1967:296). Recall consists of a synthesis of previous constructions. However, the trace stored in memory is not the product of a construction, but the act of construction (Neisser 1967:285). For instance, after learning the sentence "Mary had a little lamb", the subsequent reciting of the sentence at a later stage does not entail the recall of the exact words of the sentence, but is a reconstruction of traces left by the first constructive act. The product of the first constructive

[8] This process of construction could also include storing eye movements etc. when a particular perception is taking place. A similar position is expressed by Bradley, Cuthbert & Lang (1988). They found that reproducing eye movements when an event was first perceived facilitates recall for that event.

act when hearing the sentence will be "Mary had a little lamb". The memory trace will then not be the product but the act of construction itself. Recalling the sentence will entail a reconstruction of the first constructive act and somehow the product of reciting the sentence will mysteriously still be "Mary had a little lamb". According to Neisser's proposal it is not the same sentence but the result of construction upon construction. What is more, is that even the traces of acts are not simply revived (Neisser's initial problem with copies of stimuli), but are *used as information to support a new construction* (Neisser 1967:286).

The question then, is how do subsequent reconstructions arrive at approximately the same *content* since what is found in memory are traces of *acts* of constructions? Neisser's argument seems slightly forced. Neisser wants to avoid the fact that content is copied to awareness, or merely revived, and in this way throws out content *per se*. One may justifiably ask why it is so important not to acknowledge that something of the original event or stimuli is preserved. It could be possible that traces of the original objects are stored and that these traces are utilised in the act of construction (this possibility will be discussed in Chapter 4 of this study). It seems as if Neisser forces the mutual exclusivity of the reappearance and the construction hypotheses to such an extent that his construction principle becomes suspect. Neisser understandably tries to avoid the reappearance hypothesis at all costs and therefore focuses exclusively on the acts of constructions, or rather on the actual nature of cognition. This focus on the actual nature of cognition does in fact express the nature of intentionality discussed in the previous chapter, but intentional acts always point to some content. What is stored could be either traces of constructions or something similar to the original stimulus, but the reappearance hypothesis states that information is simply revived while the construction principle entails that stored information is used rather than copied. In his argument, Neisser failed to distinguish clearly between the presumably false premises found in the theories upholding the reappearance hypothesis, namely, (a) information is simply revived, and (b) what is perceived or recalled is simply copied or mirrored in the information eventually stored. Premise$_a$ refers to the process of perception or recall (that is, the process of cognition), and premise$_b$ refers to the content of cognition. He argued against both premises simultaneously, therefore confusing both aspects in his own account of the construction principle. Although, as was seen with the explication of intentionality, one cannot sever the bond between what is recalled and the act of recalling, the two aspects, for the sake of clarity, ought to be distinguished. One may even refine the terminology: the act of construction (verb) and the product of construction (noun) are two separate aspects even though the same word is used (construction). The memory trace, be it the result of a cognitive process called a constructive act, could be called anything, even a construction, but this is not to say that it does not *resemble* the original stimulus in some way even though it is not an exact *copy* of the original stimulus. Even if it does, in fact, resemble the original stimulus in some way (contrary to Neisser's opinion), it is not to say that it is simply revived but, indeed, may be reconstructed anew.

In fact, in his concluding paragraph of Part I on visual cognition, Neisser (1967:170) realised that one cannot dispense of content altogether:

> *My own view ... is that both memory images and percepts are constructed anew on every occasion when they are experienced. ... This approach ... necessarily is unsympathetic to the notion of a fixed and segmented record of the past. But there can be no disputing that* ***information about past events*** *is somehow stored, and to this extent those who argue for the existence of "memory traces" are surely correct. The present point is* ***only*** *that the information is not stored in the form of images, visual or otherwise* (Neisser 1967:170).[9]

Visual images, for instance, are then constructed from information (Neisser 1967:170). However, the above discussion showed that Neisser (1967), towards the end of his work, negated content in favour of the traces of *acts* of construction which are stored and used.

3.2.2.5 The role of cognitive structures or schemata in higher cognitive processes

Neisser (1967:286-292) elaborates on the construction principle when discussing cognitive structures. He identifies three levels of construction, two of which have been assumed in the discussion thus far. The first level of construction takes place in the preattentive processes where units are delineated, providing partial cues and controlling simple responses (cf. Shiffrin & Schneider 1977). The second level is that of focal attention[10] where complex structured objects or movements are built. The third level is that of background processes *which build and maintain schemata to which these objects are referred* (Neisser 1967:286). This last level or background construction process is where spatial, temporal and conceptual frameworks are built. Seeing a familiar face happens in a spatio-temporal framework, incorporating aspects such as the person's relevance to the perceiver, and his appearance at a particular time and place. This background framework creates a "generalised reality orientation", a description Neisser (1967:286-287) borrows from Shor (1959) to indicate what is meant with "cognitive structures". According to Neisser (1967:287) a cognitive structure *...may be defined as a nonspecific but organized representation of prior experiences*. He goes on to qualify what is meant by cognitive structures:

> *Our grasp of the surrounding geography, our understanding of American history, our "feel" for driving a car, our "intuitions" about linguistic form are all the result of a great number of individual experiences, but they do not reflect these experiences separately. One easily forgets the occasions on which one learned how the local streets are oriented, what the*

[9] Emphasis mine.

[10] Cf. Garner (1974) for a discussion of *attention* in the information processing approach.

Civil War was about, how to shift gears, or how to speak grammatically, but they leave a residue behind. Because these residues are organized in the sense that their parts have regular and controlling interrelations, the term "cognitive structures" is appropriate for them... (Neisser 1967:287).

In connection with the higher mental processes such as learning and remembering, cognitive structures are called schemata. Schemata play a central role in cognition, since information is organised in terms of them (cf. Bruner 1957). In Neisser's (1967:287) nomenclature, schemata are constructions, or rather, the traces of the process of construction. The cognitive structure, or schema, is thus a product of some sorts of the constructive process. Related knowledge about certain experiences is incorporated in a schema. When recall takes place, a particular schema is activated which facilitates recall of related or associated facts. The relationship between interests and memory can be explained by the functioning of schemata, since facts incorporated in a schema relevant to one's interests are easily activated and recalled (cf. Neisser 1967:288; see the discussion on William James in the previous chapter). Schemata make recall possible but, since they are organisational structures for a particular body of knowledge, they frequently have the negative effect of biasing and distorting recall and the initial construction of information (Neisser 1967:289). The expression "beauty is in the eye of the beholder" illustrates the fact that one frequently perceives what one expects to see. Even the recall of an episode may be filled with facts which were not initially part of the original experience.

3.2.2.6 The role of time and space in cognition

In his discussion of cognitive structures, Neisser includes time and space. Obviously cognition takes place sequentially, but the temporal sequence is not necessarily preserved in the cognitive structure, although a certain class of structure will preserve the sequence such as, what a person did yesterday, what he does today and what he will do tomorrow (Neisser 1967:290-291). However, actual temporal relations between successive stimuli, when perceiving or learning, usually are not deposited the same way in memory. Learning a language, for instance, took place by learning certain words first, but this temporal sequence is not reflected later on when recalling and using the language (Neisser 1967:291). The same goes for learning taking place within a certain spatial environment (Neisser 1967:291-292).

3.2.2.7 The central executive and the control of cognition

Another problem for Neisser (1967:292-296) in describing higher mental processes is that of the executive, i.e., who or what is doing the thinking, processing or construction? He (1967:293) cites Bartlett (1932:206) at this point: *An organism has somehow to acquire the ability to turn round upon its* *own 'schemata' and to construct them afresh*. Neisser (1967:293) asks the question whether one should posit a "homonculus" - a little man in the head - who executes the decisions and does the constructions:

> *If we do not postulate some agent who selects and uses the stored information, we must think of every thought and every response as just the momentary resultant of an interacting system, governed essentially by laissez-faire economics* (Neisser 1967:293).

Neisser is arguing against psychoanalysis, behaviourism and Gestalt psychology. According to him, these theories all reject the notion of a separate processor or executive responsible for cognitive output: what seems like executive processes, such as problem solving and thinking, are reduced to existing response strengths and adaptive behaviour (Neisser 1967:294-295). The problem, which is quite obvious with behaviourism, is the fear of the soul or mind. By positing an executive or central processor, psychology returns to the unscientific concept of mind[11] (cf. Neisser 1967:295). Furthermore, if one postulates an executive, does this not lead to an infinite regress since the question each time is who governs that particular executive and so on? Neisser (1967:295-296) finds an answer in the computer analogy discussed above. The positing of an executive need not lead to an infinite regress since the current[12] computer model incorporates the idea of an executive routine. Basically it entails the idea that the executive routine uses, directs and selects subroutines to execute various tasks. There exists no higher level executive routine than the main routine.[13] The main programme also need not incorporate copies of subroutines and memory as is the case with the homonculus idea. Neisser thus posits a central executive responsible for selecting and directing processes similar to the main routine idea in computer programming. Although Neisser (1967:296) uses the computer analogy in this regard, he cautions that the analogy is still imperfect since the executive routine of a computer must be established by a programmer from the start. Few programmes are able to modify their own main routines in the light of experience as extensively as is the case with humans (cf. Neisser 1967:296).

3.2.3 Visual cognition

In discussing visual cognition, Neisser (1967:16) rejects three common assumptions underlying theories and experiments on visual perception:

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[11] Or consciousness. See Chapter 2.

[12] Current, that is, for Neisser in the 1960's.

[13] Neisser (1967:296) states: *...the regress of control is not infinite: there is a "highest", or executive routine which is not used by anything else*. Of course this is true if one restricts the discussion to a specific programme. It is however also true that with current computers, for instance an IBM compatible machine running under MSDOS (Microsoft Disk Operating System), a programme (and its main routine) is actually executed under the control of a hardwired executive (BIOS) and a software executive (DOS) called the operating system. Neisser's point that the regress stops somewhere, is nevertheless still valid.

a. That visual experience mirrors or copies the perceived stimulus,

b. that the time required for a particular visual experience equals the time from the onset of exposure to the visual stimulus until its termination, and

c. that a subject's experience of the visual stimulus is mirrored by his/her verbal report of the stimulus.

Neisser (1967:16) counters these assumptions by the following:

a. Visual information is not passively received, since it is subjected to a complex process of analysis and construction.

b. This process takes place over a period of time not restricted to the exposure time to a stimulus. Tachistoscope studies show that even a brief exposure in terms of milliseconds results in visual experience. This implies that the stimulus must be preserved somehow to be available for further processing.

c. Verbal report depends not only on the visual stimulus, but on other factors as well.

Neisser's (1967:16) main thesis that cognition, and in this case visual cognition or rather visual perception, is constructive can easily be discerned here. He shows with reference to certain experiments that perception is in fact constructive which takes a certain amount of time.

3.2.3.1 Iconic memory

The first fact he (1967:16-18) establishes with reference to empirical experiments using mainly tachistoscope studies, is that visual sensation could outlast the visual stimulus. Visual input seemingly is buffered but is susceptible to rapid decay. Information can, however, be read from this buffer, *just as if the stimulus were still active* (Neisser 1967:18). It furthermore seems that the information in this buffer is equivalent to a visual image. Neisser (1967:20) typified this buffering process as "iconic memory" and the image as the "icon" (cf. Di Lollo & Dixon 1988). Iconic memory lasts about roughly one second but, since it is a visual memory, visual variables such as intensity, exposure-time and post-exposure illumination influence its duration (Neisser 1967:20). Of importance, is that the duration of the icon is affected by the length of exposure to the stimulus and the intensity of the stimulus, but only up to a certain point (Neisser 1967:21-22). The post-exposure field, or subsequent visual input, also has an effect on the duration of iconic memory, since a later stimulus may obscure (or mask) the memory of an initial exposure in a tachistoscope experiment (Neisser 1967:22,24). This phenomenon is called backward masking (cf. Doyle & Leach 1988).

Neisser (1967:15-45) starts his discussion of visual cognition with the very first few milliseconds of visual perception. Information is picked up by the eyes, some form of this information is stored for a brief period of time in a buffer which he calls iconic memory, and then this information is coded to enable a person to give a verbal report on what he/she saw. Neisser (1967:16-17) uses evidence from tachistoscope studies to clarify this process. In a typical tachistoscope experiment, a subject is required to report after exposure to brief flashes from the tachistoscope on what he saw (cf. Neisser 1967:15). Usually the same stimulus is presented at progressively longer exposure times. As a rule, a stimulus becomes recognisable at a certain exposure time. Although Neisser presents a reasonably careful argument on the process of first visual impressions, his discussion is biased in terms of the experimental evidence he uses. The experimental method, i.e., using a tachistoscope and requiring subjects to report on what they saw, necessarily requires the investigator to explain the process of the experiment. Such an explanation does not necessarily relate to real life visual processes.

3.2.3.2 Factors influencing the ability to report on the perceived image

For instance, Neisser (1967:36) postulates a verbal coding process which uses the information that is stored in the iconic memory buffer in order to enable the testee to report on what he/she actually saw. Although such a verbal coding process presumably is required when the situation dictates the need for verbal report, such as in an experimental situation, the question remains whether a person verbally codes everything he/she sees under normal circumstances. Neisser (1967:36-38) is, however, conscious of the fact that he is arguing about tachistoscope data and he tries to explain the processes taking place in terms of the experiments. He (1967:36), for instance, asks how it is possible that a subject can report the contents of the iconic memory buffer in a tachistoscope exposure, since it decays very rapidly. He (1967:36) presumes that the content of the iconic memory is passed on to a more permanent form of memory which *on logical, phenomenological and empirical grounds...must be words. The subject formulates and remembers a verbal description of what he has seen* (Neisser 1967:36). The subject therefore verbalises his visual images. In order to perceive a tachistoscope presentation, certain visual variables affect performance in terms of the availability of the icon before it decays. Likewise, the ability to report on what was seen, is influenced by what Neisser (1967:36) calls coding variables. Visual variables include exposure time, intensity of the stimulus and post-exposure field. From the studies Neisser discussed, it is clear that longer exposure time and brighter stimuli curtail the rapidity of decay of iconic memory, although the useful life of an icon is not identical to exposure time (Neisser 1967:22). The post-exposure field also influences the perception of an initial stimulus. In this regard, Neisser (1967:22-27) discusses the phenomenon of backward masking which is the effect of a second exposure on the perception of the first exposure.

3.2.3.3 Perceptual set

One of the aspects that has an effect on the quality of reporting what is seen, is perceptual set (Neisser 1967:39; cf. Postman & Bruner 1949). This means that the accuracy[14] of a subject's report can be increased by priming or focusing his attention on what to expect in a particular experiment.[15] In certain tachistoscope experiments the subjects can focus on either the object (e.g., reporting "two blue stars and four red circles") or on the dimensions (e.g., red, blue, two, four, star, circle)(cf. Neisser 1967:40).[16] What is interesting is that accuracy of report is improved by priming the subject on how to encode the stimulus beforehand when a subject is required after exposure to a stimulus to report on dimensions or attributes. Seemingly, perceptual set influences the order of encoding, i.e., the subject codes the icon in terms of the perceptual set by coding the attributes of the image. By encoding the image or icon as an object, overall accuracy on what he has seen is higher than with dimension coding, but no significant increase in accuracy for reporting on dimensions was found. Neisser's (1967:40-41) conclusion is that perceptual set affects what a subject does during the brief period of iconic storage. Perceptual set can also influence the coding process if imposed after an image is stored in the iconic memory buffer as long as the image lasts. Although Neisser initially mentioned perceptual set as a coding variable influencing verbal report, it seems clear that perceptual set does not only influence the order of verbal report but mainly the order of coding the image when storing it in iconic memory. The effect of set or priming before exposure, or after exposure, shows that

> *(T)here are no instantaneous perceptions, no unmediated glances into reality. The only way to use the term "perception" sensibly is in relation to the extended processes that can go on as the icon continues* (Neisser 1967:41).

3.2.3.4 The span of apprehension and ease of coding

Other aspects that influence the accuracy of report are of course what Neisser (1967:41-43) calls the span of apprehension or the amount of information which can be remembered within a short

[14] Not only accuracy but also speed of reacting can improve with priming as was demonstrated by Simon (1988). Cf. Kirby (1976). Also Soetens, Boer & Hueting (1985); Downing (1988).

[15] For recent research on set, priming and expectancy in a broader context of cognition, see Banks & White (1985); Colombo & Williams (1990); Coren, Porac & Theodor (1986); Darly, Fleming, Hilton, & Swann (1988); Dosher, McElree, Hood & Rosedale (1989); Duffy, Henderson & Morris (1989); Flowers, Nelson, Carson & Larsen (1984); Grainger, Colé, & Segui (1991); Lindauer (1990); Madigan, McDowd & Murphy (1991); McKoon & Ratcliff (1980); Peterson & Simpson (1989); Ratcliff, McKoon & Verwoerd (1989); Segui & Grainger (1990); Shoben, Sailor & Wang (1989); Watkins & Gibson (1988); Whitlow (1990); Winnick & Penko (1989). See also Aderman & Smith (1971). Haber (1966) discusses the effects of set (i.e., priming the subject to establish a certain set) in terms of two hypotheses: (a) set is involved in perception itself thereby enhancing what is actually perceived (the works of Bruner 1957 and Neisser 1967 are applicable here); (b) set only involves memory and enhances categorisation and the response to perception (cf. McAndrews, Glisky & Schacter 1987; Winnick & Penko 1989). Subsequent research on set and priming must then strive to link these two alternative explanations. On priming explained within a connectionist paradigm (discussed in Chapter 4 of this study) see Lukatela, Turvey, Feldman & Carello (1989).

[16] Cf. Kingstone & Klein (1991).

exposure time, and the ease of which a certain image can be coded (Neisser 1967:43-45).[17] Presumably, certain visual images are more easily remembered than others. If the stimulus comprises a long array of numbers not having an apparent pattern such as *149162536496481*, it is clear that recall or even coding will be difficult even if a long exposure time is allowed (Neisser 1967:43). What is important to realise is that the efficiency of a verbal coding variable, such as ease of coding, depends on the ability to recognise patterns before naming them (Neisser 1967:45). Even if a stimulus has an easily recognisable pattern, visual factors, such as the length of exposure time, can limit the staying power of an icon so that there is no time to recognise the pattern (Neisser 1967:45).

3.2.3.5 Recognition

Between the process of seeing and reporting, an essential stage of coding was assumed above. Coding the image stored in the iconic memory buffer can be done efficiently, if it is recognisable. It is usually discussed under the topic of "pattern" or "figure" recognition. This should not be confused with being able to recognise a pattern in the stimulus itself such as perceiving the array *001 001 001* as having a repeatable pattern or rhythm (a distinction Neisser 1967:43-45 does not point out[18]). Neisser's (1967:46-85) discussion of "pattern recognition" deals with the question how patterns or figures such as the letter *A* are recognised. The problem at this stage is how it is possible to recognise certain images such as that of a teapot or a letter *A* as being just that, despite the fact that one encounters various types of teapots having different colours or shapes, or various handwritten letter *A*'s?

Neisser (1967:48-49) considers recognition to take place whenever a single response is evoked consistently by a stimulus. When a person recognises an object he, in fact, categorises it and Neisser (1967:49) regards categorisation and recognition to be one and the same process. Categorising or recognition is, however, not equivalent to perception since certain cognitive processes such as iconic storage do not necessarily involve categorising.[19] Categorising in the sense Neisser uses the term takes place whenever an object is *named* (Neisser 1967:49). One therefore recognises the letter *A* whenever one is able to consistently name it as such. The problem of pattern recognition is probably best described by using letter recognition as an example and

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[17] Cf. Kantowitz (1985) for an overview of the problems involved in *capacity* in human information processing.

[18] One could easily assume that Neisser (1967) confuses the two types of "pattern recognition" since he ends Chapter 2 with a discussion on "ease of coding" where the recognition of rhythmic type patterns are reviewed, and Chapter 3 starts with "pattern recognition" dealing mainly with how images such as letters or faces as patterns or figures are identified.

[19] It should be noted that Neisser (1967:49) assigns a certain meaning to the term categorising by distinguishing between "classification" and "literal". An object can be classified as a dog, or one can have a literal image of a dog, without necessarily naming or categorising it as a dog as in the case with an iconic image. One should therefore distinguish between "naming" and "copying." Some form of the term category may apply to both usages: in the first instance one could say that the object is categorised as a dog while, in the last instance, similar objects can be categorised together.

Neisser (1967:49-50) asks how "stimulus equivalence" is possible in the light of different visual configurations of, for example, the letter *A*. Neisser discusses two possible explanatory theories of pattern recognition, namely the template matching theory, and the feature analysis theory (cf. Allen & Emerson 1991 for the current research paradigms of this problem).[20]

(a) Template matching theory of pattern recognition

The template matching theory entails the recognition of a figure due to its correspondence with a model or template (Neisser 1967:50). It is difficult to localise the model or template but presumably it exists in a memory trace. The problem with the template theory is that the perceived figure ought to sufficiently overlap the template in order to be recognised. The match between a template and perceived figure presumably cannot take place when a difference in size, location or orientation between the perceived image and the template exists (cf. Neisser 1967:51 Figure 11, also p.61). Neisser (1967:52, cf. p.64) however, goes on to show that figures can be recognised despite their location on the retina. Furthermore, figures are recognisable in principle, despite differences in orientation, provided a person knows which side of the figure is its top (Neisser 1967:54).[21] The same probably goes for size: an object is recognisable even if it is enlarged (Neisser 1967:58). Although a modified template-matching theory - for instance by postulating a pre-recognition processing stage theory, such as a *normalisation*[22] stage, which occurs when different hand-written A's are perceived as an A - may explain some features of pattern recognition, it cannot be complete since the question remains how it is possible to recognise a *Q* as a Q and not as an *O* (Neisser 1967:64). Presumably a normalisation process would have allowed one to disregard the very small difference between an *O* and a *Q* (see Footnote 22).

(b) The feature analysis model

The feature analysis model could explain some of the problems. This model is based on Selfridge's (1959) model for pattern recognition called *Pandemonium* (see Figure 5). The Pandemonium-model consists of three levels[23] of various demons (using Selfridge's metaphor), namely the cognitive, and the computational demons and the decision demon (cf. Neisser 1967:74-75).

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[20] Cf. also Allen & Madden (1990).

[21] In order to refute the template matching theory it is sufficient to state that recognition is *in principle* possible, despite the orientation of the figure. Neisser (1967:54-57) points out certain difficulties with regard to the orientation of a figure such as the knowledge of the perceiver of the phenomenal orientation of the figure, i.e., knowing which side is up even though the figure is upside down. This principle does not hold with reading (Neisser 1967:55) and with children's perceptual abilities (Neisser 1967:55-57) for different reasons. Cf. also Klopfer (1991).

[22] Normalisation is used especially with some computerised pattern recognition programmes. The process entails displaying a pattern on a grid of dots. Outlier dots are removed and gaps are filled in by the programme to reduce the figure to a recognisable pattern (cf. Neisser 1967:63 Figure 17).

[23] Actually, Neisser (1967:75, figure 22) depicts four levels, the first being the data or image demons.

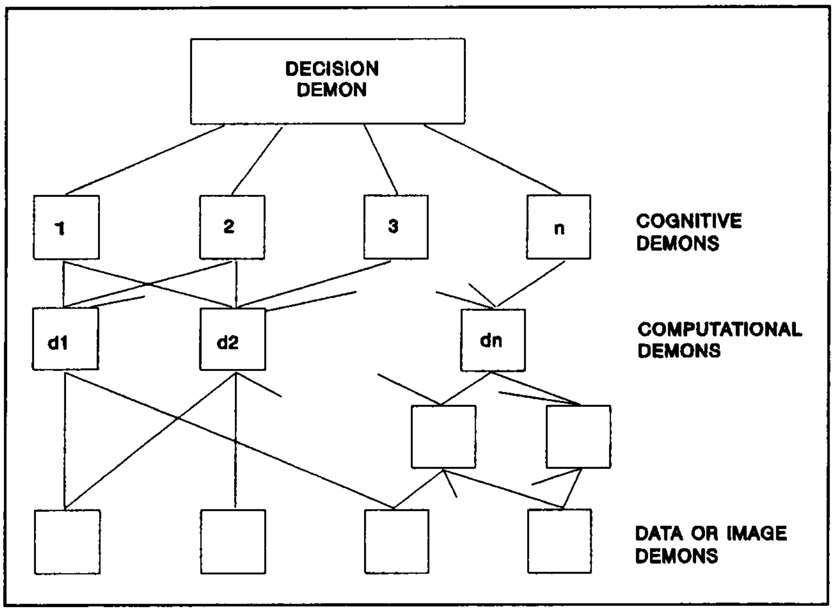

Figure 5 Parallel processing in Selfridge's (1959) "Pandemonium" programme (adapted from Neisser 1967:75)

The computational demons perform various operations on information received from the stimulus. They do this simultaneously. The cognitive demons, which, for instance, represent various patterns such as letters of the alphabet (Neisser 1967:74), continuously scan the input presented to them by the computational demons for evidence that they, the cognitive demons, are represented in the input. Finding such evidence, a particular cognitive demon emits a loud shout, and if it is loud enough, this is taken by the decision demon as evidence that the pattern is recognised. The following aspects seem important:

1. In order for a pattern to be recognised, an image or information reaches a first level of feature analysers:

   > *At the first level are "analyzers" which test the input for the presence of various specific features. The details of the features are not known: they might be parts of letters, certain kinds of gaps between them, even global properties like roundness, angularity, or the occurrence of parallel lines* (Neisser 1967:71, also p.75).

2. The feature analysers operate in parallel which in effect means that a particular analyser's, or demon's, operation is not dependent on any other process (Neisser 1967:72). The advantage of at least postulating a parallel process at this stage of visual cognition is that *perception generally does seem to have the redundancy, wastefulness, and freedom from gross misinterpretation that characterize a parallel process* (Neisser 1967:74).

3. The second level analyser *responds to a particular weighted, probalistic combination of tests at the earlier level* (Neisser 1967:71). At the first level tests are performed for specific features, while the second level responds to a combination of tests. For instance, if the letter Z must be searched for in a list of letters,[24] the first level tests for specific features such as diagonal lines and certain angles between lines (this example is purely fictional since what features are being tested for is unknown)(Neisser 1967:71). If a combination of tests corresponds to what is searched for, the outcome is assigned a weight, which tells the Z-demon at the second level that a Z was found. Neisser (1967:71) is adamant that the second level analyser is not the same as a template, although at first glance it seems similar to a template. The difference is that no single aspect is sufficient to trigger the second level analyser as is the case with template matching: a combination of features is necessary to trigger the second level analyser (cf. Neisser 1967:71).

4. By utilising probalistic weighted combinations, the feature analysis model is able to learn from past mistakes and is even able to cope with diffuse inputs that are not clearly recognisable at first (Neisser 1967:75). Learning takes place by shifting the weights assigned to different features provided it (the model) is told whether its identification of previous trials were correct (Neisser 1967:75):

> *... a Pandemonium can easily improve its performance through learning. It need only be told, trial by trial, whether its identification of the preceding pattern was correct, so it can increase or decrease certain "weights" associated with the cognitive demon that was selected* (Neisser 1967:75).

As will be seen in Chapter 4 of this study, the Pandemonium model is in fact a precursor to connectionist models using computational algorithms to assign and adapt weights associated with the features of patterns. The advantage of a large array of feature analysers is that the model is not susceptible to breakdown since in the case of malfunctioning of some feature analysers, the functioning of other analysers covers for them (cf. Neisser 1967:76).

The implication of the feature analysis model is that, at the level of the retina, one is able to process a triangle anywhere on the retina in contrast to the template theory (cf. Neisser 1967:86). But what happens when two triangles are presented? If cells on the retina are all equally sensitive to triangle-type configurations, the presentation of two triangles simultaneously ought to lead to the perception

[24] See Neisser's (1967:66-71) experiment on visual search.

of only one triangle.[25] This is clearly not the case. Even within the framework of the Pandemonium model, it is difficult to resolve the problem of simultaneous presentation of stimuli within the field of vision. The Pandemonium model needs one object, such as a letter, at a time to be able to recognise the pattern (Neisser 1967:87). According to Neisser (1967:79) experimental evidence shows that not all acts of recognition require the analysis of parts of objects. In some instances whole objects, and not their parts, are recognised at once. The problem according to Neisser (1967:87) lies with the concept of parallel processing at the initial input stage, since dealing with the whole of one's visual input at once ought to strain the processing resources unduly (cf. Neisser 1967:94). Neisser (1967:79) is of the opinion that it is necessary to retreat slightly from postulating only parallel processing in the first stages of visual recognition. At this stage, Neisser (1967:887) introduces the concept of segmentation, or rather attention, or focal attention as he prefers to call it. He (1967:88) defines attention as *...simply an allotment of analyzing mechanisms to a limited region of the field.* In the visual processing stage, Neisser distinguishes between the preattentive and attentive phases. The preattentive phase includes operations largely of a parallel and global nature, forming the objects for focal attention, but sometimes even within this largely parallel stage hierarchical processing can occur (Neisser 1967:89).[26] The preattentive mechanisms serve to segment objects and, according to Neisser, this global process need not be complex or mysterious, since simple operations may distinguish between objects *...provided they have continuous contours or empty spaces between them.* (Neisser 1967:89). The second level of pattern analysis uses the objects separated in the first phase to identify objects (Neisser 1967:89-90). Both the preattentive and attentive processes imply that

> *... the processes of pattern recognition are, after all, partly sequential. In giving up the hypothesis that all visual processing is* ***spatially*** *parallel, we necessarily introduce successive stages into our model of cognition, i.e., mechanisms which are not* ***operationally*** *parallel either. Attentive acts are carried out in the context of the more global properties already established at the preattentive level* (Neisser 1967:90).[27]

According to Neisser (1967:92) much cognitive activity in daily life is preattentive. This means that focal attention is not always needed for processing purposes. Guided movements such as walking, driving, visual tracking and other responses are under preattentive control (Neisser 1967:92). Eye and head movements are also under preattentive control and, when necessary, the preattentive

[25] Neisser (1967:86) refers to Hebb's (1949) "neural net" theory, which is in some respects similar to Selfridge's model. The main difference is that Hebb's theory incorporates the template theory (see Neisser 1967:78). The first level of feature analysers is similar to the Pandemonium model's fist level, but Hebb postulated cell assemblies which does the feature extraction. The cell assemblies are part templates replicated over the retina. Thus recognition can take place irrespective of retinal locus. According to Neisser (1967:86) the problem with this explanation is that parts of similar figures registering on different parts of the retina will have the effect of seeing only one figure.

[26] Such as when one focuses on fine detail discrimination of objects (Neisser 1967:89).

[27] Emphasis Neisser's.

processes focus the attention on relevant objects (Neisser 1967:92). Sometimes movement from the environment within the field of vision is sufficient for preattentive processes to direct eye and head movements towards the perceived movement, in order to focus attention or awareness on the moving object. At the stage of the discussion thus far, it seems that focal attention is the place were awareness comes into play, since awareness is necessary for conscious decision-making processes (see Velmans 1991 and the discussion on page 98 below).

Focal attention is not simply an analysis or an examination of input. It is rather more like a synthesis since a visual object is built or constructed from the visual input (Neisser 1967:94). Neisser (1967:94) calls this constructive activity *figural synthesis*, and although he (1967:94-95) finds similar ideas in James' and Brentano's theories, he (1967:98) concedes that his hypothesis is speculative and difficult to test even though it could explain some cognitive phenomena. Neisser (1967:102-103) provides a summary of the process of visual cognition in tachistoscope experiments in terms of figural synthesis:

1. Information reaches the eye from the briefly exposed stimulus and is stored in iconic memory.

2. The holistic preattentive processes have already distinguished between different figures present in the icon. It is possible to react to the stimulus at this stage but, on the whole, the preattentive processes have limited functions. These processes control attentional shifts, body, head and eye movements. They provide neither fine structure nor emotional content.

3. The attentive synthesis takes about 100 milliseconds. This process may be disturbed by new inputs. Even though the preattentive processes take place in parallel and have separated figural units present in the stimulus, they must be processed one at a time by the attentive processes. The parallel nature of the preattentive processes gives the impression that a person sees, for instance, a row of words all at once.

4. Accurate figural synthesis depends on the staying power of the icon. In order to name an object, figural synthesis and verbal storage must be completed before the icon decays. Perceptual set influences figural synthesis and it controls the order in which figures receive focal attention. Set affects the emotional appearance of things. It also influences the categories in which we place things. Set can also cause perception of aspects not present in the stimulus.

Neisser finds the same characteristics of the preattentive and attentive phases of visual cognition in auditory processing and in higher mental processes. For instance, recall from long-term memory also involves a fast, crude, holistic and parallel phase and a more deliberate and sequential phase. The second phase involves synthesis much in the same way as visual cognition does. The principles described above in terms of visual cognition also apply to auditory cognition.

3.2.4 Concluding discussion

The above discussion of visual cognition ought to suffice as illustration of the vein of much of the theorising on cognition up to, and since, the 1960's. Subsequent works on cognition built upon the foundations laid by Neisser. The problems of pattern recognition, memory, computations, information processing and knowledge representation recur again in later, and even in recent, works on cognition.

3.2.4.1 It is quite clear that Neisser did not mention consciousness as such in this particular work. This is also the trend in many other related works on cognitive psychology. His position on consciousness will be considered below.

3.2.4.2 The cognitive process in Neisser's seminal work is delineated as a series of processing steps. In related theories, these steps are refined, other steps are created, processing mechanisms developed, but overall it remains a flow chart depiction of the information processing process. Figure 6 shows a typical flow chart of the information processing process.[28] The depiction of cognition as a flow chart may lead one to neglect questions of the mechanisms involved in the flow chart boxes: *It is not much of an overstatement to say that such questions are often magically disposed of by the convenient notational device of merely drawing an arrow between the adjacent boxes!* (Allport 1980:30-31).

The question remains at what processing stage, or in what mechanism, consciousness resides. In a later section, consciousness will be discussed within a theory related to the information processing approach, but it will be seen that this theory differs fundamentally from traditional approaches, and even from Neisser's, in that the focus is not so much on processing but on knowledge structures.

According to Velmans (1991:667), the problem with the information processing approach in terms of consciousness, is that it is analysed from a third-person perspective. From this perspective, consciousness does not seem necessary for the process of information

[28] See Maree (1995) for a full discussion on this particular diagram.

encoding, storage, retrieval and transformation of output as depicted in Figure 6 (Velmans 1991:666).

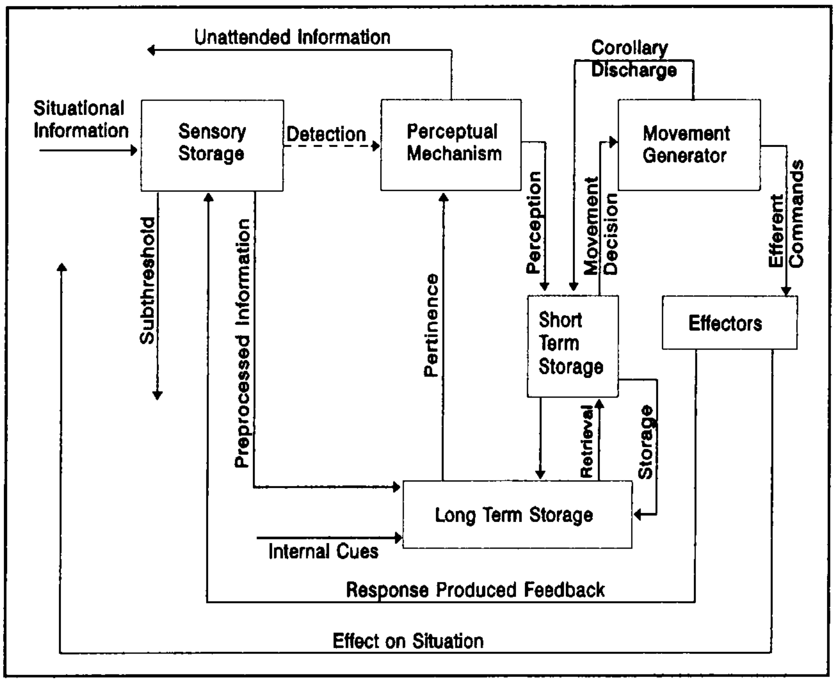

Figure 6 Mechanisms and control processes associated with the transformation and transmission of information (adapted from Singer 1980:168).

For Velmans (1991:666), consciousness is the result of information processing specifically of focal attention (see Velmans 1991:652-666 for a full discussion). Many processes such as problem solving, thinking and planning involve consciousness of the process, but other processes such as input analysis, motor control, thinking and planning also involve consciousness in terms of focal-attentive processing. Consciousness results from focal-attentive processing, and is not required for processing at any stage (Velmans 1991:666).[29] Consciousness then, from the information processing perspective, is causally inefficient. However, from the first-person perceptive this is totally untrue: ... *consciousness appears to exert a **central** influence on human affairs* (Velmans 1991:667)![30] Velmans (1991:667) does not regard the third- and first-person perspectives as incompatible, but as complementary. Although the third-person perspective is required, for instance, in understanding brain functioning, the first-person account may be more informative. Velmans (1991) seems to support epiphenomenalism[31] (consciousness has no function)(cf. Chapter 1 of this study),

[29] For a contrary view see Inhoff (1991:681).

[30] Emphasis Velmans's.

[31] Cf. Block (1991).

but his concession on the importance of the first-person perspective[32] opens the avenue of actually including a casually efficient consciousness within the third-person perspective.

Velmans illustrates the difficulty of finding a place for consciousness within the constraints of an information processing approach. On the one hand this difficulty is due to the way cognition is conceptualised in the information processing approach. On the other hand, the difficulty of accounting for consciousness within this approach is not surprising, given the cold shoulder cognitive theorists gave consciousness until recently (see Chapter 2 of this study; also Kinsbourne 1991:682).

3.2.4.3 The icon and iconic memory (the echoic memory in the case of auditory cognition) play quite a significant role in Neisser's initial theory. The significant role of the icon in Neisser's theory is emphasised by his insistence that perception is mediated: it is the iconic image, and not reality as such, that is being processed. Turvey (1977:68) described this type of theory as a form of indirect realism, since it upholds the principle of cognitive or epistemic mediation. This principle embraces Neisser's principle of construction but goes further. It implies that perception is mediated by means of prior experience and knowledge, formalised in some theories in terms of schemata or frames (Turvey 1977:78). Neisser (1967) hints at this implication in his own description of schemata. On the other hand Turvey (1977) espouses a form of direct cognitive realism by insisting on the unmediated nature of perception and cognition. The theory of the icon as a series of snapshots must be rejected, since what is seen, as in the case of the perception of movement, is not the integration (by means of construction) of successive snapshots, but movement itself (cf. Turvey 1977:75-76; Neisser 1967:140,145). Reality is known directly in an epistemically unmediated way. This hypothesis is, of course, what Neisser wanted to oppose but, as will be seen below, Neisser later conceded that reality does play a qualified role in cognition in some unmediated form, but also emphasises the role of cognitive schemata in mediating perception.

3.2.4.4 It is clear that Neisser regards the constructionist principle as fundamental to his theory. Two questions were posed in the course of the discussion. The first was concerned with the opposition between the constructionist principle and the reappearance hypothesis. It may be concluded that both are mutually exclusive in terms of the content of cognition: according to Neisser, content is not what is used in cognition, but traces of processes. The one also contradicts the other in terms of the processes of cognition. The one states that knowledge merely reappears in the same way that it is stored, while the other states that objects of cognition are constructed or synthesised. The reappearance hypothesis is slightly weaker than the assumption that the mind mirrors reality, but this question of direct versus indirect realism is certainly included in Neisser's attack of empiricist psychology.

[32] Cf. Bowers (1991:672); Carlson (1991:674).

The second question referred to the centrality of the constructionist principle to Neisser's theory. It seems that this principle - if it refers to the acts of construction and reconstruction - is not central to his theory since, at this stage, in Neisser's own words, it remains a speculative hypothesis. If one removes the idea that it is acts that are stored and used from his theory, his theory remains rather intact since he actually uses construction in the sense of the synthesis of bits of information about objects and events. It seems as if Neisser struggles with how to relate the elements given in perception and cognition with the more holistic impressions we actually have of events, objects and images. He explains the relation by means of synthesis: his answer is thus *constructionist* rather than *emergentist*, since synthesis merely allows for combination or fusion of elements, rather than emerging wholes. A constructionist approach in terms of producing wholes from elements is on the right track but cannot, due to its logical structure, provide a whole. This is indeed what the Gestaltists emphasised. As part of its logical structure, synthesis implies analysis as its counterpart, and from Chapters 1 and 2 it was seen that the emergent properties of a system cannot be reduced to its elements. What is valuable in Neisser's theory, is that he tries to emphasise the process or the dynamic/actualist nature of cognition in terms of the synthesis/fusion (process) of elements, but it still lacks the conceptual tools to actually blend both structure and function into one mechanism.

3.2.4.5 Neisser's description of schemata or knowledge structures, in terms of higher mental processes, prefigures his fuller development of the matter in his later work discussed below. In *Cognitive psychology*, a tension exists between the function of schemata and the bottom-up processes related to visual and auditory cognition. Although, in terms of the preattentive and attentive processes, he hinted at the influence of certain structures on visual cognition in terms of priming and perceptual set, this aspect is more fully developed in his later work. More emphasis is given to the synthesis or construction of percepts in a bottom-up fashion, as is clearly illustrated by the above discussion on visual recognition.

3.3 BEYOND THE INFORMATION PROCESSING APPROACH: COGNITION AND REALITY

Neisser's (1976) second important work in cognitive psychology is named *Cognition and reality: principles and implications of cognitive psychology*. It differs from the work discussed above in important respects which will be discussed in what follows. The following paragraph discusses Neisser's view of consciousness which, in a sense, brings the problems with the information processing approach in relief.

3.3.1 Consciousness and cognition

Since the concern in this thesis is with cognition and consciousness, it is interesting to note what Neisser says in the preface of *Cognition and reality*:

> *In writing "Cognitive Psychology" a decade ago, I deliberately avoided theorizing about consciousness. It seemed to me that psychology was not ready to tackle the issue, and that any attempt to do so would lead only to philosophically naive and fumbling speculation. Unfortunately, these fears have been realized; many current models of cognition treat consciousness as if it were* ***just a particular stage of processing in a mechanical flow of information****. Because I am sure that these models are wrong, it has seemed important to develop an alternative interpretation of the data on which they are based* (Neisser 1976:xii-xiii).[33]

In *Cognition and reality* (hereafter Cog&Real), Neisser (1976:xii) states that issues concerning attention, capacity and consciousness, were among the questions behind the generation of this particular work. Although Neisser (1976:103-105) is of opinion that consciousness cannot be adequately explained by an information processing model, thereby restricting consciousness to a mechanism on a flow chart, unfortunately, this is all he has to say about consciousness in Cog&Real. In fact, he (1976:105) says he did not intend developing a theory of consciousness. However, his very briefly expressed idea of consciousness reflects the alternative exposition of cognition in Cog&Real in contrast to his own previous information processing attempt discussed above. Neisser (1976:104-105) says consciousness is (a) not an independent definable mechanism but an aspect of activity. It (b) changes and develops throughout life, since it is narrowly related to learning new ways of information pick-up. It is thus related to cognition and perception, and (c) it is concerned with content - *we are conscious **of** objects, events, and situations* (Neisser 1976:105).[34] Its relationship with cognition is also apparent by our being aware of some of our own cognitive structures, which Neisser (1976:105) calls, anticipatory schemata. Consciousness thus has an inner and outward aspect, in terms of awareness of one's own cognitive structures and of the environment.

3.3.2 The ecological validity of cognitive studies

In Cog&Real Neisser (1976:6) argues against an information processing approach to cognition, and thus, against his own approach developed previously:

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[33] Emphasis mine.

[34] Emphasis Neisser's.

> *As the concept of information processing developed, the attempt to trace the flow of information through the "system" (i.e. the mind) became a paramount goal of the new field*[35]*. (I stated this goal explicitly myself, in "Cognitive Psychology")* (Neisser 1976:6).

The information processing model owes it existence, according to Neisser (1976:5,6-7), to the development of the computer. His greatest worry is that cognition - information processing, that is - is studied mainly in the laboratory and that ... *no account of how people act in or interact with the ordinary world* (Neisser 1976:7) is yet provided.[36] The proliferation of techniques and laboratory studies will lead to cognitive psychology becoming specialised and uninteresting without having any roots in real life. What is missing from cognitive psychology is what Neisser (1976:7) calls *ecological validity*. This means that cognition ought to be studied as it occurs in ordinary life. The *context of natural purposeful activity*, should be taken into account when studying cognitive processes (Neisser 1976:7). Although Neisser is of the opinion that this ecological emphasis will not mean the end of laboratory studies, it does mean that cognitive psychologists ought to take the *fine structure of information* into account *that the world makes available* to the perceiver. One of the main differences between Cog&Real and Neisser's 1967 work, is his emphasis in the former on *ecological validity*. This emphasis on ecological validity (it could just as well be termed "ecological relevance"), expresses Neisser's dissatisfaction with the *artificiality* of the information processing approach. The information processing model is based on an analysis of the elements or stages of the cognitive process in terms of artificial situations created in laboratories (amongst them tachistoscope studies). Memorising lists of non-sense syllables virtually says nothing of memory within real-life situations.[37] Thus, the artificiality of the laboratory led to cognition acquiring an "unreal" nature in the sense of being alienated from reality. In this sense, then, does the concept of ecological validity in his current work *Cognition and reality*, refer to reality, and must be seen as a denial of some of the assumptions underlying the model developed in his previous work. It is also in this sense that his fierce opposition in Cog&Real to the computer model must be understood, in contrast to his restricted approval of the computer analogy discussed above. The computer model or analogy of cognition in the past facilitated the information processing approach and contributed to the unreal character of cognition.

3.3.3 The role of the cognitive agent and of reality

In Cog&Real, Neisser discusses cognition from the perspective of perception, mainly because ... *perception is the basic cognitive activity out of which all others must emerge... Even more important,*

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[35] "New field" refers to cognitive psychology.

[36] Despite this plea some studies on schemata still legitimise the use of the tachistoscope for cognitive research (cf. Mayseless & Kruglanski 1987; Perdue & Gurtman 1988; Winnick & Penko 1989).

[37] Cf. Schlechter, Herrmann & Toglia (1990); Hanson & Hirst (1989).

however, is that perception is where cognition and reality meet (Neisser 1976:9). The focus in Neisser's work is on the encounter between reality and cognition rather than on the question of why he chose perception. His endeavour is to clarify this encounter and point out that an one-sided focus on either the perceiver or the environment is misguided. On the one hand, stands theories, such as his previous theory, which emphasise the role of the perceiver either as information processor or as constructor of reality.[38] On the other hand, is a theory, such as that of Gibson, that emphasises the role of information from the environment and that disregards the active role of the perceiver. Despite this opposition between approaches that were described above as direct and indirect realism (see paragraph 3.2.4.3), Neisser incorporates much of Gibson's theory in his own. Neisser resolves the conflict between the poles by proposing a theory of cognition - in fact, a theory of perception - where perception is regarded *as an activity that takes place over time - time during which the anticipatory schemata of the perceiver can come to terms with the information offered by his environment* (Neisser 1976:9). It seems as if - from the perceiver's side - a central role is assigned to "anticipatory schemata." The role these schemata have is dynamic: they come to "terms" with information. The binding factor between the role of the environment and the perceiver seems to be time or temporality. Precisely what Neisser means with "time", will be investigated shortly. Although the focus on time may be explained by the fact that a perceptual act takes time to be executed, it sometimes seems as if Neisser is more concerned with the interaction between the poles:

> *Perception is determined by schemata somewhat in the same sense that observable properties of organisms are determined by their genes: it results from the interaction of schema and available information. Indeed,* ***it is*** *that interaction* (Neisser 1976:57).[39]

3.3.4 A new model of cognition: the perceptual cycle

Neisser's (1976:20-24) theory of perception in Cog&Real is summarised by a model of the perceptual cycle. Cognition - or in this case, perception - consists of various phases. The perceiver has schemata that direct his attention towards the environment, enabling him to search for information. The environment presents the perceiver with information, all of which is, of course, not seen by the perceiver. His schemata enable him to look for and find specific things amongst the information presented by the environment. The environment even presents unexpected information which has the effect of transforming and modifying existing schemata - if picked up by the perceiver. In turn, these modified schemata direct perception once again, slightly changing the environmental exploration, and so on.

[38] *The prevailing view is to glorify the perceiver, who is said to process, transform, recode, assimilate, or generally give shape to what would otherwise be a meaningless chaos* (Neisser 1976:9).

[39] Emphasis mine.

3.3.4.1 Schemata

At this stage, an explanation of the term "schemata" is in order. As can be seen from paragraph 3.2.2.5 above, the idea of the schema is more fully developed here:

> *A schema is that portion of the entire perceptual cycle which is internal to the perceiver, modifiable by experience, and somehow specific to what is being perceived. The schema accepts information as it becomes available at sensory surfaces and is changed by that information; it directs movements and exploratory activities that make more information available, by which it is further modified* (Neisser 1976:54).

It seems as if the schema is the central concept of - or rather, the driving force behind - the perceptual cycle. Perception cannot take place without the guidance[40] of the schema. On the other hand, the aim[41] of perception is to modify the schema. It seems to be both the starting point and the end of perception: *At each moment the perceiver is constructing anticipations of certain kinds of information, that enable him to accept it as it becomes available* (Neisser 1976:20). Stated in another way: *The schema is not only the plan but also the executor of the plan. It is a pattern* ***of*** *action as well as a pattern* ***for*** *action* (Neisser 1976:56). The schemata *prepare* the perceiver to actively look for, and accept, certain kinds of information (Neisser 1976:20).[42] Schemata are also selective. There are many schemata related to each other. Some schemata are more general than related specific schemata. Schemata can even come into conflict with each other. In more general terms, a schema may be understood as a cognitive structure within which knowledge is organised in a more holistic

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[40] *A schema is not merely like a format; it also functions as a plan ... Perceptual schemata are plans for finding out about objects and events, for obtaining more information to fill in the format* (Neisser 1976:55).

[41] *In one sense, when it is viewed as an information-accepting system, a schema is like a format in a computer-programming language. Formats specify that information must be of a certain sort if it is to be interpreted coherently* (Neisser 1976:55).

[42] Zadny & Gerard (1974) found, for instance, that if a person ascribes a certain intention to an actor before the actual behaviour is observed, he/she is likely to recall actions bearing upon the intention. This means that people perceive others to behave in terms of expectations formed previously (cf. also Massad, Hubbard & Newtson 1979; Harris 1990; Maki 1989). This illustrates the power of schemata to regulate perception. Cf. also Thompson, Cornell & Kirkpatrick (1980); Vandierendonck & Van Damme (1988); Hue & Erickson (1991); Arcuri & Forzi (1988); see especially Shinar (1985). For a contrasting position see Biederman, Teitelbaum & Mezzanotte (1983); Horn & Downey (1990). Schemata does not only guide perception but also the higher cognitive processes such as remembering facts. Anderson and Pichert (1978) found that a change in perspective in terms of invoking another schema helped people recall previously unrecallable information under a previous set of conditions. See Bāckman (1991) for the influence of prior knowledge on episodic memory (memory for events)(cf. also Gerrards 1988; Anderson & Pichert 1978; Maki 1990).

The phenomenon of set described in literature and its effect on behaviour and perception also pertains to schemata. See, for instance, McKelvie (1984); Gibbons & Kassin (1987). On cognitive tuning and set see Harkins, Harvey, Keithly & Rich (1977) and footnote 15 above. Tuning is related to set, schemata, expectancies and priming: Carr & Bacharach (1976.:282) view tuning as *perceptual* tuning operating in early processes of perceptual selection much in the same way as priming discussed above in Neisser's (1967) theory (see page 91 above). The difference is that early tuning is guided by higher-order conceptual stimulus properties.

manner (cf. Markus 1977).[43] It is, however, not only a structure but also a process, or the act of perception. This concept of schemata differs then from other traditional concepts by incorporating both structure and function. In this elaboration of schemata, Neisser overcame the tension between structure and function present in his previous work.

3.3.4.2 Visual images as schemata

It is interesting to note that Neisser subsumes the various aspects of traditional cognitive concepts under schemata, but by viewing a schema as both a process and a structure, a more dynamic nature is ascribed to these concepts. For instance, visual images, or imagery is also discussed by Neisser (1976:128-153) as forms of schemata:

> *Imagining is not perceiving, but images are indeed derivatives of perceptual activity. In particular, they are the anticipatory phases of that activity, schemata that the perceiver has detached from the perceptual cycle for other purposes* (Neisser 1976:130).

Imagining is not perceiving, since perceiving involves picking up new information (Neisser 1976:130, cf. p.131). Images make their appearance when the normal perceiving process is interrupted (Neisser 1976:130). According to Neisser (1976:131) *(I)mages are not pictures in the head, but plans for obtaining information from potential environments* - they are *anticipatory schemata* (Neisser 1976:145). The cognitive map (see below) is one of the most often encountered forms of images since they make their appearance during locomotion when the normal perceptual process is interrupted (Neisser 1976:130) and may be regarded as readying the perceiver to accept new information from an environment not yet perceived (Neisser 1976:131). Since images are anticipations, they should have an effect on perception (Neisser 1976:144). Neisser (1976:145) regards perceptual set as a form of image: the more accurate the image, the more effective the set in influencing subsequent perception (Neisser 1976:145).[44]

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[43] Having a clear structure or even a model facilitates understanding of abstract information. This is clearly illustrated by students who rely on memorised algorithms to solve difficult abstract physics problems and have less success than students that understand the underlying concepts. Robertson's (1990) research showed that understanding material is facilitated by developing cognitive structures or schemata which use or modify existing knowledge structures. For a discussion of models and schemata see Johnson (1988).

[44] The expectancy effects of schemata are also illustrated in the perception of music in terms of existing schemata preparing a listener to expect certain tonal structures in a melody (cf. Abe & Hoshino 1990; Schmuckler 1990). Expectancy effects are very powerful since they are even able to influence the experience of fatigue. Christensen, White, Krietsch, & Steele (1990) experimentally confirmed that people may experience caffeine-related symptoms after taking pills they believed to contain caffeine. See also Oakhill & Davies (1991).

3.3.4.3 The temporal structure of cognition

A schema is a construction: it is both the *product* of perception - which is a constructive process (Neisser 1967, cf. 1976:57) - and the *act* of perception. Neisser's emphasis that perception takes place over time, may be understood against the background of this constructive act/product. He says that *the schemata that exist at any given moment are the product of a particular history as well as of the ongoing (perceptual) cycle itself* (Neisser 1976:62). By perceiving, existing schemata are changed. Schemata can thus develop, and the ability to develop or change is what happens when learning takes place. Learning is a process which takes place over time. As Neisser (1976:61) succinctly summarises this argument: *Schemata develop with experience*. In contrast to his previous position on the iconic image, perception is continuous and not merely successive snapshots of the environment (cf. Neisser 1976:22). This continuity over time is assured by the specific cyclical functioning of the schemata.

3.3.4.4 The content of perception/cognition: information

Both the elements of temporality and schemata make up the perceptual cycle. At this stage nothing was said about the contents of the schemata, namely the information to be picked up. Neisser uses the theory of Gibson (1950, 1966) as starting point for a description of the nature of visual information the perceiver sees and which fills the schemata. In the case of visual perception the information is optical *consisting of patterns of light over space and time*. According to Gibson, perception starts from the pattern of ambient light which is reflected from objects (cf. Neisser 1976:18). The pattern of light is available to the perceiver to be picked up at any given point in space. The pattern of light is called the *optic array*. The properties of the optic array are determined by nature and position of objects. The structure of the optic array specifies that the objects and information about these objects are in the light, which means that information about objects need not be processed since they are already available *in the light*:

> *The organism is not thought of as buffeted about by stimuli, but rather as attuned to properties of its environment that are objectively present, accurately specified, and veridically perceived* (Neisser 1976:19).

Although Neisser (1976:19) agrees with Gibson's (1966) emphasis on the importance of the optic array and its information, he disagrees with Gibson's negation of the role of the perceiver. Neisser's own theory of perception is then an attempt to bridge the gap between the role of the environment and the perceiver by trying to account for the cognitive processes.

In Cog&Real, Neisser concentrates in his discussion of perception on visual perception, although he by no means disregards the other sense modalities. Usually, theorists discuss one sense modality after another - Neisser (1976:29) acknowledges that he himself did so in *Cognitive psychology* - but it is obvious that the perceptual cycle utilises information from various sources of sensations (such as from the audio-visual, and haptic modalities)(cf. Neisser 1976:160-161). The information from different sense modalities is integrated even when perceiving a single event. Information from the senses may come available successively - *having heard something, we look to see it ...* (Neisser 1976:29) - or may be available all at once: *We see someone walk and hear his footsteps, or hear him talk as we watch his face* (Neisser 1976:29). Information from some sense modalities may even influence our perceptions unconsciously (such as is the case with pheromones and smell). The point is that various sorts of information pertaining to a single event influence its perception and form its related schemata. As is the case with visual perception, in speech perception the perceiver hears events and not just sounds (Neisser 1976:160; cf. also p.158). This means that the information which is available to the ears (language in this case) is already structured in some way - as is the case with visual information being available in the light. By implication, the perceptual processes for hearing are the same as for seeing, despite the intricacy of speech and its difference from visual information (cf. Neisser 1976:159). In the end, schemata pertain even to speech perception:

> *The speaker deliberately structures the events of his speech in order to express a particular meaning. If we have the appropriate schemata, we can pick up this structure quite directly, taking advantage of the several levels of organization that it exhibits. That is, we may hear both what the speaker said and what he meant* (Neisser 1976:139).

It seems then, as if schemata aim at providing meaning to the cognitive agent in terms of directing perception towards information relevant to the schema. But, even if the information perceived is inconsistent with the schema, the schema is able to find meaning by changing itself accordingly.

3.3.4.5 The essential role of motion in cognition

An important perspective being opened up by Neisser's emphasis on constructive perception, is that of the significance of the mobility of the perceiver. The perceiver is not a passive instrument receiving information, but is actively seeking information from the environment. Since perception is a constant interplay between the perceiver and the environment and since schemata guide the perceiver in his/her search for information, it is rather logical that mobility satisfies the exploratory urge. Motion enables the perceiver to actively search for relevant information in the environment.[45] The mobility of the perceiver enables the environment to yield *its* information to the perceiver:

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[45] *The act of locomotion, which requires more information if it is to be carried out successfully, also provides more information for the moving perceiver* (Neisser 1976:114).

> *Motion changes the available stimulus information in many ways. Even a shift of the head sideways is enough to reveal new aspects of most nearby objects and to occlude others that were visible before* (Neisser 1976:109).

According to Neisser (1976:110) the anticipatory nature of schemata takes the fact into account that certain information in the environment is as yet unseen:

> *What the perceiver will see when he has moved stands in an already defined relation ("behind") to what is presently visible. The relative positions of objects are known before specific information about them becomes available to the eye. Information picked up as a result of ego-motion is thus systematically related to existing schemata, and in particular to a cognitive map or orienting schema of the nearby environment* (Neisser 1976:110).

3.3.5 The difference between classical information processing and cyclical models of cognition

The cyclical nature of the perceptual process - in other words, the constant interaction between the perceiver's processes and the environment - is further elaborated by Neisser's discussion of cognitive maps. In fact, the main difference between Cog&Real and *Cognitive psychology*, is emphasised by his explanation of the relationship between schemata and cognitive maps. The term "cognitive map" was first used by Tolman (1948) and is understood as the mental representation of a spatial environment.[46] One may have a cognitive map of a city where certain locations exist in a spatial relationship to each other.[47] Neisser (1976:110,111) calls a cognitive map an "orienting schema" (cf. Sherman & Lim 1991). Just as is the case with schemata, the cognitive map is an *active, information-seeking structure* (Neisser 1976:111). It is a schema, albeit a more general schema (Neisser 1976:123), with specific schemata embedded within it:

> *Just as the room and the lamp exist together, one including the other, so my orienting schema and my schema of the lamp are simultaneously active, the former including the latter. Each is a phase of a cyclical interaction with the environment, both interactions occur continuously* (Neisser 1976:113).

The embeddeness of the schemata, i.e., their structural relationship to each other, is similar to the mental spatial relationship between the locations in a cognitive map. Although embeddeness implies a hierarchical order where specific schemata are subsumed under generic schemata - which in turn implies successiveness - the focus for Neisser is rather on the relatedness between the generic and

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[46] Cf. Antes, McBride & Collins (1988); Giraudo & Peruch (1988).

[47] Cf. Wall, Karl & Smigiel (1986).

the more specific schemata. This relatedness, or embeddeness, pinpoints the difference between Neisser's current and previous theory (cf. Neisser 1976:113 and p.126 note 9). Most cognitive theories, according to Neisser (1976:113), emphasise the successiveness of various stages (or levels) of processing. This hierarchy of processing stages is called "depth of processing" (Kerr 1982:157, cf. Craik & Lockhart 1972; Neisser 1976:126). The greater the depth of processing, the more refined or detailed the analysis of information is. According to Kerr (1982:157), depth of processing refers either to the progression from one stage to a next, or to a more detailed analysis in one processing stage. Usually the successive stages of processing are understood as entailing a movement from rather specific processes to more generic and abstract processes. Perception starts from detailed input patterns, and moves through successive stages of assimilation, identification, categorisation, and abstraction (cf. Neisser 1976:113). However, the relationship between "levels" of processing in the cyclical model is different:

> *Units at different "levels" are not just related sequentially, the lower ones feeding information to others further along; instead they are embedded, each engaging in its own cyclical relationship with environmentally available information* (Neisser 1976:124)

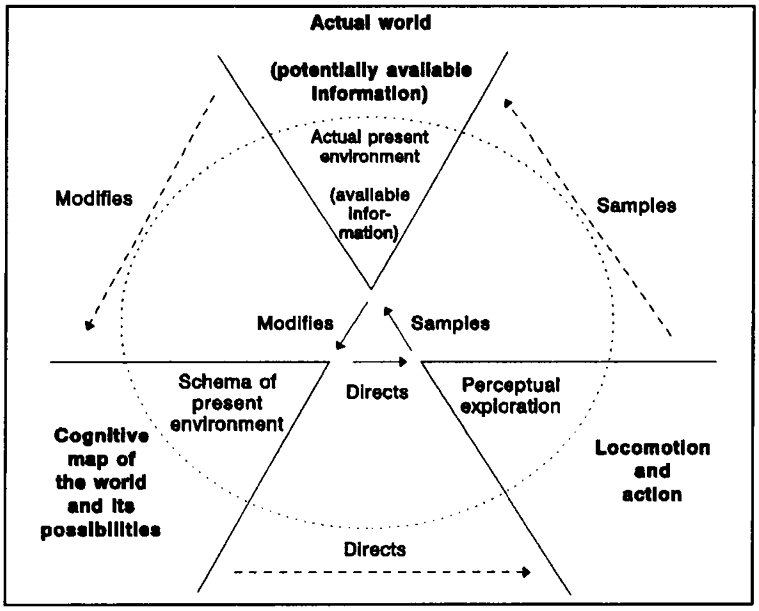

Figure 7 Schemata as embedded in cognitive maps (Neisser 1976:112)

Figure 7 illustrates the cyclical model and the embedded relations between schemata. This model graphically illustrates its difference with the sequential information processing model by taking the interaction between the cognitive agent and his/her environment seriously. In the information processing model[48] it is difficult to account for interactions taking place dynamically in a series

[48] Cf. Axelrod's (1973) information processing flow chart of schemata. The idea of schemata is certainly not new, but Neisser tries to overcome the information processing model.

of processing levels. The cyclical model does have a sequential element in that the cycle spirals forward in time, but its main function is to express the dynamic nature of cognition and perception. The dynamic nature of the cyclical model may be expressed by the terms construction, synthesis, interaction and integration, but these terms do not refer to the constructionist principle that was discussed in the previous section.

In the information processing model of Neisser (1967), construction or synthesis referred to an integration of elements in building cognitive objects. It referred to the detailed processing going on at each stage of cognition. In the cyclical model, construction emphasises more global structures and processes. It also emphasises the result of multiple *interactions*. Indeed, it seems as if meaning emerges from these global structures and the aim of cognition is to provide meaning to the cognitive agent. A schema as a procedure or an action strives to find meaningful information, and as a structure provides the meaningful content. Thus, Neisser's schemata has all the elements expected from an emergentist system: it is both content and an act and it strives to find meaning. Recalling the discussion in Chapter 2 of this study, it seems that the systemic emergentist model provides a way of conceptualising both consciousness and cognition in terms of act and content (cf. Dretske 1991:677).[49]

Neisser's model even *integrates* by means of interactions between schemata and subschemata, and its interactions provide for changes in its own structure. In a sense it is more dynamic than the emergent systemic model developed in Chapter 1 of this study, since it implies that the emergent properties can turn back upon themselves to effect changes within the system responsible for the emergent properties (cf. paragraphs 3.2.4.2 above and 3.4.1 below). Of course, the concept of emergence is not explicitly developed by Neisser and one cannot unduly burden his model with the phenomenon of emergence, thereby letting Neisser say something that he did not intend. However, its seems as if one could develop his model in this direction.

3.4 BEYOND THE INFORMATION PROCESSING APPROACH: CONSCIOUSNESS AND THE COMPUTATIONAL MIND

In the following section, an account of consciousness within an information processing approach will be considered. The theory of Jackendoff (1987) will be discussed as an example. His theory draws upon the classical information processing approach, but also moves beyond this approach in some important respects. Whereas the classical approach made much of processing and stages of processing, Jackendoff (1987) emphasises the structure of information. This way of viewing cognition is quite novel, and opens up certain avenues enabling one to move beyond the classical approach. As will be seen, he relates information or knowledge structures to specific modalities,

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[49] Dretske (1991:677) emphasises the importance of the *act* of consciousness rather than the content.

which implies that these knowledge structures differ from each other. He then goes on to describe the finer detail involved in modality specific perception and cognition. As will become clear, the knowledge structures involved in, for instance, visual cognition, exist in levels of complexity. These levels interact with each other in a specific way. The specification of levels of processing is, of course, characteristic of the classical information processing approach. However, Jackendoff (1987) does not focus on depth of processing but on depth of knowledge structures. His approach differs then from the classical approach in fundamental aspects.

Jackendoff's (1987) work is an example of how consciousness can be explained to arise from a theory moving beyond the information processing model. In order to study the connection between cognition and consciousness, Jackendoff (1987:7) states that it is important to do justice to both the phenomenological observations on consciousness and the computational nature of the mind.[50] He therefore makes a distinction between different "minds," namely the phenomenological mind and the computational mind. His work aims at explaining the connection between the two minds and how the computational mind can give rise to consciousness. The term *computational mind* is thus a description of the "information processing" processes involved in cognition on the *computational* or psychological level of analysis described in Chapter 1 of this study. The term *computation* may thus be misunderstood as referring to the computer model, as used in the classical approach to cognition. The following paragraphs will take up this issue in more detail.

3.4.1 The relationship between the computational and phenomenological minds: the levels of analysis and mind-body problem revisited

The computational mind, according to Jackendoff (1987:21), is another way of describing the brain. Although, at this stage, it is not possible to explain and elaborate all the neurological processes, the computational mind stands to the brain as a software programme stands to the hardware of the computer:

> *Just as we say that a computer program is a way of* ***specifying the operation of the machine in terms of its functional organization,***[51] *so we can regard the computational mind as an abstract specification of functional organization in the nervous system - even if, at the moment, we cannot translate from this description into hardware terms* (Jackendoff 1987:21)

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[50] *We must find an acceptable descriptive balance between the rigidity of operationalism, which forces us to throw out too much of value, and the self-indulgences of mysticism, turn-of-the-century introspectionism, and psychiatric free association. In order to raise the level of discourse, it is necessary to be sufficiently rigorous about the rest of one's psychology and about its connection to phenomenological issues* (Jackendoff 1987:7).

[51] According to Jackendoff's (1987:15) own concession, this is an explicit functionalist approach. This is a consequence of the computer analogy in cognitive studies where functionalism states that the *function rather than the physical substance of the brain is significant in studying the mind* (Jackendoff 1987:15).

The phenomenological mind entails the conscious experience or awareness of phenomena. Jackendoff (1987:5-6) distinguishes between conscious awareness and intelligent sensitivity. Intelligent behaviour need not imply awareness or consciousness, since even animals display intelligent behaviour. Humans also do display intelligent behaviour in some situations without realising it at that particular stage. Only afterwards, on reflection, a person may realise that "I did something smart" (Jackendoff 1987:6). Consciousness, for Jackendoff (1987), is then being conscious in the sense of being aware of experience. To recapitulate the mind-body problem (which is the problem of the interaction between mind and body) discussed in Chapter 1 of this study, Jackendoff's (1987) perspective on this problem will be summarised. The two extreme positions on the mind-body problem entail, on the one hand, a dualism between body and mind and on the other hand, an identity between body and mind. Within the dualist position, interactionism and epiphenomenalism may be distinguished (cf. Jackendoff 1987:8-9). Interactionism states that the physical causes certain states in the mental domain which, in its turn causes other states in the physical domain. Epiphenomenalism holds that mental phenomena exist independently from the physical domain but that the only causal relation is from the physical to the mental and not the other way round. According to the other extreme, identity theory, the phenomenological mind, the computational mind and the brain are three different ways of describing the same phenomenon (cf. Jackendoff 1987:11,22-23). Jackendoff (1987:23) hypothesises that the phenomenological mind - which he restricts to conscious awareness - in some way is caused by the computational mind:

> *The elements of conscious awareness are caused by/supported by/projected from information and processes of the computational mind that (1) are active and (2) have other (as yet unspecified) privileged properties* (Jackendoff 1987:23).

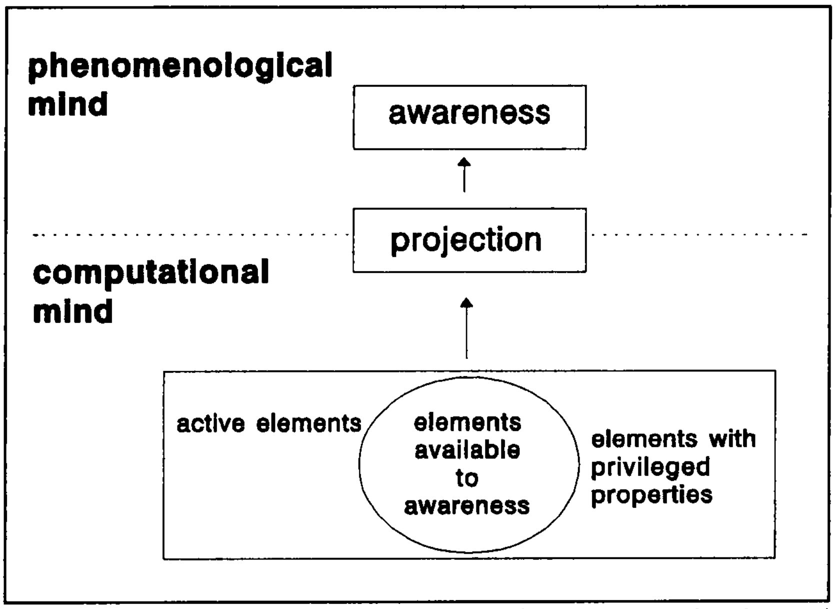

Figure 8 Jackendoff's schema of the computational and phenomenological mind (from Jackendoff 1987:24)

Jackendoff (1987:24) schematises his position as in Figure 8. The horizontal dotted line represents the divide between the mental and physical domains. According to Figure 8, awareness is mapped or projected from the computational mind. The question whether consciousness is caused (as in the epiphenomenal view) or merely another description (as in the identity theory), is left open by Jackendoff (1987:24).

Jackendoff's (1987) aim is to provide a computational theory accounting for certain phenomenological states. In order to do this, Jackendoff (1987:24-26) restricts and qualifies his initial hypothesis: (a) every phenomenological distinction must be accounted for by computational states. This means that a theory of the computational mind must be sufficiently rich to be able to explain phenomenological states or experience. (b) Computational processes must suffice to explain phenomenological states. Phenomenological states cannot explain computational states. Jackendoff (1987:26) rejects the position which states that since one is unable to explain certain phenomenological states in terms of computational and neurological processes, the cause of that state must be phenomenological.[52] The reason for the restrictions is that scientists know only how to study causal relations and at this stage we do not have the empirical means to explain the phenomenological mind, except through the computational (and perhaps physiological) processes (Jackendoff 1987:26). Jackendoff's (1987:25,26,276) restrictions on his hypothesis and methodology imply a rejection of interactionism and imply that *consciousness is causally inert*. This means that consciousness has no purpose since to be good for anything it needs to have an effect. The way Jackendoff (1987:26) formulated his working hypothesis states that consciousness cannot have an effect on the computational mind.[53]

3.4.2 Emphasis on structure rather than processes in the information processing approach

The term "computational" is somewhat misleading in Jackendoff's (1987) theory. He (1987:38-39) diverges from the standard information processing theories by focusing on the content of the computational mind and the *structure* of information. By taking the computer model seriously, cognitive psychology, and more specific information processing theories, focused on the *processing* of information. Jackendoff (1987:38) takes a structural approach[54] to computation and concentrates on the form of information that is being processed:

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[52] According to Jackendoff (1987:26), this reflects the position of Popper and Eccles (1977).

[53] Jackendoff (1987:27) concedes the following: *I myself am not too happy about this consequence. Consciousness seems too important to one's life - too much fun - to conceive of it as useless... Nevertheless, to grant consciousness purpose requires it to have causal efficacy, which in turn forces one to embrace interactionism, a move I find myself constitutionally incapable off.*

[54] *To return to the computer analogy, if a processing theory is about programs, a structural theory is about the nature of the internalized data structures on which the programs operate* (Jackendoff 1987:38).

... the basic issue is to determine what categories, distinctions, and relations must be represented in mental information structures in order to account for human behavior and experience (Jackendoff 1987:38).[55]

By virtue of language studies, Jackendoff (1987:44) gives the following reasons for a structural approach:

(a) Information is better processed when it is structured.

(b) Particular structures must be available for a number of tasks.

(c) Evidence for structure can be found independent of any knowledge of the purpose of processing.

(d) The study of structure can reveal organisation which probably could not be found with a pure processing approach.

(e) Referring to Lashley (1956),[56] Jackendoff (1987:45) points out that computation in the brain is always unconscious. What is present in consciousness is the result of processing, namely an information structure.[57]

Jackendoff (1987:51) suggests that since consciousness is obviously not unified in terms of the modality of experience (for instance, a clear distinction can be made between visual and auditory awareness),[58] a distinction can be made between different structures of information corresponding to the different faculties or modalities. This implies that, for instance, visual awareness arises from specific visual information structures in the computational mind which differ from auditory information structures. Jackendoff (1987:277) explains this by, what he calls, the *hypothesis of levels*. The hypothesis of levels states the following (Jackendoff 1987:49):

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[55] *This approach thus abstracts away from processing and concentrates on what there is to be processed* (Jackendoff 1987:38).

[56] *No activity of the mind is ever conscious. ... There are order and arrangement, but there is no experience of the creation of that order. ... Look at a complicated scene. It consists of a number of objects standing out against an indistinct background. Each consists of a number of lesser sensations combined in the object, but there is no experience of putting them together. The objects are immediately present* (Lashley 1956:4).

[57] *Lashley is pointing out that computational activity - processing - is* ***always*** *unconscious: what is revealed to consciousness is the* ***consequence*** *of processing, namely an information structure. This means that if there is to be a relation between computation and awareness, it will be most directly revealed by a theory of structure rather than by a theory of processing* (Jackendoff 1987:45)(Jackendoff's emphasis).

[58] The only senses which are not readily differentiated in terms of awareness or experience are smell and taste (Jackendoff 1987:51).

(a) *Each faculty of mind has its own characteristic chain of levels of structure*[59] *from lowest (most peripheral) to highest (most central).*

(b) *These chains intersect at various points.*

(c) *The levels of structure at the intersections of chains are responsible for the interactions among faculties.*

(d) *The central levels at which "thought" takes place, largely independent of sense modality, are at the intersection of many distinct chains.*

The next few sections will explain the levels of information structure in visual and linguistic cognition, in order to arrive at Jackendoff's intermediate level theory of consciousness. Since the emphasis in the above discussion of Neisser's (1967) theory was on visual cognition, the following sections will also focus on auditory and linguistic cognition.

3.4.3 The structure of information

In order to substantiate his theory of consciousness and the computational mind, Jackendoff (1987) discusses three information structures extensively, namely, linguistic, visual and musical structure. Each information structure consists of various representational levels.

3.4.3.1 Linguistic structure

Linguistic structure consists of four representational levels, namely the acoustic, phonological, syntactic and conceptual levels. The levels progress from the lowest (acoustic) to the highest (conceptual). In the last level, meaning is encoded in some form. What distinguishes Jackendoff's (1987) theory from other information processing theories is the positing of two intermediate levels of representation between the acoustic signal and the conceptual level.[60] Usually, it is presumed that acoustic signals are picked up by the auditory sense, processed, and arrive at the conceptual level.

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[59] Or "representation". Cf. Jackendoff (1987:277).

[60] *In order to account for human language use, it is necessary to posit two independent levels of representation - phonology and syntax - plus their internal elaborations into intonation, metrical grid or prosodic tree, and possibly functional structure.* ***Neither of these is a direct representation of either sound or meaning.*** *Each has its own characteristic primitives and principles of combination; and in each of them a distinction must be made between underlying and surface form that must be described in terms of principles of derivation* (Jackendoff 1987:85)(Emphasis mine).

According to Jackendoff (1987), linguistic information - in the case of speech perception - can only be understood by the perceiver if certain representational structures at various levels of complexity already exist. No jump from acoustic signals to meaning can be made since certain spoken words such as *attack* and *a tack* sound the same at the acoustic level, but somehow are understood correctly within a certain context (Jackendoff 1987:57).[61] The spoken words are first represented on the phonological level, enabling the perceiver to distinguish between certain sounds:

> *The fundamental tenet behind the computational theory of mind is that an organism can make no judgement or discrimination without having an appropriate representation on which to base it. In the present case, the fact that people segment the speech stream into discrete linear elements leads us to posit a level of mental representation,* ***phonological structure****, in which such segmentation does in fact exist. In phonological structure, then, a speech stream is explicitly encoded as a linear sequence of discrete* ***words****, which are themselves divided into discrete* ***phonological segments*** *(individual speech sounds)* (Jackendoff 1987:58).[62]

Thus, a certain structure exists at a slightly higher level of organisation, which enables the configuration of lower level information into that particular structure. Similarly, syntactic structure is needed to configure the phonological structure into syntactic categories and units (cf. Jackendoff 1987:68). It should be noted that the rules governing phonological structure and syntactic structure differ so that a direct mapping of segments and units is not possible (Jackendoff 1987:81).[63] For the transformation or mapping to take place between units of phonological structure and syntactic structure, certain correspondence rules are required *apart from the rules controlling the structure within a specific level* (Jackendoff 1987:81).[64]

3.4.3.2 Visual structure

Visual structure, likewise, consists of various levels of representation. Jackendoff (1987) makes extensive use of Marr's (1982) theory on visual processing[65] despite the theory's shortcomings (cf. Jackendoff 1987:178). The most primitive level of information received from the retina is the *primal*

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[61] Cf. Goldinger, Luce & Pisoni (1989).

[62] Emphasis Jackendoff's.

[63] See Jackendoff (1987:68-81) for an explication of the complex rules for syntactic structure.

[64] *Unlike the rules of syntax itself or of phonology itself, these correspondence rules will have to invoke primitives and principles of combination from both levels. The typical form of a correspondence rule will hence be roughly "Fragment X of phonological structure corresponds to fragment Y of syntactic structure"* (Jackendoff 1987:81).

[65] Cf. Cooper (1990); Kosslyn, Cave, Provost & Von Gierke (1988).

sketch which *expresses the local organization of the visual field but not yet the segmentation of the field into distinct groups* (Jackendoff 1987:170). The perception of form in the primal sketch depends on breaks in intensities in the retinal image. Such breaks indicate boundaries between regions (Jackendoff 1987:170). According to Jackendoff (1987:170), the primitives of the primal sketch are local markers which indicate position, length, orientation, the termination of edges, and corners in edges. Motion may also be a primitive in the primal sketch. From the raw primal sketch consisting of these primitives, the full primal sketch is derived consisting of groupings of primitives. The primal sketch is already more than the retinal image, but still less than a full visual interpretation (Jackendoff 1987:172). The next level is the 2½D sketch derived from the primal sketch and represents the geometry of surfaces visible to the observer (Jackendoff 1987:172). It includes contours, depth and orientation but not volume (which is a feature of a 3D representation).[66] Information from the primal sketch provides the basis for the formation of stereopsis, motion, shading surface contours, and texture gradients (cf. Biederman & Ju 1988). These aspects determine depth and orientation of visible surfaces through different types of computation (Jackendoff 1987:173). The correspondence rules between the primal sketch and the 2½D sketch are therefore quite complex and modular (e.g., the pathway through stereopsis from the primal sketch to the 2½D sketch is different from the pathway through surface contour detection (cf. Jackendoff 1987:173 figure 9.5). The 2½D sketch represents only surfaces and not objects (Jackendoff 1987:174). To account for size and shape constancies, the next level of representation is required.

The 3D model is object-centred rather than viewer-centred as4 in the 2½D sketch. The 3D model[67] represents objects in terms of volumes and in a hierarchical fashion. This means that objects are specified in levels, each in term of the previous level. For instance, a human being is first represented by means of a three-dimensional torso. An arm is defined in terms of its position on the torso and as a lower and upper arm; the lower arm is elaborated in the lower arm and hand; the hand is elaborated in the palm and fingers and so on (Jackendoff 1987:174-175). The levels progress from the main structure toward the finer detail of an object. Ultimately, the configuration of parts is important with respect to each other and to the main part of the object. The object can therefore be represented without *mention of the viewer's position* (Jackendoff 1987:175). It must be noted that the form of representation in the 3D model is geometrical rather than propositional (cf. Jackendoff 1987:181-183). The last level is the conceptual structure, which will be discussed below in terms of both visual and linguistic structures.

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[66] Cf. Roberts & Bruce (1989).

[67] Cf. Braunstein, Hoffman & Saidpour (1989).

3.4.3.3 Conceptual structure

The last level in the sequence of information structures is that of meaning. In order to understand what we see, hear, say, feel or generally perceive or produce, some form of representation encoding meaning is necessary. Jackendoff (1987:121-122) formulates, what he calls, the *mentalist postulate* of meaning within a computational theory of mind: *Meaning ...*[68] *is an information structure that is mentally encoded by human beings* (Jackendoff 1987:122). This postulate implies that language and other faculties must receive *systematic descriptions* from an independent level of conceptual structure, in addition to the other intermediate levels (Jackendoff 1987:122). The conceptual structure, as is the case with other structures, consists of a *set of primitives and principles of combination out of which all possible structures must in principle at this level can be constructed* (Jackendoff 1987:122). The conceptual structures must therefore be able to express distinctions in meaning between for instance different sentences as well as perceived relations of meaning between sentences. If two sentences differ in syntactical structure but convey the same meaning,[69] then this relation of meaning must be encodable as well computable from the conceptual structure (cf. Jackendoff 1987:122-123).[70] Apart from expressivity and inference, the conceptual must also make provision for *compositionality* or how a set of meanings within a sentence (associated with individual words), give rise to the meaning of the utterance itself (Jackendoff 1987:124). The conceptual structure must, of course, be connected to other sense modalities, since meaning can also be ascribed to touch, vision and feelings (cf. Jackendoff 1987:124-125). Furthermore, since it is possible to express visual images verbally, there must exist a computational set of rules connecting the various sense modalities. Specifying the computational rules, or the correspondence rules, for such an intricate system is a formidable task and requires much more than a precursory theory. Jackendoff (1987:135-159), by virtue of his work in linguistics, specifies some primitives in the conceptual structure for linguistic processing.

The most essential element in conceptual structure, according to Jackendoff (1987:135), is *categorisation*. Categorisation is central to cognition and not only to linguistic conceptual structure, since a perceiver must be able to relate perceived object with internal representations in order to make correct judgements on what is perceived. Furthermore, and probably more important, categorisation involves comparing internal representations between, for instance, a specific dog Rover, with the category of dogs (see Jackendoff 1987:135). Jackendoff (1987:136) argues for a

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[68] The missing clause is "*in natural language*," since Jackendoff formulated the postulate in terms of linguistic computation. The postulate does refer to other forms of computation as well, as becomes apparent in Jackendoff's discussion on visual and musical structure.

[69] The following example from Jackendoff (1987:122) illustrates the point: The judgement *If I'm not an idiot, then John isn't a genius*, can be inferred from the sentence *If John is a genius, then I'm an idiot*. The conceptual structure must make provision for this type of inference.

[70] *Crucial to the computational theory of meaning is that the validity of these inferences must be explicated by virtue of the form of their conceptual structures alone. That is, the human capacity for interpreting sentences and drawing inferences must ultimately be traced to a set of formal manipulations performed on mental representations* (Jackendoff 1987:123).

more formal way to express conceptual structure, i.e., in a non-linguistic way, since categorisation can take place in non-linguistic organisms. He (1987:136-139) then develops a symbolic type of formalism (which he calls an algebraic format)(cf. Jackendoff 1987:202) to express the primitives of conceptual structure, such as [TOKEN] concepts which refer to *individual things*, and [TYPE] concepts which refer to the categories to which the tokens do, or do not, belong. Tokens and types are related with relational statements so that the formalism reduces to the following format: [TOKEN] IS-AN INSTANCE-OF [TYPE] (cf. Jackendoff 1987:136,139). This "algebraic" encoding format is also important in visual categorisation, so much so, that the 3D level of representation links up with the conceptual structure in various ways. The conceptual structure provides the necessary descriptions to enable categorisation to take place between perceived (or imagined) objects (cf. Jackendoff 1987:198-199). In fact, according to Jackendoff (1987:200-202), certain word meanings *need* a 3D representation as well. Having my dog Fido represented linguistically, also implies knowing how the dog looks. Thus, it seems as if the conceptual structure links up with various modalities enabling interaction between them. For example, the smell of a hotdog conjures up its image and enables one to express hunger (cf. Jackendoff 1987:207).

3.4.4 The processing of information

Since the interest is in the information structures that are active in consciousness, the framework must be sketched of the processes involved in making certain information structures active (cf. Jackendoff 1987:91). For instance, in spoken language, understanding (meaning) an utterance (sound) must involve a process which invokes the correspondence rules between the different levels (Jackendoff 1987:91-92). Jackendoff (1987:92-93) argues firstly against a sequential bottom-up theory for speech understanding and a sequential top-down theory for speech production. These sequential theories entail that speech understanding or production proceeds in its entirety from one level to the next (Jackendoff 1987:92-93).

According to Jackendoff (1987:93) this is false, since speaking a sentence, for instance, does not involve having the complete sentence structured in the mind before uttering it: ... *we often have the impression of starting to utter a sentence without knowing exactly how we will end it, then completing it "on the fly"* (Jackendoff 1987:93). It is however, possible to conceive of the process taking place in parallel (Jackendoff 1987:95). This means that either bottom-up or top-down processing takes place per segment but in parallel so that the first segment reaches either the conceptual or the acoustic level, while the second segment trails a little behind it. The first segment of an utterance can therefore reach the conceptual level, whilst the last segment is being transformed into the phonological level (in bottom-up processing).

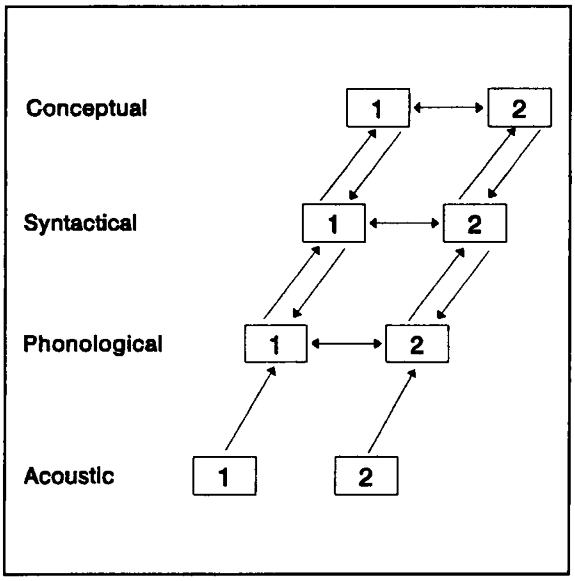

Figure 9 Interaction between information structure levels (cf. Jackendoff 1987:109)

Against the sequential and parallel processing model, Jackendoff (1987:101) argues for an *interactive parallel* approach. In the case of speech understanding, processing takes place in a holistic (intralevel) and top-down,[71] or feedback (interlevel) fashion (Jackendoff 1987:101). The utility of the intermediate levels is shown especially in the way which they provide a site for feedback and integration of information. To illustrate: given a certain utterance with two segments, the acoustic signals are transformed into phonological structures 1 and 2 (see Figure 9). Between the phonological structures 1 and 2, processing and integration is taking place - this is the intralevel processing (cf. Jackendoff 1987:102). This point may be illustrated by means of the importance of the effect of context within sentences (see Jackendoff 1987:117). Understanding the first part of a sentence, especially when the noun and its verb are separated by another phrase, presupposes the last part of that sentence. The interlevel processing takes place between mapped structures of two adjacent levels such as the phonological and the syntactical. Phonological segment 1 is transformed into syntactical segment 1, but the results of intralevel processing on the upper level are again made available in a top-down way, enabling further restructuring on the lower level to take place. This process is illustrated in Figure 9.

According to Jackendoff (1987:101), these processes on various levels and between levels can go on relatively independently. He summarises the processing theory as follows: *The overall picture that*

[71] Since speech understanding is essentially a bottom-up process, the interlevel processing refers to a top-down or feedback mechanism. Jackendoff's (1987) characterisation of the feedback mechanism as top-down in the case of bottom-up processing and bottom-up in the case of top-down processing could be confusing. The reason he calls "feedback" top-down or bottom-up, is probably to emphasise the mixing of direction of processing against a strictly sequential theory.

emerges is of a highly ***interactive*** *system made up of specialized processes* (Jackendoff 1987:103).[72] Figure 9 shows the intra- and interlevel processing between the information structure levels for linguistic processing. Figure 9 shows that, although processing takes place in parallel, it is a process taking place over a period of time.

The process sketched for linguistic processing is essentially the same for visual processing. Correspondence rules are needed for mapping between structures and processing takes place within levels and between levels as illustrated in Figure 10 (cf. Jackendoff 1987:185-188).

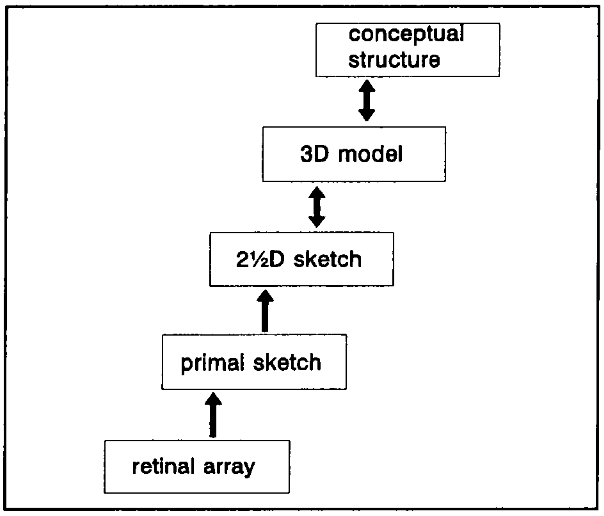

Figure 10 Visual representation and processing (cf. Jackendoff 1987:186)

3.4.5 Short term memory and the integration between levels of structure

Jackendoff (1987:113) hypothesises that something like short-term memory is responsible for the processing which takes place, on and between, all levels. In terms of language processing, he (1987:113) posits a short-term linguistic memory (STLM). For visual processing the short-term memory is called short-term visual memory (STVM) and the discussion that follows is applicable to the STVM as well (cf. Jackendoff 1987:188-191). The STLM is thus a processing device *that creates all levels of linguistic representation that can be computed on the basis of incoming information* (Jackendoff 1987:113). STLM, therefore, is responsible for the inter- and intralevel processing. Furthermore, STLM maintains the links between and within levels in *registration* in order to maintain correspondence between levels and therefore enabling feedback from higher levels (Jackendoff 1987:114). The STLM also has a selection function: *if more than one set of matched representations*

[72] Emphasis mine.

is present in STLM, it designates (or tries to designate) one as ***most salient*** (Jackendoff 1987:115).[73] For instance, ambiguous stimuli, such as the Necker cube in visual perception (see Figure 11), or the sentence *visiting relatives can be boring,*[74] does have only one interpretation at a particular time. Both views or perspectives on the cube cannot be maintained. This illustrates the selective nature of attention and conscious awareness: we cannot consciously maintain both interpretations simultaneously (cf. Jackendoff 1987:115-116).

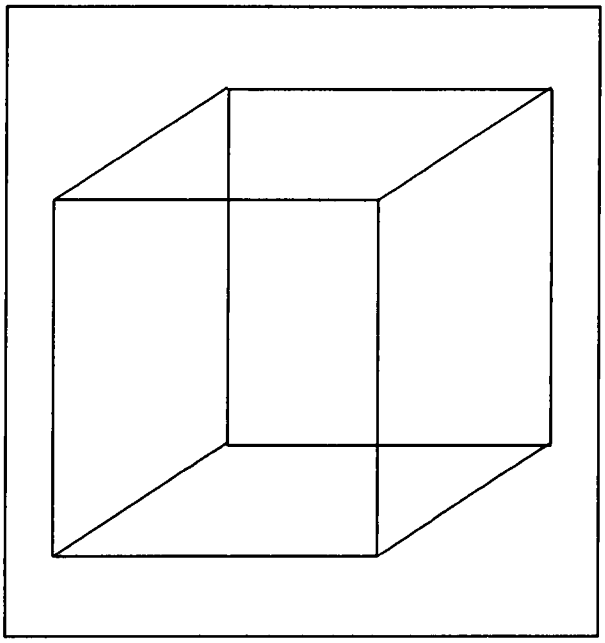

Figure 11 Ambiguous figure: the Necker cube

Since the STLM maintains all levels in registration, selection of the most salient interpretation is done on all levels: selection is not solely or exclusively the function of the highest conceptual level or "higher-level cognitive devices" (Jackendoff 1987:118). According to Jackendoff (1987:118) it seems[75] as if selection operates *without benefit of awareness or attention*. Although one seems to be able to switch consciously between interpretations over time, such as with the Necker cube, Jackendoff (1987:118) points out that it is impossible to consciously switch interpretations only after different interpretations have been experienced consciously over time. This implies that the selection process takes place without the benefit of awareness since different perspectives need to "pop up" in consciousness.

[73] Emphasis mine.

[74] Jackendoff (1987:116).

[75] It is only "seemingly so" since the evidence is not conclusive.

It however, seems true that one can wilfully and consciously seek another interpretation. Jackendoff (1987:119) states that this process might be seen as the *voluntary creation of an internal biasing context*, which *tips the scales of the selection process in favor of the desired interpretation and thereby causes the selection process to present the new interpretation to attention and/or awareness*. Although Jackendoff takes this statement as an explanation of consciously seeking a new interpretation, it probably explains conscious switching between already experienced interpretations better than the ability to search for unexperienced alternatives.

Within the framework of Jackendoff's theory, this view is more appropriate since different competing patterns are already available, albeit on an unconscious level. In fact, Jackendoff (1987:103) says that with similar sounding words such as *a tack* and *attack* both possibilities proceed from the acoustic level up, where the context (by means of intra- and interlevel processing) determines which possibility must be selected (cf. Jackendoff 1987:117). This implies that both interpretations of the Necker cube are available from the start of visual input. At some time during the process the most salient pattern is chosen. It is possible that in the case of similar sounding words (*a tack* and *attack*) both possibilities are available from the acoustic level, but in the case of ambiguous figures such as the Necker cube, it is more likely that all the computations must be restarted from the level of input to find other configurations. This is certainly what happens when one struggles to find another view on such an ambiguous figure, and the initial perspective keeps popping up. This shows that the initial computational process with configurations and interactions is so strong that it interferes with attempts to reconstruct the visual input in another way. This is why the process of finding different interpretations for such figures takes time: it is not only a matter of biasing the existing structures, as is the case after both interpretations have been experienced. It is restructuring that is required and, for that matter, restructuring on all levels.

3.4.6 The intermediate-level theory of consciousness

In terms of linguistic processing, it seems as if the short-term memory store is the place where selected information structures become available to consciousness (Jackendoff 1987:119):[76]

> *Thus at any moment STLM contains one or more matched sets of representations, each of which consists of a full or partial phonological structure matched with a full or partial syntactic structure and a full or partial conceptual structure* (Jackendoff 1987:119).

[76] This idea is certainly not new. Short-term memory and consciousness has been related in various ways many times before (cf. Lundh 1979:233).

At a certain time, the selection function selects the most salient representation and makes it available to awareness. Against theories[77] involving a single executive on higher and more abstract levels of processing, Jackendoff (1987:279) localises the phenomenological experience of having only single interpretations successively available to awareness within the selection function of short-term memory (STM).[78] In terms of a theory of consciousness, the STM can make too much available to awareness, since all levels of processing and structure are available to STM despite the selection function (Jackendoff 1987:287). The selection function in STM does indeed have all levels available. In the case of linguistic awareness, Jackendoff (1987:287-288) points out that only phonological structure is available to awareness. This is clearly illustrated by the phenomenon of the inner voice. Thought happens to be in the form of linguistic images and the phenomenological form corresponding best to linguistic images is the phonological structure: we "hear" ourselves think (cf. Jackendoff 1987:288). Neither syntax nor meaning is perceived - they determine our understanding of inner thought, and enable us to distinguish between sentences - but only the phonological structure (Jackendoff 1987:288). Both speech perception and production find their way to awareness in phonological form (Jackendoff 1987:289). Against theories ascribing awareness to higher conceptual levels, Jackendoff (1987) says that awareness or consciousness is the result of mapping from the **intermediate levels** of processing and structure. In the case of visual perception,[79] the form of awareness can be ascribed to the 2½D sketch level. This 2½D sketch is sufficiently rich to support visual awareness (that is why it is not a 2D sketch), while the 3D level is used for inferential purposes (Jackendoff 1987:294):

> *The claim, then, is that the form of visual awareness - the way things* ***look*** *is determined by the 2½D sketch, whereas visual understanding - the "content" or "meaning" of visual awareness, what one is aware* ***of*** *- is determined by the 3D and conceptual structures in registration with the 2½D sketch* (Jackendoff 1987:294).[80]

Jackendoff's (1987:298), definition of consciousness, which he calls the *intermediate-level theory*, at this stage may be described as follows:

> *The distinctions of form present in each modality of awareness are caused by/supported by/projected from a structure of intermediate level for that modality that is part of the matched set of short-term memory representations designated by the selection function and enriched by attentional processing. Specifically, linguistic awareness is caused*

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[77] Cf. Jackendoff (1987:286).

[78] ... *we incorporate the moment-by-moment singularity of interpretation in awareness into our theory simply by claiming that awareness is projected specifically from the set of representations designated by the selection function* (Jackendoff 1987:279).

[79] See Jackendoff (1987:292-293) for an explanation of musical awareness.

[80] Emphasis Jackendoff's.

by/supported by/projected from phonological structure; musical awareness from the musical surface; visual awareness from the 2½D sketch (Jackendoff 1987:298).

He calls it the *intermediate-level theory*, since awareness is not supported by the central levels of representation, but by *a level intermediate between the most central and the most peripheral* (Jackendoff 1987:298).

3.4.7 Conclusion

Jackendoff's (1987) theory of cognition and consciousness moves beyond the classical information processing approach in a fundamental way. He developed a comprehensive account of cognition based on information or knowledge structures. By focusing on the nature of these information structures he was able to arrive at a parallel interactive approach taking place between and within levels. In this way he was able to move beyond a sequential processing approach. What is also interesting to note is that his *hypothesis of levels* enables one to account for interactions between different faculties and modalities. His approach enables one to see cognition as an integrative process. At various levels the different types of structures interact with each other, thus making information from one modality available for another. This is similar to the integrative functioning of schemata in Neisser's (1976) theory (see paragraph 3.3.4.4 above). Both Neisser's schemata and Jackendoff's knowledge structures enable bottom-up and top-down interactions to take place in cognition and perception. Both authors emphasise different types of structures, although Jackendoff explicitly develops a multifarious view: different modalities and faculties have different types of structures. Even consciousness may be viewed as multifarious since these different types of structures contribute to consciousness. Visual consciousness can be distinguished from auditory consciousness, although the interactions and integrations taking place have the effect of a singular experience of consciousness.

The hypothesis of levels may seem to be similar to Neisser's view of the embeddedness of schemata (see paragraph 3.3.5), but Neisser made it clear that embeddedness of specific schemata in more general schemata, does not imply a structure of depth or sequential processing. This is actually what Jackendoff's view entails and, in this sense, his theory relates to the classical information processing approach.

Another fundamental difference between Neisser's and Jackendoff's approaches is that the information structures, according Jackendoff, have processes operating on them. Neisser's schemata are both structure and process. The view that structure and process are distinct, has a definite consequence in terms of accounting for consciousness within the process of cognition and perception. Jackendoff (1987:298) says that consciousness is *caused by/supported by/projected from* an intermediate level knowledge structure. It is clear that he leaves open the question of precisely how consciousness arises from a particular structure. On the one hand, one thus has distinct processes (correspondence rules)(see paragraph 3.4.4) operating on a knowledge structure but, on the other hand, what is required are other distinct processes which can cause or project consciousness from a particular knowledge structure. The question is, then, how a particular structure and a particular process can give rise to consciousness. One must be able to explain the mechanism. Jackendoff, being unsure of the particular mechanism, uses the terms *cause/project/support*. If both structure and function were combined into one interactive system, he could have explained consciousness as an emergent property, thus avoiding the conceptual vagueness of how consciousness is caused by the information structures. The idea is that emergent properties, such as consciousness, can only be described by the dynamics of an emergent system, since an emergentist system fuses both structure (elements) and function (processes). Neisser's view of schemata is thus more appropriate to a systemic emergentist view, although Jackendoff's theory makes the role of consciousness in cognition more explicit.

3.5 CONCLUDING SUMMARY

3.5.1 From the previous chapter it was apparent that consciousness may be viewed from a systemic emergentist perspective. This perspective includes the fusion of structural and functional components when describing and explaining consciousness. To relate cognition and consciousness in a meaningful way, it is necessary to find the same integration of components in a cognitive theory.

3.5.2 The discussion in this chapter focused on the information processing approach to cognition. This approach substantially influenced research on cognition in this century and its influence is still felt in cognitive studies. The question to be answered in this discussion was, in what way such an approach could account for consciousness as part of the cognitive process.

3.5.3 The work of Neisser (1967), *Cognitive psychology*, was discussed as an example of the classical information processing approach, since this work had an influence on subsequent theorising and cognitive studies. As an information processing approach it delineated the cognitive process as mainly a series of processing steps, starting from the perception of environmental stimuli. The processes involved in the first few seconds of perception were described in terms of laboratory tachistoscope studies. A distinction was made between preattentive and attentive processes. The preattentive processes involve crude, holistic and parallel processing, while the attentive stage involves slower, more detailed and sequential processing. Percepts are formed by means of a synthetic activity which combines elements of information into a synthetic whole. The principle governing synthesis is called construction.

3.5.4 Neisser introduced the principle of construction to emphasise the actualist nature of cognition. Cognition thus involves a process of construction, since what is perceived is not merely reproduced or mirrored by the cognitive apparatus, but rather constructed: the content of cognition does not reappear. As a principle stressing the functional nature of cognition, its importance can be appreciated, but as a mechanism it struggles to link the elements of perception and the result or content of cognition. Neisser uses it as a way to avoid the idea that what is perceived is also what is eventually stored in memory. What is stored is then *acts* of perceptions rather than percepts. When remembering and thinking, information about the original acts of perception is used to reconstruct images and memories. In the end, it seems as if Neisser's concept of synthesis expressed the idea of construction better since, by means of this constructive act, elements of perception in the preattentive stage are combined to form percepts. The only problem at this stage - and it is a rather fundamental problem - is that a distinction is made between function and structure or rather between *elements* and *process*.

3.5.5 The roots of Neisser's (1976) later work, *Cognition and reality*, were present in his previously discussed work. The concept of schemata, or knowledge structures, was already present but was only discussed in terms of higher mental processes. In his later work, the whole process of cognition was subsumed under the idea of schemata. In this later work, it became clear that schemata are both process and structure. A schema is both a cognitive act and a structure which provides the vehicle for the knowledge/information obtained. How is it possible to conceive of a schema as both an act and content? How can *anything* be both? In the context of this study the answer is that an emergentist system, by way of its nature, provides us with the conceptual means to conceive of a fused structure and process. Therefore, although Neisser's (1967) earlier work emphasised the actualist nature of cognition, he was only able to wed both structure and function in schemata in his later work.

3.5.6 One reason for his change of theoretical direction, from an information processing approach to a cyclical model of cognition, may be found in his plea for an ecologically valid approach to cognition. This means that cognition and perception must be studied in real-life situations and must be applicable to reality. His "new" approach must be seen against this background: cognition/perception takes place in the interaction between reality and the cognitive agent. It is a very dynamic situation, and if one wants to understand real-life cognition, then one must also understand the role of consciousness in this process. Consciousness is indeed a very ecologically valid concept! But does his theory provide a way of relating cognition and consciousness? From the discussion of the theory of Jackendoff in his *The computational mind*, both the shortcomings of an information processing account of consciousness, and the strength of Neisser's schemata theory (despite the fact that he does not discuss consciousness at length), became apparent.

3.5.7 Jackendoff provides a theory of consciousness within an information processing *based* approach. Consciousness, in his view, must be explained wholly from the underlying processes or structures. In other words, only an account on the computational level can provide an explanation of consciousness. This requirement is of course stated in order to avoid the various mind-body problems discussed in Chapter 1 of this study.

3.5.8 While Neisser focused in his earlier work on the process involved in cognition, Jackendoff focused on the structural nature of knowledge as determinant of the cognitive process. Various modalities and faculties of mind involve various knowledge structures on different levels. Visual cognition, for instance, involves various levels of visual knowledge structures ranging from very simple to the most abstract conceptual level. The different structures intersect and interact at various points, thus providing information from one modality to another. In terms of the processes operating on the knowledge structures, Jackendoff proposed correspondence rules enabling information from one level to be translated and used by the next higher level. The processes operate in a parallel interactive way and not, as in the classical information processing approach, in a sequential manner. Consciousness arises from the intermediate levels of structures and not, as is usually proposed by some theorists, from the most complex and abstract level. However, despite the interesting perspectives on consciousness Jackendoff provides, such as the multifariousness of consciousness, his exclusive focus on *structure*, hinders an adequate description of how consciousness can arise from knowledge structures.

It seems that neither a structural nor a functional approach on its own, can account for cognition and consciousness in a coherent way. Both the structural (elements) and the functional (process) must be fused in one systemic mechanism in order to do justice to the complex process of cognition. As was seen in the previous chapter, consciousness may be viewed as an emergent property (or *properties* according to Jackendoff's view) of a particular type of system. It seems that if cognition can be described as a system, or systems, within which both function and structure are fused, then consciousness, as an emergent property, arises quite naturally. The analysis embarked upon in this chapter will be continued in the following chapter. The problems of structure, function (or process) and the fusion between both will be brought into greater relief in the next chapter. It will be seen that these problems are prominent in symbolicism, and that connectionism provides a unique solution.

CHAPTER 4
SYMBOLICISM AND CONNECTIONISM

4.1 INTRODUCTION

According to Dinsmore (1992:vii), the current study of cognition is dominated by two major paradigms. On the one hand, we have the symbolic or *symbolicist* paradigm which has its roots in symbolic logic and the modern computer. In the symbolicist paradigm, cognition is viewed as the *manipulation of structured **symbolic** representations* (Dinsmore 1992:vii).[1] On the other hand, a seemingly incongruous paradigm developed, namely the *connectionist* theory of cognition. The connectionist paradigm was inspired by the physiology of the brain, and cognition and behaviour are seen to be the result of the interactions between simple processing elements existing in large networks (Dinsmore 1992:vii). Both paradigms have their roots in the information processing paradigm discussed in the previous chapter. The ideas underlying both the symbolicist and the connectionist tradition can, for example, be found in Neisser's 1967 work. Neisser (1967) discussed Selfridge's *Pandemonium* model of pattern recognition which, in a rudimentary form, prefigures the models developed in the connectionist paradigm (cf. Rumelhart & Norman 1978:44). In fact, the *Pandemonium* model prompted researchers such as McCulloch (cf. Lettvin, Maturana, McCulloch & Pitts 1959) to search for neuronal correlates of feature demons in the frog's nervous system (Allport 1980:28). The similarity between the mechanisms underlying the *Pandemonium* model and connectionist models will become more clear in the discussion below. With regard to the symbolicist paradigm, even its roots and its influence may be seen in Neisser's (1967) information processing theory (cf. Allport 1980:30). The symbolicist tradition was strongly influenced by the development of artificial intelligence (AI) and computer science, especially since the late 1960's (cf. Allport 1980:29). Both Neisser's information processing theory (see Chapter 3) and the symbolicist paradigm are influenced by and built upon the computer analogy. In Neisser's case, and in the case of most information processing theories, the computer analogy provided a means of conceptualising the flow and processing of information or symbols through a cognitive system. In the case of the symbolicist paradigm, the computer metaphor is taken much more seriously. Actual cognitive processes, and especially representational issues, are described in terms of computer scientific terminology and processes (cf. Hunt 1978:4).

In the following two sections these two major paradigms of cognitive psychology will be discussed and analysed in terms of how they can contribute to the development of a systemic emergentist model. The issue will again be the ability of a theory or model to link structure and process. It will be seen that symbolicism incorporates function (process) and structure in a specific way contrary

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[1] Emphasis Dinsmore's.

to a systemic emergentist perspective. The connectionist paradigm provides a unique solution to the problem of fusing structure and function. In the third section, the differences between the two paradigms will be pointed out.

4.2 THE SYMBOLICIST APPROACH TO COGNITION

4.2.1 Introduction

Symbolicism embraces a range of theories of mind or cognition, also known as classical cognitive theories, committed to models of the mind *derived from the structure of Turing and Von Neumann machines* (Fodor & Pylyshyn 1992:289).[2] This means that classical theories aim at understanding cognition in terms of computations involving *operations on symbols* (Fodor & Pylyshyn 1992:289; see also Fodor 1975, 1987; Newell 1980, 1982; Pylyshyn 1980, 1984, 1984a). Since the 1950's, Newell and Simon used the computer to simulate human problem solving activities (cf. Newell & Simon 1972). Their work and thought had a great impact on symbolicism in cognitive studies. Newell died in 1992 and left behind his last major work, *Unified theories of cognition* (1990) which both expresses his wish for a unified theory and summarises his life's work on cognition.

The following paragraph commences with a concept central to symbolicism and cognitive studies related to computer science, namely that of the *architecture* of the mind. The concept of a *cognitive architecture* is important since it underlies the symbolicists' understanding of the human mind.

4.2.2 The cognitive architecture

Newell, Rosenbloom and Laird (1989:93) define an architecture as ... *the fixed structure that provides the frame within which cognitive processing in the mind takes place.* For them, the concept of architecture takes on a specific meaning. It is derived from computer science, referring to the hardware structure enabling a system to be programmed. This concept of architecture is then generalised and applied to cognition:

> *The concept of an architecture for cognitive science then is the appropriate generalization and abstraction of the concept of computer architecture applied to human cognition: the*

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[2] See Johnson-Laird (1993:48-51). Turing envisaged a machine that had a tape running through it with either 0 or 1 written on it. The machine is able to execute four basic operations depending on what it "read" on the tape. It could replace a 1 with 0 or the other way round, and it could move the tape backwards or forwards one segment at a time. According to Turing, everything computable can be computed with this machine provided it has unlimited tape available. Von Neumann realised Turing's basic ideas by creating the first digital computer (see Dennett 1991:213). The modern digital computer's instructions can be reduced to a series of 1's and 0's representing a pulse of electricity or no pulse. This serial sequence of pulses is responsible for even the most complex programmes seen on digital computers today.

fixed system of mechanisms that underlies and produces cognitive behavior (Newell, Rosenbloom & Laird 1989:94).

Stillings, Feinstein, Garfield, Rissland, Rosenbaum, Weisler, and Baker-Ward (1987:17) describe the architecture of the mind as its overall design and connect this with the question of the mind's *general information processing capacity*. Later on they (1987:20) speak of the *functional architecture*[3] which is the *built-in processes for storing, retrieving and altering representations*. These built-in processes are unalterable and play a significant role in symbolic processing (Stillings *et. al.* 1987:20).

While Newell, Rosenbloom and Laird's definition focuses on the more structural aspect of an architecture, that of Stillings *et. al.* (1987) emphasises the functional nature of the architecture, namely, the basic processes involved in cognition. According to *The Oxford Dictionary*, an architecture is defined as (a) the art or science of building, (b) a thing built or structure, (c) style of building, and (d) construction. It seems as if definitions (b) and (d) can be applied to the current issue. In both definitions (b) and (d), architecture refers to the result of some kind of construction process (of course referring to buildings). It points to the completed structure which could have a different style from another construction (according to definition (c)). This usual understanding of architecture (when restricted to the final structure), differs from what is meant by cognitive *architecture* in cognitive science, the latter trying to convey something of the fixedness of the particular cognitive structure, and the fact that it is somewhat similar to the structure of the computer. The term *structure* is deliberately used here, since it is suspected that the concepts of architecture and structure (which is discussed in Chapter 1 and 2 of this study) correspond in some respects. The term *architecture* as used in cognitive science and the concept *structure* as used by the structuralist psychologists (see Chapter 2), refer to a certain configuration of elements which stand in a relatively fixed relation to each other and which constitute a certain structure.

While the structuralists battled to incorporate processes within the structures of mind (recall the criticisms of elementism and atomism levelled against the structuralists), process or function and "structure" are both included in the concept of cognitive architecture as used by the symbolicists. According to Stillings *et. al.* (1987:20) "structure" refers to a formal data or symbolic structure by means of which information is stored and represented. This formal structure is then stable and static and must somehow be translated into procedures in order to be useful. For instance, a computer device has a memory containing information. A mechanism for utilising this information is provided by the computer's built-in processors in order to do some useful things such as displaying data on the screen and enabling interaction with the data by means of the keyboard. In the same way, the cognitive architecture consists of built-in procedures and mechanisms to utilise the data structure (or memory).

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[3] See Pylyshyn (1984).

A functional architecture then, consists of both a formal structure and functions operating on the structure (cf. Stillings et. al. 1987:20). When Newell, Rosenbloom and Laird (1989:93) speak about a cognitive architecture as the *fixed structure* of the mind (see above), they actually mean the fixed mechanisms or the *functional* aspect of the architecture operating on symbol structures. One must therefore distinguish between the structure of the mechanisms or processes, and the knowledge structure. Both structures are fixed and stable, and both may be subsumed under the term "architecture."

Cognitive architecture, at this stage, may be understood as that structure involving both the mechanisms of cognition and the knowledge or data processed by these mechanisms. In cognitive psychology, particularly that part that is involved with cognitive science and AI, the cognitive architecture is modelled on the computer architecture (which will be explained in more detail below). Wagman (1993:21) views the concept of architecture as an *organisational framework* encompassing the concepts, methods and data of AI, much in the same way as "psychoanalytic theory" functions as an organisational framework for psychological processes described from *a particular perspective*. Thus the term "architecture" may also function in this broad sense of describing the theoretical framework from the particular perspective of computer science.[4] However, the discussion above shows that the term also refers to particular structures and functions.

4.2.3 The nature of the architecture

4.2.3.1 The computer model and the cognitive architecture

It is apparent by now that the symbolicists view human cognition as being very similar to the operations of a computer (cf. Newell, Rosenbloom & Laird 1989:96; Stillings *et. al.* 1987:18; Pylyshyn 1989:51).[5] A simple computer consists of software and hardware. Hardware involves input and output devices (the communication links with the outside world), various forms of memory and processors (see Newell, Rosenbloom & Laird 1989:94-96). In order for the computer to do anything useful, it must be able to execute software programmes. The execution of a program is done by the processor fetching instructions from the primary memory and executing them step by step. The processor consists of a set of registers, each set of which fulfils a definite function such as pointing to the data of the program, pointing to the location of the next instruction to be executed, and

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[4] *Insofar as computers and humans can be viewed as information-processing systems ..., the notion of architectures that embrace software and hardware as distinct components is regularly used in various areas of cognitive science research* (Wagman 1993:21).

[5] *Nobody doubts that computers have had a profound influence on the study of human cognition. The very existence of a discipline called cognitive science is a tribute to this influence. One of the principal characteristics that distinguishes cognitive science from the more traditional studies of cognition within is the extent to which it has been influenced by both the ideas and the techniques of computing* (Pylyshyn 1989:51).

executing a basic instruction. The fine detail of the computer and its programming need not concern us here. The point is that this architecture ... *describes a* ***mechanistic*** *system that behaves in a definite way*[6] (Newell, Rosenbloom & Laird 1989:94). Although the data or the series of steps within a particular programme may differ from the one to the next, the mechanisms required to execute the programme never change and stay fixed. From one programme to the next the processor stays the same. Even its registers and their functions stay the same. Only the content of the registers differ. If, for instance, a particular register is used to point to the location of the very first instruction or step in the programme, this function remains the same, but the address will differ. In the end, what the computer is able to do - its behaviour - is not so much dependent on its fixed mechanisms (its hardware), but on the content of its registers. What is then important to realise is that the behaviour of the machine - and virtually any behaviour is possible - is dependent on the programme, its content and the data stored in memory (Newell, Rosenbloom & Laird 1989:94). Thus, this architecture ... *epitomizes the invention of the computer, a mechanism that can exhibit flexible, complex, responsive, and task-oriented behavior* (Newell, Rosenbloom & Laird 1989:96). According to the symbolicists and proponents of AI, such as Newell, Rosenbloom and Laird (1989:96), a *natural hypothesis* is that, given the observation in humans of *flexible and adaptive behavior in seemingly limitless abundance and variety*, this flexible and adaptive behaviour of humans may be accounted for by a cognitive architecture or mechanism quite similar to the computer's architecture (depending, of course, on the programming involved).

The symbolicists, then, model the human cognitive architecture on the computer architecture. By making a distinction between levels of description in terms of human cognition and behaviour, it is possible to utilise the cognitive architecture at a specific level. Humans may be described at various (systems) levels, preferably a hierarchy of levels of which the higher is dependent on the lower (Newell, Rosenbloom & Laird 1989:96). Three basic levels may be distinguished, namely the (a) semantic or knowledge level, (b) the symbol level, and (c) the physical or biological level (Pylyshyn 1989:57) (compare the discussion on levels of description in Chapter 1 of this study). According to the symbolicists the topmost level is the *knowledge level* which describes a ... *person as having goals and knowing things about the world* (Newell, Rosenbloom & Laird 1989:96). The knowledge level includes goals to attain and knowledge from various sources. Behaviour is determined by the goal (i.e., knowledge of the desired condition and situation), but also by the commitment to reach that goal, the objective conditions of the situations (such as the demands and restrictions placed on behaviour), and the subjective conditions of the person involved. This includes knowledge from diverse and various sources, such as

> *long-term experience with similar situations, prior eduction including the acquisition of skills, and the socialization and enculturation that provide the background orientation* (Newell, Rosenbloom & Laird 1989:97).

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[6] Emphasis mine.

Behaviour is determined by this knowledge level and not by the architecture (Newell, Rosenbloom & Laird 1989:97), although operation at the knowledge level is only possible because of operations on the lower *symbol level*. The symbol level system consists of representations and information processing processes (or rather *operations*) (see Newell, Rosenbloom & Laird 1989:96). At the symbol level, according to Pylyshyn (1989:57), *(T)he semantic content of knowledge and goals is assumed to be encoded by **symbolic expressions**.*[7] Furthermore, *(S)uch structured expressions have parts, each of which also encodes some semantic content.* Thus, the ... *codes and their structure, as well as the regularities by which they are manipulated* ... constitute the symbol level (Pylyshyn 1989:57). According to Newell, Rosenbloom and Laird (1989:96), the symbol level requires to be realised in terms of some "substrate," and ... *the architecture is that substrate defined in an appropriate descriptive language*. In terms of the computer, this substrate is the register transfer level described above (see p.134 above), and in terms of humans it is the highly parallel interconnected network of neuronal circuitry (Newell, Rosenbloom & Laird 1989:97). While Newell, Rosenbloom and Laird (1989) seem to restrict the concept of "architecture" to the biological or physical level, Pylyshyn (1989:57) views all three levels as part of the cognitive architecture. However, this restriction is more apparent than real, since Newell, Rosenbloom and Laird (1989:98) also take the biological and the knowledge level into account[8] and, in fact, view the architecture as a means to characterise the totality of mechanisms involved in the flexible and intelligent behaviour (Newell, Rosenbloom & Laird 1989:98). The architecture is then a framework encompassing all the mechanisms - not only single mechanisms, such as perception or long term memory storage - involved in cognition and behaviour.[9] However, this global focus is always from the perspective of the symbol level.[10] Of course, lower levels exist, such as the cellular level, the molecular level and so on, but the focus is explicitly on the symbol level system. It is then this level, the symbol level with its substrate or architecture which, according to the symbolicists, determines human behaviour to be psychological (cf. Newell, Rosenbloom & Laird 1989:98-99).[11]

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[7] Emphasis mine.

[8] See Footnote 9.

[9] *What the notion of the architecture supplies is the concept of the total system of mechanisms that are required to attain flexible intelligent behavior. Normally psychological investigations operate in isolation, though with a justified sense that the mechanisms investigated (memory, learning, memory retrieval, whatever) are necessary and important. The architecture adds the total system context within which such separate mechanisms operate, providing additional constraints that determine behavior. The architecture also brings to the fore additional mechanisms that must be involved and that have received less attention in experimental psychology, for instance, elementary operations and control. This requirement of integration is not a pleasant condiment. Every complete human performance invokes most of the psychological functions we investigate piecemeal - perception, encoding, retrieval, memory, composition and selection of symbolic responses, decision making, motor commands, and actual motor responses. Substantial risks are incurred by psychological theory and experimentation when they focus on a slice of behavior, leaving all the rest as unarticulated background* (Newell, Rosenbloom & Laird 1989:98).

[10] Hence the name *symbolicists*.

[11] ... *the role of the architecture in cognitive science is to be the central element in a theory of human cognition. It is not the sole or even predominant determinant of the behavior of the person, but it is the determinant of what makes that behavior psychological rather than a reflection of the person's goals in the light of their knowledge. To have a theory of cognition is to have a theory of the architecture* (Newell, Rosenbloom & Laird 1989:98-99).

4.2.3.2 The requirements for the cognitive architecture

Given the fact that the cognitive architecture is modelled on the computer architecture, and the cognitive symbolicists strong affiliations with AI and computer science, it is no surprise that one of the symbolicists' main aims is to develop simulations of cognitive architectures using the architecture of the computer (cf. Allport 1980:27). In this way the symbolicist theory can be tested by actually running programs and systems simulating complex cognitive behaviour.[12] But constructing architectures requires at least a set of parameters within which these architectures must function: it must simulate *human* cognition. For instance, if the aim is to study how one learns to form past tense verbs, the architecture developed to study this phenomenon, although simulated on a computer architecture, must resemble human restrictions and capabilities. For example, the computer programme must be able to learn at a speed similar to that of humans and be able to make similar mistakes, such as overgeneralising certain past tense forms in some cases (e.g., learning that the past tense for the verb *look* is the verb followed by *-ed*, then the same must apply to the verb *run*). Based on Newell's (1980) earlier exposition, Newell, Rosenbloom and Laird (1989:99) provide a list of such requirements or parameters within which the cognitive architecture must be able to operate:[13]

1. *Behave flexibly as a function of the environment*
2. *Exhibit adaptive (rational, goal-oriented) behavior*
3. *Operate in real time*
4. *Operate in a rich, complex, detailed environment*
   a. *perceive an immense amount of changing detail*
   b. *use vast amounts of knowledge*
   c. *control a motor system of many degrees of freedom*
5. *Use symbols and abstractions*
6. *Use language, both natural and artificial*
7. *Learn from the environment and from experience*
8. *Acquire capabilities through development*
9. *Live autonomously within a social community*
10. *Exhibit self-awareness and a sense of self*

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[12] Hunt and Luce (1992:448) contest the fact that actually running a programme will provide an understanding of human cognition.

[13] The remark of Newell, Rosenbloom and Laird (1989:99) that *(W)e need to understand the requirements that shape human cognition, ...*, could be misleading since one is frequently unable to discern whether a computer or human architecture is spoken about. Comparing the (human) cognitive architecture to the computer architecture is fine in order to illustrate the nature and functioning of an architecture. However, one gets the uneasy feeling that the symbolicists are not merely comparing but equating.

A system ought to be flexible in its response to the environment. According to Newell, Rosenbloom and Laird (1989:99), this is the central capability an architecture provides.[14] Flexibility provides the system with the means to exhibit adaptive behaviour. Newell, Rosenbloom and Laird (1989:99) describe adaptive behaviour as rational and goal-orientated. This means that behaviour is adaptive, not in a haphazard way, but in a rational manner in order to reach certain goals.[15] Furthermore, cognition must operate in real time since failure to do so in an ever-changing environment could have disastrous results. Since the system operates in a changing and demanding environment (demanding in terms of the amount and diversity of information impinging on the system), it seems as if the system ought to have multiple perceptual systems. They must ... *all operate concurrently and dynamically, and some must have high bandwidth* (Newell, Rosenbloom & Laird 1989:100). The system must have a very large memory since the environment provides the opportunity for the system to know much. It is also required from the system that it be able to use symbols and abstractions which may or may not fulfil the requirement that it be able to use language. Furthermore, the system should be able to learn from experience on a constant basis and it should be able to acquire skills during the course of its development.[16]

An important requirement is the ability to live autonomously within a social community. On the one hand, greater autonomy means greater freedom from the constraints of the environment, but on the other hand, it seems as if humans are dependent on the social community since, by leaving their communities, humans ... *become inept and dysfunctional in many ways* (Newell, Rosenbloom & Laird 1989:100).

The last requirement, that of the ability to exhibit self-awareness and a sense of self, is somewhat obscure according to Newell, Rosenbloom and Laird (1989:100), since ... *it is not evident what functional role self-awareness plays in the total scheme of mind.* Although self-awareness or consciousness is recognised as being part of human cognitive functioning, one may gather from this remark that it would be difficult to incorporate consciousness within the symbolicist framework. It thus seems that current knowledge of human cognition determines the extent to which a particular aspect can function as a requirement for the construction of an architecture. The question immediately arises whether the symbolicist framework is the correct one for modelling human cognition. However, the performance of an architecture, its successes and failings will, in the end, show how close it is to actual human performance. The point is that the formulation of requirements for a particular architecture is dependent on our current knowledge of cognition. As our

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[14] What makes Newell, Rosenbloom and Laird (1989:99) so sure that an architecture provides a system with the ability to behave flexibly?

[15] According to Newell, Rosenbloom and Laird (1989:99) the goals of (rational and adaptive) behaviour are survival and propagation.

[16] Newell, Rosenbloom and Laird (1989:100) are not certain about the relationship between *learning* and *development* (as is the case with the ability to manipulate symbol systems and the ability to use language). Learning and development could turn out to be two sides of the same coin, but meanwhile they prefer to list both requirements separately.

understanding of cognition becomes more refined, other requirements may come to the fore. For instance, Anderson (1983:15) necessitates the requirement of parallel processing based on the ability not only to receive input from multiple channels, but also to execute multiple actions while processing information: *We can be simultaneously perceiving objects, driving a car, generating a sentence, and processing a conversation.*

Whatever the specifications for the cognitive architecture may be, the assumption is that they can be accounted for by symbol processing. However, it is also true that certain specifications for the cognitive architecture and phenomena related to it, could turn out not to be supported by symbol processing (Pylyshyn 1989:86). The belief that most processes cannot be supported by symbolic processes, provided the initial impetus for the development of the connectionist framework.

4.2.4 The elements of the cognitive architecture

In order to fulfil, some or all, the requirements discussed above, the cognitive architecture must be able to perform certain functions. A distinction can be made between the structure and the function of the architecture for the simple reason that in computer science different structures and mechanisms were developed and are in the process of being developed, which produce certain similar functions (cf. Newell, Rosenbloom & Laird 1989:102,103; Pylyshyn 1989:67-68). For instance, programme A may differ in structure from programme B, but both produce the same result. The structural differences between certain computer programming languages (such as Fortran and C) are a case in point. Whatever the structure and mechanisms of the architecture, *(T)he central function of the architecture is to support a system capable of universal computation* (Newell, Rosenbloom & Laird 1989:103). From the symbolicist perspective, the central function is then the manipulation of symbol systems (cf. Newell 1980). This central function of the architecture is supported by certain subfunctions, such as memory, symbols, operations and interpretation. Newell, Rosenbloom and Laird (1989:102-103) stipulate the most important functions:

1. Memory
- *a. Contains structures that contain symbol tokens*
- *b. Independently modifiable at some grain size*
- *c. Sufficient memory*

2. Symbols
- *a. Pattern that provides access to distal symbol structures*
- *b. A symbol token in the occurrence of a pattern in a structure*
- *c. Sufficient symbols*

3. Operations
- *a. Processes that take symbol structures as input and produce symbol structures as output*
- *b. Complete composibility*

4. *Interpretation*

   a. Processes that take symbol structures as input and produce behavior by executing operations

   b. Complete interpretability

5. *Interaction with the external world*

   a. Perceptual and motor interfaces

   b. Buffering and interrupts

   c. Real-time demands for action

   d. Continuous acquisition of knowledge.

According to Newell, Rosenbloom and Laird (1989:108), these functions support human cognition as is stipulated by the requirements for the architecture described in paragraph 4.2.3.2 above. For human cognition to take place, the architecture needs vast amounts of memory or structures that persist over time (Newell, Rosenbloom & Laird 1989:104). Memory is composed of symbol structures, called so, since they contain symbol tokens (Newell, Rosenbloom & Laird 1989:104). Symbol tokens are, according to Newell, Rosenbloom and Laird (1989:105),[17] patterns or references in the various memory (symbol) structures that refer to other memory structures.[18] It is not unlike a *pointer* used in some computer languages, which is a token (consisting of a single entity such as a byte or a word) somewhere in the computer's memory pointing to another location which may contain data to be processed (cf. Stubbs & Webre 1985:68). The reason memory structures contain tokens is that it is sometimes not possible to assemble all the code for a particular computation ahead of time. It is therefore necessary to obtain additional data at other parts of the memory (cf. Newell, Rosenbloom & Laird 1989:105).

A system consisting of only static symbol structures can do nothing with these structures in memory. Thus, certain mechanisms must exist to perform operations on the symbol structures or enable the symbol structures to perform certain functions. For instance, a stored programme in the memory of the computer is useless unless some mechanism can utilise the steps specified in the programme structure. The cognitive system must therefore have code or mechanisms that perform *operations* on the symbol structures to create new symbol structures or modify old structures

[17] *Symbol tokens are patterns in symbol structures that provide access to distal memory structures, that is, to structures elsewhere in memory* (Newell, Rosenbloom & Laird 1989:105).

[18] *At some sufficiently large grain size the memory structures must be independently modifiable. There are two reasons for this. First, the variety of external world is combinatorial - it comprises many independent multivalued dimensions located (or iterated) throughout space and time. Only a combinatorial memory structure can hold information about such a world. Second, built-in dependencies in the memory structure, while facilitating certain computations, must ultimately interfere with the ability of the system to compute according to the dictates of the environment. Dependencies in the memory, being unresponsive to dependencies in the environment, then become a drag, even though it may be possible to compensate by additional computation. Within some limits (here called the grain size) of course structures may exhibit various dependencies, which may be useful* (Newell, Rosenbloom & Laird 1989:104).

(Newell, Rosenbloom & Laird 1989:105).[19] Some particular symbol structures, which may be called *codes, programmes, procedures, routines or plans*, can determine that a series of operations occur on other symbol structures (Newell, Rosenbloom & Laird 1989:105). This process of applying the operations to symbol structures is called *interpreting the symbol structure* by Newell, Rosenbloom and Laird (1989:105). This process of interpreting data or symbol structures entails *the ability to convert from symbol structures to behavior* (Newell, Rosenbloom & Laird 1989:106). What is fundamental to the cognitive architecture proposed by Newell, Rosenbloom and Laird (1989), is the constant loop between interpretation and construction.[20] New symbol structures can be constructed or old ones modified. Some of these new symbol structures can be used as programmes to construct/modify other structures (cf. Newell, Rosenbloom & Laird 1989:106). Basically it boils down to a programme which is able to programme itself. By being able to do this, it is flexible, since it can be changed according to internal and/or external demands. The basic architecture sketched here has all the components available - memory, symbols, operations and interpretation - to meet some of the requirements specified in paragraph 4.2.3.2 above (cf. Newell, Rosenbloom & Laird 1989:106-107). This symbol system or symbol based architecture is then flexible by being able to change its structures. It also provides the ability to represent goals and execute operations according to the goals. It can incorporate vast amounts of knowledge by being able to represent this knowledge symbolically. The symbolic nature of the knowledge structure also allows it to access other knowledge structures by using some symbolic codes as pointers to other data. It does not have to repeat, for instance, the representation of an apple a thousand times, but can access a single representation from distant structures by using minimum code. It also lends itself to the manipulation and representation of structures requiring symbolic code such as language and abstract knowledge. It can also provide for learning to take place since it can create long-term symbol structures (cf. Newell, Rosenbloom & Laird 1989:107).

The final aim of the cognitive architecture is to function within the real world.[21] The architecture should therefore be able to connect the symbol system to the external world. The senses are "interfaces"[22] between the world and the internal symbol system. The connection between the architecture and the external world requires a number of additional functions from the architecture (cf. Newell, Rosenbloom & Laird 1989:107):

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[19] In computers, an operator is applied to a set of operands. For instance, code is loaded in the registers of the computer. The first code or operator specifies data code to be loaded into the register. The second operator code tells the computer to add a number to the initial data code.

[20] *Operations can construct symbol structures that can be interpreted to specify further operations to construct yet further symbol structures* (Newell, Rosenbloom & Laird 1989:106).

[21] *Symbol systems are components of a larger embedding system that lives in a real dynamic world, and their overall function is to create appropriate interactions of this larger system with that world* (Newell, Rosenbloom & Laird 1989:107).

[22] ... *the architecture must provide for the interfaces that connect the sensory and motor devices to the symbol system* (Newell, Rosenbloom & Laird 1989:107). The term *interface* derives from computer science terminology. The usage of computer science nomenclature with regard to cognition clearly shows the symbolicists' commitment to the computer metaphor.

(a) It must provide the means of connecting the symbol system to both the sensory and motor devices.

(b) A number of buffers for information are required since the internal mechanism, namely the symbol system, is separated from the external world. Although the logic for such a requirement is clear, especially within a computer model of the mind, the motivation which Newell, Rosenbloom and Laird (1989:107) provide, seems suspect. They say that, since both "worlds" are separated,

> *(O)ne implication is that the external world and the internal symbolic world proceed asynchronously. Thus there* ***must*** *be buffering of information between the two in both directions.*[23]

It is not clear why the separation of the two environments necessitates asynchronous processes. The positing of asynchronous processes naturally demands buffers of some kind. It is assumed that internal processing is rather slow and therefore needs buffers to control the constant rate of information input from the various senses. The mere fact of being conscious of one's own thoughts and acts in *real-time*, runs counter to the idea that processing could sometimes be so slow as to require a temporary blackout just to empty buffers and catch up with processing. While it "appears" and certainly feels as if one is operating in real-time, human experience would have been most painful if we, with human architectures, were bound to the same time constraints as most computers are.

(c) In addition to buffers, Newell, Rosenbloom and Laird (1989:107) require *interrupts* to *cope with the transfer of processing between the multiple asynchronous sources of information*. This requirement of interrupts is based purely on the computer architecture developed to date. This function, as well as the buffering function, could indicate that the cognitive architecture is not only modelled on the computer architecture, but also is developed in such a way as to be implementable on a computer architecture.[24] The question arises again whether the symbolicist model is the most suitable framework for cognition. It seems as if the multi-disciplinary nature of cognitive science had the effect of changing the ultimate aim of

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[23] Emphasis mine.

[24] Compare Jorna's (1990:123) similar concern when discussing Anderson's ACT* architecture: *Several characteristics which Anderson mentions, such as production-compilation and production-tuning, seem to be borrowed more from the possibilities and constraints of computer implementation than from psychological reality of human cognition*. Also compare Anderson's (1983:7) following remark when he describes production systems: *The concept of a production system is vague, and it is hard to determine where its boundaries end and where other computer science formalisms or psychological theories begin*. It seems as if the theory associated with symbolic and computational systems compels one towards using computer metaphors or even modelling cognition on the computer architecture.

symbolicist cognitive psychology from merely understanding cognition in terms of the computer metaphor to explicitly formulating the cognitive architecture in such a way as to be implementable on a computer architecture (cf. Footnote 22 above).

Be that as it may, it seems as if the third requirement stated in paragraph 4.2.3.2 above, namely that the architecture be able to function in real-time,[25] determines much of the functions of the architecture as it interacts with the real world (if the architecture did not have to interact with the outside world, then the real-time constraint on its functioning would not apply).

4.2.5 Summary

The assumption underlying the symbolicists paradigm is that the human mind depends on symbol processing and symbol structures for cognition to take place. This assumption is based on the computer metaphor stating that the cognitive architecture is similar to the computer architecture. *Cognitive architecture* refers to that structure involving both the mechanisms of cognition and the knowledge or data processed by these mechanisms. Finding similarities between the computer and mind is facilitated by formulating the requirements for a human cognitive architecture. From the symbolicist perspective it seems as if the computer architecture is extremely suited for modelling cognition especially when certain requirements are emphasised, such as the need to have vast amounts of memory, the ability to cope with language and with similar abstract and symbolic languages, the ability to behave flexibly and the ability to behave rationally, i.e., have goals and the ability to maintain those goals. The current developments in computer science and AI make it possible to realise most of these requirements. At this stage it seems as if most requirements can be met by artificial intelligent systems to a greater or lesser extent, except the requirement of awareness and consciousness. Another requirement based on actual human performance not mentioned above is that of creativity, or the ability to produce novel concepts or ideas. At this stage it is very difficult to imagine or devise symbol systems capable of creating new ideas. The danger of formulating and emphasising certain requirements for the cognitive architecture which unwittingly accommodates the computer architecture better than others, is very real. Symbolicism, as a paradigm within which cognition can be understood, must be evaluated in terms of its success to explain cognition on its own terms and not on grounds of the success of implementing it on a computer architecture. Being successful at this is a goal in itself: many AI programmes and computer simulations of human cognition found successful technological applications, not because

[25] Incidentally, the real-time constraint does not imply or necessitate a buffering or an interrupt system. The interrupt system is indeed required by Newell, Rosenbloom and Laird (1989:107) for the cognitive architecture to be able to switch in time to new processing demands in response to the continually changing environment which presents new information constantly. A computer architecture requires interrupts since that is the way current operating systems were made, but it is conceivable that another system or capability of the cognitive architecture, which is not based on interrupts, may do the job of switching processing to other structures just as well.

the aim was to understand human cognition, but because the application was modelled on cognition (cf. Vere 1992:460).

In the next section an example of symbolicist architecture, namely Anderson's (1983) ACT* architecture, will be described in order to demonstrate its basic functioning. This is an example of a *total* architecture aimed at modelling global cognitive processes in contrast to specific or *partial* architectures which model specific cognitive processes (Wagman 1993:20-21). The other example of a total architecture - discussed by Newell, Rosenbloom and Laird (1989) - is that of Newell's SOAR (*State Operator and Result*). The differences between ACT* and SOAR will be pointed out in the next section, but ACT* will be discussed in more depth since it clearly demonstrates certain principles of an architecture.

4.2.6 An example of a symbolicist architecture: Anderson's (1983) Adaptive Control of Thought (ACT*)

According to Newell, Rosenbloom and Laird (1989:127) Anderson's (1983) architecture is an example of one of the most comprehensive cognitive architectures developed to date. The architecture is named ACT*[26] which stands for *Adaptive Control of Thought* (Anderson 1983:ix). Other architectures exist, such as the SOAR architecture (see Laird, Newell & Rosenbloom 1987; Newell 1990; Laird, Newell & Rosenbloom 1987),[27] but the basic principles involved in developing and designing an architecture are present in Anderson's ACT* (cf. Newell, Rosenbloom & Laird 1989:109-120).[28]

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[26] Anderson (1983:vii-ix) developed a series of systems trying to explain elements of human cognition by using and developing computer simulations of these systems. ACT went through a series of revisions (ACT, ACTE, ACTF, ACT*) since its inception in 1973 (see Anderson 1976 for ACTE; cf. Anderson 1983:17-19; 1990:2-3).

[27] Newell, Rosenbloom and Laird (1989) discuss both the ACT* and SOAR architectures in terms of the five functional requirements *memory, symbols, operations, interpretation,* and *interaction with the external world* discussed in paragraph 4.2.4 above.

[28] Newell, Rosenbloom and Laird (1989:109-119) discuss the similarities and the differences between ACT* and SOAR. The following summary of their discussion ought to suffice (see Newell, Rosenbloom & Laird 1989:119-120):

Differences between the architectures

(a) ACT* has two long term memories (declarative and procedural) while SOAR has one production memory.

(b) ACT* has a single space environment with deliberate subgoals, while SOAR has multiple problem spaces and an impasse mechanism. This means that the way memory dependant operations are executed differs slightly (cf. Newell, Rosenbloom & Laird 1989:116-117). In ACT* goals and subgoals focus the attention of the system by letting productions execute which have particular goals in their conditions. In SOAR, the problem spaces with their set of conditions specify the preferences for the selection (decisions) of productions. When the decision cycle cannot produce a single decision, the impasse mechanism allows the generation of subgoals for the system to overcome the impasse (cf. Newell, Rosenbloom & Laird 1989:117).

(c) The operation of productions differ. In ACT* productions feature as problem solving operations, while in SOAR productions operate as an associative memory (Newell, Rosenbloom & Laird 1989:112).

(continued...)

The development of ACT* represents a theory of higher level cognition concerning the principles of control of thought - that which gives thought or cognition its direction - and simultaneously is an attempt to understand the *adaptive function* of these principles (Anderson 1983:ix). What is important to note is that Anderson (1983:1) emphasises the unity of cognition. This means that the various aspects associated with cognition, such as memory, language or problem solving, are but ... *different manifestations of the same underlying system* (Anderson 1983:1). Although some peripheral systems may exist in specialised form, a common cognitive system for higher level processing lies behind these. Anderson (1983:1) feels so strongly about this common system[29] that he connects it with what it means to be human: ... *the essence of what it is to be human lies in the principles of this*

[28](...continued)

Similarities

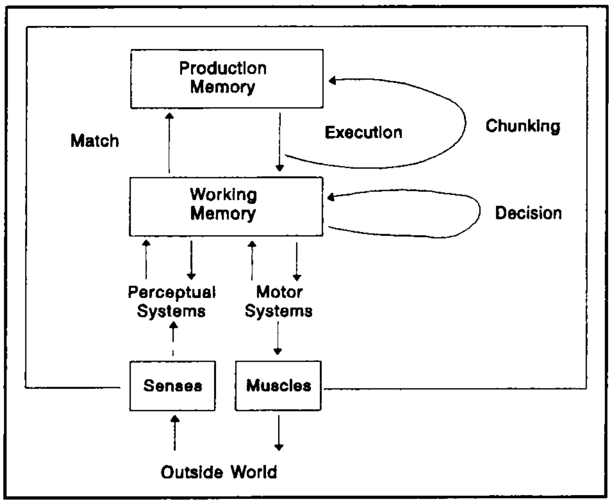
(a) Both are designed as production systems.

(b) Both are responsive to the real-time requirement due to them being production systems.

(c) Both abandon the application formalism of applying operations to operands.

(d) Both separate the act of storing symbolic structures in long-term memory from the deliberate acts of performing tasks.

The following figure gives a schematic representation of the SOAR architecture (adapted from Newell, Rosenbloom & Laird 1989:111). Compare this figure with the ACT* architecture (Figure 12).



[29] Anderson's (1983:3-5) arguments for a unitary cognitive system may be summarised as follows:

(a) The short evolutionary history of the many higher cognitive functions, such as language (and solving mathematical puzzles), probably precludes the development of specialised systems such as for language. There simply was no time.

(b) Related to the above, is the fact that the mind displays great plasticity in acquiring functions (such as programming a computer) *for which there was no possibility of evolutionary anticipation*.

(c) The last argument for a unitary cognitive system is that it seems as if various cognitive activities display common features.

core, higher-level system. It could be that he even had consciousness in mind when he (1983:1) followed that

> *(W)e may not differ from many mammalian species to which we are related in our peripheral perceptual and motor processes, but we assuredly do differ in our complex thought patterns and our intelligence* (Anderson 1983:1).

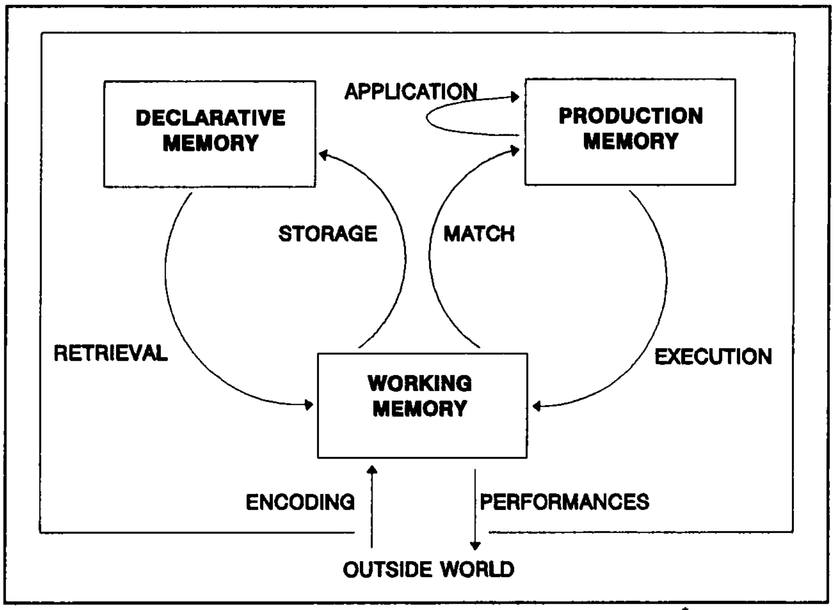


Figure 12 Schematic representation of the ACT* cognitive architecture (Anderson 1983:19)

Act*'s production system consists of three types of memory: a declarative, production and working memory (Anderson 1983:19)(see Figure 12). Both the declarative and production memories are long-term memories. Working memory holds all the information (retrieved from long-term memory or any temporary structures) that is accessible to the system at any one stage (Anderson 1983:19; see also p.151 of this study). The declarative memory has the form of a semantic net and is used for factual knowledge. The procedural memory consists of productions (the *how* of processes)(cf. also Anderson 1980:223).[30] Apart from the memories, the system consists of certain processes, namely encoding, storage, retrieval, match and execution, that are applied to the contents of working memory (Anderson 1983:20,47). Representations of the environment are *encoded* and placed in working memory. Permanent records of working memory are *stored* in permanent memory (declarative memory). These records can be *retrieved* from permanent memory into the working

[30] Anderson (1980:223) describes procedural knowledge as *cognitive skill*, which is the *ability to perform various intellectual procedures*. Despite this definition, Anderson (1980:223,225) takes riding a bicycle and driving a car as examples of procedural knowledge. One would rather distinguish between cognitive skill and motor skill, although learning a motor skill probably does involve cognitive processes initially until the execution of the motor skill becomes automatic (see Anderson 1980:226-230). With the ACT* system, Anderson (1983:215) phrases it more carefully: procedures *do* include motor behaviour, but the ACT theory focuses on cognitive skills.

memory. In the *match* process, productions are selected according to the contents of working memory. New working memory structures are created by the *execution* process through the production actions.

4.2.6.1 The production system

The memories and processes make up the architecture of ACT*. The architecture functions by means of production systems. A production system is made up of many productions or production rules.[31] A production consists of a condition-action pair which is an IF-THEN statement where the IF-part consists of the conditions, and the THEN-part consists of the actions to be executed if the conditions agree with the content of working memory (cf. Anderson 1983:5; 1980:238-245; Jorna 1990:121). For instance:

IF	person 1 is the father of person 2 and person 2 is the father of person 3
THEN	person 1 is the grandfather of person 3.

Anderson (1983:7-9; 1980:243) gives an example of a production system for doing an addition problem (such as 614 + 438 + 683). The system consists of productions (or rules) such as

P1	IF	the goal is to do an addition problem
	THEN	the subgoal is to iterate through the columns of the problem.

The system consists of many such productions (P1..P*n*) stating goals and actions. The system does not necessarily follow productions sequentially from P1 to P10 but starts at the main goal (namely do an addition problem) and follows a certain path in order to satisfy subgoals and set new ones to solve the problem. The way Anderson (1983:10) formalised the example, reminds one of a computer programme with routines, subroutines and imbedded routines.[32] The production can be executed if the clauses in the condition (IF ...) are available or present in working memory (Anderson 1983:11). This means that some information will be retrieved from long-term memory. The action-part of the production rule (THEN ...) normally adds to the content of working memory (by producing new productions, goals or information), but can also lead to external behaviour (Anderson 1983:11). In fact, *(P)roductions provide the connection between declarative knowledge and behavior* (Anderson 1983:215). The data in the condition-action pair can be represented by a semantic network in each case (cf. Anderson 1980:241). Thus, the IF-clause can be represented by

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[31] Jorna (1990:120) calls the productions "production rules" although it seems that a *production* could refer to the action that takes place whenever a *production rule* (an IF-THEN condition pair) is executed. The production rule is then the formalised parameters of a production (cf. Anderson 1983:6).

[32] Cf. Anderson's (1983:11) terminology: popping goals, using variables, and flagging. Again the computer architecture is taken very seriously!

a subnetwork, and the THEN-clause (production) by another network. The condition network includes variables to be filled in with data found in long-term memory. If a pattern match is found, then the production is completed. It should be clear that a production has a highly *computational* nature (Anderson 1983:12), which is one reason why the architecture is able to get from static knowledge structures to behaviour (cf. Anderson 1983:37,215).

An important aspect is that the interaction between declarative and procedural knowledge plays a crucial role in the architecture of ACT* (cf. Jorna 1990:121). The key to understanding ACT* is that it tries to model human cognition by means of the ability to form new productions. Anderson (1983:217-254) illustrates this phenomenon by means of the stages of learning to solve geometry problems. The process of learning the skill of solving geometry problems moves through three stages.

(a) Firstly, declarative knowledge is used to consciously find procedures of solving the problem (Anderson 1983:217-231).

(b) Secondly, the system compiles the series of steps developed into units of procedures (Anderson 1983:235). This first step in the compilation process is called *composition*, where the series of steps to solve a problem are collapsed into units of procedures by forming new operators. These operators embody the series of steps. Secondly, by means of *proceduralisation* new versions of the procedures are formed which do not require the specific declarative information. The declarative information is now built into the production (Anderson 1983:235).

(c) The last stage of learning is called *the tuning of productions* (Anderson 1983:241). In this stage the search for efficient procedures of doing a task is facilitated. The best and speediest way of doing a particular task is chosen from a set of related alternatives.

This whole process is summarised by Anderson (1983:255):

> *Skill development, according to the ACT learning theory, starts out as the interpretive application of declarative knowledge; this is compiled into a procedural form; and this procedural form undergoes a process of continual refinement of conditions and raw increase in speed. In a sense this is a stage analysis of human learning. Much like other such analyses of behavior, this stage analysis of ACT is offered as an approximation of a rather complex system of interactions. Any interesting behavior is produced by a set of elementary components, with different components at different stages. For instance, part of a task can be performed interpretively while another part is compiled.*

The claim is that the configuration of learning mechanisms described is involved in the full range of skill acquisition, from language acquisition to problem solving to schema abstraction.

Anderson (1983:240) acknowledges that procedure compilation in a computer modelled system such as ACT* differs from actual human learning. The process in humans is gradual in order to account for mistakes and allowing for adaptation in skills and procedures to take place. With computers, the programmer tells the computer what the data, and the programme is, and how to apply the one to the other.

4.2.6.2 Declarative representation

The second important facet of the architecture comprises the long-term memory structures called the declarative memory. According to Stillings *et. al.* (1987:18) *declarative* refers to ... *the static, fact-like nature of representation: they are* ***inert*** *structures that are operated on by* ***processes***.[33] A clear distinction is thus made between structure and process. It seems as if the bulk of knowledge needed for any behaviour to be executed is captured by the declarative memory, and its contents consist of pure facts. The analogy with the computer is also applicable here: even a software programme in its inactivated form consists of static and inert facts, albeit facts or statements in a particular sequence and format. The point is that the facts, statements or inert elements remain inert until used in a particular process.

According to Anderson (1983:22), declarative knowledge *can be decomposed into a tangled hierarchy of cognitive units. Each cognitive unit consists of a set of no more than five elements in a specified relation*. The cognitive unit encodes *a set of elements in a particular relationship* (Anderson 1983:23). Complex structures are created by hierarchical structures which means that one unit can be an element of another. A unit consists of five elements. The cognitive units are then small parts or nodes that are related to each other by means of connections (paths)(see Anderson 1983:22-23,25). This network of associations between nodes is called a semantic network. The nodes in a network have association strengths based on the extent to which a node is used. In ACT* there are three types of cognitive units, namely, propositions, strings and spatial images, each with its own representational requirements (Anderson 1983:26).[34] The temporal string encodes the order of a set of items, the spatial image encodes spatial configuration and the proposition encodes meaning (Anderson 1983:45). The five processes mentioned above (see p.145), operate differently on each of the three representational types (Anderson 1983:47).

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[33] Emphasis mine.

[34] The three representational types have their analogy with data types in computer science (Anderson 1983:26). The term "analogy" is probably an euphemism for "based upon."

4.2.6.3 The semantic network

As an example of the associationist network[35] used in representation, Anderson's (1980) propositional representation of meaning will be discussed. A proposition is ... *the smallest unit of knowledge that can stand as a separate assertion* (Anderson 1980:101-102). The proposition is thus the smallest (or most primitive) unit which could sensibly be judged to be either true or false. For instance, a complex sentence can be reduced to a set of primitive units, each expressing a fundamental truth or meaning about the original sentence. According to Anderson (1980:102),[36] it is true that people do not remember the exact wording of sentences, but reduce them to their meaning. The meaning of a sentence may be represented by a *propositional network* (see Figure 13).[37] In Figure 13, a proposition is represented by a circle[38], which is connected to arguments and relations. Each element in this structure, namely the proposition (the circle to distinguish it from the other elements), relations and arguments represents a node. A node is, therefore, that element where connections from other elements meet. Nodes link up with each other to form a propositional network.

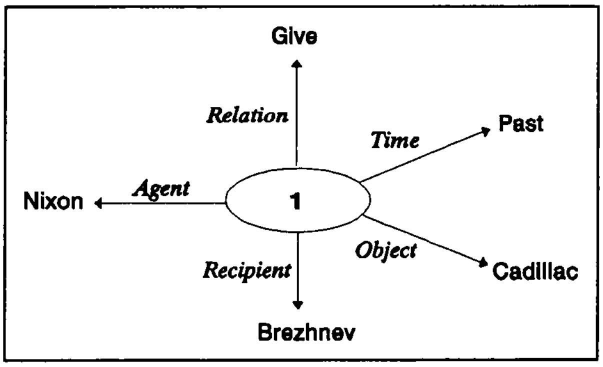

Figure 13 Example of a propositional-network (Anderson 1980:104)

To draw a node with its arguments and relations, all the relational terms in a sentence must be identified (*father of*, *on top of*, etc.)(cf. Anderson 1980:106-107). Then, the propositions for each relation must be identified. The proposition node (represented by a circle), is connected to the relation via an arrow (see Figure 13). The nounlike units are also represented by nodes. The nouns

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[35] See Lachman and Lachman (1979) for a history of symbolicist memory representation structures.

[36] *Thus, it seems that information is represented in memory in a way that expresses the meaning of the primitive assertions but does not preserve exact wording* (Anderson 1980:102).

[37] Various systems similar to Anderson's (1980) exist (see Rumelhart, Lindsay and Norman 1972; Anderson 1983, 1976; Anderson and Bower 1973; Norman and Rumelhart 1975; Quillian 1969). Different notational schemes may also be used (see Kintsch 1974, Friendly 1979).

[38] According to Anderson (1980:103) it is an ellipse.

must refer to specific instances or objects, such as *Nixon* in Figure 13. If not, then the specific object can be arbitrarily indicated by an *X*, which is connected to the class that object refers to by an *isa* label. Proposition nodes and noun nodes are connected to each other by means of arrows. The arrows can then be labelled with semantic descriptors such as subject, object, location, time, etc. In the end, networks terminate in noun units (Anderson 1980:109).

The meaning of specific concepts is represented in a network in terms of other concepts (cf. Fodor & Pylyshyn 1992:293). Anderson (1980:111) calls this process of defining concepts in terms of other concepts *configurational meaning*. The whole meaning of a concept is however not contained in the configurational structure. Some concepts do have an experiential link: *... the total meaning of a concept is not just the other nodes it is connected to but also the sensory and motor information connected to some of these nodes* (Anderson 1980:111). This propositional network is also called an associative structure. Anderson (1980:113) says that the links between nodes may be regarded as an association between ideas (nodes). He (1980:113) cites experimental evidence which shows that the memory of the meaning of certain sentences were influenced by the number of links concepts were away from each other. A subject cued with a particular word, recalled or associated those concepts closest to that word in a propositional representation (cf. Weisberg 1969; Ratcliff & McKoon 1978). Association is then defined as the proximity of concepts within a propositional network. Furthermore, the more frequently a fact is encountered with a particular concept, the greater the association between the fact and the concept (Anderson 1980:116). This facilitates recall of that particular fact.

4.2.6.4 Spreading activation

Knowledge structures within declarative knowledge become activated by means of a mechanism called spreading activation:

> *Activation spreads through the declarative network along paths from original sources to associated concepts. A piece of information will become active to the degree that it is related to current sources of activation* (Anderson 1983:86).

Anderson (1983:86-87) cites the neurobiological plausibility of spreading activation as one reason for believing that this is actually the way knowledge structures are activated (it is interesting to note that although a dispute between symbolic and connectionist systems exist, concepts such as parallel processing, associative networks, and spreading activation are used by proponents of both frameworks).[39] The basic idea of spreading activation is that *associated* structures become active as soon as a particular structure or element is activated. In terms of ACT*, working memory *is*

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[39] See Andrews (1989) for a discussion of activation and other models of memory access.

spreading activation since the activation of certain elements makes them available for further production (cf. Anderson 1983:888-89). Anderson (1983:89) states that activation can start in three ways: (a) When input corresponds to a particular memory element or node, then that element is activated, (b) when a production builds new structures, this process becomes the source of activation, and (c) when a production focuses a goal element on a structure in working memory, the focused structure becomes the source of activation.

Spreading activation takes place automatically and is normally an unconscious process. Anderson (1983:96) emphasises this fact by referring to priming[40] studies (cf. Wickelgren 1979:278). If a test subject is, for instance, primed with a certain word, associated concepts are accessed quicker than non-related concepts. Spreading activation explains this phenomenon, but priming also illustrates the automatic and unconscious nature of the spread of associative activation since test subjects are not usually aware of the association between the prime and the target: *The fact that priming is obtained without awareness is a direct reflection of the automatic and ubiquitous character of associative spread of activation* (Anderson 1983:96). Although spreading activation usually takes place unconsciously, the activated parts of a network can form part of working memory. In fact, the only way memories or knowledge can be retrieved to be visible or available to conscious attention, is by means of activation of relevant structures (cf. Anderson 1983:118).

4.2.7 Summary

4.2.7.1 Symbolicism is based on the digital computer model to varying degrees. Strong versions hold that the mind may be viewed as a computer-like machine engaged in symbol processing (cf. Nelson 1987), while weaker versions deny this strict modelling.

4.2.7.2 Information processing theories are also based on the computer metaphor as we have seen in the previous chapter. In the case of information processing theories, the aim was basically to model the flow of information through a processing system. The computer provided the means of conceptualising input, processing and output of information. In terms of processing, the processes largely remained undefined and unspecified. The cognitive agent was an information processor: signals impinging on the system from the outside were converted into information units or bits, processed by various systems, utilised by short-term memory and stored in long-term memory. As was stated in the previous chapter, the place and function of consciousness or awareness is somewhat difficult to determine within the information processing approach. Short-term memory seems to be the place where consciousness comes into play, but for the bulk of the remaining processes it is not

[40] Cf. Anderson (1983:96-107) for a discussion of priming studies and their application to the ACT* model. See also the previous chapter for a discussion on priming.

required (cf. Shiffrin & Schneider 1977). It is also unclear in what way information processing causes consciousness (see Chapter 3 of this study).

4.2.7.3 Symbolicism differs from information processing, firstly, through its emphasis on the actual architecture of cognition. The similarity between the computer architecture and cognition is more than mere analogy. Secondly, symbolicism explicitly emphasises representational issues. It focuses on the fact *that* information is represented, and on *how* it is encoded and represented. The computer architecture makes provision for the encoding, representation and accessing of symbol structures, thus it is said that the mind also has a symbolic knowledge structure (cf. Fodor & Pylyshyn 1992:294). The most popular structure is the propositional network or the semantic net.

4.2.7.4 As was the case with information processing discussed in the previous chapter, symbolicism makes a distinction between function and structure. It is clearly delineated as code and process, representational structure and procedure or declarative structure and production. In symbolicism this distinction is taken very seriously with the realisation that, since its emphasis is on representational issues, something must be done to utilise the static knowledge structures in order to effectuate behaviour. Within the multidisciplinary framework of computer science and AI, the static structures are actuated by algorithms such as the condition-action pairs used in the production systems of ACT and SOAR. However, in one sense the structures do activate themselves. As soon as a particular node is activated in the semantic network, then associated (linked) nodes become activated to various degrees (see paragraph 4.2.6.4 above). Activation can become stronger or decay, depending on the source of activation (cf. Anderson 1983:92). If a particular node activates four other nodes, the activation strength tapers down if those four nodes must divide the activation again. However, the purpose of activation is to make a particular structure, or segment of a structure, available to working memory where productions use the activated structure. Thus, activation is not in itself a self-actuating mechanism since an activated structure still needs productions to translate knowledge into behaviour (Anderson 1983:88).

4.2.7.5 Symbolicism is a representationalist theory (see Chapter 2 of this study). According to Fodor and Pylyshyn (1992:291) representationalists *hold that postulating representational (or 'intentional' or 'semantic') states is essential to a theory of cognition*. Thus, the symbolic structures of mind encode the states of the world, and it is just this fact that the mind represents information or states that makes a theory of mind a psychological theory of cognition (cf. Fodor & Pylyshyn 1992:318 note 4). Indeed, what makes representation *cognitive* is its intentional or semantic nature: it is intentional since it is internal representation *about* the external world, and it is semantic since it encodes *meaningful* information about the world. The theory of representationalism seems to have all the elements required for a systemic approach: a symbolic system has structure, it aims at meaning (recall Anderson's *configurational meaning* on page 150 above) and it is intentional (i.e., it is about something). The missing element is, of course, that the representational structure does not contain actuating mechanisms: structure and function are separated. As was seen in Chapter 2 of this study, intentionality is more than mere representation, or in Neisser's (1967) idiom: the mind does not merely mirror reality, it constructs it. Thus intentionality is an *act* and does not only express the fact that a particular symbol stands for something else.

4.2.7.6 The role, cause and nature of consciousness and awareness within the symbolicist paradigm are difficult to pinpoint. A distinction is made between unconscious and conscious processes. Unconscious processes (such as spreading activation, pattern recognition or encoding) make up the bulk of cognitive activity. Consciousness is regulated to short-term memory or working memory, and could play the role of regulator (executive) by determining goals and ensuring that those goals are reached, but sometimes conscious choice to execute certain actions may be the result of unconscious goal setting procedures (cf. Johnson-Laird 1993:365). Consciousness, at least with regard to cognition, seems to operate on the symbolic level since thought has meaningful content. Very little is said by the symbolicists about the origin of consciousness within a symbolic system.

The reluctance (or maybe incapability) to deal with consciousness within the symbolicist framework is best illustrated by Newell's (1990, 1992) exposition of a "unified" theory of cognition which concentrates mainly on the capabilities of SOAR. His unified theory is criticised by, amongst others, Dodwell (1992:444) and LaPolla and Baars (1992:448) for not dealing with the issue of consciousness. Newell's (1992a:475) response to this criticism that *... **no** existing cognitive theory provides clues about consciousness*[41] is quite interesting. The reason for this, according to Newell (1992a:475), is that the nonfunctional aspects of consciousness cannot be included in a theory of cognition since such a theory aims at explaining functional aspects of the mind. The functional aspects of consciousness in cognitive theory are already subsumed under *awareness*, and according to Newell (1992a:475), cognitive architectures such as SOAR deal with awareness. Awareness is then defined as deliberative behaviour, and SOAR (ACT as well) illustrates that the analysis of a problem requires deliberations about what to solve and how to go about it. The operating system of SOAR does exhibit awareness in terms of the decisions it must make to solve a particular problem. But is this really awareness? The definition Bunge and Ardila (1987:235) give on awareness, discussed in Chapter 2 of this study, requires amongst other things, sensing internal or external changes. Does a programme sense in the same way a living organism does? This question may be left open at this stage except to say that it is debatable whether an artificial architecture can exhibit awareness according to this

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[41] Emphasis Newell's.

definition. The problem, however, is what Newell means by nonfunctional aspects of consciousness: the internal subjective experience of a range of thoughts and emotions may be termed nonfunctional if one cannot understand the function of these experiences at this stage of scientific investigation. However, this does not mean that it is. The main difficulty for a symbolicist architecture is to simulate this subjective quality, and Newell's concession that cognitive theory (symbolicism) does not deal with consciousness, shows that an architectural system cannot account for emergent phenomena such as consciousness. The question may then rightfully be posed whether a theory can pretend to be about cognition without addressing some of the fundamental aspects on what it means to be human.

4.2.7.7 Why can an architectural design incorporating a symbolic system not account for emergent phenomena? The difficulty lies not so much in the computational nature of the cognitive architecture. One may assume that certain cognitive activities indeed use a rule-like system such as when engaged in problem solving activities. The problem lies with the structural nature of the architecture which incorporates the memory structures. The symbol system based on the propositional network-idea is much too static, atomistic[42] and associationistic. Neisser's (1967) criticism of associationism and the reappearance hypothesis applies here (see Chapter 3 of this study). Despite its neural quality, the symbol structures are encoded in an associationistic network: concepts or nodes are associated in a rather straightforward manner by invariant links despite the fact that the strength of the link may vary. Nodes are invariant elements linked to each other. New concepts or larger structures such as schemata or scripts can be formed by constructing a hierarchical structure of nodes and links, but structures, nodes and associations are always established by the external processes operating *on* the symbol structure. The problem is not the structurality of the symbol system, but its inability to overcome the elementistic and static character of an associationistic structure. It stays elementistic and static if it is not able to incorporate processes within itself. The moment any similar structure is able to fuse structure and process, it becomes systemic and emergentist.

In the following section symbolicism's rival paradigm will be discussed, in order to see whether it is able to provide for the shortcomings of symbolicism.

4.3 THE CONNECTIONIST APPROACH TO COGNITION

While the symbolist models of cognition rely heavily on the computer metaphor, proponents of connectionist models, although in some sense also acknowledging the importance of the

[42] Cf. Chalmers (1992:31); Stone & Van Orden (1989).

computer,[43] base their models on the brain: *We say that such models are neurally inspired, and we call computation on such a system brain-style computation. Our goal in short is to replace the computer metaphor with the brain metaphor* (Rumelhart 1989:134). Although connectionist models - also called PDP or parallel distributed processing models[44] - do have a physiological plausibility, their main aim is not to simulate the brain as such, but to use it as a model in order to explain cognition psychologically and computationally:[45]

> *They hold out the hope of offering computationally sufficient and psychologically accurate mechanistic accounts of phenomena of human cognition which have eluded successful explication in conventional computational formalisms; and they radically altered the way we think about the time-course of processing, the nature of representation, and the mechanisms of learning* (McClelland, Rumelhart & Hinton 1986:11).

Churchland and Sejnowski (1989:43) quite rightly state, that until such time that physiological experimental methods enable the study of the interaction of sets of neurons over time, building "artificial" neural biologically constrained models and studying their behaviour provide cognitive scientists with the means to model human cognition.

4.3.1 Definition of connectionist systems

PDP models differ from most other theories and models in one aspect: processing takes place reasonably[46] simultaneously in many units, hence the name *parallel distributed processing* (cf. Rumelhart, Hinton & McClelland 1986:47). But, not even the parallel nature of processing of connectionist models demarcates it finally from other models and processes which normally have a sequential processing character. The crucial aspect is the way it represents knowledge:[47]

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[43] Cf. Rumelhart (1989:133).

[44] See McClelland, Rumelhart & Hinton (1986:43).

[45] *One of the appeals of parallel distributed processing is the fact that it seems closer to the neural basis of cognition than most other approaches to cognitive processes. The idea that intelligent processing can emerge from the interactions of a large number of simple computational units and their interactions is, of course, directly inspired by what we know about the way the brain works* (Rumelhart & McClelland 1986a:327)(cf. also McClelland, Rumelhart & Hinton 1986:11).

[46] According to Rumelhart, Hinton and McClelland (1986:61), new values can be determined simultaneously or *synchronously* for all units, or at random and *asynchronously*. By utilising computer technology, a serial processor can simulate parallel distributed processing since it is only when looking at the model at a very short time-span that it becomes apparent that only one unit is updating its values at a particular moment. Due to the speed of the processor it seems as if units update simultaneously.

[47] *From conventional programmable computers we are used to thinking of knowledge as being stored in the state of certain units in the system. In our systems we assume that only very short term storage can occur in the states of units; long term storage takes place in the connections among the units. Indeed, it is the connections - or perhaps the rules for forming them through experience - which primarily differentiate one model from another. This is a profound difference between our approach and other more*
(continued...)

knowledge is not represented by nodes or units[48] as with semantic networks, but by the *strengths of connections* between units (Hanson & Burr 1991:185), hence the name *connectionism* which is probably a more apt description for this class of models. For instance, referring to the brain model, if a neuron represents a processing unit, then a unit of knowledge such as "dog", does not reside within that particular neuron (cf. Rumelhart, Hinton & McClelland 1986:47). Facts of knowledge cannot therefore be localised or pinpointed by identifying specific neurons in the brain (or nodes in a semantic network). The neuron is rather a very simple processing unit which receives inputs from other neurons and outputs signals to other neurons. A neuron is of course connected to many other neurons. What it does or does not send to other neurons, depends on the strengths of the input received from other processing units. Furthermore, it does not operate in isolation. The final achievement of a group or network of neurons depends on the pattern of activations or the strengths of connections between that particular group of neurons (cf. Rumelhart, Hinton & McClelland 1986:49; see also the *excursion* on p.166 of this study):

> *These models assume that information processing takes place through the interactions of a large number of simple processing elements called units, each sending excitatory and inhibitory signals to other units. In some cases, the units stand for possible hypotheses*[49] *about such things as the letters in a particular display or the syntactic roles of the words in a particular sentence. In these cases, the activations stand roughly for the strengths associated with the different possible hypotheses, and the interconnections among the units stand for the constraints the system knows to exist between the hypotheses. In other cases, the units stand for the possible goals and actions, such as the goal of typing a particular letter, or the action of moving the left index finger, and the connections relate goals to subgoals, subgoals to actions and actions to muscle movements. In still other cases, units stand not for particular hypothesis or goals, but for aspects of these things. Thus a hypothesis about the identity of a word, for example, is itself distributed in the activations of a large number of units* (McClelland, Rumelhart & Hinton 1986:10).[50]

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[47](...continued)
conventional approaches, for it means that almost all knowledge is ***implicit*** *in the structure of the device that carries out the task rather than* ***explicit*** *in the states of units themselves* (Rumelhart, Hinton & McClelland 1986:75).

[48] In a connectionist system, there is no direct correspondence between an element to be represented and a processing unit. This type of representation is called *local representation*, and although simple and straightforward, it is misleading in terms of the way knowledge is represented in a connectionist system (see Hinton, McClelland & Rumelhart 1986:77).

[49] "Hypothesis" means that a particular processing unit represents the *likelihood* that a particular feature is present or not (indicated by positive or negative values)(cf. Rumelhart, Smolensky, McClelland & Hinton 1986:8-9).

[50] See also Rumelhart, Hinton & McClelland (1986:46-47): *In some models these units may represent particular conceptual objects such as features, letters, words, or concepts; in others they are simply abstract elements over which meaningful patterns can be defined.*

4.3.2 Representation in connectionist models

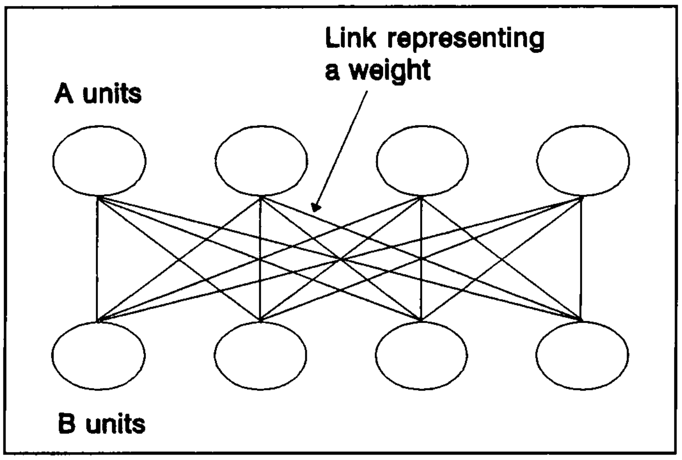

Figure 14 Schematic representation of a one-layered perceptron

As was mentioned above, representation is a crucial aspect of PDP or connectionist models. Indeed, the representation of *patterns* is crucial to PDP models (cf. Beale & Jackson 1990:15). Although many different versions and computational models exist in the connectionist framework, a very simplified model called a *pattern associator* described by McClelland, Rumelhart & Hinton (1986:33-40) will be discussed to illustrate the principles of representation. The pattern associator, represented in Figure 14, is an example of a *simple linear model* (Rumelhart, Hinton & McClelland 1986:62) or a *perceptron* (Beale & Jackson 1990:44).

4.3.2.1 The simple pattern associator

In Figure 15, two pattern associators are represented in matrix form. The upper row (+1 -1 -1 +1) in Figure 15a can be called the A processors or units and the righthand column (-1 -1 +1 +1) can be called the B units.

(a)

+1	-1	-1	+1	
-,25	+,25	+,25	-,25	-1
-,25	+,25	+,25	-,25	-1
+,25	-,25	-,25	+,25	+1
+,25	-,25	-,25	+,25	+1

(b)

-1	+1	-1	+1	
+,25	-,25	+,25	-,25	-1
-,25	+,25	-,25	+,25	+1
-,25	+,25	-,25	+,25	+1
+,25	-,25	+,25	+,25	-1

Figure 15 Two simple pattern associators represented as matrices (from McClelland, Rumelhart & Hinton 1986:35)

If, for instance, the visual pattern of a rose and its corresponding aroma needs to be represented, so that each time the one occurs, the other is activated, let the A units represent the sight of a rose and the B units the aroma as in Figure 15a. The activation pattern for the visual representation of a rose is then +1 -1 -1 +1 given that the A unit may either be positively (+1) or negatively (-1) activated, with 0 representing a neutral intermediate value. The aroma of a rose is then represented by the pattern -1 -1 +1 +1 on the B units. This particular pattern associator uses discrete activation values although, in general, activation values may also be continuous (cf. Rumelhart, Hinton & McClelland 1986:48). Continuous values may be bounded (taking on a value within certain boundaries or limits such as 0 to 1) or unbounded (any real number). Discrete values may be binary (-1, +1) or consist of a small set of values (-1, 0, +1 or 1, 2, 3, 4, 5) (cf. Rumelhart, Hinton & McClelland 1986:48). The question is, then, how to arrange the strengths of the connections between the A units and the B units, when, given the activation pattern of the A units, the result will be the pattern of the B units (cf. McClelland, Rumelhart & Hinton 1986:35).

In the example above (Figure 15a), the effect of an A unit on a B unit is determined first of all by the sign of the A unit and the corresponding connection. Multiplying the sign of the A and the connection yields the sign of the B unit. For example, a positive A unit and a negative connection yields a negative or inhibitory B unit. The value then of a particular B unit is determined by adding the strengths of the all the connections in a row for that B unit. In the example the strength of the connections was set to 0,25 to yield a value of 1 for both the A and B units.[51] In Figure 15a, the A pattern and B pattern are associated by means of the particular connections as displayed in the matrix. If one thus has the A pattern (+1 -1 -1 +1) available with the strengths (which includes both the value and the sign and which refers to the strength of the A unit's activatory or inhibitory effect) of the connections, then the B pattern will be reproduced. The same pattern associator can cope with various A patterns and connections strengths to produce different B patterns, without different A patterns and connections strengths interfering with each other (McClelland, Rumelhart & Hinton 1986:37).[52] Figure 15b displays another A and B pattern with different connection strengths.

4.3.2.2 Connectionist memory

According to Hinton, McClelland and Rumelhart (1986:79-80), the implication of the ability of a connectionist system to represent different or reasonably similar patterns by means of a set of weights on the same units,[53] is far reaching. It means that a cognitive system's memory is

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[51] For instance, the first unit of the B level units has a value of -1. This value was obtained by finding the product of the values of the A units and the weights in the first row of the matrix and then adding the values together:

$$(+1.-0{,}25)+(-1.+0{,}25)+(-1.+0{,}25)+(+1.-0{,}25) = -0{,}25 - 0{,}25 - 0{,}25 - 0{,}25 = -1$$

[52] If the input patterns are orthogonal, there will be no interference (Rumelhart, Hinton & McClelland 1986:63).

[53] Cf. McClelland & Rumelhart (1986:190).

essentially *constructive*. A particular memory is not accessed by means of a specific address. Accessing a memory in this way means that an exact match must be found. Rather, even though the memory may be partially incomplete - which it usually is - it is *reconstructed* by means of pattern completion. A partial memory or description is presented as a partial activation pattern and activates some of the processing units (Hinton, McClelland & Rumelhart 1986:80). Interaction between the units activates other units which then completes the pattern. The particular memory is therefore reconstructed on a set of processing units. The implication of a connectionist system is then that patterns (or memories or knowledge) are reconstructed due to the system's ability to represent knowledge in terms of a set of weights of connections between units. Furthermore, knowledge of a memory is not localised anywhere. A pattern does not exist if it is not activated. Lastly, multiple "memories" may be activated on the same set of parallel processing units. The fact that the connectionist system does not require an exact copy of the original memory or pattern, simulates human memory better than other nonconstructive models which depict memory as a filing cabinet with specific slots for exact copies of specific memories (cf. Hinton, McClelland & Rumelhart 1986:81; Stern 1991; recall Neisser's constructivism discussed in Chapter 3 of this study).

4.3.2.3 The multilayered connectionist model

The basic principle for the connections between two patterns was illustrated above. Generally, a PDP model associates two patterns, usually an input and an output pattern. The patterns are "represented" by processing units (Rumelhart, Hinton & McClelland 1986:46-47). One may distinguish between *input*, *output*, and *hidden* units. The input may come from any source such as from the senses, while the output units could activate, for instance, motor movements (Rumelhart, Hinton & McClelland 1986:47). The hidden units are processing units not visible outside the system or model, to other systems (Rumelhart, Hinton & McClelland 1986:48). A perceptron with hidden units, represented in Figure 16, is also called a *multilayered perceptron* (Beale & Jackson 1990:67; see Hanson & Burr 1991:181).

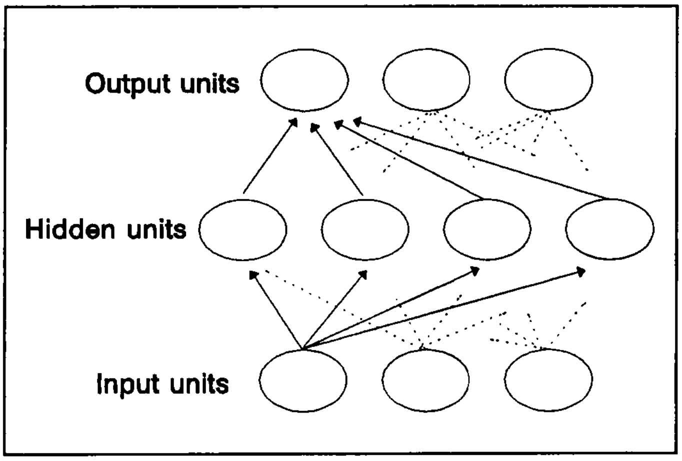

Figure 16 A simple connectionist network with input, output and hidden units

In the pattern associator or *one-layered perceptron* discussed above (see Figure 14), no hidden units were used (cf. Beale & Jackson 1990:39-61). The units, as such, are only the processors calculating the output values to other units or systems from the inputs of other units. The main feature of the PDP model is then the connections *between* the units. A pattern of connectivity between the network of units is represented by a set of weights indicating the strength of connections (Rumelhart, Hinton & McClelland 1986:49). As illustrated above, the weights can be arranged in a matrix. In most cases, the input to a particular unit is the weighted sum of the separate inputs from other units (Rumelhart, Hinton & McClelland 1986:49). A positive weight represents an excitatory input and a similar effect on the corresponding output unit, while a negative number represents an inhibitory input and associated effect on the output unit. No connection between two units is depicted as no weight, i.e., by 0. The strength of the connection is indicated by the absolute value of the weight.

> Beale and Jackson (1990) discuss the differences between a single layer perceptron and a multilayered perceptron quite clearly. Basically, research on PDP systems came to a standstill due to the findings of Minsky and Papert (1969) which indicated that single layered perceptrons could not solve or learn *linearly inseparable*[54] problems or patterns (Beale & Jackson 1990:58; cf. Hanson & Burr 1991:171 footnote 3; also Khanna 1990:70; see Rumelhart, Hinton & McClelland 1986:65).[55]

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[54] " Linear inseparability" means *a single linear function of the input cannot in principle separate one category from the other* (Hanson & Burr 1991:188).

[55] An example of a linearly inseparable pattern is posed by the famous exclusive-or (XOR) problem (see Rumelhart, Hinton & Williams 1986:330-334; cf. Beale & Jackson 1990:58; Hanson & Burr 1991:188). The pattern produced by the XOR logic is as follows:

x	y	z
0	0	0
0	1	1
1	0	1
1	1	0

Presenting two 0's or two 1's produces 0, and presenting a 1 and a 0 produces a 1 as output. By constructing the perceptron or network with two input units (to represent the x and y patterns) and one output unit (to represent the z output pattern), there is no way the perceptron can produce the correct output. Given the basic functioning of a network, a unit outputs a value to the output unit as soon as its value is one or more. The output unit fires correctly as soon as it is activated by either input unit having a value of 1 and it does not fire if both input units are turned off. However, it does fire incorrectly when receiving activation from both input units since it is supposed to stay off.

Another way of illustrating the impossibility of the perceptron to learn to represent this problem, is by showing it on a two-dimensional graph, where the input patterns are represented on the x and the y axes. The two patterns requiring an output of 0 and 1 cannot be separated by a single straight line (cf. Beale & Jackson 1990:58-59).

The first solution to the problem is to combine perceptrons, with each perceptron yielding an output for specific input patterns. According to Beale and Jackson (1990:65), the problem with this setup is that the network is unable to learn the correct output patterns, since weights between connections cannot be adjusted due to the binary threshold function. A unit outputs either a 1 or 0 but combinations between weights yielding intermediate values cannot be passed on. The solution is to use a nonlinear thresholding function, such as the sigmoid function

$$S(x) = \frac{1}{1 + e^{-cx}} \quad \text{(cf. Kosko 1992:39),}$$

which can yield intermediate values and therefore allow the network to make slight adjustments to weights. The unit is therefore not only on or off (cf. Beale & Jackson 1990:66). The new model for the solution of the XOR problem consists of a network with one hidden unit (which acts as a feature detector, indicating when both input units are on)(Beale & Jackson 1990:76), and a non-linear thresholding function. Adding hidden units to a network increases its computational (continued...)

According to Beale and Jackson (1990:60), interest was rekindled in PDP systems when Rumelhart and McClelland[56] introduced certain improvements in the perceptron architecture (cf. Kosko 1992:197).

4.3.3 Connectionist learning

It is, of course, not necessary to set the values of the connections by hand (cf. McClelland, Rumelhart & Hinton 1986:36). A pattern associator can "learn" the strengths of the connections merely by presenting it with the A and B patterns and by specifying "learning" rules in the form of computable functions. The first and most simple learning rule was proposed by Hebb (1949) which McClelland, Rumelhart & Hinton (1986:36) paraphrased as follows:[57]

> *When unit A and unit B are simultaneously excited, increase the strength of the connection between them.*

Since activations can be either excitatory or inhibitory, the learning rule can be modified to include the sign of a particular activation and its effect. The strength of the connection between two units is then the product of their simultaneous activation (cf. McClelland, Rumelhart & Hinton 1986:36). Based upon the Hebbian rule, Smolensky (1989:57) calls the association between two units *statistical* rather than logical, since the *strength of the connection between two units is a measure of the statistical relation between their activities*. The state of activation of a particular unit is thus not the result of single logical rule: it is rather a statistical inferential result due to the collective influence of many units (see Smolensky 1989:57). According to McClelland, Rumelhart & Hinton (1986:37) the Hebbian rule has serious limitations and various other refined and more complex rules are used to specify the learning procedure.[58]

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[55](...continued)
power by virtue of its increased discriminant ability, and its power to construct input-to-output mappings (Hanson & Burr 1991:181; see also pp.182-183 & 196-197 for further specifications of the unique abilities hidden units allow networks to achieve). This multi-layered perceptron or PDP system is able to learn to present the correct output to the relevant input patterns (cf. Beale & Jackson 1990:75 and 77 for an illustration of the solution). The key to the success of this network being able to solve the non-linear problem is the generalised delta or back-propagation learning rule proposed by Rumelhart, Hinton and Williams (1986), which is simply a method for adjusting weights back through the network by trying to minimise the error between the output pattern and the desired pattern.

[56] Although Rumelhart *et. al.* (1986) successfully applied the back-propagation algorithm coupled with immense interest in PDP computing, it soon became apparent that Parker (1982) and Werbos (1974) derived the algorithm earlier.

[57] See also Rumelhart, Hinton & McClelland (1986:53).

[58] The following describes the functioning of a one-layer and a multilayer network learning algorithm:

The one-layer perceptron learning algorithm (cf. Beale & Jackson 1990:48-50).

(a) Initialise weights and thresholds

(continued...)

[58](...continued)
Define $w_i(t)$, $(0 \leq i \leq n)$, to be the weight from input i at time t, and θ to be the threshold value in the input node. Set w_0 to be $-\theta$, the bias and x_0 to be always 1.

Set $w_i(0)$ to small random values. This initialises weights and thresholds.

(b) Present input and desired output

Present input $x_0, x_1, \ldots, x_n$ and desired input $d(t)$.

(c) Calculate actual output

The threshold function in this case is a step function f_h (called the Heaveside function)(Beale & Jackson 1990:43) outputting either 1 or 0 per neuron unit. The threshold θ can either be subtracted from the weighted sum input values for unit i in which case the output function will be:

$$y(t) = f_h \left[\sum_{i=1}^{n} w_i(t) x_i(t) - \theta \right]$$

or the neuron unit can be biased by the threshold value by defining an extra unit x_0, which is always on (+1), and with a weight of $-\theta$. The output will then be calculated as follows:

$$y(t) = f_h \left[\sum_{i=0}^{n} w_i(t) x_i(t) \right]$$

(d) Adapt weights

If correct	$w_i(t+1) = w_i(t)$
Output 0, should be 1	$w_i(t+1) = w_i(t) + x_i(t)$
Output 1, should be 0	$w_i(t+1) = w_i(t) - x_i(t)$

OR

If correct	$w_i(t+1) = w_i(t)$
Output 0, should be 1	$w_i(t+1) = w_i(t) + \eta x_i(t)$
Output 1, should be 0	$w_i(t+1) = w_i(t) - \eta x_i(t)$

where $(0 \leq \eta \leq n)$, a positive gain term which controls the adaptation rate.

OR with Widrow-Hoff delta rule

when

$$\delta = d(t) - y(t)$$
$$w_i(t+1) = w_i(t) + \delta \eta x_i(t)$$

where d(t) is desired response and y(t) is actual response.

The multilayer perceptron algorithm (cf. Beale & Jackson 1990:73-74).

(a) Initialise weights and thresholds

Set all weights and thresholds to small random values

(b) Present input and desired output

Present input Xp = x0, x1, ..., xn-1
and target output Tp = t0, t1, ..., tm-1 where n = number of input nodes and m = number of output nodes. Set w0 = $-\theta$ and x0 = 1.

(continued...)

What is very important to realise is that the strength of a connection is determined locally (McClelland, Rumelhart & Hinton 1986:37; see Churchland & Sejnowski 1989:29). In other words, it is not necessary to supervise all the connections simultaneously in order to determine each one's value (cf. Rumelhart, Hinton & McClelland 1986:47). A connection needs to consider *only* the values of the units it is connected to. The strengths of the connections are actually not determined in a single step but in a series of steps where the values of the connections are slightly adjusted. This process of strength adjustment is then called "learning". Various algorithms for the adjustment of strengths were developed (cf. Footnote 58).

According to Rumelhart, Hinton and McClelland (1986:54-55), the learning that takes place in PDP models can be broadly categorised into two classes, namely, associative learning and regularity discovery. The pattern associator illustrated above is based on the *associative learning* scheme. Whenever a particular model manages to reproduce a certain activation pattern when another activation pattern is presented, then the learning scheme used is that of associative learning.[59] In

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[58](...continued)
For pattern association, Xp and Tp are the patterns to be associated, and for classification Tp is 0 except one element which is 1 which represents the class for a particular pattern Xp.

(c) Calculate actual output

Each layer calculates

$$y_{pj} = f\left[\sum_{i=0}^{n-1} w_i x_i\right]$$

and passes this as input to the following layer. The final layer outputs values o_{pj}.

(d) Adapt weights

Start from output layer and work backwards

$$w_{ij}(t+1) = w_{ij}(t) + \eta \delta_{pj} o_{pj}$$

$w_{ij}(t)$ is the weights from node i to node j at time t, η is a gain term, and δ_{pj} is an error term for pattern p on node j.

For output units

$$\delta_{pj} = k o_{pj}(1 - o_{pj})(t_{pj} - o_{pj})$$

For hidden units

$$\delta_{pj} = k o_{pj}(1 - o_{pj}) \sum_{k} \delta_{pk} w_{jk}$$

where the sum is over the k nodes in the layer above node j.

[59] Two subclasses for associative learning may also be distinguished (cf. Rumelhart, Hinton and McClelland 1986:55): (a) *Pattern association* where the goal of the model is to build an association between two patterns defined or represented on two sets of units; (b) *Auto-association* where a pattern is associated with itself with the goal of pattern completion. On the presentation of a part of a pattern, the remainder must be completed by the model.

the *regularity discovery* situation, units learn to respond to certain patterns in their input. According to Rumelhart, Hinton and McClelland (1986:55), the two learning classes sometimes cannot be distinguished, but it is nevertheless useful to indicate the different goals of the two kinds of learning. Associative learning is concerned with storing the relationships among subpatterns, while *(R)egularity detectors are concerned with the meaning of a single unit's response* (Rumelhart, Hinton and McClelland 1986:55). Regularity detectors are especially useful for feature discovery.

4.3.4 Representing memory structures

Usually, units in a connectionist system or network represent *microfeatures* or aspects of a particular pattern (cf. Rumelhart, Smolensky, McClelland & Hinton 1986:8; Hinton 1981). In this way the connectionist network is similar to Selfridge's Pandemonium discussed by Neisser (1967) as a feature detector (cf. Chapter 3 of this study). Single features of an object are represented by the weights between the processing units. Bigger units of meaning can be constructed from the microfeatures, but one problem is that the network becomes unmanageably large if all the microfeatures of all the objects within a particular schema must be represented. Although bigger structures, such as a schema or script, may be represented on the processing units on an one unit-one schema basis,[60] it is very difficult to compress the complexity of big units, such as a schema, into the simple processing units of a connectionist network and still make provision for the complex internal structure of a schema. It seems as if the individual processing units of connectionist models were designed for representing simple features (cf. Rumelhart, Smolensky, McClelland & Hinton 1986:8). The problem is on the one hand, how to represent bigger semantic units, and on the other hand, how to represent bigger units such as schemata with overlapping variables. For instance, particular schemata, such as going to the restaurant, going to church or going shopping, have common variables and it is sometimes only the context and the relationship between variables or aspects within a schema which distinguishes it from another schema. The Necker cube is a case in point. The same set of points and lines may be viewed as two different three-dimensional cubes depending on one's initial perspective (cf. Rumelhart, Smolensky, McClelland & Hinton 1986). The restaurant and church-going schemata usually both have speaking to other people, or driving in a vehicle to the venue, as some of their elements. The distinguishing feature between the two schemata is that other variables (in terms of the context of operation of the variable) constrain the interpretation of, for instance, "driving to the venue."

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[60] By representing a semantic unit or concept such as *car*, or even a whole sentence on one single input unit, it may seem that we are back at symbolicism: Input unit 1, for instance, refers to my car, input unit 2 to my house and input unit 3 to me driving instead of to microfeatures. However, it may be argued that representing bigger semantic units in this way differs from semantic networks since the representing is not done by the units (nodes) but by the connections. Moreover, the input to a particular connectionist network is not the same as the actual representation by the network: input is just that, despite its symbolic significance.

The solution which Rumelhart, Smolensky, McClelland and Hinton (1986) found for this problem, was not to focus on the individual units of a network, but on the possible *states* of the network as a whole (see Rumelhart, Smolensky, McClelland & Hinton 1986:11). As soon as all the constraints are satisfied, the network settles into a solution or a *stable state*. Given a network with 8 input units, and each having a possible binary value, then the possible states the network can settle into are equal to 2^8 (cf. Rumelhart, Smolensky, McClelland & Hinton 1986:11). However, due to the constraints built into the network - i.e., due to the arrangement of weights of the connections - the network may eventually settle into only a few states. The state it will eventually settle into depends on the initial input it receives (cf. Rumelhart, Smolensky, McClelland & Hinton 1986:13). Therefore, activating one particular input unit will result in stable state *A*, while the activation of another input unit could result in stable state *B*. Indeed, it is easily imaginable that in a complex system such as the human cognitive apparatus, the stable states of various modules or subsets of distributed networks serve as the inputs for other modules (see McClelland & Rumelhart 1986:174-175)

Rumelhart, Smolensky, McClelland and Hinton (1986) use a relatively complex example of a network consisting of forty descriptors of five particular rooms in a house, namely a kitchen, bedroom, bathroom, living room and an office. Each room represents a schema for that room. The same forty descriptors, such as ceiling, door, oven, etc., were used for the five room-schemata. Each processing unit represents a room descriptor.[61] The weights between the forty units were then calculated, i.e., the constraints were determined. Rather than settle into one of 2^{40} possible states, the constraints were such that only one of five states were possible at a particular time, depending on the initial input (Rumelhart, Smolensky, McClelland & Hinton 1986:26). By activating an input unit which is descriptive of one of the 5 schemata, and not allowing its value to vary (this is called *clamping* an input unit),[62] the network was allowed to run and it eventually settled into a stable state representative of the initial descriptor. That particular schema is then said to be activated. The way the network settles into a stable state is described differently by various authors (cf. Rumelhart, Smolensky, McClelland & Hinton 1986:13 footnote 4).

4.3.5 Computing requirements for the connectionist system

While the macrostructure of cognition, which is its processing stages viewed from a time-scale of seconds and minutes, has a definitive sequential or serial quality, this does not mean that processes on the microlevel also take place sequentially (cf. McClelland, Rumelhart & Hinton 1986:12). Connectionist models provide a plausible explanation and description on the microlevel of the

[61] It should be noted that the units in their example represent rather abstract concepts. For instance, the descriptor "has a television" supposedly would first be instantiated on its own network in order to cover for different types of televisions. See Rumelhart, Smolensky, McClelland and Hinton (1986:25).

[62] Rumelhart, Smolensky, McClelland & Hinton (1986:25)

macroprocessing stages for the following reason: attempts to specify the microsteps involved in a particular stage of processing usually exceed the plausible time limit for actual human cognition (cf. McClelland, Rumelhart & Hinton 1986:12). For instance, modelling even a simple activity, such as recognising the letter A, involves specifying hundreds of computational steps which, in the end, requires powerful hardware which can make thousands of calculations within a time-frame of milliseconds. It is generally accepted that the brain, on the other hand, is a very slow computational device. Any computations involved on the microlevel must therefore be few, but still effective (cf. McClelland, Rumelhart & Hinton 1986:12; also Rumelhart, Hinton & McClelland 1986:75). All processing and computation must comply to what Feldman (1985) called the *100-step program constraint*: specific processing must take place within 100 computational steps (cf. Smolensky 1989:56).[63] Connectionist processing provides such a solution to the computational and time constraints placed upon modelling cognition. Connectionist processing models may therefore be viewed as an alternative to *serial* models for the microstructure of cognition.

Excursion: Differences between the brain and a connectionist network

One of the main differences between the physiology of the brain and the structure of connectionist networks, is the number of connections between actual neurons and units as modelled on a connectionist system. Most experiments implementing units and connections are small compared to the complex and intricate network in the cerebral cortex where the number of synapses (connections) a single neuron may receive, range from a few hundred to tens of thousands (Crick & Asanuma 1986:336). Modelling this enormous amount of connections between units will require much computational power and whether the behaviour of networks with an excess of 200 000 units are similar to that of smaller networks, is not known (cf. Churchland & Sejnowski 1989:41).

Other differences, which actually are very crucial, exist. For instance, the unit in a PDP system does not model a neuron very well since not much is known about the finer workings of neurons.[64] Units may be interpreted in three ways (Aizawa 1992:72): (a) *subneuronally* where the unit and its incoming connections is likened to a dendritic spine with various synapses; (b) *supraneuronally* where a single unit stands for a group of neurons; (c) *neuronally* where a unit and its links simulate a neuronal cell body with its axons and dendrites. According to this interpretation a unit does have some properties similar to a neuron, such as having multiple inputs, a summation rule, a threshold rule, and a single output to several other units, but the similarity ends there (Crick & Asanuma 1986:369-370; see also Sejnowski 1986 for a discussion of the computational difficulties in modelling neurons). For instance, the famous back-propagation learning rule of Rumelhart, Hinton and Williams (1986) does not have a biological counterpart, since signals in brain cells usually travel only in one direction (Aizawa 1992:72). Another difference between a connectionist network and the brain is that unlike units which can give both excitatory and inhibitory responses, neurons do not excite some cells and inhibit others

[63] *That is, we seek explanations for these mental phenomena which do not require more than about a hundred elementary sequential operations. Given that the processes that we seek to characterize are often quite complex and may involve consideration of large numbers of simultaneous constraints, our algorithms must involve considerable parallelism. Thus, although a serial computer could be created out of the kinds of components represented by our units, such an implementation would surely violate the 100-step program constraint for any but the simplest processes* (Rumelhart, Hinton & McClelland 1986:75).

[64] *... the brain's solutions to the problems of vision, motor control, and so forth may be far more powerful, more beautiful, and even more simple than what we engineer into existence ... Nature is more ingenious than we are. And we stand to miss all that power and ingenuity unless we attend to neurobiological plausibility* (Churchland & Sejnowski 1989:43).

(Crick & Asanuma 1986:370; also 338-339). According to current knowledge, one gets either excitatory or inhibitory neurons. In fact, more excitatory neurons exist than inhibitory ones (Crick & Asanuma 1986:362).

4.3.6 Constraint satisfaction

Connectionist models were introduced above as a class of models which are modelled on the brain, and which, due to this modelling, are structured as a *constraint satisfaction* architecture. In other words, since the connectionist framework takes its cue from what is known of the functioning of the brain, it tries to satisfy the constraints imposed on it by this neurophysiological knowledge. The idea of *constraint satisfaction* goes further than the apparent external limitations the brain model imposes on the PDP framework. Internally, from within the connectionist system itself, it is conceptualised as a constraint satisfaction network: processing units and their connections impose constraints on each other,[65] and

> *(I)f such a network is allowed to run it will eventually settle[66] into a locally optimal state in which as many as possible of the constraints are satisfied, with priority given to the strongest constraints* (Rumelhart, Smolensky, McClelland & Hinton 1986:9).

This is another way of saying that the stronger a connection between two units is (i.e., the bigger the weight), the greater the necessity to produce a particular result on the output unit (inhibition or activation)(cf. Rumelhart, Smolensky, McClelland & Hinton 1986:8-9). Rumelhart, Hinton and McClelland summarise it as follows:

> *We see the kinds of phenomena we have been studying as products of a kind of constraint satisfaction procedure in which a very large number of constraints act simultaneously to produce behavior. Thus, we see most behavior not as the product of a single, separate component of the cognitive system, but as the product of large set of interacting components, each mutually constraining the others and contributing in its own way to the globally observable behavior of the system* (Rumelhart, Hinton & McClelland 1986:76).

Thus, behaviour is viewed by the connectionists as the result of multiple constraints acting on each other. This role of constraints is different than the role of constraints in developing a model. The concept of constraints was already encountered in the discussion of the symbolicists' requirements for the cognitive architecture. In that paradigm, the real-time constraint played a significant role in

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[65] See Rumelhart, Smolensky, McClelland and Hinton (1986:9-11) illustrating the constraint satisfaction network by means of the Necker cube.

[66] A connectionist network settles or *relaxes* into a solution (Rumelhart, Smolensky, McClelland & Hinton 1986:9; also Khanna 1990:5).

the development of an architecture such as ACT or SOAR. Similarly, as was said above, the brain metaphor imposes constraints on the connectionist architecture: in some models units roughly correspond to neurons and links to synaptic connections. This type of constraint may be called $constraint_1$. The 100-step computing constraint discussed in paragraph 4.3.5 is an example of a $constraint_1$. The second, more fundamental sense of *constraint* - to be termed $constraint_2$ - is connected with the nature of the connectionist architecture. It *functions* as a constraint structure while the classical cognitive architecture functions as an *interrupt* system. This means that the classical system goes on with its task until it is interrupted with a new instruction or goal, while the connectionist system produces behaviour trying to satisfy multiple constraints simultaneously.

4.3.7 Emergence within the connectionist framework

The multiple constraint satisfaction network provides a way of viewing the complex functioning of schemata as discussed in Chapter 3 of this study. According to Neisser (1976), schemata function as structures guiding actions and as structures to be modified by actions. Rumelhart, Smolensky, McClelland and Hinton (1986:20) view schemata in a similar way when asking:

> *How can we get a highly structured schema which is sufficiently rich to capture the regularities of a situation and to support the kinds of inferences that schemata are supposed to support and at the same time is sufficiently pliable to adapt to new situations and new configurations of events?*

Although it is possible to represent reasonably static knowledge structures on a connectionist network as was discussed in paragraph 4.3.4, the specific problem for connectionism is to represent dynamic structures. As was seen above, symbolic systems utilise rules and networks to convert static structures to behaviour. With connectionist models the solution is not so obvious since it seems as if the models are wholly *representationalist* with no way to convert to action. Schemata as dynamic structures, brings this problem with connectionism to the fore. Is it then possible to model schemata - which are used to interpret the cognitive agent's environment, and are able to be changed by that environment - on a connectionist network? This dynamic nature of schemata calls for a *fusion between structure and process*: the structure must be able to be changed by environmental information, but it must also guide actions. This almost paradoxal structure and functioning of schemata is very difficult to model on most computational systems, but according to Rumelhart, Smolensky, McClelland and Hinton (1986:20), PDP networks are aptly suited for this task:

> *Schemata are not "things". There is no representational object which is a schema. Rather,* ***schemata emerge at the moment they are needed from the interaction of large numbers***

> ***of much simpler elements all working in concert with one another.***[67] *Schemata are not explicit entities, but rather implicit in our knowledge and are created by the very environment that they are trying to interpret - as it is interpreting them* (Rumelhart, Smolensky, McClelland & Hinton 1986:20).

In contrast with a semantic network within the symbolicist framework, semantic units such as schemata cannot be represented by a complex configuration of nodes and links or by a network of symbols. In fact, in a connectionist network, no object represented on it can be identified by pointing at a specific node. How is an object represented? By means of a complex interaction between simple processing elements. The same goes for schemata: they only exist as a network of weights, *emerging* when this network of multiple constraints settles into a stable state. Rumelhart, Smolensky, McClelland and Hinton (1986:20) continue:

> *Input comes into the system, activating a set of units. These units are interconnected with one another, forming a sort of constraint satisfaction network. The inputs determine the starting state of the system and the exact shape of the goodness-of-fit landscape. The system then moves toward one of the goodness maxima. When the system reaches one of these relatively stable states, there is little tendency for the system to migrate toward another state.*
>
> *The states themselves are the* ***product of the interaction*** *among many groups of units. Certain groups, or subpatterns of units tend to act in concert. They tend to activate one another and, when activated, tend to inhibit the same units.* ***It is these coalitions of tightly interconnected units that correspond most closely to what have been called schemata.*** *The stable pattern as a whole can be considered as a particular configuration of a number of such overlapping patterns and is determined by the* ***dynamic equilibrium*** *of all these subpatterns interacting with one another and with the inputs* (Rumelhart, Smolensky, McClelland & Hinton 1986:20-21).[68]

Thus, in a very unique way, knowledge and schemata can be represented by stable states emerging from the interacting network. From the above discussion, it seems as if the stable state depends on the input, and in this way, what is represented is determined by the environment, but it is also possible to change its configuration by explicitly learning variation in patterns.

When describing the "emergent" nature of schemata, Rumelhart, Smolensky, McClelland and Hinton (1986:56) liken the PDP framework to fluid dynamics: *Turbulence is not predicted by the knowledge of the elements of the system; it is inherent in the interactions among these elements.* In the same way

[67] Emphasis mine.

[68] Emphasis mine.

(P)roperties of networks "emerge" from the interactions of the elements. ... In general, we see cognitive phenomena as ***emergent*** *from the interactions of many units.* [69]

The connectionist paradigm, provides one with a computational model for a system which fuses structure and process. The "nodes" are actually processors determining input and output, while the result of this self-actuating mechanism is the representation of semantic units. On the one hand, using the term *emergence* may be too strong, since Searle (1992) pointed out that emergence cannot be casually reduced to the underlying mechanisms and structures (cf. Chapter 2). On the other hand, it may turn out that emergence *is* the result of a constraint satisfaction network, which means that one can actually identify the emergent structure in terms of the configuration of weights between a certain number of units (which is quite a formidable task if one wants to analyse interactions between actual neurons in the brain). However, the connectionist paradigm is still in the process of proving its worth, but it showed that a dynamic representation of knowledge is possible in ways not conceived by proponents of the symbolicist paradigm (see *excursion* below).

Excursion: Examples of connectionist applications
According to Smolensky (1989:49), connectionist research aims at modelling lower level perceptual processes and high level processes such as object recognition, problem solving, planning, and language understanding.[70] Some examples include the following:

Speech perception: McClelland and Elman (1986) tried to show that PDP systems can, to some extent, cope with the computational demands of modelling speech, and can account for what is known about speech perception. Much work has been done on language: (a) Learning the past tenses of verbs was also simulated by a PDP network (Rumelhart & McClelland 1986); (b) Sentence processing (McClelland & Kawamoto 1986; also Seidenberg 1992); (c) Converting text to speech (Churchland & Sejnowski 1989); (d) Learning language (Gorin, Levinson, Gertner & Goldman 1991); (e) Learning phonological rules (Lee & Gasser 1992).

Reading: Related to speech perception is the activity of reading. McClelland (1986) illustrates how a modified PDP network may be used for reading text. What is interesting with this type of application is that the demands of the empirical situation (in this case the act of reading and the type of mistakes humans make when reading), require essential corrections be made to the PDP system. In the case of the activity of reading, McClelland (1986) showed that in, for instance, letter recognition, a hardwired network for each letter in the alphabet is necessary in order to make word processing for more than one word possible. The problem is that a duplication of hardwired modules results in computational inefficiency. However, multiple letter recognition modules can be simulated by a connectionist network. The answer McClelland found was to make one network programmable by a central knowledge system which can change the connections and required inputs according to the

[69] Emphasis mine.

[70] According to Smolensky (1989:48-49), models of the following have been developed: Speech perception, visual recognition of figures, development of specialised feature detectors, amnesia, language parsing and generation, aphasia, discovering binary encodings, dynamic programming of massively parallel networks, acquisition of English past tense morphophonology from examples, tic-tac-toe, inference about rooms, and qualitative problem solving in simple electric circuits.

demands of the situation (this is called a Connection Information Distribution (CID) mechanism).[71] This particular system was then able to recognise single words but also, when trying to recognise two words simultaneously, make errors of interference and transference.

Another example is the recognition of handwriting (cf. Fukushima & Imagawa 1991).

4.3.8 Criticism of connectionist systems

Although connectionist systems show much promise in explaining various aspects of cognition such as pattern recognition and memory structure, it is important to take cognisance of the limitations of these models. The following remarks ought to suffice:

4.3.8.1 Connectionist pattern recognition does not express the full story of human cognition, since recognition in humans is usually accompanied by meaning. For instance, Gorin, Levinson, Gertner and Goldman (1991) argue against the separation of understanding speech and its transcription, since most research on technical applications of automated speech recognition (ASR) technology focus on transcription. The assumption is that the *form* of speech - for technological purposes - can be successfully separated from its content. However, recognising speech is not the same as understanding it. For the purpose of practical applications, such as voice recognition at Automatic Teller Machines (ATM), it is not necessary to understand content. According to Gorin, *et. al.* (1991:126), the usual understanding (in the technological field!) of verbal communication must be turned on its head: *Meaning is not present so that we can accurately recognize words, but rather linguistic structure (is) useful in order to facilitate the extraction of meaning.* Unfortunately, Gorin, *et. al.* (1991:127) restrict themselves to a poor definition of meaning and understanding by stating that a machine understands one's message if it correctly "maps" a verbal message to one of its own actions. The action of a machine, for instance to sweep the floor, is meaningful only by virtue of the person giving the command: the machine still does not understand the message!

4.3.8.2 Does the connectionist use of the term "learning" really capture the essence of what human learning in general entails? The connectionist's use of the term learning refers to the adjustment of weights between units. This may well be learning on a microlevel, but on a macrolevel, where learning sometimes requires deep understanding of the subject matter

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[71] *The CID mechanism consists of a central knowledge store, a set of programmable modules, and connections between them. The structure is set up in such a way that all of the connection information that is specific to recognition of words is stored in the central knowledge store. Incoming lines from the programmable modules allow information in each module to access the central knowledge, and output lines from the central knowledge store to the programmable modules allow connection activation information to be distributed back to the programmable modules* (McClelland 1986:129).

(such as when reading a Nietzsche text or a poem), it is doubtful whether weight adjustment on a small scale in current simulations does justice to this complex phenomenon.

4.3.8.3 According to Dinsmore (1992a:12) connectionist learning requires hundreds of thousands of iterations (cf. Pomerleau 1991). The human brain is a slow processor compared to the speed of computers on which connectionist simulations run. It thus seems that the brain is incapable of coping with so many iterations. It also seems as if the brain is much more efficient at learning than connectionist systems.

4.3.8.4 Learning on connectionist systems is achieved by using reliable and systematic examples, while human learning makes use of random sampling of the environment (Dinsmore 1992a:12). Thus, the very structured nature of connectionist learning differs from actual human learning (cf. Johnson-Laird 1993:190).

4.3.9 Summary

To summarise some of the properties of connectionist models, such as the pattern associator model discussed above:

4.3.9.1 Connectionist models are based on the brain architecture which means that processing takes place in a distributed fashion over a network of simple processing units functioning in parallel.

4.3.9.2 Connectionist models are able to learn patterns by means of certain computational algorithms. Currently it is used as the most efficient solution to particular problems, especially pattern recognition tasks and problems (cf. Cooper 1991:81).

4.3.9.3 Patterns are represented not by units but by the strength of the connections between the processing units. A connectionist system is thus a constraint satisfaction network which means that the units place constraints on each other in order to settle in a stable state. The stable state represents a pattern, object or concept and may be said to have *emerged* from the parallel distributed processing.

4.3.9.4 The structure of a connectionist model is such that it is able to recognise patterns even if the input patterns differ slightly from what it has learned. It is thus able to generalise correlated patterns and recognise central tendencies (McClelland, Rumelhart & Hinton 1986:35,39; Hinton, McClelland & Rumelhart 1986:82). Damage to certain units and/or connections has a slight effect on the model's ability to recognise patterns. It degrades gracefully under degraded input or damage (McClelland, Rumelhart & Hinton 1986:36).

4.3.9.5 Uncorrelated patterns do not interfere with each other. Thus the same network is able to recognise or learn different patterns (McClelland, Rumelhart & Hinton 1986:37). However, one problem is that, if patterns for different concepts are too close to each other, interference might occur (Hinton, McClelland & Rumelhart 1986:82,108-109).

4.3.9.6 An advantage of distributed representation is that new concepts or representations can be created without it being necessary to find additional units or hardware (Hinton, McClelland & Rumelhart 1986:85-87). Since knowledge is stored in the connections between units, only modification of the strengths of the connections is necessary to create new concepts. The key is that each representation must be a stable pattern (cf. Hinton, McClelland & Rumelhart 1986:87).

4.3.9.7 It is also important to realise that connectionism is only an approximation of biological models of the brain. Certain learning algorithms are used which does not apply to the functioning of actual neurons. Connectionist models have thus real limitations in modelling human cognition.

4.3.9.8 It was also seen that the connectionist architecture may provide a way to conceptualise the intricate relationship between structure and process (or function). It seems as if the fact that the elements of the connectionist structure are processing units and not symbols, as is the case with semantic networks, enables the system to utilise its structure and functions simultaneously. Its structure is then a certain configuration of processing units which may change dynamically in the process of weight change between units. Knowledge consists then as a configuration of interactions and not as a static structure. Its structure in terms of the stable state it reaches, is determined by itself. A connectionist system is thus a self-actuating system within which structure and process is fused: the two cannot be separated.

4.3.9.9 What, then, is consciousness according to the proponents of the PDP framework? Unfortunately, not much is said about consciousness within this framework. According to Rumelhart, Smolensky, McClelland and Hinton (1986:39) the *contents* of consciousness correspond to sequences of stable states of the cognitive system, but this still does not explain the origin of consciousness. According to the systemic emergentist model of consciousness described in Chapter 2 of this study, a connectionist system comes close to such an emergentist model. Connectionism, in terms of the fusion of structure and function, provides a description of how such a system could work computationally as a constraint satisfaction network. However, as noted above, connectionist systems still have some limitations in modelling human cognition.

4.4 DIFFERENCES BETWEEN THE SYMBOLIC AND CONNECTIONIST FRAMEWORKS

Both symbolicism and connectionism contributed much to cognitive science. With the rise of connectionism in the 1980's a fierce debate between the paradigms was enacted (cf. Hawthorne 1989). Connectionism was hailed as the solution to understanding the human mind. Since then the initial fervour subsided and the trend is to find common ground between the paradigms. It is however important to point out the differences between the two paradigms in order to see whether they can co-operate in the enterprise of explaining cognition. The following list notes the basic differences between the models.

4.4.1 Both use associative networks to represent knowledge. In the case of symbolic systems knowledge is represented symbolically by atomistic, discrete and static elements, while connectionist models represent knowledge as a range of values distributed over a configuration of units or elements (cf. Blank, Meeden & Marshall 1992:114). The networks of the symbol systems represent a higher, more abstract level of knowledge than the subsymbolic representation of the PDP system (Simon & Kaplan 1989:8).

4.4.2 McClelland and Rumelhart (1986) demonstrated the use of a connectionist system in simulating human memory. The characteristic of human memory, namely the ability to store both central tendencies, but also specific details of events, was simulated reasonably successfully on their PDP system.[72] McClelland and Rumelhart (1986) achieved this by means of a fairly simple learning rule, namely, the delta rule. This rule adjusts weights between connections entirely locally. It is this ability of a PDP network to make adjustments locally which distinguishes it from a symbolic system which requires the ... *explicit formulation of rules and abstractions under the guidance of some explicit overseer* (McClelland & Rumelhart 1986:214).[73] A parallel distributed network is thus able to store information entirely by making local adjustments in connection strengths without the need for a "manager" controlling the whole process of instantiating a pattern on a particular network.

According to McClelland and Rumelhart (1986:214-215) this does not mean that explicit rule formation and implementation have no place in cognition and memory:[74] they *only wish to*

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[72] *One central dilemma for theories of memory has to do with the choice to represent general or specific information. On the one hand, human memory and human learning seem to rely on the information of summary representations that generalize from the details of the specific experiences that give rise to them. ... On the other hand, specific events and experiences play a prominent role in memory* (McClelland & Rumelhart 1986:171).

[73] See also Rumelhart & McClelland (1986:217).

[74] And when learning languages (cf. Rumelhart & McClelland 1986). It seems as if the PDP approach is applicable to most processes involved in human cognition and behaviour (of course, according to its proponents!). This means that most human processes do not involve explicit rule formation. Although a particular process (such as constructing memories), may be described by a rule, the mechanism responsible for the formation of this process does not contain any statement of the rule (Rumelhart & McClelland 1986:217).

suggest that such mechanisms need not be invoked whenever behavior is observed that appears to be described by some generalization or rule.

4.4.3 The memory architecture of symbolic and connectionist systems differs. This implies that both the structure and the processes of storing and retrieving memories differ. Storing and retrieving a memory in a symbolic system is a simple and primitive process, according to Smolensky (1989:56). All that is needed is a location and a content, while in a connectionist system, storing and retrieving is a more complex process. In addition, the symbolic system requires nothing more than sequential addressable memory, while a connectionist system requires a parallel architecture.[75]

4.4.4 Some cognitive processes require parallel processing, such as speaking, recognising a face or even driving a vehicle, and connectionism provides the architecture for these cognitive processes (cf. Lee & Gasser 1992:180). Recognising a face in various contexts from various angles requires *holistic* processing which a parallel system provides. Symbolic systems have difficulty with holistic processing (cf. Russel 1989; Dinsmore 1992a:5).

4.4.5 Although both systems depend on constraints in order to function, symbolic systems use *hard constraints*, and connectionist systems use *soft constraints* (Smolensky 1989:57-58). In terms of hard constraints, Smolensky refers to the "hard" or exacting logic employed in symbolic systems. IF-THEN sequences do not allow for cases needing a PERHAPS-THEN logic (as the current developments in fuzzy logic allow; see Kosko 1992). Hard constraints are brittle and break down under certain circumstances (Hanson & Burr 1991:170). On the other hand, connectionist systems make use of soft constraints. Although each unit represents a "soft" constraint, it can be overridden easily by values from other units. In the end the system tries to "relax" into a stable state which satisfies all the constraints equally of the total system (Smolensky 1989:57).

4.4.6 Symbolic systems have difficulty coping with input noise and unexpected input while connectionist systems are fairly robust in recognising patterns in the presence of noise and incomplete input (Dinsmore 1992a:5). Although it is true that the instructions in a symbolic system may break down with disastrous results, Anderson (1983:231) points out that faulty or inappropriate condition-action pair forming in humans does in fact lead to life-threatening situations, such as a child crossing a street without looking for traffic. The implication is then that the formation of new rules (productions) or learning takes time and needs to be supervised, especially at earlier stages.

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[75] Of course, the classical Von Neumann architecture enables the simulation of a connectionist system, as most neural network software attest to.

4.4.7 According to Smolensky (1989:64), the serial nature of thought or cognition on a macrolevel is plainly a succession of stable states reached by parallel distributed systems. The succession misleads one to think that the processes underlying the macrolevel functions are also of a sequential nature - which is what proponents of the symbolic paradigm advocate. However, according to Hanson and Burr (1991:184), it is superficial to distinguish between symbolicism and connectionism on grounds of sequentiality on a macrolevel.

4.4.8 In contrast to symbolicism, connectionism is viewed as subsymbolic (cf. Chalmers 1992:31). Although they support connectionist processing, Hanson and Burr (1991:196-197) argue against Smolensky's (1988) view that connectionist systems are "subsymbolic". In fact, the hidden units' ability to map input to output units, i.e., its ability to recognise input categories and to generate a response to identify that category, is similar to the condition-action pairs found in rule-based systems. In other words, an algorithm for a particular unit to output a value if the sum of the input surpasses a threshold value, is nothing but an IF-THEN rule (cf. also Adams, Aizawa & Fuller 1992:54).

Despite these differences, the current move is, according to Dinsmore (1992a:20-21), to find common ground between connectionism and symbolicism by devising hybrid systems involving both symbolic and connectionist processes (cf. Lange 1992; cf. also Bechtel 1990). It seems as if symbolic systems are most suited to deal with higher level cognitive processes which can be formulated in terms of rules, while connectionist systems provide the subsymbolic support (Dinsmore 1992a:17). Although it assumed that symbolic systems suit higher level reasoning better, Rumelhart (1992) argues that connectionist systems with their microstructures can also be utilised for higher level reasoning processes.

4.5 CONCLUDING SUMMARY

The subject of this chapter was the two main computationalist approaches or paradigms in cognitive psychology. Their influence on and contribution to cognitive psychology in understanding the human mind came from a multidisciplinary endeavour, the participants of which ranged from linguistics to computer science and artificial intelligence (AI) studies.

The two paradigms are symbolicism and connectionism. Symbolicism views cognition as symbol processing and is based on the architecture of the modern digital computer. Connectionism takes its cue from the physiology of the brain and loosely models its systems on the working of the brain. The aim of the discussion in this chapter was to determine in what way process or function and structure is incorporated in their models.

4.5.1 The assumption underlying the symbolicists paradigm is that the human mind depends on symbol processing and symbol structures for cognition to take place. This assumption is based on the computer metaphor stating that the cognitive architecture is similar to the computer architecture. *Cognitive architecture* refers to that structure involving both the mechanisms of cognition and the knowledge or data processed by these mechanisms. Finding similarities between the computer and mind is facilitated by formulating the requirements for a human cognitive architecture. From the symbolicist perspective it seems as if the computer architecture is extremely suited for modelling cognition especially when certain requirements are emphasised, such as the need to have vast amounts of memory, the ability to cope with language and with similar abstract and symbolic languages, the ability to behave flexibly and the ability to behave rationally, i.e., have goals and the ability to maintain those goals. The current developments in computer science and AI makes it possible to realise most of these requirements.

4.5.2 An example of a symbolicist system was discussed. The architecture of ACT* (*Adaptive Control of Thought*) of Anderson (1983) was described. ACT*'s production system consists of three types of memory: a declarative, production and working memory. Both the declarative and production memories are long-term memories. Working memory holds all the information (retrieved from long-term memory or any temporary structures) that is accessible to the system at any one stage. The declarative memory has the form of a semantic net and is used for factual knowledge. The procedural memory consists of productions (the *how* of processes). Apart from the memories, the system consists of certain processes, namely encoding, storage, retrieval, match and execution, that are applied to the contents of working memory.

4.5.3 Symbolicism makes a distinction between function and structure. It is clearly delineated as code and process, representational structure and procedure or declarative structure and production. In symbolicism this distinction is taken very seriously with the realisation that, since its emphasis is on representational issues, something must be done to utilise the static knowledge structures in order to effectuate behaviour. Within the multidisciplinary framework of computer science and AI, the static structures are actuated by algorithms such as the condition-action pairs used in the production systems of ACT* and SOAR. It was seen that the activation of memory structures is not in itself a self-actuating mechanism, since an activated semantic network still needs productions to translate knowledge into behaviour.

4.5.4 It was seen that the architectural design of a symbolic system cannot account for emergent phenomena such as consciousness. The structural nature of the architecture which incorporates the memory structures poses a problem, since the symbol system based on the propositional network-idea is much too static and atomistic. Concepts or nodes are associated in a rather straightforward manner by invariant links despite the fact that the strength of the links may vary. Nodes are invariant elements linked to each other. New nodes and associations are always established by the external processes operating *on* the symbol structure. The problem is not the structurality of the symbol system, but its inability to overcome the elementistic and static character of an associationistic structure. It stays elementistic and static if it is not able to incorporate processes within itself. The moment any similar structure is able to fuse structure and process, it becomes systemic and emergentist.

4.5.5 The connectionist architecture provides a novel solution to the problem of structure and function. It was seen that connectionist models are based on the brain architecture which means that processing takes place in a distributed fashion over a network of simple processing units functioning in parallel. Connectionist models are able to learn patterns by means of certain computational algorithms. Patterns are represented not by units but by the strength of the connections between the processing units. A connectionist system is thus a constraint satisfaction network which means that the units place constraints on each other in order to settle in a stable state. The stable state represents a pattern, object or concept and may be said to have *emerged* from the parallel distributed processing.

4.5.6 It was also seen that the connectionist architecture may provide a way to conceptualise the intricate relationship between structure and process (or function). It seems as if the fact that the elements of the connectionist structure are processing units and not symbols as is the case with semantic networks, enables the system to utilise its structure and functions simultaneously. Its structure is then a certain configuration of processing units which may change dynamically in the process of weight change between units. Knowledge consists then as a configuration of interactions and not as a static structure. Its structure in terms of the stable state it reaches, is determined by itself. A connectionist system is thus a self-actuating system within which structure and process is fused: the two cannot be separated.

4.5.7 A connectionist system may provide a computationalist account of an emergentist systemic model (see Tryon 1993). Although it shows much promise, connectionism still needs to address certain higher level cognitive operations. Thus, despite the differences between the symbolicist and connectionist models, it seems as if future work lies in hybrid systems incorporating both distributed systems and symbol systems.

4.5.8 Although connectionism can provide a rudimentary account of emergent phenomena, it is virtually silent on the topic of consciousness. The most to be said is that the stable states of a connectionist system provide the *contents* of consciousness. Theoretically, symbolicism cannot provide an account of consciousness due to its representationalistic nature which separates structure and function. Connectionism ought to be able to provide an account, at least, of the origin of consciousness in terms of an emergent phenomenon arising from a representationalist system *fusing* structure and function, but it does not. The reason probably lies in the way the models are devised and tested: both symbolicism and connectionism devise systems to be run on the digital computer, and it is doubtful whether computationalist accounts of the human mind - at this stage at least - can provide an adequate simulation of human cognition and consciousness. At least until the stage that we have understood emergent phenomena and their relationship with the underlying systemic structures and processes, we will not know whether a computational account of cognition and consciousness along the lines of connectionism is possible.

The point, in the end, is that it is valid to view cognition as symbolic and computational. One may even view it as information processing. The view one takes depends on one's experiential history - intellectual and otherwise. Viewing cognition as a symbolic processing event may be applicable at a certain time in the history of psychological endeavour to understand the human mind, but it could be that we must challenge the prevailing views and propose an alternative model in order to overcome the restrictions of traditional and classical theory. Indeed, it seems as if a systemic emergentist model of cognition can simultaneously be a model for consciousness and cognition since it illustrates the intractable relationship between mind structures and functions. The last chapter in this study will try to flesh out the systemic emergentist model and draw the analyses of the various models of cognition together.

CHAPTER 5

A CONCEPTUAL FRAMEWORK FOR VIEWING COGNITION AND CONSCIOUSNESS: AN EMERGENTIST SYSTEMIC MODEL

5.1 INTRODUCTION

The aim of this study is to develop a conceptual framework within which the relationship between cognition and consciousness can be viewed. To obtain this goal, this study followed a particular strategy described in Chapter 1, which can be summarised in the following way. The assumption of this study is that cognition and consciousness must be viewed from a systemic emergentist perspective. From this assumption follows certain systemic emergentist principles, formulated as heuristic principles, and specified in Chapter 1. The systemic emergentist principles include emergence, structure, function, the fusion between structure and function, the constitution of systemic wholes, and interaction. Two principles, namely structure and function, were used in a heuristic fashion to discuss approaches to consciousness. It was seen in Chapter 2 that these two perspectives need to be incorporated in an understanding and definition of consciousness. Simultaneously, the nature of the principles became better defined. The same strategy was followed with the analysis of the various approaches to cognition in Chapters 3 and 4. In addition the place of consciousness in the various approaches was determined and it is hypothesised that the ability to account for the systemic emergentist principles within a particular approach determines its ability to incorporate consciousness within the process of cognition. This hypothesis and related matters will be taken up in greater detail in this chapter, and be discussed in terms of the results of the previous analyses.

The main question to be answered is whether the analysis of the various paradigms and theories is sufficient to provide a conceptual framework for further study of cognition and consciousness. It must be noted that the conceptual framework comprises a conceptual model and ***not*** a fully developed theory (the characteristics of a model and the difference between a model and a theory will be explicated below in paragraph 5.1.2). Does the conceptual model provide any new and fresh insights into consciousness and cognition, and their relationship? The key to understanding consciousness and, in the end, its relation to cognition, lies in a new way of conceptualising some of the traditional constructs and principles of science. Indeed, some of the concepts cognitive scientists and psychologists have struggled with, run counter to the traditional ideas applicable to empirical science. It is quite important to be aware of these differences, since the study of cognition and mental phenomena such as consciousness, actually aims at being empirically investigated. The aim in science is never to remain with theory - theory is the guiding set of expectancies to enable the scientist to explain certain phenomena - but to validate (or falsify) theory in the light of empirical testing (of course, mere empirical testing is also not the aim of science: the aim is to understand, explain and in the end to control). Cognitive psychologists and scientists did not so much introduce the mental into science as that they emphasised the role of mentalistic phenomena, despite the ignorance of consciousness from some quarters. As will be seen below, it seems as if the gradual reintroduction of mentalistic concepts and phenomena, such as consciousness, in psychology does necessitate a reevaluation of explanatory constructs and principles.

5.1.1 The aim of this chapter

The aim of this chapter is to develop a conceptual model of cognition and consciousness. To guide the reader through the argument of this chapter, it can be specified as follows:

(a) The first step is to identify the requirements of the model in order to formulate what one can expect from such a model (paragraph **5.1.2**). In terms of conceptual frameworks, a distinction between a model and a theory must be made. The requirements of a conceptual model will be specified, against which the model being developed here, will be measured.

(b) Since the model is called a *systemic emergentist* model, the model will be viewed first from the perspective of General Systems Theory (paragraph **5.2**) and then from Sperry's emergent interactionist theory (paragraph **5.3**) in order to specify the requirements for a systemic and an emergentist view. This is necessary in order to clarify what is meant with *systemic*, and how this conception of a system supports emergence. It will also become clear that emergence functions as a causative mechanism within a system. Three aspects play an important role in the eventual conceptual model, namely function, structure and emergence, and the aim of this section is to clarify the relationship between these aspects.

(c) The clarification of systems, function, structure and emergence will be followed by a corroboration of these concepts, especially that of function and structure, from the perspective of the various cognitive theories discussed in the previous chapters of this study (paragraph **5.4**). This section functions as a further focusing of the concepts to be included in the conceptual model by means of an integration of the previous analyses of cognitive theories.

(d) As part of the process of developing the systemic emergentist model, a framework must be sketched in terms of the phenomena the model must be able to explain and relate. It is no use developing a model without actually specifying what needs to be modelled. In the end, the success of the model will be determined by its ability to relate and explain certain phenomena. Cognition and consciousness can be viewed from the three levels of analyses discussed in Chapter 1, namely the biological, psychological and phenomenological levels. Since the biological level lies outside the scope of this study, the psychological and phenomenological levels can be used to specify the characteristics of cognition and consciousness. Psychological theories usually have difficulty accounting for the phenomenological experience of consciousness from the psychological level of analysis. Thus, the characteristics of consciousness will be specified on the phenomenological level of analysis in order to determine whether the systemic emergentist model can succeed in accounting for both levels of analysis.

Accordingly, the characteristics of cognition and consciousness (with the main emphasis on consciousness), will be identified (paragraph **5.5**) with reference to the phenomenological (paragraph **5.5.1**), and psychological (paragraph **5.5.2**) levels of analysis. The theories of cognition discussed in the previous chapters will provide the characteristics of cognition and consciousness from the psychological level of analysis, while the characteristics of consciousness will be specified from an example of a phenomenological description of subjective experience.

(e) Having the groundwork laid in this way, the final model will be described and certain principles responsible for the constitution of an emergentist system will be stipulated (paragraph **5.6**).

(f) Finally, in paragraph **5.7**, the systemic emergentist model will be evaluated in terms of the psychological and phenomenological characteristics of cognition and consciousness (specified in paragraph **5.5.3**) to determine its performance as a model. The model will also be evaluated against the requirements for a conceptual model (specified in paragraph **5.1.2**), in order to determine whether it indeed satisfies these requirements. The total critical identification of strengths and weaknesses of the systemic emergentist model is necessary in order to determine its usefulness as a conceptual framework relating cognition and consciousness.

5.1.2 Science theoretical requirements for a conceptual framework

The aim of science is to understand and explain reality, and in this process, conceptual or abstract ideas are generated embodying these explanations, in the form of statements, definitions and hypotheses (Mouton & Marais 1990:136). As soon as these conceptual statements concerning a certain segment of reality to be explained stand in a particular relationship to each other, a conceptual framework is formed. A conceptual framework tries to systematise the ideas concerning certain phenomena to some extent. A conceptual framework involves the structures of science, namely, typologies, models and theories. The nature of a particular structure is determined by its function. According to Mouton and Marais (1990:137,144), the following functions can be ascribed to the three structures:

(a) **Typologies:** classification and categorisation

(b) **Models:** heuristic and exploratory

(c) **Theories:** explanatory

Models also include the function of typologies, while theories include both the functions of typologies and models. It must be noted that models and theories sometimes cannot be demarcated quite clearly, although a model may be viewed as the precursor to a fully developed theory. The characteristic of a typology is that it categorises phenomena according to certain types. Thus, certain phenomena are excluded from the categorisation. The idea of systematisation and categorisation is to provide a frame of reference for data gathering (Mouton & Marais 1990:138). A model also performs the same function but with the additional function to start formulating certain hypothesis in terms of its systematisation function. The main function of a model is heuristic, i.e., it provides an exploratory perspective on the phenomena to be studied (Mouton & Marais 1990:139). It provides a systematisation of the relationships between variables and phenomena identified in the typology. It provides a rudimentary way of viewing the constructs involved and of the relationship between the constructs. A flow chart diagram of the information processing process of cognition is an example of a model (cf. Chapter 3 of this study). A model also provides a way of viewing constructs and phenomena in terms of other better known phenomena. For instance, a solar system model of atoms involves explaining the behaviour of electrons and protons in an atom in terms of the better known behaviour of planets moving around the sun. This heuristic function is also known as the metaphoric function of models (cf. Giere 1979:79). The model as a scientific metaphor emphasises its heuristic function since the model provides a way of viewing phenomena and their relationships *as if* they really do function in the way the model depicts it (cf. Kaplan 1964:265). The model's *as if* character provides the scientist with a frame of reference to work with the phenomena and constructs and their relationships. This metaphoric characteristic also implies that the model is a *provisional* structure, since it generalises and simplifies to a certain extent. It does not intend detailed explanations. It represents and emphasises certain aspects of the phenomena to be studied, and in this way enables exploratory hypotheses to be formulated. It is thus not a complete structure of phenomena but it guides further study and research. Mouton and Marais (1990:141) summarise the important characteristics of the model as a precursor to a theory.

(a) Models identify central problems and questions concerning certain phenomena.

The model thus provides questions and directions for further inquiry that may lead to a better understanding of the phenomena (Gorrell 1981:130).

(b) Models limit, isolate, simplify and systemise the domain under consideration.

The model posits certain assumptions concerning *the structural, causative or functional nature* of the domain of phenomena it is modelling (Gorrell 1981:132). Thus the model functions as a scaled down version of a theory by providing basic explanations of what is to be understood of the phenomena under question. It is possible for the model to indicate the rudimentary causal, functional or structural properties of the domain under investigation by virtue of its simplifying and systematising powers (cf. Gorrell 1981:132).

(c) Models provide a particular universe of discourse within which one can talk about the phenomena.

The model provides a way of talking about the phenomena under investigation. It thus provides terms describing the properties of the model and constitutes a "language" in order to discuss the model and what it models. It can introduce new terms or use ordinary language or terms from other fields in a slightly different sense to make discourse about the phenomena possible (cf. Gorrell 1981:132).

(d) Models provide explanation sketches and the means by which predictions can be made.

According to Mouton and Marais (1990), Gorrell (1981) overstates the case of models by attributing explanatory power to them, since the difference between theories and models is thereby negated. However, one may view a model as an explanatory *sketch*, implying that it is not yet a full theory, and that it starts providing rudimentary explanations. The fact that the model systemises the structural, functional and causative nature of the modellandum already involves some explanation.

A theory goes much further than a model in terms of explaining certain phenomena. It provides causal answers to the question *why* certain events happened, i.e., its explanation is always in terms of reasons or causes (Mouton & Marais 1990:143). It also tries to relate explanations to specific laws, and it tries to provide the principles underlying certain phenomena as explanatory principles. Despite the range and depth of explanation provided by a theory, in contrast to that of a model, it differs from a model in terms of the model's metaphoric or *as if* nature: theories provide very specific relationships between the theory and the phenomena under investigation. It thus postulates real relationships and not a possible framework between it and the explanandum as is the case with the model (cf. Mouton & Marais 1990:136).

To conclude: the conceptual framework being developed in this study is that of a theoretical *model* and not of a theory as such. The characteristics of a model discussed above, will be kept in mind when the eventual model of cognition and consciousness has been stated and will be used as criteria to evaluate the model. Since the conceptual framework intended here is not a theory, one cannot expect the full explanatory power and integrative capability of a theory from this model. However, some of the characteristics and functions of cognition and consciousness will be tested against the model in order to determine its power and its shortcomings. From this final evaluation, further research hypotheses can be generated.

5.1.3 Building the model

The model being developed in this study is called a *systemic emergentist* model of cognition and consciousness. From the outset it was made clear that this model includes certain ideas concerning systems and certain ideas concerning emergence. Throughout the study these two aspects were addressed and touched upon although sometimes in an implicit manner. Before the model can be fully described, the principles underlying systems and emergence must be made explicit.

The concept of *emergence* in terms of the model being developed here, seems a central one and was frequently used in the discussion of the various theories of cognition. It was first introduced in Chapter 1 as *emergent materialism* which indicates the metatheoretical or philosophical starting point for the scientific study of mind. Emergent materialism (or emergent *naturalism*) ascribes reality to both the physical and mental realms. In terms of the study of the mind, it entails a correspondence between neural events and mental events, but holds that the mental cannot be ontologically (or fundamentally) reduced to the biological substrate. Mental events and mental phenomena, such as consciousness, are emergent properties resulting from the combinatory action of larger groups of underlying units, such as cells. The emergentist hypothesis stated in this philosophical position does not include an explanation of how emergence works. This is not to say that one cannot explain emergence. In Chapter 1 it was seen that in some cases, (such as in chemical reactions), the properties of a system can be related its constituent parts. In other cases, such as with consciousness, the emergent properties of a whole cannot be readily reduced to its constituent elements. The concept of *emergence* was thus employed in Chapter 1 within the context of systems. The definition Bunge and Ardila (1987:101) used, applies here: *Every system has some global or systemic properties that are emergent relative to those of its components, that is, that the latter lack*. It is therefore necessary to have a slightly more detailed look at what a system entails. It will be seen in the following section that the systems theory of someone like Miller provides an intimate link between structure and function, a link which supports emergence of novel properties. It will be seen that certain systemic principles support emergence. The section following the one below will then examine emergence *per se* and provide a link between the principle of emergence and consciousness.

5.2 THE *SYSTEMIC* EMERGENTIST MODEL: A PERSPECTIVE FROM GENERAL SYSTEMS THEORY

In the following paragraphs an overview of what a system entails, will be given. A definition of a system will be provided, while the function and structure of a system will be discussed. The importance of the fusion between structure and function and the role of emergence will be referred to. The idea is to provide a frame of reference for the *systemic* part of the systemic emergentist model being developed in this study. The characteristics of a system identified here will provide the eventual model with a specification of some properties, and it will become clear why the term *systemic* was chosen from the outset to describe the intended model. It must be noted that this section does not provide a full overview of General Systems Theory (see Levine & Fitzgerald 1992), but analyses systems from Miller's (1978) perspective of systems theory. His perspective may be termed Living Systems Theory (Levine & Fitzgerald 1992:3), and is included in General Systems Theory (cf. Miller & Miller 1992:10-11). The value of his perspective lies in the integration of the principles underlying various nonliving systems with that of living systems. Within his perspective the concepts of function, structure and to a lesser extent, emergence, are clarified.

5.2.1 Definition of a system

According to Levine and Fitzgerald (1992:1) systems science originated and developed in a multidisciplinary way (cf. Von Bertalanffy 1972). Disciplines such as engineering, mathematics, computer science, biology, and economics contributed to its formation.[1] A system may be defined as *an organized whole: an assemblage or combination of things or parts forming a complex or unitary whole* (Kast & Rosenzweig 1972:14), or according to Miller (1978:16):

> *A system is a set of interacting units with relationships among them. The word "set" implies that the units have some common properties. These common properties are essential if the units are to interact or have relationships. The state of each unit is constrained by, conditioned by, or dependent on the state of other units. The units are coupled. Moreover, there is at least one measure of the sum of its units which is larger than the sum of that measure of its units.*

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[1] Cf. Levine and Fitzgerald (1992:1-3) for a very short discussion on the various contributors to the field of systems science (see Ashby 1961; Cannon 1939; Forrester 1961; Miller 1978; Von Bertalanffy 1968; Wiener 1948; Zeeman 1977).

According to Kast and Rosenzweig (1972:15), General Systems Theory[2] is related to functionalism, since functionalism emphasises *systems of relationships and the integration of parts and subsystems into a functional whole.* Both these definitions sound much like holism and Gestalt theory[3] discussed in Chapter 1 of this study.

From these definitions it follows that a system consists of a structure. The structure has units which interact. It is interesting to note that Miller (1978) states in his definition that units have some common properties and that the state of a unit is *constrained* by the state of other units. This sounds like the parallel distributed network structure examined as a *constraint satisfaction network* in Chapter 4. A constraint satisfaction network implies that the state of a single unit is dependent on the combinatory state of other units. Furthermore, the holistic definition of a system above, implies that the interaction (due to the relationships) between units, involves the integration of units and subsystems into a *functional* whole. It seems as if the interactions and subsequent integration that take place within a system, involves the constitution of that particular system. Indeed, it is being constituted as a whole: one may also say that the holistic nature of the system *emerges* from the interactions.

5.2.2 The nature of systems

Miller's (1978) focus is on concrete systems, which is empirically real systems (cf. Miller 1978: 21,22). He (1978:16-19) distinguishes between concrete, conceptual and abstracted systems (cf. also Miller & Miller 1992:11). Conceptual systems are of theoretical nature and the aim of science is to increase the identity between concrete and conceptual systems. As will be seen in the next paragraph, Miller's (1978:24) emphasis on structure, as spatial coordinates derives from the primacy of empirical or concrete systems. Miller (1978:17) defines a concrete system as a *nonrandom accumulation of matter-energy in a region in physical space-time, which is organized into* ***interacting interrelated*** *subsystems or components.*[4] An abstracted system focuses on the relationships inherent to concrete systems: it consists of these relationships *abstracted* or selected from a particular perspective (Miller 1978:19).[5] According to Miller (1978:19), abstracted systems are much more common in the social sciences than in the natural sciences, since the focus in the social sciences

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[2] General Systems Theory is used and applied in many contexts. The main problem with the systems approach is that it uses some mechanistic principles not always applicable to living organisms or systems. For instance, a system can be modelled by a flow chart diagram, which reminds one of the information processing approach. Indeed, it seems as if at a certain stage in its developmental history, that information processing and systems theory interacted (cf. Jenkins 1972:57-60).

[3] See Miller (1978:44 note 44).

[4] Emphasis mine.

[5] The perspective may include an observer's interests, theoretical viewpoint or philosophical bias (Miller 1978:19).

is usually on relationships. Relationships are much more difficult to express spatially as a structure than, for instance, the units or elements of a concrete system.

5.2.3 The structure of a system

Miller's view of systems is most interesting, since he considers a system to have both structure and function. Miller (1978:22) defines *structure* as a particular three-dimensional arrangement of subsystems or components at a particular time. This arrangement may change from moment to moment *depending on the characteristics of the process in the system* (Miller 1978:23). The structure of one system may seem more stable than that of another system that changes rapidly, since a slow rate of change makes observing its structure possible. However, despite its changing nature, the *spatial* configuration of its parts is its structure. Miller (1978:22-23) mentions the fact that slowly changing or stable systems may be called a "structure" while a rapidly changing process can be called "function." Miller (1978:23) prefers to use structure as referring to an arrangement of components in a three-dimensional space, and not as a term denoting stability. He (1978:23) also distinguishes his understanding of the term structure from the scientific usage of structure referring to *generalised patterning*. Structure is then *an entire set of relations ... among any group of variables* (Miller 1978:23). It refers to both patterns in time (e.g., the structure of music or a language), and to patterns in space (the structure of a crystal)(cf. Miller 1978:23). Miller (1978:23), however, prefers the spatial definition of structure, and for the sake of empirical science, distinguishes between the spatial and temporal dimensions.[6] In social science the distinction between temporal and spatial configurations is not so obvious (Miller 1978:51).

From Miller's description of structure it seems as if it can be represented as a spatial configuration. Physiological systems, such as the organs in a human body, do have a three-dimensional configuration. In Chapter 1 the various levels of analysis were discussed in terms of cognition. On the psychological level of analysis a spatial representation is not so readily conceivable as is the case on the lower biological level. The problem is much more pronounced on the phenomenological level (for instance, how does one represent the subjective phenomenological experience of a beautiful sunset?). However, even an abstract system consisting of pure relationships, can be modelled or represented spatially or as a three-dimensional configuration (see paragraph 5.4.1.3 below). It must be kept in mind that the more abstract a system becomes, the more removed from reality a modelling or representation of such a system becomes. The benefit of representing the structure of a system spatially is to make the relationship between the elements more understandable and at least to emphasise its structure, which is distinct from its function.

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[6] The reason for this distinction is that the spatial dimension refers to the physical sphere or space, and the temporal dimension refers to the conceptual space (Miller 1978:23). The focus in empirical science is on concrete systems (consisting of *a nonrandom accumulation of matter-energy*) while theoretical, logical or mathematical systems are conceptual systems (cf. Miller 1978:17).

5.2.4 The function/process of a system

Process refers to the change of matter-energy or information over time in a system (Miller 1978:23). A process can be reversible or irreversible, or according to Miller (1978:23), *less readily reversible*. For instance, the history of a living system, is part of the process of that particular system, and although a history implies that a living system develops over time, sometimes the changes effected in its structure may be reversed (for instance, regrowing an appendage after accidental loss such as occurs with lower life forms). Usually the history of the system cannot be readily reversed. Process also includes *the ongoing function of a system*, which is normally reversible actions. Miller (1978:23) links process (function and history) and structure closely: the structure of a system changes momentarily with functioning, but since function is reversible, the structure never changes permanently. When the change due to its function becomes so great that it becomes irreversible, then *a historical process has occurred* (Miller 1978:23). This historical process, then, establishes a new structure.

5.2.5 The fusion of structure and function

In the social sciences, systems have been described in terms of structures, while these structures are actually processes or functions, or describe abstracted systems (see Miller 1978:23). Miller (1978:23-24) is aware that systems, processes and relationships can be confused and that terminology in different contexts (or scientific fields) can mean different things (such as using "structure" while actually referring to "process"). He (1978:24) therefore insists on the differentiation between structure and process in the following way: *structure* is the arrangement of a system's elements in three-dimensional space at a given moment; *process* is the change of matter-energy over time. In living systems theory, a system is only understood when both its structure and processes are known (Miller & Miller 1992:14). A distinction between structure and function must be made, but in practice the two cannot be separated: *Living systems theory unifies structural and process science, stressing the importance of identifying **the structures responsible for each process** at every level* (Miller & Miller 1992:14).[7] Structure and process are thus intimately linked. Structures are *responsible* for processes. Miller identifies twenty subsystems critical to the life of living systems. It seems as if these subsystems make up the *components* of a particular system's structure. These subsystems are involved in various types of processing. For instance, some subsystems process information, some are responsible for the storage of information, and so on (cf. Miller & Miller 1992:26-31). An important perspective is that he sees structure as supporting or causing processes.

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[7] Emphasis mine.

5.2.6 Emergence

Miller (1978:25) is very clear on the fact that living systems are organised in a hierarchy of levels, starting at cells, proceeding to organs, organisms, groups, organizations, societies and ending at supranational systems. Systems at a particular level are made up of systems from lower levels. Higher level systems exhibit properties not present in systems in the lower levels (Miller 1978:28). These properties, according to Miller (1978:28), *have been called emergents*. They are called emergents since *significant aspects of living systems at higher levels will be neglected if they are described only in terms and dimensions used for their lower-level subsystems and components* (Miller 1978:28). Despite this concession, Miller does not want to ascribe creative powers to a system:

> *I agree that certain original aspects - new patterns of structure and process - are found at levels which are not seen at lower ones. For these new qualities new terms and dimensions are needed. But that is no reason for a complete, new conceptual system* (Miller 1978:28).

Emergents are not mystical and magical, and in describing them, the usual methods of scientific analysis must apply. Indeed, the eventual explanation of emergent properties may be reduced to a system's design and the complexity of the system (Miller 1978:28,78).[8]

5.2.7 Conclusion

The definition of a system provided by General Systems theory will be taken as the starting point for the model developed in this study. A system may be viewed as a functional whole consisting of a particular structure. Thus, since the aim of this study is to develop a *systemic* model, this implies that the model involves a system. The characteristics of a system may be stipulated as follows:

(a) A system is a functional whole. The emphasis is on its functionality, although its holistic nature also needs to be addressed. A system cannot be reduced to its parts or subsystems, since its eventual performance as a system depends on the integration of all its parts. The concept of emergence, which is taken up below, makes its holistic nature more clear.

(b) It consists of a structure which can be spatially represented.

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[8] *At several or perhaps all levels new sorts of structures or processes occur which are not seen at lower levels of systems. These are emergents.* ***They are made possible by the greater complexity of the higher levels*** (Miller 1978:78)(Emphasis mine).

(c) It performs certain functions, which in essence can be viewed as energy or information transformation. It is then a process of ongoing functioning, or activity.

(d) On the one hand, new structures can be formed by means of the system's functioning (process), while on the other hand, the system's structure supports its functioning.

(e) Its structure consists of subsystems also performing certain functions.

(f) Structure and function cannot be separated but both support the whole system.

The importance of Miller's theory lies in the fusion between structure and function, and the fact that both structure and function in their fusion supports emergent properties. One must keep the distinction between the function of the elements, and the resultant function of the system in mind when one says that function and structure are fused. The function and structure of the elements support the function of the system. The system's function cannot be reduced to, or inferred from, the functions of the elements of the system.

Miller's conception of a system entails that a structure supports certain processes and functions. The structure itself consists of subsystems or elements, each having their own functions. The combined effect of the components functioning enables the system to have a new function not seen in the functioning of the components. This is its emergent property. Combining various systems on the same level, with each contributing to the other, a new system on a higher level emerges, again with its own properties and function(s). Thus, to Miller, emergence is not magical: it can be reduced to the functioning of lower level units having a particular configuration. But is this true? Does *emergence* not exclude the ability to reduce the resultant properties to its lower level structures and functions? The following section takes up this question in more detail.

5.3 THE SYSTEMIC *EMERGENTIST* MODEL: A PERSPECTIVE FROM EMERGENT INTERACTIONISM

In the following section Roger Sperry's view of emergence will be discussed. Although some of the aspects were discussed in Chapter 2 of this study, it will be seen that Sperry associates the current emphasis on consciousness and cognition with the concept of emergence. The principle of emergence is then found to involve a new concept of causality which includes both upward and downward causal control. In the following discussion, the fundamental nature of emergence as a causal principle and as a principle underlying consciousness is pointed out.

5.3.1 The cognitive revolution and a new concept of science

Sperry (1987), after analysing the history of psychology the past 70 years, came to the conclusion that a new paradigm overthrew the more traditional paradigms in psychology. The new paradigm is called the cognitive or consciousness/mentalist paradigm.[9] Sperry, in fact, speaks about the cognitive revolution that took place in the history of psychology and dates the start of this revolution to the late 60's, early 70's. The cognitive revolution is a *revolution* since all the prevailing paradigms were superseded by the mentalist paradigm. The biggest "culprit" in the history of psychology was behaviourism, and the mentalist paradigm succeeded in resurrecting the mental and consciousness as phenomena worthy of scientific scrutiny. However, the new cognitive paradigm achieved more than the overthrow of behaviourism. It launched a new concept of science itself:

> *The new mentalist paradigm is deduced to be a more valid paradigm for all science, not just psychology, and to represent a new "middle way" position in philosophy which integrates positivistic thought with phenomenology ... The result is a revised scientific description of human nature and also nonhuman nature and of the kinds of forces in control, a changed world outlook that brings a new era in the sciences-values relation, a resolution of the freewill-determinism issue and other promising developments in the long standing worldview conflicts between science and the humanities. These and other far reaching humanistic as well as scientific implications call for a deeper understanding of the causes and structure of the consciousness revolution and what it signifies* (Sperry 1987:39).

Sperry (1987) claims much for this new paradigm: it is one thing to say that a particular paradigm, theory or model brings a new perspective to a particular field of study such as psychology, but it is quite another thing to claim that it changes the face of science and actually solves some of the classical problems of philosophy. These and related claims of Sperry will not be examined in detail in this study since the focus is actually on emergence and consciousness, although the understanding of consciousness as an emergent phenomenon does, in the end, have some bearing on certain scientific concepts.

The eventual turn away from behaviourism since the 1970's, can be ascribed to a prior collapse of the fundamental tenets of behaviourism, akin to Kuhn's (1970) *scientific revolution* (cf. Sperry 1987:41). The downfall of behaviourism may, amongst others, be ascribed to sociological or other subjective factors normally accompanying such revolutions, but according to Sperry (1987:41) ... *the switch to mentalism, when it finally did occur, was more than just a diffuse sociological or Zeitgeist*

[9] Sperry (1987) prefers the term "mentalism" to indicate this new paradigm, since it includes broader concepts and phenomena related to consciousness and cognition. Certain paradigms or schools in cognitive psychology sometimes do not refer to consciousness as such or may even deny being mentalist.

trend and had to be based upon revisions of the underlying conceptual foundations. If this is the case, then a study of the history of psychology in terms of the theoretical or conceptual foundations of psychology, ought to show whether such a critical change has occurred, in order to justify calling the shift from behaviourism to mentalism, a *paradigm shift* (cf. Sperry 1987:41).

5.3.2 A new view of causality

The key factor, according to Sperry (1987:42-43), effecting the change in the fundamental concepts of psychology, was a new emerging perspective on brain function and consciousness during the 1960's, a perspective *that introduced a causal view of subjective qualities in brain processing* (Sperry 1987:43). Sperry (1987:43) refers to the work of Fodor (1968), Miller, Galanter, and Pribram (1960), Neisser (1967), Popper (1979),[10] and Putnam (1960) to support this thesis (see also Sperry 1965, 1969). What is this *causal view* of mind and consciousness? In the words of Sperry (1987:43), this

> *... new theory conceived subjective qualities to be emergent properties of brain processes that interact causally at their own cognitive level and also at the same time exert downward causal control in a supervening sense over the activity patterns of their neuronal components.*

Important here is that consciousness or mental phenomena exert a downward causal effect on brain processes, which is, of course, a very contentious claim. The whole mind-body debate (and it is not a minor debate since it has been raging for ages) revolves around the question of how much emphasis must be placed on the role and function of the mind, and it seems as if a mind-over-matter idea contradicts the fundamental laws of physics (cf. Chapter 2 of this study).

Both the new cognitivist and classical behaviourist paradigms share the assumption that physiological processes are responsible for mental phenomena (Sperry 1987:43). However, according to Sperry (1987:43),

> *(I)n direct contradiction to the behaviorist paradigm, subjective mental and cognitive phenomena were given a causal, functional or interactionist role in brain processing and thereby a new legitimacy in science as autonomous* ***ineliminable*** *explanatory constructs.*[11]

[10] Sperry (1987:43) refers to Popper's Second Arthur Holly Compton Memorial Lecture, *Of clouds and clocks*, presented at Washington University on 21 April 1965. This lecture was reprinted in Popper (1979).

[11] Emphasis Sperry's.

The implication of Sperry's (1987) analysis of the effect of the consciousness revolution on psychology and science is rather serious. In the end it boils down to *two different worldviews* or *two opposing views of physical reality* which are based on two differing views of causality (Sperry 1987:44). On the one hand, one has the classical view of causality associated with natural science, which Sperry (1987:45) calls the *microdeterminist* view. This view entails a reduction of everything to physics and chemistry and ultimately to quantum physics. The key here is that a *reduction* takes place: phenomena are explained by means of fundamental reductions. An object or behaviour is *nothing but* .... By executing this reduction of phenomena to microfeatures, the macro phenomena are said to be determined by these microfeatures, hence *microdeterminism*.

On the other hand, one has the new mentalist or cognitive driven view of causality: ... *things are controlled not only from below upward by atomic and molecular action but also from downward by mental, social, political and other macro properties* (Sperry 1987:45). This view differs radically from the first classical view, since it also supports downward causation. This means that emergent phenomena and their properties have a causal influence and effect on the microfeatures underlying it. It acknowledges upward causation and the fundamental role of microdeterminism as the classical view does, but also makes provision for downward causation, unlike the classical view. According to Sperry (1987:46), if this principle of *emergent interaction with downward determinism is valid*, then mentalistic phenomena and subjectivity cannot be eliminated from *explanatory causal constructs*.

5.3.3 Emergence and downward causation

For Sperry (1987) emergentism and downward causation go together. It is the phenomena that emerge from the interactions of elements at a lower level that exert downward control on these very same elements. Sperry (1987:46-47) uses various examples to illustrate downward control (see also Sperry 1964, 1965, 1969, 1981).[12] For instance, a molecule in a particular airplane may be held in place by features at a microlevel, but its eventual space-time trajectory is governed by macrolevel forces (those of the plane as a whole), making the effect of the lower level features seem rather trivial (Sperry 1987:47). In Sperry's (1987:47) own words:

> *The atomic, molecular and other micro forces are continuously active but at the same time they are enveloped, submerged, superseded, "hauled and pushed around" by, or "supervened" by an infinite variety of other higher molar properties of the systems and entities in which micro elements are embedded - without interfering with the psycho-chemical activity of lower levels.*

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[12] See Vandervert (1991) for a criticism of Sperry's examples that illustrate or model emergent interactionism.

The crux of the matter is to distinguish between levels of reality: higher levels have certain properties that are not present at lower levels. Quantum physics cannot explain higher level phenomena. For instance, Heisenberg's famous "uncertainty principle" in quantum mechanics, does not apply to higher levels of reality or to phenomena emerging from the lower levels (Sperry 1987:49). It seems as if certain laws emerge at each higher level that supersede the laws of lower levels and actually start determining the lower levels (Sperry 1987:49; cf. Nowak 1976:419-420). The laws governing the connections of an electronic circuit, for instance, are not determined by quantum mechanics (Sperry 1987:47-48). It comes from a higher level: subatomic physics cannot fully explain why a circuit fails due to inverting the connections of a particular element on the circuit. The explanation must be augmented by the higher organisational principles of circuit design (cf. Sperry 1987:47-48).

The same applies to the circuitry of the brain (Sperry 1987:48). The firing of a neuron involved in cognitive functioning is determined by local excitatory and inhibitory inputs to the particular cell. However, according to Sperry (1987:48), the timing of the neurons firing and its inputs *would also be found to be determined predominantly by the train of mental events that happens to be in process*. Although mental events may be reduced to brain activity in the sense that it is caused by the firing of groups of cells, mental events seem to have a downward causal control on the brain activity. Thus mental events and brain activity seem to interact: brain activity is responsible for mental events, and mental phenomena or events control, or have an effect, on brain activity. The whole question of the possibility of "mind over matter" (in terms of mental events controlling physical events) dissolves in the face of realising that laws applicable on (or emerging at) higher levels supersede those at lower levels, despite the fact that lower level events are responsible for the emergence of higher level phenomena and properties:

> *The downward control view contends that the higher emergent forces and properties are more than the collective effect of the lower because critical novel space-time factors are not included in the laws governing the components* (Sperry 1987:48).

This seems to be the key to Sperry's view of emergentist phenomena. Emergent phenomena and their novel properties *cannot be reduced to the components underlying them*.

Sperry contends that the new emergentist view of science accepts classical microdeterminism and reductive methodology and only supplements it with a downward causation principle. In a sense this is a contradiction of what he believes emergence entails: one cannot add the principle of downward causation to classical microdeterminism and expect microdeterminism to change to a principle of emergence! The classical view of microdeterminism or upward causation coupled with reductionism does not necessarily make provision for new, emergentist phenomena. According to Sperry's (1987:49) own concession, the view according to classical science is that an object is ... *a collection of its elements in a special new space-time arrangement*. This "special arrangement" of components does not entail the production of emergent properties since the principle of fundamental reductionism associated with classical science precludes emergentism. Reductionism entails that a whole *can* be reduced to its components. However, microfeatures are responsible for emergent phenomena, phenomena whose properties *cannot* be reduced to the components, since the emergents are on a higher level and are governed by laws and principles not present in the components at the lower level. In the end, microdeterminism or upward causation that does make provision for emergence, involves a broadening of the classical concept of causation. It is thus not merely a case of supplementing microdeterminism with macrodeterminism or downward causation. The principle of microdeterminism must first be broadened to include emergence to make provision for subjective and mentalistic phenomena. Only after mentalistic phenomena have been established by means of a principle of emergence can one invoke macrodeterminism to explain the interaction between the mental and the physical. Sperry (1987) wants to emphasise the role of interactionism within the changing view of the principles of science, and he takes his cue from the interactionism that is clearly prevalent in cognitivism and mentalism in psychology (cf. Sperry 1987:52; see also the conclusion below). For interactionism not to dissolve into dualism it is necessary to emphasise the supervening and macrodeterminist properties of mentalistic phenomena (Sperry 1970:586; see also Sperry 1980:201). However, the question of emergence precedes supervenience: the origin and appearance of mind and consciousness need to be understood and explained. Indeed, the key problem in cognitive studies is just how consciousness and anything mentalistic are possible at all. The question of how the brain gives rise to the mind logically precedes the question of how the mind interacts with the brain.

As mentioned above, Sperry (1993:880) believes that his version of mentalism is not dualistic in any way. Dualism implies two separate realms of existence. However, mental states emerge from brain processes and cause behaviour and since they are so intertwined with brain states, they cannot be dualistic. According to Sperry (1993:880), *(m)ental states in this form cannot exist apart from the active brain. At the same time, mental states are not the same as brain states*. Thus dualism is countered by the fact of the very close intertwining of brain and mental states. However, Sperry's invoking of interactionism to avoid dualism is actually unnecessary since he (1993:880) says that the two states differ

> *in the way a dynamic emergent property differs from its component infrastructure. It is characteristic of emergent properties that they are notably novel and often amazingly and inexplicably different from the components of which they are built.*

Thus the recognition of emergence (upward causation) is sufficient to explain two different levels of phenomena. In this case, the one biological and underlying the second higher level of the mental. Each level is governed by its own laws and actually differs in quality from the other level:

> *Once generated from neural events, the higher order mental patterns and programs have their own subjective qualities and progress, operate and interact by their* ***own casual laws and principles*** *which are different from and cannot be reduced to those of neurophysiology* ... (Sperry 1980:201).

5.3.4 Conclusion

5.3.4.1 Sperry related the phenomenon of consciousness (and other cognitivist or mental phenomena) with that of emergence and downward control. It reminds one of the bottom-up or top-down processing problems in cognition. In the first chapter of this study, Indurkhya's (1992) cognitive theory of creative metaphor was discussed, amongst others, to illustrate the interactionist nature of cognition, or at least the bi-directional nature of the interactions taking place between various levels of representations. The theory of Jackendoff discussed in Chapter 3 of this study also entailed both an upward and downward movement of processing between different levels of knowledge structures. The levels of analysis proposed in Chapter 1, namely the biological, psychological and phenomenological levels, also entail a bi-directional movement between levels. The bottom-up and top-down views of the directionality of processing found early acceptance in theories of cognition, although not as both taking place within one cognitive system. Some earlier theories can be classified as either a top-down or bottom-up theory. For example, Neisser's (1967) earlier work on cognition may be classified as a bottom-up approach (starting from microfeatures and working up to holistic processes), and his (1976) later work discussed in Chapter 3, may be classified as a top-down approach (e.g., schemata determine and drive lower level and microlevel cognitive processes). Jackendoff's view, on the other hand, entails both a bottom-up and top-down approach. As soon as one has a bi-directionality between levels of representation or processing, then it may be termed *interactionist*.

5.3.4.2 It seems that the idea of movement up or down between levels (levels of analysis, representation, processing, etc.), that found early acceptance in cognitive theories, paved the way for an interactionist theory of mind, or at least made the idea more acceptable. Thus, the logical consequence of the bi-directional movement view is that subjective phenomena (such as consciousness), can have a top-down effect on lower level processes. Although the aim of this study is not to explain consciousness as a supervening phenomenon, a downward causal effect of consciousness must be taken into consideration, especially in the systemic view developed here.

5.3.4.3 The upward and downward principles of causation discussed by Sperry must be clearly distinguished from the classical scientific microdeterminist causal principle (cf. Searle 1992).[13] An upward principle of causation is not the same as emergence, although emergence does entail an upward movement through levels of systems. Emergence entails the creation of novelty, while upward causation does not necessarily entail the creation of new properties and features.

5.3.4.4 Both Miller and Sperry make a distinction between levels of reality. An important aspect is that a system on a particular level is governed by laws and principles not readily reducible to the lower level. The existence of principles and laws governing phenomena on different levels of reality, may be ascribed to the principle of emergence.

5.3.4.5 The principle of emergence (upward causation or microdeterminism according to Sperry) makes allowance for *subjectivity* as a separate ontological category (cf. the discussion of Searle's view in Chapter 2 of this study). Within this particular category, mental phenomena, such as consciousness, may be included. In terms of a generic model of emergence, the claim is not that emergent phenomena *always* have a subjective quality. Empirical objects attest against this claim. What *is* claimed is that in terms of the interaction between the biological (neurophysiological) and psychological levels, emergence does, amongst others, entail the constitution of subjective phenomena. Within the context of *human* brains, the systems involved are such that they give rise to mental phenomena which cannot be reduced to their constituent parts or subsystems.

5.4 THE CONCEPTS OF STRUCTURE AND FUNCTION IN COGNITIVE THEORIES

The following aspects were identified above that can form part of a systemic emergentist model for cognition and consciousness:

(a) A causative principle, namely emergence, which drives the process of forming a systemic whole.

(b) A system having a function or functions.

(c) A structure supporting its function.

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[13] Searle (1992) said that this redcutionistic view is characteristic of *physicalistic materialism* (see Chapter 2 of this study).

(d) A fusion between structure and function, which supports the holistic nature of the system.

To develop an adequate systemic model accounting for the phenomenon of emergence, it is necessary to analyse the concepts of function and structure. One of the results following from the discussion above, which already became apparent in the previous chapters, is that function and structure cannot be separated. Only when both are merged within one system, can the phenomenon of emergence be explained adequately. In the following section the results of the discussions in the previous three chapters will be summarised and integrated in order to emphasise the necessity of a holistic view. In the discussion of consciousness in Chapter 2 of this study, it was seen that in the history of psychology, consciousness was studied within structural and functional paradigms. Even then it became apparent that the distinction entailed a segregation which had specific consequences for a view of consciousness. It must be stated from the outset that structure is usually associated with inert and unchanging structures, while function is associated with changing, and dynamic processes. The discussion above on General Systems Theory showed that this is not necessarily the case (see paragraph 5.2.3 above).

5.4.1 Structure

The structural approach involves the study of the *elements* or constituents of mental phenomena such as consciousness. The main problem with this approach is not so much that the elements of mind are configured in a particular way, but that they are restricted to static atoms. The structuralists realised, of course, that the components of the mind are not static, but struggled to incorporate process in their concept of mind. However, if one may for the moment consider the mind to consist of static elements, what will the implications be for cognition and consciousness? For instance, taking Neisser's (1967) depiction of visual cognition discussed in Chapter 3 as an example, the process of visual cognition may be reduced to certain elementary components or processes configured in a certain way. For the sake of the example, one must disregard the fact that Neisser's theory is essentially an information *processing* approach. The focus is on the structure or the configuration of static components, which in this case happens to be processes. Visual cognition may be divided into preattentive and attentive processes. The preattentive processes consist of a series of steps, namely the registration of visual information on the retina, the storage of the image in the iconic buffer, and the control of attentional shifts and body movements. In the attentive processes, components such as attention, figural synthesis, recognition, etc., may be distinguished. Whatever the nature of the processes or the components involved, they may be depicted in terms of a flow chart where the components stand in a certain relation to each other. Even a particular component may be reduced further to mere elementary components. For instance, iconic storage may be reduced to certain information stored in a particular format in a particular place, for a specific time, etc. The format of the information may also be reduced further into the components of the information or the coding format, not unlike the propositional format of the symbolicists discussed in Chapter 4. The point is that cognition does have certain elements, or rather, it does have a certain structure consisting of a certain configuration of elements or components.

For the purpose of this example, the configuration of components must be considered static. Can one say that the structural relationship between the various components as depicted on a flow chart is stable, unchanging and static? The relationship between, for instance, the registration of stimuli and iconic memory seems rather straightforward: it is fixed in a sequential manner. Considering a flow chart illustrating the information processing approach such as found in Figure 6 in Chapter 3, it seems as if the components depicted there are fixed: information proceeds through the cognitive system in a fixed manner. To claim the opposite seems almost absurd: is it possible that the components of an information processing system are not fixed and static but that they can move around, change their relationship to each other and even develop other functions due to their changed relationship? The same applies, for instance, to the encoding of knowledge in the fashion of the symbolicists: can the configuration of elements be changed without eventually changing its meaning? For example, if one has a propositional or semantic network, can one swop a verb node for a noun node without the risk of sounding insane? It is clear that the configurational meaning as expressed by Anderson (1980), depends on a reasonably stable relationship between at least *types* of nodes. For example, one cannot change the verb and the noun around in the sentence *John picks an apple*, and expect that the resulting sentence (*Pick johns an apple*) to make sense. In the same way, it is difficult to imagine a certain sequence of information processing stages to be swopped around. If cognition consists of a sequence of components (or processes), then it seems that a certain stability in the configuration is necessary. A component responsible for coding information cannot be swopped for a component activating behaviour.

The question is, if a certain stable configuration between the elements or components of cognition is required in order for the cognitive system to function, in what way may the cognitive structure be regarded as dynamic? One may consider the way some of the theories within the four paradigms of cognition discussed in Chapters 3 and 4 handled the issue.

5.4.1.1 The information processing approach

As seen above, according to the information processing approach, cognition consists of a series of different processes operating on information. The processing components stand in a particular relation to each other (they have a structural configuration), and they are not static, since they do function actively (they *process*). Since the information processing model does have both structure and function, what may be regarded as the problem with this model? From the discussion of Neisser's (1967) theory as representative of this approach, it became clear that consciousness is viewed as only another stage of processing. It is reduced to a component on the flow chart. One problem with viewing consciousness in this way, is that it falls back on the old substantiality idea of consciousness. Consciousness is then seen as an object, entity or a "thing" having substance. This runs against the current idea of consciousness as a process or state (see Chapter 2 of this study). Indeed, this may be viewed as part of the problem with the information processing approach: by dividing cognition into a series of processes or mechanisms responsible for processes, it substantialises many of these processes and mechanisms. In the end one would expect to find a localised mechanism in the brain responsible for coding information and then sending it off to various other locations in the brain. The computer metaphor is of course largely responsible for a substantialised view of processing and the mechanisms involved in information processing. Talk about coding, buffering, decoding, interrupts, and memory storage and retrieval assumes that there are particular components (similar to an Integrated Circuit) in the brain responsible for the same processes as is the case with the computer. However, it must be kept in mind that the computer metaphor is just that: it functions as a model to enable one to conceptualise and understand cognition. The complaint levelled against the symbolicists is also applicable to information processing theorists taking the computer metaphor too seriously, namely that the architecture of cognition and that of the digital computer may differ despite the firm belief that it is similar. Some versions of symbolicism and Artificial Intelligence hold the mind to consist of software running on *wet* hardware.

Another problem with the information processing approach, is that details concerning the "information" is sometimes lacking. It is clear that the mechanisms involved operate on the information, but one does not have a clear idea what the structure of information is. The classic idea of information the human processor receives and manipulates, specified as bits, is also based on the computer. Information, be it visual, tactile or auditory, is reduced to binary code consisting of 0's and 1's, or whether a neuron does not, or does, fire. Although no real problem with these kinds of reductions exists (chairs ultimately can be reduced to atoms!), the point is that binary code does not tell the scientist anything about the structure of the information. Information processing theorists normally assume that the same mechanisms operate on different kinds of information. It may be possible that tactile information is processed differently than visual information, and that it is processed by different mechanisms. Indeed, recent research suggests that even distinctions in verbal information or language are processed in different centres in the brain. For instance, verbs are processed at another locality than nouns. Although it is premature to evaluate the validity of the research at this stage, it suggests that the propositional networks or schemata of symbolicism may be wrong, since intricate links are posited between basic units of meaning (for instance, a proposition usually includes a noun and a verb).

In Chapter 3, it was seen that Jackendoff proposed a structural approach to information processing. He suggested that the structure of information determines the processing. Different types of modalities have different information structures, and even within a particular modality, such as vision, levels of information structures exist. This is quite a novel approach to information processing or computational theory, and it tries to redress the lack of emphasis on the structure and nature of *information*. As was discussed in Chapter 3, Jackendoff (1987) motivated the case for a structural approach strongly. Amongst others, he contends that information is better processed when structured. The term *structure* in this context means that the elements of information stand in a particular relationship to each other. In fact, the information goes through various levels of restructuring, influencing each other in a top-down and bottom-up fashion. The interaction between the structure of information also takes place on the same level. The transference of structures from one level to another is of course where the processing of information happens. In the end, the focus on information structure reveals certain processes not thought of before within a pure information processing approach.

An almost similar focus on "information" is provided by Neisser's (1976) later work. Whereas his (1967) earlier work focused on the mechanism and processes of cognition, his later perceptual cycle theory focused on larger semantic units. Schemata are indeed knowledge structures. The difference between these knowledge structures and Jackendoff's information structures, is that Jackendoff's structures reach *meaningful* structures only at the last abstract or conceptual level. A schema is meaningful to its owner from the outset. Neisser (1976) does not provide a detailed account of how a schema reaches its particular proportions. One may suspect that it could be formed in a series of steps ranging from the least to the most abstract level of knowledge, much in the same way as Jackendoff's theory of levels. However, Neisser (1976) explicitly rejected the successive stages view of the information processing approach. Schemata are embedded and interact with the environment. As was said in Chapter 3, the sequential nature (and levels or depth of processing approach) of information processing theory makes continuous interaction with the environment difficult.

5.4.1.2 Symbolicism

The structural considerations concerning knowledge representation discussed above, are taken much further by the symbolicists. The structural nature of knowledge as symbols and the relationships between symbols are specified in detail. It was seen in Chapter 4 that symbolicists such as Anderson, specify knowledge structures in terms of propositional networks. Propositional networks specify elements or rudimentary knowledge components that stand in a particular relationship to each other. The relationship between elements is associationistic, and this associationistic structure determines configurational meaning. As was discussed above, a certain stable configuration is necessary in order for a particular node or network to make sense. Comparing this approach to the structuralist approach of the early consciousness theorists as discussed in Chapter 2, it seems that knowledge, in the case of the symbolicists, is viewed atomistically which is similar to the atomistic view of the elements of mind and consciousness as viewed by the early structuralists. The problem with atomism or elementism is that it tends to lead to a static view of the structures involved. The principles of association proposed in the history of psychology seems inadequate to counter the static nature of the structures of mind and knowledge. Associationism, as James criticised it (see Chapter 2), cannot account for the rich complexity of the phenomenological mind: it cannot explain why conscious thought tends to find other avenues when thinking of past experiences rather than eliciting the whole experience with its associated components.

Neisser (1967) criticised associationism in psychology for the same reason. He connected associationism with what he called the Reappearance Hypothesis. Knowledge or any related mental phenomena does not merely appear from consciousness as it is stored, i.e., knowledge structures and their associated elements are not revived to appear in exactly the same form as it is stored. In fact, his criticism goes further than the utilisation of stored structures. Percepts are not, in the first place, stored in exactly the same forms as they appear in the environment: the mind does not *mirror* reality. Between the process of perceiving reality and storing in memory, constructive processes are utilised. The same goes for the stage between retrieving "information" from memory and thinking a thought when reconstructive processes are brought into play. Thought and mental processes for Neisser (1967), even in his first information processing theory, entail construction. Cognitive construction entails the synthesis of elements. By positing a constructionist mechanism operating on the elements of knowledge and information, the inertness of the elements is overcome to some degree. The idea with synthesis is, for instance, that a visually perceived object is built up from its basic elements. Elements are combined to form bigger units and these units are synthesised in still bigger meaningful units. This act of combining elements through to higher levels of abstraction (much like Jackendoff's theory) actually moves beyond what is assumed in the symbolicist's semantic network. The propositional network assumes a single level of signification without much regard for lower levels which make up a particular element in the network. For instance, one may assume that a single element in a node, say the verb *run*, can be associated with various other elements defining or describing one's personal experience and knowledge of *run*. However, one must ask whether this verb can be broken up into elements in the same way as a visual object can. For example, the letter *A* can be divided into certain lines having a certain slant. How does one distinguish the elements of *run*? Does it consist of the action of running presented as a visual image delineated as a series of snapshots, or does it consist of abstract concepts such as *moving forward*, *rapid movement*, *involves the legs*, etc.? In order to grasp the meaning of *run*, does one construct a single idea *run* from all the constituent elements? Furthermore, how does the construction of the same verb work when the verb is heard, spoken, when one hears running footsteps, one sees a person running or when one thinks about someone running. Are the same processes of construction involved? According to Jackendoff the same processes are not involved since the informational structure differs in each case.

The point is that both the *associationistic* propositional network idea, and the *constructionist* theory of knowledge structures are not without their problems. The associationistic theory assumes that representational structures are reasonably static (and only partly active due to spreading activation) and it assumes that the configuration of elements is reasonably stable. The constructionist theory views knowledge structures as consisting of a combination (not necessarily an association) of constituent elements to make bigger wholes. [Neisser (1967) sees the constituent elements in a slightly different way: it is not the information as such that is stored or utilised, it is the *act* of constructing a particular perceived object, that is stored and used. The same question as above with regard to constituent *elements* of information applies. What are the constituting *acts* of construction for a more abstract concept, such as *believing in God*, when thinking this particular thought?]

The difference between the nature of the elements in the knowledge and informational structures of symbolicism and constructionism is the following: for the symbolicist, an element or component is the smallest possible unit of meaning. The component symbolises an aspect readily recognisable in reality. An element for the constructionist, such as Neisser, is a constituent part (feature) or act of a particular object. That is why synthesis is needed: certain features are combined to form a whole [Constructionism does entail more than the mere combination of features. From Chapter 3, it became apparent that perceptual objects or thought are also "coloured" by existing knowledge structures. What one perceives or thinks is thus, in a sense, "contaminated" by what one already knows and has experienced.]

5.4.1.3 Connectionism

In the discussion of connectionism in Chapter 4, it was pointed out that the knowledge structures proposed by connectionists are also in a sense associationistic structures. These structures also consist of elements, but the elements do not stand for either features or symbols as is the case with the constructionist or symbolicist approaches. The elements or components of the structures are simple processors that compute the strength of association between the components. Thus, the elements are associated in an almost similar manner to a symbolicist network. It may also be called an associationistic structure but it differs from the more traditional assocationistic structures in one important respect: units of meaning or elements of knowledge are not represented on the components themselves as in the traditional network structures. Knowledge is represented by the connections *between* components. A unit of knowledge is also not represented on a *single* connection by a single weight, but by a combination of connections between a group of components: knowledge is represented simultaneously in a distributed manner.

This is quite a novel approach in representational structures, and opened up many new possibilities in conceptualising the way knowledge is handled by the brain. Whereas the above discussed theories of cognition are based on the computer metaphor, connectionism is based on the brain metaphor. Connectionist networks thus try to mimic the way the brain works. However, both symbolicism and connectionism are computationalist since the performance of their models depend on the computation of certain algorithms.

One of the most interesting features of a connectionist network is that one network is able to represent many units of knowledge whereas a symbolicist structure needs multiple networks for different structures of knowledge. The importance of this matter is not so much related to the space saving quality of a connectionist network as to its flexibility. In the discussion above it was mentioned that symbolicist structures require a certain stability of configuration: the function of a particular unit cannot be swopped for another with a different function. This is not the case with the connectionist network: since knowledge is represented in a distributed manner as a set of weights, the configuration of elements need not stay the same. One does not have a verb-unit and a noun-unit and it is conceivable that the same network can represent both verbs and nouns despite their different functions.

The connectionist view of knowledge structures provides a way to conceptualise structures, configurations and the dynamic nature of structures in a novel way. One must, however, be made aware of the restrictions of neural networks at this stage. The most important restriction appears from the characterisation of connectionist networks as *sub*symbolic. This depiction intends to distinguish it from symbolic structures. Being on a higher level of abstraction, symbolic structures and components are operated upon by procedures (processes) by including the symbols in various condition-action pairs in order to effect behaviour. Problem solving, for instance, is an example of very specific execution of algorithms using symbols. Higher level reasoning processes seems to need IF-THEN type algorithms (according to the symbolicists).[14] The subsymbolic model of cognitive structures seems to underlie the symbolic level of cognitive functioning. Some symbolicists seem to agree that connectionism provides a reasonably sensible explanation of the microfeatures of cognitive structures but it needs to be viewed as supporting the symbolic level. This concession underscores the criticism levelled above against symbolicist propositional networks: it fails to give an account of the components or constituent elements of the higher level symbols. On the other hand, connectionist models fail to provide adequate rules for thinking: it is most suited for representational issues. Despite the fact that one can represent a rule such as *IF yesterday's date was the 13th THEN write down today's date*, the problem is to translate the representation into a particular action wholly within the connectionist system. This is, amongst others, the reason for hybrid systems where inferential rules are combined with connectionist representations.

Despite these limitations, connectionist models provide a way to conceptualise structures and interactions differently from that of the symbolicist and constructionist models. A novelty with connectionist systems is the utilisation of the elements of the structure as processors, and the

[14] Even more so if cognition is goal-driven since problem solving processes can be programmed much easier if specific goals are posited beforehand.

connections between the processors as the representations. The structure is vastly different from the other structures discussed thus far. One may represent the weights between the processors in a three-dimensional space as distances between the processing units. In this way the particular interactions between units can be visualised. For instance, the smaller the weight between two units, the longer the distance between the two units. A longer distance indicates a weak relationship or interaction. The bigger the weight, the shorter the distance, indicating a strong interaction (interactions may also be viewed as *attractions*).

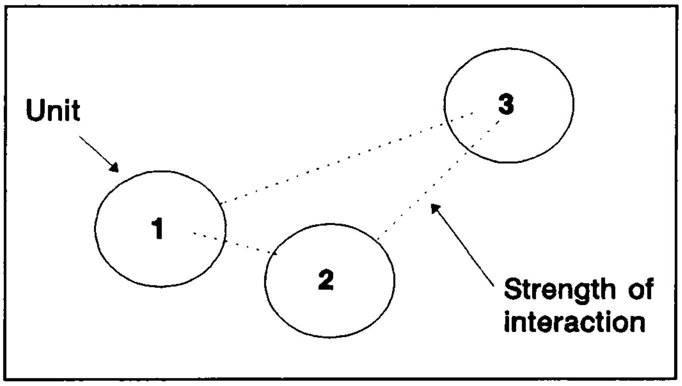

Figure 17 Configuration of three elements representing object 1

Figure 17 shows, as an example, the configuration of three units representing the object *cow*.[15] The weights between units 1, 2 and 3 are represented by the distance the units are from each other. Figure 18 shows the same network representing *grass*. Since the weights for each representation differ, the distances between units for each also differ. In the end, the *configuration* of the structures differs. It is this spatially portrayed configuration that represents a particular knowledge unit.

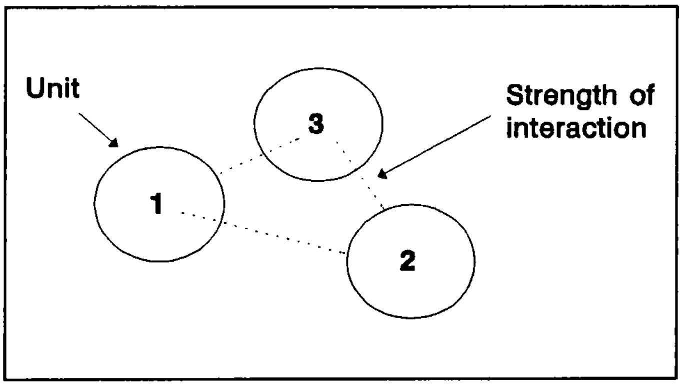

Figure 18 Configuration of three elements representing object 2

[15] Only three units were chosen to illustrate the example. Actual neural networks have many interconnected units which is difficult to portray three-dimensionally.

The connectionist system's units do not change their physical location: they can also be depicted as a matrix of units. A reconfiguration does not entail a physical reshuffling of units. It is only the strength of the associations between links that change the units' spatial relationships. One may suspect that the interactions between neurons in the brain work in the same way, accounting in some sense for its plasticity. Neurons do not physically move around, although they tend to form new connections with other neurons. This is precisely what the weights of the links between units do. A zero weight means no connection. In the three-dimensional depiction, no calculated weights between a unit and other units effectively means the disappearance of that particular unit.

As was seen in Chapter 4, a neural network is relatively sturdy. Single units that disappear occasionally (similar to neurons that die), do not affect the overall performance of the network substantially. This means that the three-dimensional portrayal will also be relatively unaffected, and one will still be able to distinguish multiple configurations from each other. This situation does not apply to the symbolicist network, since the disappearance of a unit or node could lead to a breakdown in performance (see Chapter 4).

5.4.1.4 Conclusion

Although the question of structure started off at the configuration of the processing components of the information processing systems, it ended with the structure of knowledge representation. The question is thus whether one can equate the structure of knowledge with the architecture of cognition, and whether one must distinguish between levels of structure. It will be recalled that, in the case of the symbolicists, certain elements of the structure cannot be swopped around as is the case with the architecture involving certain processors. Does this mean that higher level structures involve more stable configurations, with specific components having specific functions? This seems to be the case, since the lower level structures involve units operating like connectionist systems. Units are not tied down to specific aspects or functions, but function only by virtue of a combined effort. The need for more stable configurations and units with specific functions exposes the problem with connectionist models as discussed above. The particular architecture of a connectionist system makes it difficult to translate representations into actions. As was mentioned above, this is why hybrid systems are needed. If one compares the physiology of the organs of a human body, it becomes clear that, although the organs (for instance, the lungs and the heart) consist of cells at the microlevel - discounting the fact, for the moment, that even the structure of the cells may differ - at a macrolevel the organs function totally differently. The relationship between the organs as macrocomponents requires stability: one cannot swop the heart for the lungs.

However, the last word is certainly not spoken on this matter, since it seems as if one can repeat this particular connectionist structure, or rather distributed structure, on more than one level of reality. For instance, if one views *a society* as a system consisting of components (namely, people), then it seems as if this particular system also functions as a parallel distributed system: the people "units" or "simple processors" determine the strength of interactions between them (*interaction* could, for instance, be defined as the strength of repulsion or attraction between people). The particular combinatory action of assemblages of people determines bigger structures with specific functions (e.g., committees for fund-raising). This "symbolic-subsymbolic" level of structure metaphor may be stretched to the limit and one certainly would find interesting comparisons. However, question needs to be answered with regard to social groups: does a group of individual units, when determining the strength of interactions between them, *represent* anything by means of these interactions? Although this example of repeating basic structures on different levels of reality is hypothetical, the idea is not so far-fetched. For instance, a current trend in General Systems Theory is to view systems for the human brain, mind and the world as fractal dynamical (or chaotic) systems. Basically this mathematical theory entails, amongst others, that certain structures are repeated recurrently on different levels of reality, from the microlevel to the macro- or even cosmological level (see Vandervert 1990).

From the analysis of the history of consciousness and the major paradigms in cognitive psychology in this study, it may be concluded that structural considerations are very important in conceptualising both cognition and consciousness. The way structure is viewed is, however, very important. The static, elementistic view of structure is rejected in favour of a dynamic structure which can be represented as a spatial configuration. A structure consists of various components or elements standing in a particular relationship to each other.

At this stage it seems as if one must view systems as consisting of at least two levels. The lower level consists of microelements functioning in a parallel distributed way. This particular level can change the configuration of its elements, thereby changing the properties observed at a higher level. The elements need not be shuffled around physically although the interactions between them have the effect of a spatial reconfiguration. The second, slightly higher level, depends on the microlevel. The effect of the parallel distributed microlevel structure is the constitution (or emergence) of a higher level system responsible for a specific function.

Both the computer and the brain metaphors underlying the various cognitive paradigms are involved in this conceptualisation. The brain metaphor underlies the first connectionist-like level, and the computer metaphor (upon which the information processing, the computational and the symbolicist approaches are based) underlies the higher level that constitutes a system similar to the processing components of the information processing approach or the production systems of the symbolicists. The following section describes the functional components of the system in more detail.

5.4.2 Function

The second aspect identified in this study, important describing systems, is that of *function*. In the discussion of functional psychology in Chapter 2, it was seen that consciousness is defined as a process. Consciousness, for James, is an ever changing, dynamic process, much more streamlike than substantial (i.e., being a tangible, stable substance). The two views of consciousness, the structuralist and the functional, stand in opposition to each other, since the one views consciousness as static and elementistic, while the other views it as a dynamic process. These two opposing views were also found in the discussion of the major cognitive paradigms in Chapters 3 and 4.

What does one mean with the term *function*? In the analysis conducted in this study, it was used interchangeably with the term *process*. Does the term *function* mean the same as *process*? One may, on the one hand, say that *a certain process has been going on for quite awhile*, without implying that that particular process had a specific function. This particular statement emphasises the temporal nature of the process and not its changing or dynamic nature. Function, on the other hand, expresses the purpose of a particular mechanism or process. One may say that the function of memory storage (a process) is to enable future access. One can also say that a static component has a function. For instance, the function of a brick is to constitute a wall.[16] But a brick is certainly not a process as is building a wall. The function of an object or process may also be seen in the context of systems theory. The function a particular component fulfils is aimed at maintaining the integrity of a whole system, or at least alleviating a need in order to ensure the survival of the system. In order to fulfil a need, a process is certainly necessary, but one may also say that the reasonably static symbolicist propositional network has a particular function, namely, enabling procedures (productions) to work properly. However, one may also contrast the static nature of an object (its structure), with an active process (its function). This is precisely the way structure/function is used in this study. It started off by viewing structure and function as a dichotomy expressing inertia versus action, and ended with the view of structure as a *patterning* of elements, which includes process, action or function.

In the following paragraphs, the role of *function* within the various paradigms will be summarised.

5.4.2.1 Information processing approach and beyond

In Neisser's (1967) initial work, the active part of cognition can be assigned to the processes of construction. As discussed above, construction is a process of synthesis. It is dynamic as opposed

[16] Taking the argument slighlty further may eventually lead to the realisation that a brick, while functioning within a wall, is not so static after all. It must withstand various forces, and must exert its own force. Even a static brick lying on the floor is very active in resisting the gravitational pull of the earth, absorbing and giving off heat and energy, etc.

to static and unchanging. Construction operates on static data or information. It became clear from the discussion in Chapter 3 that a distinction between structure and process is made in the information processing approach. Information may be seen as having a particular structure (although this is not emphasised in the classical approach), on which certain processes operate. The main emphasis in the classical information processing approach, discounting Neisser's (1967) initial theory for the moment, is on processes or the function of certain mechanisms of cognition. Neisser (1967) conceptualised *processing* as constructive and even denied the static nature of informational structures in contrast to the reappearance and mirroring hypotheses. In fact, what is used in cognition is *acts* of perceiving and thinking.

The typical emphasis on processing and computation was tempered by Jackendoff's emphasis on the structure of information. To him the dynamic nature of cognition is entailed in the processes translating the structures of information from one level to another. Again, separate mechanisms are involved. On the one hand, one has structures of information, and on the other hand, the processes operating on the structures. Neisser's (1976) conceptualisation of the perceptual cycle provided a way to view structures as dynamic. A schema has a pattern or configuration of units, and it is the mechanism for causing behaviour or processes. In Neisser's (1976:56) own words, it is ... *a pattern of action as well as a pattern **for** action*. Thus, a schema is conceived as a knowledge structure, but it is not mere static knowledge or elements of facts as is the case with symbolicist structures (see paragraph 5.4.1.3 above). It is an active structure able to direct behaviour and be changed by behaviour. A schema is thus a very dynamic structure or process, always changing and developing in the light of a person's constant interaction with himself and the environment. Neisser's schema is the type of structure needed for developing an adequate and new model for cognition. It incorporates both knowledge and processes. This distinction is necessary since the usual structuralist view of cognition (cf. Jackendoff) focuses on information or knowledge structures, although it was seen that processes or mechanisms also exist as a particular structure. In the end it is not so much the structure and function of a particular (cognitive) system that needs to be fused, but a structuralist view of knowledge and a functionalist view of processes. As will be seen in the following two paragraphs, this particular dichotomy needs to be addressed. In the various theories of cognition and consciousness, the structuralist-functionalist principles led to opposing perspectives on the nature of cognition. The structuralist principle was eventually incarnated into a structuralist view of knowledge and information while the functionalist principle became embodied in a focus on cognitive *processes*.

5.4.2.2 Symbolicism

By now it ought to be clear that the main emphasis of the symbolicists is on symbolic knowledge structures, and on processes operating on these structures. A move beyond the information processing approach is their specification of the *architecture* of cognition, which seems to be an indication of the structure of the processes involved in cognition. In a very clear manner, the architecture is specified in terms of the computer architecture. In order to function adequately, a specific architecture is needed in terms of memory, buffers, etc. The architecture is determined by the constraints placed on it from within and without the cognitive system. Despite the clear elucidation of both the active and static parts of cognition, both having clear structure in terms of stable components in a certain configuration, it still fails to fuse structure and function adequately. As discussed above, the value of the *architecture* is that it actually turns the idea of activating a static structure around: an architecture requires active components or processes in order to have a "static", or rather, a stable structure. This latter idea can be incorporated in the second level of a system: i.e., its appearance as a reasonably stable whole depends on its underlying active processes (incorporated within its microstructure).

5.4.2.3 Connectionism

Connectionism as a paradigm succeeds, in one important respect, where others had failed: it fuses structure and process (or function) in a novel way. The stable components of a static structure suddenly become active or functional. An associationistic network with its usual implication of static elementism is turned on its head and in the process succeeds to represent knowledge in a new way. The connectionist structure becomes a self-actuating structure. It is a structure that can reconfigure itself by functioning as a constraint satisfaction network. The importance of the connectionist system must not be underestimated, since the processors do not need elaborate algorithms, they do not need to know the results of all the other processors, they do not operate sequentially, and they do not need a central executive or overseer to perform their duties. Their combined action is responsible for the emergence of seemingly novel properties.

However, as mentioned above in paragraph 5.4.1.3, the very serious limitation of connectionist systems must again be kept in mind. At this stage it fails to account for higher level actions as opposed to representational issues. A pure representational structure as espoused by connectionists, despite being a self-actuating structure, cannot cause higher level rules to be executed. From the conclusion above (paragraph 5.4.1.4), it seems that the model of a system developed in this study requires the microlevel parallel distributed structure to cause an active mechanism on the second level, which in the end can be responsible for particular processes. The computational problem for the connectionists is then to design the connectionist system in such a way that a *process* emerges without the need for designing hybrid systems or adding symbolicist architectures. In fact, if connectionism wants to be consistent in its use of the brain metaphor, this is a fundamental requirement: it indeed seems as if the brain is able to cause mechanisms of processing from a purely parallel distributed base.

5.4.3 Conclusion

The structural and functional perspectives in the study of mind and consciousness were clearly apparent in the way these phenomena were studied at the turn of the century. After behaviourism regulated the subjective and mentalistic phenomena to the periphery of psychological studies, new paradigms arose that placed the study of cognition in the centre of psychological investigation. In this, study four paradigms were identified, namely, the information processing approach, symbolicism and connectionism. Within the broad information processing approach a distinction can be made between the classical approach and the newer approaches moving beyond the classical approach. Initially these paradigms did not focus on consciousness as such, but the emphasis is slowly changing. Usually the paradigms can be distinguished in terms of their underlying metaphors, such as the computer and the brain metaphor. Other ways of distinguishing can also be used, such as distinguishing between symbolic theories and subsymbolic theories, or making a distinction between computational and noncomputational theories, or even distinguishing between a top-down or bottom-up processing approach.

Table 3 Classification of cognitive theories according to the nature of knowledge representation and cognitive processes

Theory	**Knowledge representation**	**Cognitive process**
Classical information processing	Not clearly delineated structure (information usually constructed from elements)	Separate processes operating on information
Neisser's cyclical theory	Schema structure: active and dynamic	Schema: functions as a process
Jackendoff's structural approach	Hierarchy of knowledge structures: change between levels and within levels	Separate translation/interaction processes operating on structures
Symbolicism	Associationistic structure: static, elementistic	Separate procedures operating on structures
Connectionism	Knowledge structure: active and dynamic	Processes imbedded within structure

In this study the cognitive theories were discussed in terms of the principles of function and structure, principles that were found in the initial study of mind and consciousness at the turn of the century (see Chapter 2). Theories of cognition focus on representational and/or processing issues. Structural considerations are most apparent within the issue of knowledge representation while function/process is emphasised in the processes of cognition, and this is the reason why the theories of cognition were discussed in terms of the knowledge representation and cognitive processes. In Table 3, it can be seen that most theories require separate processes operating on knowledge structures. Neisser's (1976) cyclical theory utilises the schema both as structure and as process, while the connectionist knowledge structure fuses both knowledge structure and process.

Thus, the classification of cognitive theories can be done on grounds of whether a theory requires separate processes operating on knowledge structures. In other words, does its knowledge structure have a function requiring separate processes to activate that function, or is it a self-actuating structure enabling it to function?

One may argue that the active cognitive processes also have a particular structure, which can be represented as a spatial architecture, but the issue at stake here is that one is so used to thinking in terms of separate knowledge *structures* and cognitive *processes*, that other possibilities tend to escape notice. When thinking about cognition, a natural or rather historical distinction between knowledge/information and processes comes to mind, a distinction which is also associated with separating structure and function. It is only rarely realised that structure and function/process naturally belong together. Neisser's (1976) model of the schema prefigures this natural fusion. Connectionism modelled this fusion clearly at least on the representational level. Pointing out the role of structure and function within cognitive theories does not imply that these principles were the explicit focus of these theories, or that connectionism intended the fusion between structure and function. An assumption of this study is that a focus on structure and function within cognitive theories is one profitable way of identifying the shortcomings of a theory when accounting for the role of consciousness within cognition. It is also a new perspective from which to devise a model within which cognition and consciousness can be explored. The *main assumption* of this study is that a separation of structure and function, which is reflected in the separation of knowledge representation and cognitive processes, lies at the root of failing to account for consciousness adequately within the process of cognition.

From the discussion above, the following characteristics and requirements for a system can be inferred which ought to form part of the systemic emergentist model:

5.4.3.1 A requirement for a system is that its function and structure be fused. Function and structure cannot be separated.

5.4.3.2 The fused function and structure supports the constitution of the system as a whole. In other words, the eventual function of the system cannot be separated from its structure.

5.4.3.3 In order for the structure to give rise to the system's particular function, the structure itself must involve active processes. This requirement follows from the description of function or process according to Miller. Process involves the transformation of energy or information. To enable transformations to take place, the supporting structure cannot be inactive or static.

5.4.3.4 The requirement for an active underlying structure necessitates a distinction between the function of the system and the functions of the underlying structure. One thus has the functions of the structure on one level and a resulting function of the whole system on a higher level. For the sake of clarity one may call the function of the whole system, the *emerging* function since it is actually formed by the supporting structure.

5.4.3.5 The structure supporting the system is not inert or inactive, but involves activity, and the ability to effect transformations. Despite the fact that the structure involves processes (i.e., it is functional or able to perform functions), the characteristic of a structure stated by Miller, requires that it have a spatial configuration. Both the ability to represent the structure spatially, and the requirement of functionality are satisfied by the connectionist model (see Table 3). Although Neisser's (1976) model of a schema also satisfies the criteria to some extent (a schema is both a structure and a process), he does not specify the particulars of the structural nature satisfactorily.

5.4.3.6 Thus, taking the cue from the discussion of the connectionist model above as the most appropriate modelling of a fused structure and process (paragraph 5.4.1.3 above), the systemic emergentist model's depiction of the structure can be described. The system seems to entail two levels in terms of the underlying structure (the lower level) and the appearance of the system as a whole (the higher level). The first or lower level may be viewed as similar to a connectionist structure, namely as consisting of microelements functioning in a parallel distributed way. This level's self-actuating structure is then similar to a connectionist system or neural network. It is able to change the configuration of its elements by adapting the strength of connections between the elements. This is made possible by viewing the elements as simple processors and the connections or links as providing representations. A particular representation may be illustrated by the three-dimensional or spatial configuration of elements (see paragraph 5.4.1.3). The result of a particular configuration constitutes the next level, holistic appearance of the system.

To conclude: the distinction between structure and process must be just that: a distinction without separating the two aspects. In the past, this distinction became substantialised into separate components, namely, a knowledge structure and a processing architecture. The effect of separating function and structure was that each particular model or theory of cognition ran into some difficulty in explaining the full range and complexity of the mind. This problem is especially pronounced with the phenomenon of consciousness and related *subjective* phenomena. The following section will address cognition and consciousness from the perspective of the various cognitive theories and from a phenomenological perspective in order to define the particular characteristics to be explained by a systemic emergentist model.

5.5 CHARACTERISTICS OF COGNITION AND CONSCIOUSNESS

Before the actual systemic emergentist model can be described, the aspects or characteristics of cognition and consciousness need to be specified. This specification is necessary since the model must be able to provide a rudimentary framework within which these characteristics can fit. In this way the model can actually be tested in terms of what it can and cannot explain or model. The next step is then to indicate the avenues to be explored with the model.

The most difficult characteristic of consciousness and cognition to account for is the subjective and personal quality of experience. One must thus identify the characteristics of these subjective qualities of conscious experience. This will be done by means of describing consciousness and cognition at the phenomenological level (cf. Chapter 1). The second aspect to be discussed is the characteristics of cognition and consciousness identified at the lower psychological level. This will be done by means of the theories of cognition discussed in Chapters 3 and 4. Throughout the discussion the function of consciousness and the relationship between cognition and consciousness will be kept in mind, since these two aspects will also be dealt with in the final testing of the systemic emergentist model.

5.5.1 The phenomenological experience of consciousness

A phenomenological description of the subjective experience of consciousness does not necessarily entail a definition of what consciousness is. However, the dimensions or characteristics of the phenomenological experience of consciousness can be gleaned from some such definitions. For instance, Izard (1977:137) defines consciousness as *the total array of sensations, perceptions, cognitions, and affects that characterize the individual*. The first point of interest is that, in accordance with the position advocated in this study, cognition is viewed as an integral part of the experience of consciousness. The second point of interest is that emotions or affect are also included in the experience of consciousness. How then is thought (arising from cognitive processes) and other types of content related, and can the content of consciousness provide clues to its origin? Thus, the main question to be probed in this section is whether a phenomenological description of consciousness can provide characteristics of consciousness to be explained by a model of consciousness and cognition.

5.5.1.1 The role of sensations, perceptions and emotions in conscious awareness

The particular topic of emotions and its relation to cognition was neglected to date within the study of cognition (cf. Pekala 1991:68). Although the relationship between cognition and affect is not, as such, the focus in this study, it seems from an experiential viewpoint that both emotion and cognition somehow mingle in their conscious apprehension. The student's frustration in not being able to solve a particular physics problem is a case in point. This is not to say that cognition can be restricted to higher level processes such as problem solving utilising inferential processes. If the gist of this study, in terms of what cognition involves, is taken to its logical consequence, then cognition may be viewed as those processes involved in finding meaning: cognitive processes and representational states aim at appropriating and utilising information that makes *sense* to the cognitive agent. Thus, even an emotional reaction towards a particular object, such as an inexplicable intense dislike for a person, is a way of knowing. The emotional reaction or disposition is a way of making sense of events, persons or objects, although it may not be *sensible* or rational (one must beware of equating being rational with the act of cognition!). Not only does the initial emotional predisposition entail something cognitive, any subsequent dealings with and evaluation of a person, event or object will be coloured by one's initial emotional response. That is why it is difficult to be "objective" or unbiased towards, for instance, a worker one intensely dislikes who needs to be evaluated on grounds of work performance!

According to Pekala's (1991:80) evaluation of the work of Izard (1977), emotion underlies the organisation of sensation. Sensory-cortical processes produce affective experience and form the basis for other operations of consciousness. The basic affective responses combine with cognitive processes and drive other perceptual and motor processes. Thus, Pekala (1991:80) agrees with Izard (1977) that consciousness is made up of combinations of sensations, perceptions, cognitions, and affects.

5.5.1.2 Thought and consciousness

From the discussion in Chapter 2 of the hierarchical view of consciousness of Bunge and Ardila (1987), it follows that consciousness must be distinguished from awareness and self-awareness. Awareness requires sense organs so that an organism can sense internal and external changes. Self-awareness is on a higher level than awareness, since an organism can become aware of its own feelings and actions. Self-awareness also implies that the organism is able to distinguish itself from other objects. Consciousness entails a further step, namely, the ability to think about perceptions and conceptions. According to Bunge and Ardila (1987), one has a progression from sensations to feelings, actions, perceptions and conceptions. Consciousness makes thought available to the agent, but the lower level content of awareness, namely feeling, sensing and doing, is also present. Thought opens the possibility to reflect on feeling, sensing and doing. However, the fact that consciousness always has content implies that the content need not be exclusively pure representational states of knowledge. This is the mistake of the symbolicist paradigm of cognition and similar representationalist theories. The content of consciousness also includes the content of emotional and sensational experience, but always with the possibility to *reflect* on the experience. However, Pekala (1991:34) views reflection as part of the *noeses* of consciousness. It is thus only one subjective intentional act among many others (such as perceiving, willing, imagining, etc.)(cf. Chapter 2 of this study). *What is then primary within consciousness?* Is it mainly a cognitive process, since it involves thought to a large extent, or is it the place where many different experiences come to awareness? This is a key question in the riddle of consciousness. The answer to this question will actually determine in what direction to look for the cause of consciousness, and its relationship with cognition. The important point is that one must distinguish what appears in consciousness from its causative mechanisms.

The hierarchical view of consciousness espoused by Bunge and Ardila (1987) implies that consciousness (or at least self-consciousness), stands at the pinnacle of hierarchical levels, progressing from simple processes to more complex and fully-developed processes. This perspective is akin to the view that consciousness is the end result of an evolutionary developmental process. According to this view, higher level cognitive processes such as thought and language represent the final evolutionary stage in human development. It seems natural to assume that consciousness emerges with the ability to think, and this could be true, but to *restrict* consciousness to the most abstract levels of cognition is to deny the ability to consciously experience rudimentary sensations and feelings. This is one reason why Jackendoff proposed an intermediate level theory of consciousness. The content of consciousness is formed by both higher level *and* lower level processes and structures (cf. Chapter 3 of this study).

Baars' (1988) global workspace theory (GW) theory of consciousness and cognition goes much further than other theories in terms of the access other systems have to consciousness. The GW theory entails that the cognitive system consists of a distributed architecture of processors and a global workspace (similar to a blackboard) which the different systems use to perform operations (cf. Baars 1988:86-89). The global workspace then "broadcasts" its information to the other distributed processors and systems. It must also be noted that the distributed processors function in parallel, independently and compete for access to the global workspace. The functioning of the processors is largely unconscious while the global workspace is associated with consciousness (Baars 1988:102). For instance, the senses (e.g., vision, hearing, touch and taste) also function as conscious workspaces, which implies that the content of a particular sense modality is available to consciousness. Baars' (1988:126,134) basic contention is that the content of consciousness (formed by the different specialised processors) is broadcast widely throughout the central nervous system as a whole.

Thus, consciousness seems to have access to other states of awareness, such as experiencing sensations and feelings. Whether perceptions, feelings and lower level awareness of sensations form part of the same system giving rise to consciousness is, at this stage, irrelevant. What is important is that the *experience* of these aspects is accessible to consciousness. However, having a conscious experience of an emotion (which is the result of a supposedly lower level process), does not necessarily entail that consciousness does emerge from the lower level processes and systems.

According to the systemic emergent model advocated here, consciousness may be viewed as a process emerging from the interaction between subsystems (see paragraph 5.6 below). Although it is not clear at what particular level of systems it emerges, it can be hypothesised that consciousness requires at least more developed cognitive subsystems for its emergence. Apart from the criticism levelled at the symbolicist and computationalist theories in the previous chapter, it may be said that the particular configuration of subsystems (or the architecture) required for the emergence of consciousness ought to be at least on a higher level than that of the symbolicist and computationalist architectures. At this stage with their particular architectures, which actually involve high level reasoning and problem solving processes, the presence of consciousness is not apparent, despite the fact that someone like Newell claims awareness for his particular cognitive architecture.

5.5.1.3 Intentionality and meaning

The matter may be illuminated by the concept of intentionality which was discussed fully in Chapter 2 of this study. Intentionality was described as a fundamental characteristic of consciousness. Traditionally it was seen as indicating that consciousness has content. However, the concept of intentionality must be broadened: it expresses a directionality towards *meaningful* content. It does not express mere content nor is it a static characteristic: it is a process and it entails a constant tension between existing meaningful structures and perceived phenomena struggling to find meaning within established structures. Intentionality is also a very personal aspect of consciousness. The meaningful content of consciousness is always subjective and very personal, since one person's experience of a particular event (such as that of a football game), may differ radically from that of another person. A representationalist interpretation of intentionality focuses on the content of consciousness and awareness and, as was seen in Chapter 2, even a computer can then be said to be "aware" since it is able to represent content or knowledge. However, the actualist view of intentionality espoused here, moves beyond representationalism towards a process of establishing meaningful content localised within a particular personal consciousness. The link then, between cognition and consciousness, lies not so much on the ability to consciously reflect or think but on the ability to have *meaningful* thoughts and experiences. Both consciousness and cognition aim at finding meaning albeit on different operational levels. Most cognitive processes, such as visual perception, start off in a parallel fashion, and the nearer to consciousness and awareness the process progresses, the more sequential and serial it becomes. This means that despite the difference in the mode of operation between lower level cognitive and perceptual processes and higher level cognitive and conscious processes, all processes support the final appropriation of meaning.

5.5.1.4 The process (thought) and content of consciousness

In conclusion it can be said that the content of consciousness involves thought, various sensations, perceptions and emotions, but always with the possibility to reflect on these aspects. The possibility to reflect, even on thought itself, could imply that the mechanisms involved in causing consciousness are higher level processes rather than the lower "information processing" processes. However, it is also possible that rudimentary awareness emerges at lower level processes involving sensations, perceptions and emotions and feeds into a fully developed consciousness as one progresses through hierarchical levels. The systemic emergentist model provides a particular perspective on the causative mechanisms of consciousness and will be discussed below.

The content of consciousness, thus, provides clues to determine were to look for the origin of consciousness (its causative mechanisms), but can also be misleading in terms of the level of origin. Thus, the fact that higher level thought processes appear in consciousness can mislead one to think that consciousness arises only with higher level cognitive processes. On the other hand, the appearance of content generated at a lower level, cautions one to restrict the origin of consciousness to higher level processes. The relationship between lower level content and higher level content is clarified by viewing consciousness as the process where content struggles to find personal meaning. Thus, intentionality as a fundamental characteristic of consciousness integrates the various types of content within one process: this is why a conscious emotional response is a way of knowing, or rather a way of making sense of, information.

In the following section, the very personal and subjective quality of consciousness will be examined in order to establish clear distinctions between types of content.

5.5.1.5 A phenomenological description of subjective consciousness: clarifying the subjective quality of conscious content

To illustrate the phenomenological description of conscious experience, the following excerpts from Sartre's (1965) novel *Nausea*, will be discussed. This phenomenological account provides a description of the protagonist's conscious experiences in a particular situation. Certain characteristics of subjective conscious experience can be indicated, which will provide clear distinctions between the different types of content of consciousness.

> *I had forgotten, this morning, that it was Sunday. I went out and walked along the streets as usual. I had taken 'Eugénie Grandet' with me. And then, all of a sudden, as I was pushing open the gate of the municipal park, I had the impression that something was signalling me. The park was bare and empty. But ... how shall I put it? It didn't have its usual look, it was smiling at me. I stayed for a moment leaning against the gate, and then, suddenly, I realized it was Sunday. It was there in the trees, on the lawns, like a faint smile.*

It was impossible to describe, you would have had to say very quickly: 'This is a municipal park, this is winter, this is a Sunday morning.'

I let go of the gate, I turned round towards the houses and the staid streets and I murmured: 'It's Sunday.'

It's Sunday: behind the docks, along the coast, near the goods station, all around town there are empty warehouses and machines standing motionless in the darkness. In all the houses, men are shaving behind their windows: their heads are thrown back, they stare alternately at their mirror and at the cold sky to see whether it's going to be a fine day. ...

The sea was now the colour of slate; it was rising slowly. ... The sun went down slowly over the sea. On its way it lit up the window of a Norman chalet. ... The light grew softer. At this uncertain hour, something indicated the approach of evening. Already this Sunday had a past. The villas and the grey balustrade seemed like recent memories. One by one the faces lost their leisured look, several became almost tender. ...

The first light to come on was that of the Caillebotte lighthouse; a little boy stopped near me and murmured ecstatically: 'Oh, the lighthouse!'

Then I felt my heart swell with a great feeling of adventure. ...

I am alone , most people have gone home, they are reading the evening paper and listening to the wireless. This Sunday which is drawing to a close has left them with a taste of ashes and already their thoughts are turning towards Monday. But for me there is neither Monday not Sunday: there are days which push one another along in disorder, and then, all of a sudden, revelations like this.

Nothing has changed and yet everything exists in a different way. I can't describe it; it's like the Nausea and yet it's just the opposite: at last an adventure is happening to me and when I question myself I see that ***it happens that I am myself and that I am here****: it is* ***I*** *who am piercing the darkness, I am as happy as the hero of a novel.*

Something is going to happen: in the shadows of rue Basse-de-Vieille there is something waiting for me, it is over there, just as the corner of that quiet street that my life is going to begin. ... I see nothing. ... Was I mistaken? ...

When I found myself on this boulevard de la Redoute again nothing remained but bitter regret. I said to myself: 'Perhaps there is nothing in the world I value more than this feeling of adventure. But it comes when it pleases; it goes away quickly and how dry I feel when it has gone! Does it pay me these brief, ironical visits in order to show me that my life is a failure?'

Behind me, in town, in the big straight streets lit by the cold light of the street lamps, a tremendous social event was dying: it was the end of Sunday (Sartre 1965:63-84).

This phenomenological description encompasses a number of characteristics of consciousness. The protagonist first of all describes his perceptions of his surroundings, in other words, he describes the way certain objects and events appear to him (e.g., the colour of the sea, the appearance of faces as tender, etc.). In this description certain images are evoked in the reader as well. One may form an image of the grey, bleak sea, see the sun going down that lights up houses in a certain way, experience the cold air in the park, hear the stillness of the early morning and generally experience the mood of the setting. For instance, one's own experience with the loneliness of a Sunday evening, the feeling of anticipation, or of anxiety, at the end of a closing day, can form one's particular conscious experience of the image that forms when reading the text. The protagonist is also able to form images of unperceived events and objects, and these images are tainted with his current experience of the Sunday morning. For example, he experiences the park as smiling and friendly, and this feeling of well-being is carried over into his images of men who shave and anticipate a fine day. Almost simultaneously, he has contrasting images of objects and buildings standing motionless in the dark and cold.

These perceptual experiences and images form a fundamental part of consciousness. The way things appear in perceptual experiences and images, which is of course particular to one's own experience, can be called *qualitative* conscious experience. It is qualitative since it entails a very rich range of sensual experience (i.e., the visual, auditory, tactile, taste and olfactory senses). It is not, for instance, merely a visual experience but an experience tainted in a certain way. The protagonist experienced the colour of the sea in a certain way, but to someone else, the bleakness of the sea may actually have a soft and calming quality. The protagonist also had a particular experience of the park: it smiled at him. This metaphor conveys the quality of the appearance of the park with its setting to the protagonist. The different ways things appear to a particular individual is also called *qualia*[17] (Flanagan 1992:62). Much debate has been going on in order to get rid of qualia in scientific discussion of consciousness (cf. Flanagan 1992:61-85). However, qualia form an integral part of conscious phenomenological experience, and must be explained by whatever theory or model one develops. Images or *imaginal experience* differ from perceptual experience in that it is not direct experience but internally generated experiences or quasi-perceptual experiences that include visual images, auditory "images," inner speech and even bodily feelings (cf. Baars 1988:14). Both imaginal and perceptual experience constitutes a large part of the content of consciousness.

Imaginal and perceptual experiences differ from the abstract content of consciousness in so far as the latter refers to *immediately expressible concepts* (Baars 1988:14). This includes beliefs, intentions, meanings, knowledge, and expectations (Baars 1988:14). Abstract concepts do not have the same quality as imaginal and perceptual experience. A distinction must then be made between qualitative and nonqualitative conscious content, although Flanagan (1992:67) advocates a broadened concept of qualia to include beliefs, hopes and desires. His argument is that the phenomenological or subjective experience of different abstract concepts or events, differ in quality. For instance, the experience of a desire "feels" different from holding a belief (Flanagan 1992:68). Although Flanagan does have a valid point that must be kept in mind, the difference in quality between perceptual/imaginal experience and abstract states is much more apparent than real since abstract concepts do not have the same *rich, clear and consistent* qualities of the former (Baars 1988:14).

Sartre's (1965) text above also provides examples of nonqualitative experiences. The protagonist experiences expectations: *Then I felt my heart swell with a great feeling of adventure ...*, and *(S)omething is going to happen ....* Although he does not know what to expect, he expresses the fact

[17] Singular = *quale* (Flanagan 1992:66).

that he feels that something is going to happen, and when his expectation is not fulfilled, he expresses his disappointment. He also, in the end, expresses his own evaluative thoughts on his *feelings* of adventure, and concludes that his experience of dryness and loss when the feeling of adventure is gone, probably emphasises the fact that his life is a failure. This conscious evaluation and reflection on feelings and experiences entails an ascription of meaning to these experiences and feelings. Even the protagonist's final conclusion that behind him *a tremendous social event was dying*, is the expression of an abstract concept. It must be noted that the way these intentions, meanings and expectations are expressed, confirms the thrust of Flanagan's (1992) argument that even the so-called nonqualitative contents of consciousness do have qualitative aspects, but in a more encompassing sense intended by Flanagan. To reiterate what was discussed above, cognitive acts are never pure and objective, especially when they become accessible to consciousness. The protagonist above expresses meanings and abstract concepts in such a way that they convey a particular mood, a mood that was formed by his qualitative perceptual and imaginal experiences.

In conclusion, the following characteristics of subjective conscious experience can be indicated. These characteristics identified on a phenomenological level can be specified as the ability to

- have imaginal experiences
- experience sensations, perceptions and emotions
- experience these aspects in a certain way
- describe these experiences
- think about these experiences
- recall these experiences
- find these experiences and other content as meaningful
- envisage future experiences.

(a) A distinction must be made between types of content in terms of their quality: the first includes qualia which involves imaginal or perceptual experiences. The second involves nonqualitative content which includes expressible abstract concepts.

(b) The content of consciousness, especially the very personal way things appear to a particular individual, is coloured, or rather contextualised, in terms of past experience, current mood, and expectations. One may actually say that the current content of consciousness is formed and positioned by whatever schemata (to use Neisser's terminology) currently are active. Moods, feelings and sensations are an integral part of a person's functioning, such that perceptions (what is perceived, in what way it is perceived and what is expected to be perceived) and associated "knowledge" structures cannot be divorced from these personal and subjective experiences.

(c) The way things appear to consciousness seems to be the result of this contextualisation process. This particular contextualisation process aims at integrating various dimensions of experience in order to provide a person with meaningful experience. Consciousness is thus the place were content is experienced as meaningful, integrated or structured. In fact, the ability to consciously reflect or think about the contents of consciousness, aids in the process of making content meaningful.

5.5.2 Cognition and consciousness from the perspective of cognitive theory on the psychological level of analysis

The results of the analysis in the previous chapters in terms of cognition and consciousness will be summarised and integrated below, in order to provide an identification of particular characteristics of consciousness as viewed from the psychological level of analysis.

5.5.2.1 Information processing approach

Information processing theories do not make explicit allowance for consciousness within the flow diagram of processes operating on information. The information processor is largely an unconscious agent since most processes going on can be completed without the intervention of consciousness. The unclarity of the role and function of consciousness contributed to this state of affairs. If consciousness must be included, it will be regulated to a submechanism on a flow chart. Consciousness is equated to awareness or attention, since within this paradigm, certain processes need the function of conscious attention to complete the train of information processing events. For instance, when learning a skill such as riding a bicycle, the first stage is to consciously attend to the steps involved in learning the skill. After sufficient practice, the actions and behaviour become automatic with no further need for conscious awareness. New and unexpected information demands conscious awareness. Despite this allowance for conscious awareness, no explicit development of consciousness in phenomenological experience is provided by the information processing approach.

Neisser's (1967) constructivist perspective on information processing emphasised that the perception or the remembering of events, behaviour or other stimuli are never copied directly to awareness. The results of acts of construction can enter awareness, which means that much processing or construction takes place unconsciously. Indeed, the process of, for instance, visual cognition, involves largely unconscious cognitive processes. Eventual access of conscious content depends on these processes. These processes function as constraints on what is eventually available to consciousness. The unconscious constraints are, amongst others, perceptual set, the duration of iconic memory, the ability to report on perceived events which is determined by coding variables such as exposure time, intensity of the stimulus and post-exposure field (cf. Neisser 1967:36). Even pattern recognition and the ease of coding certain structures determine what is eventually available to awareness. Neisser (1967) allocated these unconscious cognitive processes to the preattentive stage of cognition. The attentive stage focuses awareness and directs attention to stimuli in order to effect a further synthesis of input and to enable conscious decisional processes to take place. Preattentive processes are parallel and involve detailed processes, while attentive processes are sequential and focus on holistic information.

Thus, even though Neisser's (1967) initial theory was largely based on the information processing approach, some elements in his theory do prefigure the ideas found in more recent cognitive theories (cf. Baars 1988). One must distinguish between unconscious cognitive processes taking place in a parallel and distributed manner, and processes of a more holistic and sequential nature that are accessible to awareness and consciousness. A phenomenological description of consciousness does in fact confirm that one is able to hold restricted units of information in consciousness, and that these units are experienced holistically. The phenomenon of the Necker cube described in Chapter 3 shows that one is able to hold only one interpretation of the cube at a time. Although one knows that a second view is possible, the specific perspective is available to awareness in a holistic manner. Secondly, different views of the figure can only be held consecutively (or sequentially) and not simultaneously. The same is true of information coming from different sense modalities: one may, for instance, focus consciously on the lamp on the table, but as soon as one's name is spoken by an unobserved person, one's conscious attention switches to the auditory information. It seems as if unconscious processes compete for conscious access, much in the same way as Selfridge's demons compete for access to higher level processors (cf. Neisser 1967 and Chapter 3 of this study).

Neisser's (1967) particular theory provides the following characteristics for a theory of cognition and consciousness:

(a) The relationship between consciousness and cognition is specified quite clearly: consciousness is part of the cognitive process in so far as it enables holistic interpretation of information, it directs awareness to events and objects for further analysis, and it enables conscious decisions to come into effect.

(b) Unconscious processes enable certain information to reach consciousness by constraining information in a certain manner.

(c) Furthermore, unconscious cognitive processes function in a fast, parallel and a distributed manner. It may be inferred that these characteristics of preattentive processes enable constraints to have an effect. For instance, despite the particular reception or coding of information, perceptual set can influence what is eventually seen or heard.

A model of cognition and consciousness must, in the end, be able to explain both the parallel nature of unconscious processes and the sequential and limited capacity nature of conscious processes.

5.5.2.2 Beyond the information processing approach: The cyclical theory of cognition

Neisser's (1976) cyclical theory of cognition does allow for consciousness to some extent. He acknowledges the importance of the phenomenon of consciousness on a broader base than the information processing approach. Although he does not explicitly develop a theory of consciousness, it seems as if the function of consciousness is incorporated within the performance of schemata as the driving force behind the perceptual cycle. Consciousness is an activity (and not a particular substance or element) that is related to the process of learning and thus to cognition and perception. It is largely concerned with the content of the cognitive process. In this way it determines the subjective quality of our experiences, since information perceived is situated within a particular context or a web of relations that include the perceived information's relation with its environment and relations with existing schemata. Perceived information is not mere information but *meaningful* information for a particular subject, and this experience of meaningfulness of information can be ascribed to the activity of consciousness.

Consciousness and cognition are related very directly in terms of the perceptual cycle and the role of schemata. It was said in Chapter 3, that the perceiver is not passively receiving information, but actively seeking information from his/her surroundings. The nature of schemata is then such to enable this process to take place. One may infer that one of the functions of consciousness is to assist this process and to assist the formation and continuous reconstruction of schemata. If some of the content of the schemata is not available to consciousness, anticipations cannot be explored, and expectations will not be fulfilled or disconfirmed: in short, schemata will not be able to grow (learn) and will remain impoverished and incoherent fragments of information. It seems as if the integration of information within existing schemata needs to be meaningful to the particular subject, since coherence, structure and reasonable stability are needed to make sense of one's surroundings and perceptions.

Thus, from Neisser's (1976) theory, the following aspects must be kept in mind when devising a model of cognition and consciousness:

(a) The ability to change and receive information: the cognitive process is cyclical to a certain extent.

(b) This cyclical process enables structures (schemata) to be formed and to grow and learn.

(c) Consciousness assists this processing of learning.

(d) Consciousness is involved in making information meaningful to the perceiver. This facilitates the learning process.

(e) Consciousness seems to be concerned with the subjective quality of experiences. This subjective quality seems to be related to the context within which perception takes place. Both existing schemata (embodying past experiences) and current environmental information interact to form the unique content of consciousness at a particular time.

5.5.2.3 Beyond the information processing approach: The structuralist approach

As was mentioned before, cognitive theories struggle to find a particular function for consciousness. The structuralist information processing or computationalist approach of Jackendoff does not ascribe any function to consciousness. This conclusion arises from his requirement that the phenomenological mind must be fully accounted for by the computational mind and its underlying neurophysiological structures. This means that the phenomenological mind cannot explain computational states of mind. Interactionism is thus rejected. There is then no room for upward (emergence) and downward causation as is the case with Sperry's theory. However, the requirement that underlying computational and biological processes explain the phenomenological experience of consciousness, need not lead to the rejection of interactionism or the view that consciousness has no function. It is clear from the systemic emergentist perspective that the principle of emergence allows for the creation of new properties that are irreducible to the properties of lower level systems. If this is true, then in some cases a direct link between certain physiological states and certain high level phenomenological states cannot be established, since the conscious state at the phenomenological level is the result of multiple and distributed interactions of microlevel systems. It is then true that underlying process can explain conscious states, but only within an emergentist framework (which, in fact, entails a slightly different view of causality than that of Jackendoff's). An emergentist view also entails that emerging systems have a particular function, so that one must reject Jackendoff's and other similar standpoints that consciousness does not have any function.

Jackendoff (1987) views consciousness as a projection of structures of information onto consciousness from an intermediate level of a hierarchy of structures. Consciousness is not a function of the uppermost level of this hierarchy of knowledge structures ranging from concrete to the most abstract level. Consciousness is not the result of this uppermost level but the content of consciousness is determined in a top-down fashion by higher levels as well as in a bottom-up fashion by the lower levels. It thus arises from an intermediate level. Jackendoff's analysis of the most abstract level of conceptual structure shows that meaning can be ascribed to lower level structures of various sense modalities. This means that the experience of lower level informational structures (such as touching a particular surface), and the meaning encoded in high level conceptual structures intersect and interact at intermediate levels to produce the content of consciousness (it is interesting to note that Jackendoff does advocate an interactionist principle in the form of top-down and bottom-up processing within the hierarchy of informational structures!). Although Jackendoff advocates an intermediate level theory of consciousness, it must be noted that his model of information structures is a matter of perspective fed by the history of cognitive theory. Traditionally, the cognitive process is said to progress from less complex to more abstract levels of cognition (cf. Neisser's 1967 discussion of cognition in Chapter 3). As will be argued below, consciousness can be associated with the most abstract levels of cognition, but if one views Jackendoff's hierarchy of information structures horizontally (without negating the progression taking place), consciousness still emerges (or in Jackendoff's nomenclature: consciousness is projected) from the interactions taking place between the different systems of information structures, although the intermediate levels have the greatest effect in producing the content of consciousness. Viewing the model in this way, as depicted in Figure 8 in Chapter 3, shows that consciousness emerges or is projected from a particular configuration of processes and structures at a lower level. In this model, consciousness as the emerging property of subsystems, still functions at a higher level than the subsystems.

To summarise the important aspects of cognition and consciousness:

(a) Whether one views consciousness to be functional depends on one's philosophical starting point. In contrast to Jackendoff's assumptions, a systemic emergentist perspective allows for an interactionist view of mind and brain in the sense Sperry intended in the discussion above. It actually allows for a broadening of the concept of causality entailing upward, or emergentist, causation and downward causation. The systemic emergentist view also allows for the functionality of a system, since, as was seen above (paragraph 5.2), a system is always functional.

(b) According to Jackendoff's view of the relationship between cognition and consciousness, it seems as if consciousness arises from the particular cognitive processes and informational structures. Although he cannot specify in what way consciousness is projected from the levels of processes and structures, the content of consciousness is at least provided by the cognitive structures. His theory again emphasises that cognition underlies and supports consciousness.

(c) The content of consciousness does not necessarily arise from the most abstract and complex levels of cognitive structures, but can be formed by both lower and higher level cognitive structures.

5.5.2.4 Symbolicism

The issue of the phenomenological experience of consciousness within the symbolicist framework is virtually nonexistent (cf. Baars 1988:42). The symbolicists, as is the case with the computational or information processing approach, equate awareness and consciousness to a large extent. Newell (1992a:475), in reaction to the complaint that his SOAR theory does not provide a theory of consciousness, stated explicitly that it does not provide such a theory (cf. LaPolla & Baars 1992). The most that can be said is that the awareness of a production system such as ACT*, is dependent on the knowledge that it uses and the goals it needs to reach. One may then say that the system is "aware" of the goal. For instance, if the goal is to add the digits 3 and 4, the system is aware that it needs to add the numbers and that it is aware of the procedures involved. However, this line of reasoning seems a bit forced. The subjective quality of awareness is denied. The same line of reasoning may be applied to other nonliving systems and objects such as a thermometer: is a thermometer aware due to its aim of giving an indication of temperature? Although it is not denied that goal setting is a fundamental part of the functioning of cognitive systems, it must be stated that subjective awareness cannot be reduced to mere goal setting. The phenomenological description of awareness and consciousness implies that there is more to both consciousness and awareness. What is true, is that consciousness does help to make goals explicit and to recruit unconscious processes to complete the goals (cf. Baars 1988:352). For instance, doing an arithmetic problem requires being aware of the particular goal consciously. The conscious goal to add two digits recruits the associated *unconscious* subgoals in order to complete the problem. The unconscious subgoals correspond to Anderson's (1983:7-9) subgoals in his production system (cf. Chapter 4 of this study). If one's conscious attention to the problem at hand is distracted, by for instance, a loud noise in the room next door, a conscious effort to reaffirm the goal of completing the problem is required.

Newell (1992a) makes a distinction between functional and nonfunctional consciousness and restricts functional consciousness to awareness, attention and other aspects that do seem to be functional in the cognitive system. However, subjective consciousness is characterised as nonfunctional, and this seems to be the mode of thinking in the computational, symbolicist and information processing approaches (Newell, Rosenbloom and Laird 1989:100-101). Within the symbolicist paradigm, at least this one important characteristic of consciousness is recognised, namely, the role of high level goals in completing procedures. It is by no means the only function of consciousness, since qualitative aspects (which refers to Newell's nonfunctional consciousness) are not addressed by the symbolicists. One of the reasons for this state of affairs is probably the static and elementistic nature of the symbolic representational memory structures: it is very difficult to incorporate qualitative experiences within a propositional structure, and it is much more difficult to personalise such networks in order to make provision for individual and subjective experience.

5.5.2.5 Connectionism

As was discussed in Chapter 4, the connectionist framework does not provide much on consciousness, except that the content of representational states corresponds to the content of consciousness. According to Rumelhart, Smolensky, McClelland and Hinton (1986:39) it is the relatively stable states of sets of networks that dominate the content of consciousness. The time-scale of consciousness also corresponds to the time-scale of sequences of stable networks, which could account for the sequential nature of the content of consciousness. However, since connectionist models describe the microstructures of cognition, it cannot be expected at this stage that they can fully account for higher level processes such as problem solving and consciousness (Rumelhart & McClelland 1986:144). Nevertheless, it was seen in Chapter 4 that connectionist models do provide a way of conceptualising emergence, since settling into a stable state represents an emergent property which is not reducible to the components of the system. The systemic emergentist model developed here is then, in part, based on connectionist principles.

In terms of representing knowledge and experiences of a more qualitative nature, a parallel distributed network is much more accommodating than a symbolicist network. This means that a particular experience, for instance, of an apple as it appears to a particular individual, need not be represented as an abstract concept as is the case with a pure semantic network. It is quite conceivable that, since representation is a function of multiple constraints, a whole range of experiences can be represented by a stable connectionist configuration.

A valuable perspective of connectionism is that it characterises cognition as a decentralised process without the need for a particular executive or self that controls cognition. This perspective stands in contrast to earlier cognitive theories, such as Neisser's (1967) who makes explicit mention of the need for a central executive controlling all the cognitive processes. The connectionist paradigm allows for multiple processes with specific functions without the need for central control. The particular interactions between this distributed system of specialised processors determine the outcome of cognition, and it is just this fact that leads to the denial of consciousness (cf. Dennet 1991). However, an underlying distributed system does not do away with the need for some kind of control at a certain stage of cognition, although the control could be very restricted. Consciousness seems to have a controlling function to a certain extent: it is able to set and maintain certain high level goals as was seen above. Sperry's view also suggests that the mind and consciousness do have downward or supervening control to some extent. It is no use denying that consciousness exists and that one does have some control over thoughts, goals and actions: denying consciousness speaks against the phenomenological experience of consciousness and of a self. The point is that consciousness and one's integrated experience of "self" can well be the result of distributed processes.

The results of the discussion in this particular paragraph (5.5.2) will be summarised below as part of the summary for the whole section.

5.5.3 Summary: the characteristics, functions of consciousness, and the relationship between consciousness and cognition

From the ***psychological level*** of analysis in terms of the various cognitive theories discussed in this study, the following characteristics of cognition and consciousness can be stipulated:

5.5.3.1 Consciousness enables holistic interpretation of information, it directs awareness to events and objects for further analysis, and it enables conscious decisions to come into effect.

5.5.3.2 Consciousness has a limited capacity. Unconscious processes have a greater capacity due to their distributed nature.

5.5.3.3 It is characterised by sequentiality of content, whereas unconscious cognitive processes function in parallel.

5.5.3.4 The sequentiality of conscious content entails that the time-frame within which consciousness operates is slow (measured in seconds upward). Unconscious processes operate fast due to their distributed nature.

5.5.3.5 The cognitive process (which includes both conscious and unconscious processes) is cyclical to a certain extent, due to its ability to change and receive information. This cyclical nature is similar to an interactionist perspective, or that of upward (emergentist) and downward (supervening) causation.

5.5.3.6 This cyclical or interactionist nature of cognition enables learning to take place.

5.5.3.7 Consciousness assists in this process of learning,

(a) due to its ability to set and maintain high level goals,

(b) and its ability to make information meaningful to the perceiver.

5.5.3.8 The ability to set and maintain high level goals also assists in other cognitive processes, such as problem solving, executing actions, and recall.

5.5.3.9 Consciousness is concerned with the subjective quality of experiences.

5.5.3.10 The content of consciousness does not necessarily arise from the most abstract and complex levels of cognitive structures, but can be formed by both lower and higher level cognitive structures.

The ***relationship*** between consciousness and cognition can be described as follows:

Cognition and consciousness cannot be equated, since many cognitive processes are nonconscious. On the other hand, consciousness and cognition cannot be wholly separated since certain cognitive processes and elements support and give rise to the content of consciousness. Consciousness seems also to influence cognitive structures and processes by setting goals, finding meaning and facilitating the formation and reconstruction of knowledge structures. Over and above the *functional* relationship between cognitive processes and consciousness, consciousness probably *arises* from particular interactions between specific cognitive processes.

A description of consciousness from the ***phenomenological level*** of analysis provides the following characteristics of consciousness:

5.5.3.11 The content of consciousness can be classified as qualitative (entailing *qualia*), and nonqualitative. Qualitative experience includes sensational, emotional, and perceptual experiences. It also includes imaginal experience. Nonqualitative experience refers to immediately expressible abstract thoughts or concepts.

5.5.3.12 The content of consciousness is the result of a contextualisation process: it is situated within personal and subjective experience acquired in the past, presently experienced and expected to be experienced in the future.

5.5.3.13 The content of consciousness is the result of a process aimed at making experience meaningful to the particular subject. A main function of consciousness seems to be to facilitate in making experiences meaningful.

5.5.3.14 Although thought is part of the content of consciousness it, as well as the other types of content, can become the object of reflection or thought. This ability emphasises the function of consciousness to find meaning within the diverse range of conscious content.

The distinction between the different types of content (of which thought forms part) and the ability of thought to be self-reflexive, provides different clues to the ***origin of consciousness***. On the one hand, the self-reflexive ability points to high level cognitive causative mechanisms, while, on the other hand, the content that includes sensations and emotions points to lower level causation.

5.6 A CONCEPTUAL FRAMEWORK FOR VIEWING COGNITION AND CONSCIOUSNESS

After the above discussion of function, structure, systems and emergence, how does the conceptual framework for relating cognition and consciousness then look? Chapter 1 of this study postulated a model which was called a *systemic emergentist model*. The specifics of this model can now be described. The various elements involved in the systemic emergentist model are described below, with a discussion of some of the implications of the model. The elements comprise the following:

(a) In paragraph **5.6.1**, the concepts of function, structure and their fusion are discussed. These aspects entail the microstructure of a system.

(b) The holistic appearance of the system as constituted by the microlevel structure is discussed in paragraph **5.6.2**.

(c) In paragraph **5.6.3**, the concept of emergence is discussed in terms of the various components of the system.

(d) Following the discussion of emergence as a principle of upward causation, the interlevel interaction between systems is discussed in paragraph **5.6.4**.

The principles involved in the formation of a system as depicted by the systemic emergentist model are then finally pointed out (paragraph **5.6.5**). These principles will be applied to the characteristics of consciousness identified above (paragraph 5.5.3).

5.6.1 Structure, function and their fusion

At this stage of the study, the details of the aspects involved in a systemic emergentist model are much more clear. This particular model involves a system, which means that the system consists of various elements forming a structure, and that it performs certain functions. The system is not static or invariant, implying that its constituent elements are also not static or invariant. In this sense, the system is dynamic and able to change over time. This does not mean that it is unstable (it could, of course, become unstable under certain conditions). This particular system is perceived as a whole (or a gestalt), and although it is possible to describe its constituent elements, it is not always possible to see how the whole is derived from its parts. By defining a particular grouping of elements as a system, it is implied that the resultant system is more than the sum of its parts: in fact, if it is possible for a set of elements to interact in a particular way, a system is created. The system itself emerges from the particular interactions taking place between its elements.

The structure of the system consists of various elements or subsystems. This structure entails a particular configuration, which may change over time. Something does not have a structure if it has elements fixed in a static configuration or if the configuration changes slowly over time. The term *structure* is used here as a way of indicating that a particular relationship between the elements exists, which can be represented spatially. It is this configuration of relationships that constitute a structure and not the system's stability. That fact that some structures are more stable than others does not imply inertia. A structuralist view of the nature of systems, namely that of *invariant* elements within a static configuration, is no longer viable. Neither is an *elementistic* or atomistic view applicable to systems: a system cannot be reduced to its elements.

The concept of a system espoused here is a dynamic one. It entails functionality, process and change. The dynamic or actualist nature of a system is distinguishable in three ways: (a) it has a particular function and therefore is able to effect changes in its environment and/or is able to be involved in surrounding processes; (b) it is a process in itself, i.e., it is not inactive; and (c) by virtue of it not being inactive, it is changeable. The fact that it has a function, that it is a process, and that is changeable is the result of the dynamic nature of the supporting or underlying structure. Thus, the dynamic appearance of the whole system *emerges* from the dynamic nature of the structure. One must then distinguish between an emergent function of the system as a whole, and the inherent functionality of the structure. In fact, function, process and changeability is reiterated within the supporting structure albeit in a different way, since emerging properties cannot be reduced to the properties of the underlying structure. The underlying structure is then not mere structure, or a mere configuration, but an active, changeable and functional structure. In this sense it is a self-actuating structure. If function and structure are seen as two sides of the same coin, then one can say that emerging functions and properties of the system as a whole are supported or caused by the underlying structure. Thus, the functionalist principle feeding various theories of cognition (e.g., the information processing approach) and consciousness (e.g., that of James) cannot be complete without giving any consideration to structure. In the same way the structuralist principle apparent in, for instance, symbolicism, cannot be divorced from function/process. However, as was seen above, giving account of structure and function within one theory (e.g., Jackendoff and even symbolicism) is still not sufficient since they tend to operate as separate principles.

That the traditional opposition between structuralist and functionalist considerations has had a detrimental effect on theories of cognition and consciousness, became clear in this study. Theories and paradigms tend to favour the one or the other, and one rarely finds a theory fusing both. Another problem is that theories of cognition usually identify issues of knowledge, information and representation with structuralist considerations. The same goes for cognitive *processing* and functionalist considerations. The fusion of function and structure can only facilitate an understanding of cognition and consciousness. Neither a structuralist nor a functionalist perspective can provide a full explanation of cognition and consciousness. The view of a system developed here involves both, not as separate parts, but as *distinguishable* expressions of a single or unitary phenomenon.[18]

What does this fusion between function and structure entail? Since it was discussed extensively above in section 5.4, only the main aspects involved will be reiterated. In contrast to the structuralist perspective, the elements of a system's structure can be viewed as active and dynamic components. One way to represent the elements as active units is to view them as processes/processors similar to the processing elements of a neural or connectionist network. Any representational activity is then embodied in the links between the processing elements. It was also stated above that this composition enables one to view the configuration, i.e., its structure, spatially. A spatial representation enables one to clearly visualise the configuration and reconfigurations. The system, then, consists of this microlevel structure, which is stable to a certain extent, but which is also able to change dynamically. The stability of the system's microlevel structure is due to its functioning as a constraint satisfaction network, similar to a connectionist system. By trying to satisfy simultaneous constraints, the strengths (or weights) between elements settle into an optimal solution. New inputs to the system will cause a reconfiguration since new constraints will be applicable. The system is thus not a free-floating ever-changing system, but settles into stable states due the constraints each element places on the other elements. The idea of the model being developed here is not to provide full detail on the computational nature of such a system, or how it can possibly work in practice, but to sketch a framework for further investigation and development. The most that can be said at this stage is that its computational nature is probably similar to that of a connectionist system, while keeping the restrictions and inadequacies of the connectionist model in mind.

5.6.2 The holistic nature of the system

The next level of the system consists, amongst others, of its appearance as a whole. The appearance or manifestation of the system is constituted by the lower microlevel structure. Characterising the holistic nature of the system as "appearance" does not imply that the system, as a whole, is not real, i.e., that it consists only of microlevel units. Its holistic manifestation defines its appearance. For instance, if the system is a particular empirical and observable phenomenon or object, then one sees the object or phenomenon as it appears as a whole. Some systems, such as cognitive systems, cannot be observed, but this does not mean that they are not real. It also does not imply that they have substance or corporeality such as empirically observable systems. Lack of substance also does not mean being not real, since phenomena such as processes or forces do not have substance but are very real. One must also remember that the particular level of analysis applicable in cognitive psychology involves inferred systems (see Chapter 1 of this study).

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[18] It can almost be compared to the wave or particle nature of light.

At the one end of the scale, one has the empirically observable biological level and at the other end, the phenomenological level. Between actual phenomenological experience (which is of course subjective experience), and the neurophysiological performance of the brain, the cognitive psychologist has to devise models, mechanisms, systems, and theories to provide a link between the upper and lower levels. Indeed, in the past, more emphasis was given to explaining the phenomenological level from the psychological level (for instance, a theory of intelligence was developed to predict and explain human behaviour and not so much the behaviour of neurons). Correlating the phenomenological level and the biological level calls for a multidisciplinary endeavour.

Be that as it may, the point is that the cognitive psychological systems need not be substantial or observable in order to be real. Even if a particular conceptual model represents the functioning of a group of neurons (i.e. it is close to the empirical observable world), then that particular model of the system of neurons may indicate certain properties abstracted to a level above the empirical level. This abstracted system could represent a particular mechanism described on the psychological level of analysis. For instance, analysis of the functioning of a group of neurons in the brain shows that it forms a system responsible for the production of English verbs (first level system). Similar systems (which now become subsystems), operate in concert to form a system on the next level. This next level system could be called the Language Production system. The postulating of a Language Production (LP) system lies on the psychological level of analysis, and it is the task of the psychologist to provide theories on how this system functions. But a further level is also possible. The various cognitive systems postulated (such as the LP system, a Visual Information Integrator system,[19] or even an iconic memory buffer, and a long-term memory, etc.), may give rise to systems close to subjective experience or the phenomenological level.

What is said above is that systems form the units/elements of higher level systems and, in so doing, appear as unitary and holistic phenomena. Systems progress through various levels, and a set of systems/units/elements forms a new system on the next level. Figure 19 shows a graphic representation of systems and subsystems.

In Figure 19, the subsystems on level 1 form the microstructure for system 1 at level 2. System 1 and other systems make up the subsystems of the microstructure of system 2 on level 3, and so on. At each level the resultant system has new properties not present in its microstructure, and with its new properties it appears as a whole or complete phenomenon.

[19] As an example of a possible system!

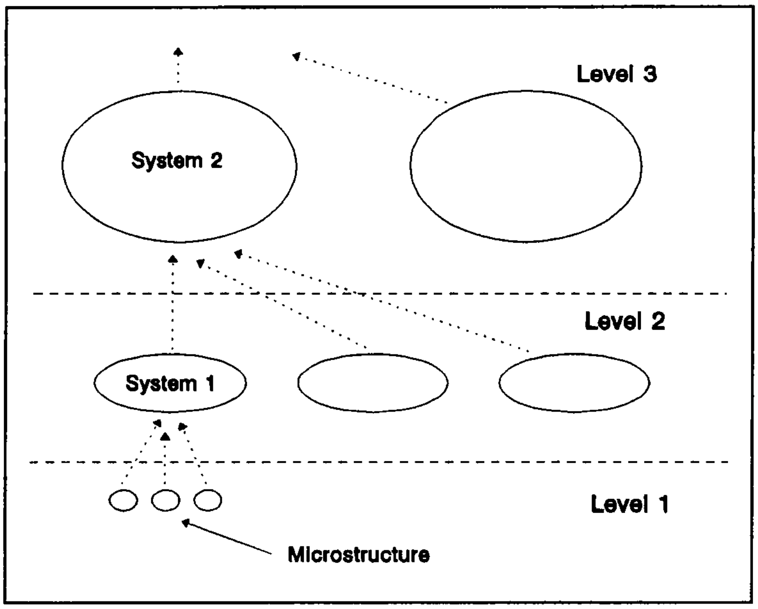

Figure 19 Hierarchical arrangement of systems and subsystems

The hierarchical arrangement as depicted in Figure 19 and the fact that units in the microstructure are active processes/processors, logically entails that a system has a function, or that it emerges as a process effecting changes in its environment. This is due to the fact that the system forms part of the microstructure of the system on a higher level, and within this particular microstructural arrangement a subsystem or unit functions as a processor. In its emergence or appearance as a whole, it is not static or invariant. It is in itself a process or an active mechanism aimed at activating other processes. Emergence must then be understood as a mechanism constituting the system as such (its appearance as a whole), and as creating its properties (i.e., its function).

5.6.3 Emergence

In Chapter 1, Gadamer's hermeneutical philosophy was used to illustrate that understanding (*Verstehen*) takes place, on the one hand, within a field of tension created by the desire to understand, and on the other hand, the (perceived) incompleteness of the object actually asking to be understood. For meaning to be found, the subject needs to be open towards the particular object, and the object needs to be "vague" enough in order for the subject to want to understand it. Stated simply, this means that the object needs to be sufficiently unstructured in order to grab the attention of the subject. It needs to attract or pull the desire of the subject to understand in its direction, and this is only possible because the subject does have that openness, desire, tendency or need to find meaning in its environment. Meaning thus emerges within this interaction between subject and object. Stated in terms of cognitive theory, understanding takes place when the cognitive agent manages to find an optimal configuration within his knowledge structures that is congruent with the informational structures that he perceives. With this statement it is not claimed that "meaning" is defined in one broad sweep as a configurational structuredness. What is claimed is that in terms of the model of a system developed here, meaningful knowledge, perceptions or experience probably become incorporated within the constraint satisfaction microstructure of the system.[20] The microstructure's *tendency* to find a stable configuration can be described as its directionality towards meaning. In other words, a tendency towards settling into a certain state depends on its inputs and the feedback it receives on the applicability of its configuration. Taking the multi-layered connectionist network as an example, it means that the network receives certain inputs, and tries to find the optimal weights between units so that its eventual output corresponds to the desired object. It receives constant feedback (as is the case with the back propagation network discussed in Chapter 4) on how far its representation of an object is from the real object.[21] In the discussion of Indurkhya's (1992) cognitive theory of metaphor, it was seen that new meaning is created within the interaction between lower and upper levels of knowledge representational structures. This "struggle" to restructure upper and lower level representations (or concept networks) may also be viewed as a constraint satisfaction process. The tension between levels of structures is caused by a lack of congruence, and by the systems' *tendency* to find congruence.

Since a system's microstructure tends to reconfigure under certain conditions, and since it was stated above that the microstructure determines the appearance of the system, it can be inferred that this tendency *is* emergence. Emergence may be explained by the nature of a system which entails its structure and its function fused in a particular manner. Thus having a microstructure functioning as a constraint satisfaction network, where the units are processes and the interactions (strength of links) function as possible representations,[22] a system with a particular appearance and function emerges. There probably is nothing magical about emergence (cf. Miller's remark in paragraph 5.2.7 above), since with this model of a system, the origin of emergence can be explained in terms of underlying processes and structures fused in a particular way. However, the question why this particular system setup causes emergence is much more difficult to answer and one must not be misled to think that the phenomenon of emergence is hereby fully understood or explained.

One implication of this model of systemic emergence is that it is not the *complexity* of the system that determines emergence contrary to the prevailing opinion in some circles (cf. Footnote 8 above).

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[20] It probably is more accurate to say that it becomes part of the microstructures distributed over many systems and even levels of abstraction.

[21] The limitations of the back propagation network must be kept in mind (see Chapter 4).

[22] The "representation" of a system may be meaningful to an outside observer or it may not, depending on the function of the system, i.e., some systems may function as knowledge representation systems and others may be used to send instructions to the muscles.

It is rather a particular setup within the structure and function of a system that produces emergence. A system's microstructure becomes complex as soon as the number of subsystems or units increase. Representing a microstructure having ten units in a three-dimensional space seems feasible, but if thousands of units (which undoubtedly is the case in the assemblages of neurons in the brain) are represented in this way, then it will seem complex. Thus, quantity certainly does not determine complexity although having an immense number of units configured in a *particular way* certainly seems complex. However, for a constraint satisfaction type network, the solution to the optimal configuration is not complex, since, as was seen in Chapter 4, one unit does not have to know what other units do. For a single processing executive to try and figure out the optimal solution on its own seems almost impossible. It is then not the complexity, or the number of units/subsystems configured in a particular manner, that determines emergence, but the particular system advocated here.

A next consequence of emergence and the accompanying multi-level arrangement of systems in an hierarchical fashion, is that certain laws and principles apply on each level that cannot be reduced to the lower level. In the discussion of Sperry's theory, this aspect also became apparent. This means that the laws governing systems on a particular level also emerge from microlevel functioning and form part of the holistic constitution of the system. What these laws and principles are, cannot be specified in advance but must be determined in observing the system performing. One can expect that the laws operating on a particular level govern the behaviour of the systems on that particular level. Thus, the properties of an emergent system, or rather a system's emergents, can be specified as its appearance (how it looks), its function (what it does), and how it performs certain functions. Of course, as soon as systems become subsystems, then the nature of the interactions between the subsystems constitute new principles of operations or laws governing their interactions. This much can be said of the subsystem interactions: they function as a distributed network bringing about their own rules of operation, one of which is constraint satisfaction.

5.6.4 Interlevel interaction between systems

The last point to be dealt with in connection with the systemic emergentist model, is that of the bi-directional interaction between levels of systems. In order for a certain configuration to become established, the units of the microstructure of a system interact. This intralevel interaction between units or subsystems causes upward processes to come into effect. Thus, a system is constituted on a level higher than the microstructure (cf. Figure 19). A system's emergence is then caused by the bottom-up direction of interlevel interaction. The configuration of systems on a particular level is dependent on each one's microstructure. The systemic emergentist model entails that a reconfiguration within the microstructure brings about a change in appearance and function of the resultant system. Thus, a change in nature of one system (which becomes a subsystem the next level up), has an effect on its role and place within the configuration of subsystems on the same level. Changes from the bottom effect structures above on the various levels.

The next question pertains to the top-down direction of interlevel interaction, which is the more difficult question to answer. The above discussion on Sperry's view of interactionism showed that he posits a downward causative process in addition to emergence or upward causation. The downward direction of causation implies that systems on higher levels can cause changes in the microstructures of systems on lower levels. Although the groundwork has been laid for explaining emergence to some extent, the opposite process at this stage is much more unclear. For instance, can a system bring about changes in its own microstructure? If this is possible, then it means that as soon as a system reconfigures its own microstructure, its appearance and its function changes. The question is then whether it is still able change itself since it is then a different system. A more plausible possibility is that a system is changed from outside itself. The origin of the change may be another system on the same level, or another system on the next level above. If it is another system on the same level the impetus for the change must, at some stage, come for a system at the level above, since the issue here is top-down processes. Another question is whether changes are made directly to a system's microstructure, or whether they are made to the system as it appears. Since a reconfiguration in microstructure determines appearance, it can be assumed that an impact on the system as it appears does have an effect on its microstructure and thus again on its appearance. A very simple example is heating a plastic object until it melts. Thus, the initial action was on the object as it appears as a whole. Eventually changes were carried through to its microstructure (its molecules), which changed its appearance.

Given the prevalence of top-down processes and bi-directional processing in cognitive theories, and the ideas of supervenience, and downward causation, it seems natural to assume that a top to bottom process of effecting change must exist. This is, however, not the place to argue for its existence, or even to explain the mechanisms underlying it as was done with emergence. The systemic emergentist model developed here does not make allowance for its explanation at this stage. However, if such a process does exist, then this is one of the first aspects this model must be able to account for. As was said above in reaction to Sperry's theory, it is necessary to come to grips with emergence first, before the reverse process can be addressed.

5.6.5 The principles of a systemic emergentist model

The systemic emergentist model is quite simple and derives from certain basic principles which can be specified as follows:

(a) The model depicts a system.

(b) The system consists of a fused structure and function (which may be called *the principle of structural and functional fusion*).

(c) The *principle of emergence* governs the system and arises from the fused structure and function.

(1) The **principle of structural and functional fusion** is actually sufficient to construct a model of the system. From this principle follows:

(a) *A specification of the nature of the micro-, lower or underlying level of the system*. The nature of the underlying or microlevel of the system entails the following

- It is a distributed structure.
- Its performance is governed by the principle of constraint satisfaction.
- It is able to settle into stable states.
- It is able to change.
- It can be represented spatially.
- The structure entails an inversion of classically understood elements (structure) and processes (function) thus, its elements are processes while its processes or interactions embody the structure (classically understood as representations).
- The structure thus has function(s), can change and involves processes (transformation of energy or information).

(b) *The possibility of a principle of emergence*. It is thus a postulation that emergence is possible with this particular microlevel structural/functional configuration.

(2) From the **principle of emergence** follows:

(a) *A specification of the emergents*. This includes

- its dynamic nature which includes
    - the function of the system
    - its nature as a process
    - its ability to change over time
- its appearance (how it looks)
- other properties specific to the system.

(b) *The constitution of the system*. This is how it appears/emerges as an holistic entity.

(3) From both **principles of structural/functional fusion and of emergence** follow:

(a) *Multi- or hierarchical levels of systems.* This is possible since emergent systems on one level form the subsystems or elements of a system on the next higher level.

(b) *Inter- and intralevel interaction.* As soon as systems on one level become the subsystems of the next emerging system, intralevel interactions start to take place. Since this intralevel interactions cause the next level system to emerge, interlevel interaction becomes a possibility.

(c) *Laws governing the behaviour of a particular level of systems.*

Thus depicted as an abstract model constructed from these basic principles, the systemic emergentist model is represented in Figure 20. The figure is self-explanatory and reflects the principles and actual configuration of a system as discussed above. In Figure 20 it can be seen that the system consists of various interacting elements (or subsystems) on the microlevel structure. These elements are not static atoms but dynamic processes. The configuration resulting from the interaction between the elements constitutes emergence which is responsible for the "visible" system as a whole. On the holistic emergent level the system has function, an appearance and is able to change by being a process in itself.

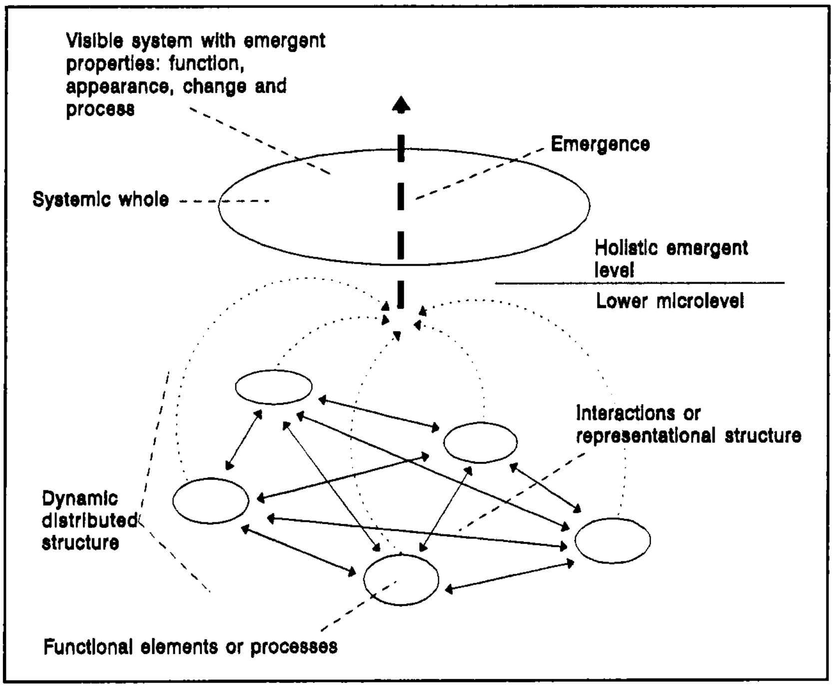

Figure 20 Schematic representation of the systemic emergentist model

The principles stipulated above and represented in Figure 20 can now be used to determine whether the characteristics of consciousness and cognition can be modelled from a systemic emergentist perspective.

5.7 EVALUATION OF THE SYSTEMIC EMERGENTIST MODEL

In the following paragraph, the characteristics of consciousness and cognition as specified in paragraph 5.5.3 above, will be used to test the model. However, throughout the study and especially in Chapter 2, it was noted that theories of cognition have difficulty dealing with subjectivity, and with the personal experience of phenomena. This personal and very subjective experience as the special way things appear to a person, was termed the experience of *qualia* above. The problem of subjective experience becomes the problem of consciousness, and despite the very difficult problem of accounting for how qualitative conscious experience is possible, a more difficult problem is explaining the origin of consciousness.

5.7.1 Cognition and consciousness within a systemic emergentist framework

As was remarked elsewhere, the reality of consciousness was in some way always at issue in various psychological theories. The discussion of the mind-body problem in Chapter 1 showed that mind or consciousness can stand in different relationships to the brain. The phenomenological experience of consciousness attests to the reality of consciousness, and it is quite difficult explaining some aspects of human behaviour without consciousness. A simple example is the ability to produce cultural artifacts, such as art, music and texts, and even scientific theories. It is quite difficult imagining unconscious automata producing these aspects. The first-person experience of consciousness also attests to the reality of consciousness despite the difficulty of observing and analysing consciousness from a third-person perspective.

If one takes the reality of consciousness for granted, then the difficulty is to make provision for a certain phenomenon (namely, subjectivity), that is not usually allowed for in empirical science. The problem is to provide for a separate ontological category, over and above the empirical level scientists are used to dealing with. As Sperry indicated, the usual concept of causality does not apply to this particular ontological category. Searle also indicated that the difficulty in accounting for subjectivity is just the fact that there *is* a separate ontological category which cannot be reduced to the lower levels that are actually responsible for its existence.

Can the systemic emergentist model account for a separate ontological category that makes provision for subjectivity, the phenomena of mind, the mental and consciousness, and that is actually caused by lower empirical or biological levels of reality? As was seen in the discussion above, the principle of emergence can be construed as a broadened concept of causality. Thus it provides for emergents, such as mental phenomena, to arise from lower level systems. The principle entails the irreducibility of emergents to lower level systems, which makes it difficult to see precisely how, for instance, neurons can cause mental phenomena. Thus, on grounds of the fact that the systemic emergentist model makes provision for multiple hierarchical levels of systems, each governed by particular laws and each having properties not reducible to lower levels, makes it possible to envisage the constitution of a new and separate ontological level encompassing mental and related phenomena. Within a systemic emergentist framework it is possible to conceive of subjectivity arising from a purely biological level. How these systems are arranged and how many levels there are before consciousness arises, is another matter requiring explanation, and which cannot be explained by the model.

In the following section various aspects of the systemic emergentist model will be evaluated against the characteristics of consciousness indicated in paragraph 5.5.3. The fourteen characteristics of consciousness as indicated from the psychological level of analysis of cognition and from the phenomenological level of description are taken up in the particular sequence indicated in paragraph 5.5.3. The characteristics addressed in the above-mentioned paragraph are italicised to facilitate reference to paragraph 5.5.3. It must be noted that the following discussion is highly speculative since the systemic emergentist model is used heuristically to indicate possible relationships between phenomena and possible functioning of mechanisms.

5.7.1.1 The *holistic interpretation of information* by consciousness is effected by the fact that consciousness is the result of the performance of subsystems. Although not so apparent with lower level systems, the principle of emergence can be construed as intentionality on the level of consciousness. The subsystems' performance is aimed at finding the best configuration between them in order to optimise the congruence between perceived information and existing knowledge. Thus, the struggle to find meaning is most prevalent on the level of consciousness. Finding meaning is reflected in the ability to find a stable state on the microlevel. Since the conscious level can actually be one of the highest levels in the hierarchical arrangement of systems, and since a system's properties are actually less than the number of microlevel subsystems (its nature is unitary or holistic in contrast to the pluralistic nature of its microlevel structure) it follows that the content of consciousness appears holistically.

The ability to *direct awareness* to detail, and the ability to enable conscious decisions, requires a feedback mechanism or at least the ability of systems to have an effect on lower level systems. For instance, if one hears a noise in the next room, interrupting one's train of thought, then consciousness can direct awareness to the analysis of the noise, and on grounds of the analysis or interpretation cause a decision to investigate. If the *decisional processes* are on a lower level than consciousness, a mechanism is needed to direct processing downwards. Although interactionism is part of the model, downward control is not made explicit. Another way of conceptualising the activation of decisional process is also possible within this model. It could be that a decisional system is on the same, or a higher level, than consciousness, so that the output of the consciousness system actually interacts with the decisional system on the same level. This means that other systems on the same level settle into a stable state due to its distributed configuration and feed into a higher level system responsible for behaviour. This way of conceptualising changes the traditional way of modelling cognition and consciousness. Consciousness then becomes an integral part of the cognitive and behaviourial process. This means that consciousness is not on the highest level of processing but stands between lower level processing such as perceiving information and higher level processes causing behaviour. If the process starts, for instance, from information impinging on the retina, and then moves through a series of steps involving constructing an image in the brain, making the image available to consciousness, decisional processes (which could be in some cases conscious and in other cases unconscious), causing motor actions to be executed (such as directing eye movements to specific detail), and finally, perceiving new information, then a loop is completed which starts the process over again. One thus has a cyclical process and not a hierarchical process terminating at the highest level. This does not mean that systemic emergentist approach does not apply. One can still have subsystems feeding into higher level systems but the highest level feeds back to the lowest level.

5.7.1.2 The *limited capacity* of consciousness can be explained by the fact that it is the result of a stable state in lower level systems. Multiple information becomes integrated on the microlevel and the stable state restricts the amount of information available to consciousness. This is also the result of the holistic nature of conscious content. Lower level subsystems have greater capacity since their information is received from different sense modalities. This is also probably the reason why hearing a dog barking can simultaneously evoke an image of a dog, whether the bark signifies danger or playfulness, or whether the bark is recognised as belonging to one's own dog, etc. It seems as if the content of consciousness is formed by lower level cognitive systems involving memory, and systems from other sense modalities. The ability to recognise information and assign meaning to the information probably is coupled with other subsystems receiving this information and settling into a state that enables a holistic image to be formed.

5.7.1.3 The *sequentiality of content* can also fit into the limited capacity characteristic of the consciousness system. One must note that the limited capacity of consciousness implies that single thoughts can be held consecutively in consciousness. This is due to the fact that single and consecutive stable states are formed. This does not imply that a single thought or image is poor in content. As was seen above, the single stable state of consciousness at a particular moment is the result of many subsystems holding much information. This is why a single thought, if explored further (such as the dog barking), seems to be very rich in content. The richness is due to the many subsystems underlying the holistic result. In principle, various meanings and different ways of representing the thought are available at the lower level although the eventual result is a particular configuration of microelements. A slight reconfiguration can change the emphasis in conscious content. The sequentiality is then due to the fact that the microlevel reconfigures. The limited capacity and sequentiality characteristic of consciousness also imply that consciousness is not very close to the low level biological systems.

5.7.1.4 What was said above also applies to the *time-frame of thought* measured in seconds rather than milliseconds. Reconfigurations of subsystems requiring milliseconds is very close to biological systems. The nature of the systems implies that the higher one moves up on the scale the slower the process of reconfiguration becomes since it involves more lower level subsystems.

5.7.1.5 As was said above, the interactionist nature of cognition is implied by the systemic emergentist model. However, downward control is not explicated by the model. It is possible to conceive of the levels of systems forming a loop or be involved in a *cyclical process* as discussed above.

5.7.1.6 If an adequate construction of the feedback process can be made, whether by means of downward control or a cyclical arrangement of systems, then the *learning process* can be accounted for. In principle, the systemic emergentist model allows for learning in terms of bottom-up inputs and enabling stable reconfigurations within the microlevel of memory systems. A problem with the model is whether one must distinguish between separate memory systems maintaining their configurations for certain memories, or single systems able to reconfigure on demand. The problem with the last option is that a single network must "remember" multiple configurations and settle into those configurations on demand. How does it store the weights for different microlevel configurations? On the neuronal level the problem is in what way memories are stored as a distributed network. The storing of a single memory fact is conceivable on a particular set of cells, even changing the configuration in terms of related new information. However, even though the number of cells in the brain is immense, running out of space can be a problem at some stage especially if new and unrelated information is learned. How does a network system cope with a great number of facts?

5.7.1.7 The question of consciousness *making information meaningful* was addressed above (5.7.1.1 and 5.7.1.2. Cf. 5.7.1.13 below). Again the ability to maintain and set goals and make information meaningful requires a feedback loop or downward control. It is also possible that the consciousness level feeds into a *goal setting system* on a higher level on par with the decisional system discussed above. Again consciousness becomes integrated into the cognitive process when viewed in this way.

5.7.1.8 *Maintaining goals* and assisting in higher level *problem solving processes*, requires that consciousness has access to other systems involved in problem solving, and that the result of these systems be available to consciousness. For instance, solving a maths problem requires consciousness to have access to a language production system. Conscious content is not the mere mirroring or reflection of content within consciousness: one is able to *reason* quite consciously. Thus, a process of reasoning or thought expressed in language (as imagined language) must become available to the consciousness system. Indeed, thought, with the ability to infer and relate, requires a very sophisticated system which cannot be fully explained by the systemic emergentist model. The problem actually arises with how a function arises from a representational microlevel structure. This is a crucial problem with the systemic emergentist model. Although it indicates how states and functions can emerge from a distributed microstructure, it is unclear how one can coach a system into action by reconfiguring the microlevel, despite the fact that the system, per definition, is functional.

If one views the system as functional, i.e., having an impact on other systems, then one can in principle construct a language production system, or a thought/reasoning system. A single thought is the result of a process of constructing the thought by means of the various subsystems. For instance, one system can be responsible for the construction of verbs, while another handles nouns and so on. The thought or sentence is then the result of a stable state reached between the various subsystems. This single thought is of course followed by another, which in some way is related to the previous thought. How does one recognise the relationship and how does the cognitive system ensure that thought follows a reasonable logical sequence especially with reasoning? One must postulate a system responsible for controlling thought sequence to some extent, or a very direct feedback mechanism. Postulating multiple sentence systems on the same level is not feasible, for the simple reason that thought units follow sequentially: one does not express a whole paragraph of sentences, which is the implication of the holistic nature of a system. How can one explain that sentences do not, most of the time, follow haphazardly? Thus, as soon as the content of a particular thought is appropriated within consciousness as meaningful, the next sentence or thought follows. It seems as if consciousness to some extent controls the sequence of meaningful thought, although it sometimes does happen that thoughts seem unrelated (the fact that a person under sedation struggles to express himself coherently, implies that consciousness does have a controlling function). Again, the problem is with the feedback mechanism to lower levels especially since a full perceptual, cognitive, and motor cycle cannot be completed when reasoning by means of internal thought.

5.7.1.9 The concern of consciousness with the *subjective quality* of experiences will be dealt with below (5.7.1.11).

5.7.1.10 The *intermediate position of consciousness* within levels of systems was dealt with above (5.7.1.1), and it seems that such a position within a systemic emergentist model is quite feasible.

5.7.1.11 The main question is whether the systemic emergentist model makes provision for the *qualitative experience of consciousness*. Can it account for qualia or the way things appear to a particular individual? The structure of the system is such that it allows for inputs from various subsystems which could include emotional, sensational and perceptual experience. It also allows for particular stored memories to become available and to interact with the other subsystems (see 5.7.1.1). In this way the holistic appearance of a particular content of consciousness incorporates the inputs of the microlevel processes: the content is rich in possible information and meaning (see 5.7.1.3). Thus, the systemic emergentist model allows for a particular individual's qualitative experience since the emotional, sensational and perceptual information is fed through from lower levels to higher level systems. It also allows for the storage of such experiences which is not the case with some representational theories such as symbolicism. How can emotional content be stored in a semantic network? The problem can be solved by a distributed microlevel network, since it is conceivable that a particular emotion or sensation can be represented as a configuration of weights between processing elements. The particular "feel" of one emotion can be represented as a set of weights and it can also be coupled with more factual content. For instance, the representation of "dog" with its meaning, feel, etc. can be represented as a particular configuration of a network structure. Thus, in principle it is possible to represent qualitative data on a connectionist network. This makes allowance for different people to have different configurations in the microstructures of their memory systems representing the "same" fact.

5.7.1.12 Consciousness as the result of *contextualisation in terms of present and past experiences*, was in part explained above. The result of various systems feeding into the consciousness system, contextualises the content in terms of memories and present experience obtained from the senses and other systems. This is another way of saying that content is rich rather than poor. However, the difficulty lies in explaining *expectancies* and *inferential capacity*. This problem was touched upon above (5.7.1.8). An expectancy can be defined as a tendency arising from having an unfulfilled goal which in turn is the result of a particular knowledge structure. For instance, the expectancy to receive a raise at work, can be based on the existing knowledge that one's work is very good, and that normally under such conditions a person does receive a raise in salary. Expecting the sun to rise tomorrow is also based on past experience and knowledge. Likewise expecting sugar in the sugar bowl is also based on existing knowledge formed by past experience with sugar bowls. The unfulfilled goal is constituted by the fact that the expectancy is yet to be confirmed. Although past experience informs one that sugar is found in the sugar bowl, the goal is to find out if it is really so, and thereby the expectancy is created.

Formulating an expectancy in this way makes it clear that knowledge structures and goals are involved. As was seen above, it is the task of consciousness to formulate and maintain certain goals (5.7.1.7). A goal setting system was postulated above. The formation of a goal can fit into the systemic emergentist approach by postulating different subsystems contributing to the eventual formation of a specific goal. Indeed, the content of consciousness can also contribute to the goal. For a goal to become part of the consciousness system, a feedback mechanism is again required. It is a much more difficult task determining the nature of all the subsystems of a goal system. However, since certain knowledge structures form the basis of expectancies, it seems reasonable to postulate memory systems feeding into the goal system, either directly, or via the consciousness system, especially if an expectancy is formulated consciously. A goal, emerging from the goal system, and deposited in the consciousness system, creates a tension between what is known, and the incompleteness of the knowledge structure on which the expectancy is based. One thus has a similar situation as with the description of intentionality and emergence (see paragraph 5.5.1.3). The creation of an expectancy can be viewed then as emerging from the struggle to find meaning within an incomplete knowledge structure. Since meaning constitution is part of the function of consciousness, intentionality can be seen as the principle of emergence as it specifically functions within the consciousness system.

The case with the ability to make inferences is probably the same as with expectancies, since an expectancy requires an inference to a possible situation based on existing information. In fact, an expectancy cannot be formulated if an inference cannot be made. The description above applies then to the ability to infer. This basic ability, whether described as inference or expectancy formation, probably underlies most reasoning and problem solving processes.

5.7.1.13 As was said above, intentionality probably is the same as the principle of emergence applied to consciousness. This particular process is aimed at making the content in consciousness *meaningful* to a particular person. The content which emerges is not merely the reflection or mirroring of whatever impulses come from lower systems, such as sensing and feeling. The content of consciousness is the result of the interaction of various subsystems. These interactions involve, according to the principles of the systemic emergentist model, a struggle to find a coherent, congruent, and stable microstructural configuration. This stable configuration within consciousness is then the emergence of meaningful content.

5.7.1.14 The most difficult part to explain is the ability of consciousness to be host to *reflection*. Thought as content of consciousness can, and often does, become the object of thought itself. Does this require more than one consciousness system, in order for one system to observe the content of the other and be able to reason about it? Or is this ability to experience myself as thinking only the result of the looping process developed for other purposes, such as was postulated above for the goal system (5.7.1.12), the decisional system (5.7.1.1) or a system responsible for the coherency between successive sentences (5.7.1.8)? It must be noted that if the content of consciousness feeds into higher level systems, then it is possible that a feedback mechanism can reflect some content back to consciousness. It could be that with a language production system, which requires the feedback from the higher levels to maintain the integrity of the stream of language produced, a system or capability developed to enable reflection to take place. One must actually determine the function of reflection and self-reflection to determine its place within consciousness and whether it warrants a separate system. What can be said at this stage is that it probably performs an integral part in maintaining the main functions of consciousness such as determining meaning, especially where information or content does not make sense.

5.7.2 Positive and negative indicators of the performance of the systemic emergentist model

In terms of what the model can and cannot do in modelling the process of cognition and consciousness, positive and negative aspects can be indicated based on the discussion above (paragraph 5.7.1).

The following **positive aspects** can be pointed out for the model.

5.7.2.1 The model is able to indicate new and integrated relationships between consciousness (as a system), and other cognitive processes also conceptualised as systems. Thus, consciousness seems to have an intermediate position within the hierarchical levelling structure of cognition. Consciousness does not necessarily arise from only the highest level of performance. It depends on a particular configuration of subsystems. Viewed in this way, consciousness does have an integral part to play within the process of cognition, and supports and facilitates the functioning of other systems. This integration of consciousness within the process of cognition is reflected on a larger scale by cognition's integration within the whole sensori-motor functioning of a human being. Both cognition and consciousness as systems and as subsystems, involve the full cycle of human performance and behaviour, since sensory, emotional, and perceptual systems, from the biological level to higher level reasoning processes, seem to have an impact on cognition and consciousness.

5.7.2.2 The model is able to explain, to some extent, the emergence of consciousness, and thus of a seemingly separate ontological level. It shows that it is possible, with a certain configuration of subsystems, for consciousness to emerge and to form a separate system.

5.7.2.3 The model indicates that consciousness has a very specific functional role within the process of cognition. It is not a mere canvas against which data is made available to awareness. It is functional. The model indicates that consciousness could have more than one function.

5.7.2.4 An interesting point is that the model allows for intentionality to be viewed as the specific expression of the principle of emergence within the consciousness system. This view has far-reaching implications. Traditional science excluded the ontological level of the mental from its investigations, for the reason that it cannot be observed and experimentally manipulated. This state of affairs was most prevalent in behaviourism and other related fields of study. The traditional separation between the human and natural sciences seems to reflect this sentiment, but goes much further by saying that the study of the human and social differs so radically from the subject matter of the natural sciences that it calls for a different methodology. By showing that the mental ontological level emerges from the biological, and that the principle of intentionality - that was seen as the hallmark of consciousness - is actually the same as the principle (or law) of emergence applicable to all systems, it can be assumed that the distinction between natural and human/social sciences is illegitimate. The same laws and principles must then hold in different domains. The *scientific* study (or empirical scientific study) of the mental is then in principle possible, and one need not assume that different laws apply and, therefore, that different methods are required. This view entails a radical naturalisation of human and related sciences *and* of psychology.

5.7.2.5 The systemic emergentist model proposes different relationships between various cognitive systems, especially if consciousness is viewed as an integral part of cognition. Thus, systems such as a decisional system, a goal system, and an inferential system have relationships and interactions with the consciousness systems. New relationships can be suggested within this model. The hierarchical level view suggests that certain systems are on a lower, same, or higher level than consciousness. This also opens the possibility of viewing cognitive systems within new relationships to each other not thought of before.

The suggestions made above (5.7.1) differ clearly from a sequential information processing view.

5.7.2.6 The systemic emergentist model also suggests that some systems utilise the same upper or lower level systems. For instance, the output of a goal setting system can be utilised by other systems such as a language production system, consciousness and a reasoning system.[23]

5.7.2.7 In some cases, the model can suggest new and slightly different roles for systems functioning in current theories of cognition. For instance, within this model, the memory system incorporates both procedures and declarative structures as opposed to symbolicist production systems. Also, where single, or even two, memory structures are used in other theories, the systemic emergentist model suggests multiple memory systems specific to different modalities and other systems.

5.7.2.8 The systemic model can also recommend the existence of new systems especially in cases where currently known systems or mechanisms do not require such a system due to the way the relationship between cognitive processes are currently viewed.

5.7.2.9 The model can also do away with mechanisms and processes currently thought to exist. For instance, it could turn out that memory does not consist of a declarative and procedural part.

The **weaknesses** of the systemic emergentist model can also be pointed out on grounds of the applications above (paragraph 5.7.1).

5.7.2.10 The model indicates the need for a feedback mechanism. However the exact nature of this feedback mechanism cannot be explicated by the model. It is assumed to be interactionist, i.e., it incorporates both upward and downward influences between higher and lower levels. Despite this interactionist assumption, it is a model explaining upward causation and not downward causation or direction of movement. The groundwork has been laid for saying that a particular substructure and configuration causes upward movement of forces and effects. The arrangement of systems for a downward direction of effect has not been explicated. The aim of this study has been modest in the sense of trying to arrive at a point were theorising about upward causation can *start*. However, this very same emergentist model indicates the need for postulating downward control. The systemic perspective implies that systems are arranged from lower to higher levels. By

[23] In terms of the model, these systems are also speculative at this stage. Some systems do resemble the processes and mechanisms of other cognitive theories (such as a memory system).

applying the model to consciousness and cognition it becomes necessary to start indicating the relationship between various systems more precisely. One can, with the help of the model, start indicating the precise places where feedback or downward control is necessary.

5.7.2.11 It must be noted that although a downward control mechanism seems required, other possibilities within the systemic emergentist principles are opened up to be explored. The hierarchical structure (arrangement) of the systems can be modelled as cyclical thus alleviating the need for downward control directly through the higher to the lower levels. Control stays upward although the arrangement of systems allows for the recurrance of processes. In this way consciousness can change its own input without requiring downward control, and the ability to change can be explained within an emergentist model. The point is that it must loop back *outside* the other systems. The shortcomings of the model can then be used to explore other possibilities.

5.7.2.12 A problem with the systemic emergentist model is its indication of how the function of a system arises. It is true that function, process and appearance have been defined as emergents, but still the movement from representation to activity is unclear. The groundwork has been laid to explain this movement from the microstructure to the level of the system. A function cannot arise from pure representational states. Since the inverted function/structure or fused function/structure incorporates activity on the microlevel, it is much easier to imagine the emergent system to have a function or involve activity. However, it was said that emergents cannot be reduced to the system's constituents. Thus, in a sense, one does not really need to explain the emergence of function. The real problem comes in when one wants to move from content to reasoning or other similar mental activities. The problem was also reflected in the connectionist paradigm: connectionist networks function as purely representational states and in order to cause higher level reasoning processes, hybrid systems are required for reasoning and other rules. How, for instance, can an IF-THEN rule be caused to arise from the microstructure?

5.7.3 The heuristic performance of the model: indicating further research and investigation

Can the systemic emergentist model indicate directions for further research and assist in the formulation of hypotheses? The following aspects can be stipulated and follow from the discussion above. These aspects give an indication of the model's *heuristic* performance.

5.7.3.1 The model provides the framework for analysing the cognitive process in terms of

- what systems are involved
- the relationship between the systems on the inter- and intralevels
- identifying specific inputs and outputs of each system.

Using existing knowledge of cognition and the pointers indicated for the consciousness system, a theory on the structure of cognition can be developed.

5.7.3.2 Within this theory specific functions for the various systems can be stipulated. The function of the consciousness system will be clarified when it is fully integrated in the structure of cognition.

5.7.3.3 In developing a systemic emergentist theory of cognition, new systems can be identified and others thought to exist can be modified or negated, depending on the relationship between systems. The systemic emergentist model opens this possibility due to it providing a new perspective on the phenomena and mechanisms of cognition and consciousness.

5.7.3.4 Since the model indicates the need for a feedback mechanism, namely downward control or a cyclical arrangement of systems, further investigation can focus on

- working out the details of such a mechanism on the conceptual level to fit in with the systemic emergentist approach. Thus, the nature of this mechanism must be determined.
- delineating the structure or architecture of the systems to provide a cyclical arrangement.

Both the requirements for direct downward control or cyclical arrangement of systems are additional constraints placed on the development of a theory. These constraints were not identified blindly, but arose from the systemic emergentist model.

5.7.3.5 The question of how function can follow from representation must be addressed more fully by a systemic emergentist theory. This is necessary since a theory could eventually entail description of the systems on a mathematical or algorithmic level. This means that, in principle, it could be possible to describe systems and functioning mathematically and simulate systems computationaly. Despite this goal, a clear understanding of how function arises from representational states is necessary to understand how functional systems arise from the biological level.

5.7.3.6 The systemic approach calls for the integration of various levels of analysis. Thus it could stimulate a multidisciplinary effort in understanding cognition and consciousness. By providing a theory from a particular perspective, investigations from diverse fields such as neurophysiology and computer science are needed for a fully integrated understanding of the process of cognition and consciousness. For instance, a clear understanding of the neuronal and biological level will provide a further testing of the systemic emergentist approach in terms of whether psychological systems originate from the biological level in the way the systemic emergentist approach envisages it.

5.7.3.7 The systemic emergentist approach also allows for the integration of other human systems such as affective, sensation and motor systems. This result is mainly due to involving consciousness as a system within the process of cognition. This particular requirement implies a further deepening of the systemic emergentist theory in terms of its explanatory power.

5.7.3.8 The eventual theory construction on grounds of the conceptual model implies investigation in three areas.

(a) **Philosophical**: the ontological implications of the systemic emergentist model has an impact on the mind-body problem. If further investigation shows that the same principles apply to empirical and mental systems, then new light can be shed on the relationship between the mind and the body. The constitution of a new ontological dimension also has implications for scientific investigation in general: the mental level cannot then be ignored in explanations involving causality. Furthermore, it could also have methodological implications. It could turn out that scientific methods applied in one field can be applied to the mental field or that empirical methods must be modified to study systems on a scientific basis.

(b) **Theoretical**: theoretical investigations include theory building as was indicated above but also closer cooperation with other scientific fields of endeavour. The testing of the model and of the theory must involve an analysis to determine whether data fit the systemic emergentist theory better than competing theories. This means testing the explanatory power of the theory and it involves phenomena such as consciousness, not readily explained by other theories. On a speculative level, the systemic emergentist model seems to account for consciousness within cognition in a rudimentary way.

(c) **Empirical**: the eventual theory and even the model can lead to empirical investigations in order to test predictions and explanations by the theory. For instance, the model seems to agree with the time-frame of cognition. An empirical test could involve determining the time-scale of various levels of known "systems" and to see whether this agrees with the time-scale suggested by the model and the theory. Another possibility is to try and match what is known of biological systems with the conceptual model. The actual functioning of biological systems could indicate gaps within the conceptual model or the other way around. For instance, if a direct downward control mechanism can be devised theoretically, then one can search for a similar mechanism on the biological level.

5.7.4 The performance of the model as a conceptual framework

The last question is whether the systemic emergentist model satisfies the characteristics of a conceptual model stipulated above in paragraph 5.1.2. The characteristics are reiterated below with an indication of whether the systemic emergentist model satisfies these requirements.

5.7.4.1 *Models identify central problems and questions concerning the certain phenomena*

The systemic emergentist model indeed provides questions and directions for further inquiry. It is able to facilitate philosophical, theoretical and empirical investigations. It is even able to identify gaps within its own structure (such as downward control) that require further investigation.

5.7.4.2 *Models limit, isolate, simplify and systemise the domain under consideration*

The model also posits certain assumptions concerning *the structural, causative or functional nature* of the domain of phenomena it is modelling. The model provides indications of the relationships between other systems, it gives an indication of the causative mechanisms in terms of an explication of the principle of emergence, and it provides the structural or architectural nature of a system. It also provides specific functions for consciousness and integrates consciousness within other cognitive systems.

5.7.4.3 *Models provide a particular universe of discourse within which one can talk about the phenomena*

It is clear from the discussion of the model that since it provides a framework for viewing cognition and consciousness, that it makes it possible to talk about consciousness and cognition from a particular perspective. It also introduces terms, such as emergence and even intentionality used in a slightly different sense. Even the way one conceptualises memory structures is changed by the model, with the realisation that traditional static structures become active and dynamic.

5.7.4.4 *Models provide explanation sketches and the means by which predictions can be made*

This particular model provides rudimentary explanations especially in terms of the relationship between cognition and consciousness. Since consciousness functions as a system, it becomes functional in its interaction with other cognitive systems. The clear systematisation of the structural, functional and causative components of a system allows rudimentary predictions and explanations of phenomena.

In conclusion it may be stated that the systemic emergentist model does satisfy the criteria for a model. The model cannot be viewed as a theory, since its application to the characteristics of cognition and consciousness is speculative and rudimentary, and since certain gaps have been identified. However, it fulfils its heuristic function by allowing and encouraging further investigation and development as was indicated above (5.7.3).

5.8 CONCLUSION

5.8.1 This study started off with the postulation that a model incorporating a systemic perspective and making allowance for emergence can provide a new perspective on the relationship between cognition and consciousness. It was assumed that this model can provide a different perspective for viewing cognition as a process and of consciousness as a phenomenon greatly neglected within traditional thought on cognition. Glimmerings of the direction within which the study must move was provided by illustrative examples, namely the hermeneutical theory of Gadamer, the interactionist theory of cognition of Indurkhya and Gestalt theory. From a short overview of the mind-body problem, a materialist emergentist perspective was chosen as philosophical starting point. It was also realised that a distinction between different levels of analysis must be made, and the fruitfulness of such an approach was seen in this last chapter.

5.8.2 In the second chapter, consciousness was discussed in terms of the history of its study and in terms of the main approaches towards its study. It became apparent that during the history of psychological research, consciousness was not taken seriously as a phenomenon to be dealt with. Some theories of cognition still cannot account for consciousness. One of the important reasons was that consciousness and mentalistic phenomena seem to occupy a sphere lying outside serious scientific investigation. The reductionistic nature of science also makes it difficult to account for mentalistic phenomena, since it does not allow for phenomena arising from lower levels of reality that are not reducible to these lower levels.

5.8.3 It was also seen that consciousness was studied from structural and functionalist perspectives. In Chapter 2 it became apparent that this separation of structure and function probably lies at the root of theories', especially cognitive theories', difficulty in accounting for consciousness.

5.8.4 The principles of structure and function were thus used in the subsequent analysis of cognitive theories to determine in what way these principles are reflected in the various cognitive theories. The theories that were analysed were the information processing approach represented by Neisser's initial constructivist approach. Then two theories representing a move beyond the information processing approach were discussed. They were Neisser's later cyclical theory of cognition, and Jackendoff's structuralist theory of cognition and consciousness. Two main paradigms in cognitive science were thereafter discussed, namely, symbolicism and connectionism.

5.8.5 The result of the analysis of cognitive theories showed that structural considerations are most apparent in representational issues, which involve memory structures, while the functionalist perspective is embodied in mechanisms involving processes of cognition. These principles and their relationship are represented differently in the various theories.

5.8.6 In the analysis of the theories of cognition, aspects were looked at which indicated that structure and function can somehow be fused, in order to arrive at a dynamic and functional structure. Two theories had aspects which fit this requirement. Neisser's cyclical theory of cognition espoused a view of knowledge structures or schemata that included both structural and functional aspects. Indeed, it was seen that Neisser's schemata are active structures making action possible as well as incorporating experiential knowledge. Connectionism provides another way of viewing active structures. The elements of a structure become processing elements rather than static symbolic atoms. The representational work is done by the strength of interactions between processing elements. Thus, the parallel distributed network functioning as a constraint satisfaction system was taken as a model for the microstructure of a system.

5.8.7 The principle of structural and functional fusion was developed further on grounds of information provided by General Systems Theory and Sperry's view of emergent interactionism. The principle of structural and functional fusion makes the constitution of a system possible by allowing emergence to take place. Emergence functions as a causative principle and may also be termed upward causation.

5.8.8 The functioning of an emergentist system allows for the constitution of emergent properties and functions not reducible to its constituent elements. In this way the systemic emergentist model can explain how a new ontological level can come into being and at the same time be irreducible to a lower level.

5.8.9 The systemic emergentist model incorporates an inverted structure/function or a fused structure and function. This means that what is usually understood under structure becomes dynamic and active. Processes take the place of the usual elements of a structure and the structure is now represented by the strength of interactions between the process. This dynamic structure can be represented spatially.

5.8.10 The underlying dynamic structure of a system causes the system to arise or emerge. This emergence is responsible for the system's holistic appearance, which includes its properties, its functions and how it looks. The fact that a system is functional arises from the microlevel's dynamic structure and the fact that it incorporates processes.

5.8.11 The model was tested against the characteristics of cognition and consciousness, and it seems that it is able to indicate relationships between systems and subsystems. It is also able to locate consciousness as a system within the process of cognition, and it strengthens the function of consciousness as a system integrating and providing coherent meaning of inputs and content. The model is able to account for the qualitative nature of conscious content to some extent. An implication of the model for memory structures is that the qualitative nature of experiences can be stored in distributed constraint satisfaction microlevel networks. This is possible due to the microlevel's fused structure and function.

5.8.12 Consciousness, according to the model, originates or emerges from a particular configuration of cognitive subsystems and possibly other related subsystems (such as systems providing sensational, perceptual and affective content). The model indicates that consciousness does not emerge from the highest levels of cognitive functioning. Systems on higher levels actually use outputs from the consciousness system and reflect some aspects back to the consciousness system.

5.8.13 The model also indicates the need for feedback to lower levels of systems in terms of either direct downward control or a cyclical loop to lower levels. Although the particular mechanisms are not explicated by the model, the requirement for feedback opens new avenues for research and investigation.

5.8.14 The model also has a problem indicating the movement from representation as embodied in its microstructure, to effectuating processes, although it is implied by the principles of an emergentist system. The same problem exists with connectionist networks as indicated in Chapter 4 of this study. This inadequacy also encourages further research.

5.8.15 The model makes theory building a possibility since the next step is to indicate the systems involved in cognition and consciousness on grounds of existing knowledge and using the principles of the systemic emergentist model.

5.8.16 The model has implications on other levels, such as the philosophical level. If the principles of the model are corroborated by a comparison with other theories in terms of explanatory power, and if it fits empirical evidence well, then it has implications for the mind-body problem. It can thus clarify the nature of emergence and reduction. It also has an implication for causal principles. It was determined above that intentionality within the consciousness system functions in the same way as the causative principle of emergence. This means that the same principles and laws apply to systems on various levels. This justifies the inclusion of the study of mentalistic phenomena within serious science.

5.8.17 The systemic emergentist model was evaluated against the requirements for a conceptual model, and it was determined that it fulfils a fundamental heuristic function by indicating directions for further investigation and theory building. It was also able to indicate functional, structural and causative mechanisms and systemise relationships between phenomena in the domain of study. It also indicated gaps and inadequacies within itself, which also indicated new avenues for further exploration.

In sum, the aim of this study is fulfilled. A conceptual model was developed in this study providing a specific conceptual framework within which the relationship between cognition and consciousness can be determined. In the end, the origin of consciousness within other cognitive processes was indicated and its integrated relationship within the process cognition was stipulated, albeit in a speculative and rudimentary way, in accordance with the requirements of a conceptual model. It seems that consciousness is functional in terms of providing meaning to the cognitive agent, and it assists in various processes of cognition (such as decision making, reasoning, making inferences, and setting and maintaining goals). In the end, it provides one with rich and meaningful experiences in order to facilitate interaction with one's environment.

OPSOMMING

Cognition and consciousness: developing a conceptual framework.

deur

David Jacobus Francois Maree

Promotor: Prof. W.J. Schoeman
Departement: Sielkunde
Graad: D.Phil.

Tot op hede was die rol van bewussyn in die proses van kognisie onduidelik. Aan die een kant word bewussyn fenomenologies as werklik ervaar, maar aan die ander kant is dit vir kognitiewe teorieë moeilik om vir bewussyn verantwoording te doen. Bewussyn en verwante verstandelike verskynsels is in die verlede tot 'n groot mate afgeskeep. Dit is egter slegs onlangs dat kognitiewe teoretici hul besorgdheid oor die verwaarlosing van bewussyn in kognitiewe studies en sielkunde uitgespreek het.

Hierdie studie neem aan dat ontoereikende teoretiese perspektiewe verantwoordelik is vir die onvermoë om rekenskap te gee van bewussyn in kognisie. Die doel van hierdie studie was om 'n konseptuele raamwerk te ontwikkel waarbinne die verwantskap tussen kognisie en bewussyn beskou kan word en waarmee nuwe rigtings vir teoriekonstruksie en empiriese ondersoek aangedui kan word. 'n Spesifieke strategie is gevolg om hierdie doel te bereik. Hierdie studie vertrek van die aanname dat kognisie en bewussyn vanuit 'n *sistemiese verskynings- (emergentist) perspektief* beskou moet word. Vanuit hierdie perspektief kom sekere sistemiese verskyningsbeginsels na vore wat verskyning, struktuur, funksie, die samesmelting van struktuur en funksie, die konstituering van sistemiese gehele, en interaksie insluit. Twee beginsels of perspektiewe, naamlik struktuur en funksie, is op 'n heuristiese wyse gebruik om benaderings tot bewussyn te bespreek. Hierdie twee perspektiewe behoort in die begrip en definiëring van bewussyn ingesluit te word.

Dieselfde strategie is gevolg met die ontleding van vier hoofstroombenaderings tot kognisie, naamlik die informasieverwerkingsbenadering, die beweging verby informasieverwerking, simbolisisme, en konneksionisme. Dit is gehipotetiseer dat 'n spesifieke benadering se vermoë om verantwoording te doen vir die sistemiese verskyningsbeginsels, die vermoë om bewussyn in die proses van kognisie in te sluit, bepaal. Die aard van struktuur, funksie en verskyning is verhelder deur 'n bespreking van Algemene Sisteemteorie en Verskynings-Interaksionisme. Die verskillende benaderings tot kognisie het op verskillende wyses tot die begrip van die sistemiese verskyningsbeginsels bygedra. 'n Konseptuele model, naamlik die sistemiese verskyningsmodel, is

ontwikkel wat gebaseer is op die beginsel van 'n verenigde struktuur en funksie. Dit beteken dat 'n sisteem 'n mikrostruktuur het wat uit aktiewe en funksionele elemente bestaan. Die beginsel van 'n verenigde struktuur en funksie oorbrug die tradisionele skeiding tussen struktuur en funksie/proses. Die samesmelting het verskyning tot gevolg. Weens die konfigurasie van elemente (prosesse), verskyn 'n sisteem as geheel met sy eienskappe. Sisteme vorm subsisteme op hiërargiese wyse wat wisselwerking tussen vlakke van sisteme bewerkstellig. Verskynings kan nie tot die elemente van 'n sisteem gereduseer word nie.

Die model is geëvalueer met die kenmerke van kognisie en bewussyn wat op 'n sielkundige en fenomenologiese vlak van ontleding bepaal is. Dit het aangetoon dat bewussyn funksioneel is en integraal is tot kognisie. Dit is bevind dat die sistemiese verskynsingsmodel die meeste van die vereistes van 'n konseptuele model as 'n rudimentêre verklarings- en heuristiese meganisme kon bevredig. Die model was ook in staat om verdere rigtings vir navorsing aan te dui, asook om sekere gebreke in die model self aan te dui.

SUMMARY

Cognition and consciousness: developing a conceptual framework

by

David Jacobus Francois Maree

Promoter: Prof. W.J. Schoeman
Department: Psychology
Degree: D.Phil.

The role of consciousness within the process of cognition has been very unclear to date. On the one hand, the phenomenological experience of consciousness is very real but on the other hand, theories of cognition seem to struggle to account for consciousness. Consciousness and related mentalistic phenomena have been neglected to a great extent in the past. It is only recently that cognitive theorists voiced their concern about the neglect of consciousness within cognitive studies and psychology.

This study assumed that the difficulty to account for consciousness within cognition is due to the inadequacy of theoretical perspectives. The aim of this study was then to develop a conceptual framework within which the relationship between cognition and consciousness can be viewed, which can also open avenues for theory construction and empirical investigation. To obtain this goal, a particular strategy was followed. The assumption from which the argument in this study originated was that cognition and consciousness must be viewed from a *systemic emergentist perspective*. From this assumption certain systemic emergentist principles followed which include emergence, structure, function, the fusion between structure and function, the constitution of systemic wholes, and interaction. Two principles, or perspectives, namely structure and function, were used in an heuristic fashion to discuss approaches to consciousness. These two perspectives need to be incorporated in an understanding and definition of consciousness.

The same strategy was followed with the analysis of four mainstream approaches to cognition, namely the information processing approach, the move beyond information processing, symbolicism and connectionism. It was hypothesised that the ability to account for the systemic emergentist principles within a particular approach determines its ability to incorporate consciousness within the process of cognition. The nature of structure, function and emergence was clarified from the perspective of General Systems Theory and Emergent Interactionism. The various approaches to cognition contributed in different ways to the understanding of the systemic emergentist principles. A conceptual model, namely the systemic emergentist model, was developed, based on a principle of a fused function and structure. This means that a system has a microstructure consisting of

active and functional elements. The concept of a fused function and structure overcomes the traditional separation of structure and function/process. This fusion enables emergence to take place. Due to the configuration of elements (processes) a system as a whole and its properties emerge. Systems form subsystems in a hierarchical fashion which allows for interaction between levels of systems. Emergents cannot be reduced to the elements of a system.

The model was evaluated against the characteristics of cognition and consciousness determined on the psychological and phenomenological levels of analysis. This showed that consciousness is functional and an integral part of the process of cognition. In terms of the requirements for a conceptual model as a rudimentary explanatory and heuristic device, it was found that the systemic emergentist model was able to satisfy these requirements to a large extent. The model was also able to indicate further avenues for research and point out certain deficiencies in itself.

REFERENCES

Abe, J. & Hoshino, E. 1990. Schema driven properties in melody cognition: experiments on final tone extrapolation by music experts. *Psychomusicology,* **9**, 161-172.

Adams, F., Aizawa, K. & Fuller, G. 1992. Rules in programming languages and networks. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.49-67).

Aderman, D. & Smith, E.E. 1971. Expectancy as a determinant of functional units in perceptual recognition. *Cognitive Psychology,* **2**, 117-129.

Aizawa, K. 1992. Biology and sufficiency in connectionist theory. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.69-88).

Aleksander, I. & Morton, H. 1990. *An introduction to neural computing.* London: Chapman and Hall.

Allen, P.A. & Madden, D.J. 1990. Evidence for a parallel input serial analysis model of word processing. *Journal of Experimental Psychology: Human Perception and Performance,* **16**, 48-64.

Allen, P.A. & Emerson, P.L. 1991. Holism revisted: evidence for parallel independent word-level and letter-level processors during word recognition. *Journal of Experimental Psychology: Human Perception and Performance,* **17**, 489-511.

Allport, D.A. 1980. Patterns and actions: cognitive mechanisms are content-specific. In G. Claxton (Ed.). *Cognitive psychology: new directions.* London: Routledge & Kegan Paul. (pp.26-64).

Andersen, P.A. 1986. Consciousness, cognition, and communication. *Western Journal of Speech Communication,* **50**(1), 87-101.

Anderson, J.R. 1976. *Language, memory, and thought.* Hillsdale, NJ.: Erlbaum.

Anderson, J.R. 1980. *Cognitive psychology and its implications.* San Francisco: Freeman.

Anderson, J.R. 1983. *The architecture of cognition.* Cambridge, MA.: Harvard University Press.

Anderson, J.R. 1990. *The adaptive character of thought.* Hillsdale, NJ.: Lawrence Erlbaum.

Anderson, J.R. & Bower, G.H. 1973. *Human associative memory.* Washington, D.C.: Winston.

Anderson, R.C. & Pichert, J.W. 1978. Recall of previously unrecallable information following a shift in perspective. *Journal of Verbal Learning and Verbal Behavior,* **17**, 1-12.

Andrews, S. 1989. Frequency and neighborhood effects on lexical access: activation or search? *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **15**, 802-814.

Antes, J.R., McBride, R.B. & Collins, J.D. 1988. The effect of a new city traffic route on the cognitive maps of its residents. *Environment and Behavior,* **20**, 75-91.

Arcuri, L. & Forzi, M. 1988. Prior expectations and manner of data presentation as factors influencing covariation estimates for incomplete contingency tables. *Acta Psychologica,* **67**, 121-133.

Ashby, W.R. 1961. *An introduction to cybernetics.* London: Chapman.

Axelrod, R. 1973. Schema theory: an information processing model of perception and cognition. *The American Political Science Review,* **67**, 1249-1266.

Baars, B.J. 1988. *A cognitive theory of consciousness.* New York: Cambridge University Press.

Bāckman, L. 1991. Recognition memory accros the adult life span: the role of prior knowledge. *Memory & Cognition,* **19**, 63-71.

Baird, J.C. 1984. Information theory and information processing. *Information Processing & Management,* **20**, 373-381.

Banks, W.P. & White, H. 1985. Semantic congruity and expectancy as seperate processes. *Memory & Cognition,* **13**, 485-493.

Bartlett, F.C. 1932. *Remembering.* Cambridge: Cambridge University Press.

Bartlett, F.C. 1958. *Thinking.* New York: Basic Books.

Baruss, I. 1987. Metanalysis of definitions of consciousness. *Imagination, Cognition, and Personality*, **6**, 321-329.

Battista, J.R. 1978. The science of consciousness. In K.S. Pope & J.L. Singer (Eds.). *The stream of consciousness: scientific investigations into the flow of human experience.* New York: Plenum. (pp.55-90).

Beale, R. & Jackson, T. 1990. *Neural computing: an introduction*. Bristol: Adam Hilger.

Bechtel, W. 1988. *Philosophy of mind: an overview for cognitive science.* Hillsdale, NJ.: Lawrence Erlbaum.

Bechtel, W. 1990. Multiple levels of inquiry in cognitive science. *Psychological Research,* **52**, 271-281.

Biederman, I. & Ju, G. 1988. Surface versus edge-based determinants of visual recognition. *Cognitive Psychology,* **20**, 38-64.

Biederman, I., Teitelbaum, R.C. & Mezzanotte, R.J. 1983. Scene perception: a failure to find benefit from prior expectancy or familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **9**, 411-429.

Black, M. 1962. *Models and metaphors*. Itacha, NY.: Cornell University Press.

Black, M. 1979. More about metaphor. In A. Ortony (Ed.). *Metaphor and Thought*. Cambridge: Cambridge University Press.

(pp.19-45).

Blank, D.S., Meeden, L.A. & Marshall, J.B. 1992. Exploring the symbolic/subsymbolic continuum: a case study of RAAM. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.113-148).

Block, N. 1991. Open peer commentary: evidence against epiphenominalism. *Behavioral and Brain Sciences,* **14**, 670-672.

Boekaerts, M. 1987. Individual differences in the appraisal of learning tasks: an integrative view on emotion and cognition. *Communication and Cognition,* **20**, 207-223.

Bonanno, G.A. 1989. Sampling conscious thought: influences of repression-sensitization and reporting conditions. *Imagination, Cognition and Personality,* **8**, 295-308.

Boring, E.G. 1933. *The physical dimensions of consciousness.* New York: Appleton-Century-Crofts.

Boring, E.G. 1937. A psychological function is the relation of successive differentiations of events in the organism. *Psychological Review,* **44**, 445-461.

Boring, E.G. 1950. *A history of experimental psychology.* (2nd ed.). New York: Appleton-Century-Crofts.

Bowers, K.S. 1986. *The unconscious reconsidered.* Paper presented at the Western Canada Clinical Psychology Conference. University of Saskatchewan, Saskatchewan, Canada.

Bowers, K.S. 1991. Open peer commentary: (Un)conscious influences in everyday life and cognitive research. *Behavioral and Brain Sciences,* **14**, 672-673.

Bradley, M.M., Cuthbert, B.N. & Lang, P.J. 1988. Perceptually driven movements as contextual retrieval cues. *Bulletin of the Psychonomic Society,* **26**, 541-543.

Braunstein, M.L., Hoffman, D.D. & Saidpour, A. 1989. Parts of visual objects: an experimental test of the minima rule. *Perception,* **18**, 817-826.

Brentano, F. 1924. *Psychologie vom empirischen Standpunkt.* Band I. Leipzig: Felix Meiner.

Bruner, J.S. 1957. On perceptual readiness. *Psychological Review,* **64**, 123-152.

Bunge, M. 1980. *The mind-body problem.* Oxford and Elmsford, NY.: Pergamon.

Bunge, M. & Ardila, R. 1987. *Philosophy of psychology.* New York: Springer-Verlag.

Cannon, W.B. 1939. *Wisdom of the body.* New York: Norton.

Carlson, R.A. 1991. Open peer commentary: consciousness and content of learning: missing or misconceived? *Behavioral and Brain Sciences,* **14**, 673-674.

Carr, T.H. & Bacharach, V.R. 1976. Perceptual tuning and conscious attention: systems of input regulation in visual information processing. *Cognition,* **4**, 281-302.

Chalmers, D.J. 1992. Subsymbolic computation and the Chinese room. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.25-48).

Chapman, M. 1988. *Constructive evolution: origins and development of Piaget's thought.* Cambridge: Cambridge University Press.

Chomsky, N. 1965. *Aspects of the theory of syntax.* Cambridge: MIT.

Christensen, L., White, B., Krietsch, K. & Steele, G. 1990. Expectancy effects in caffeine research. *The International Journal of the Addictions,* **25**, 27-31.

Churchland, P.M. 1981. Eliminative materialism and the propositional attitudes. *Journal of Philosophy*, **78**, 67-90.

Churchland, P.M. 1989. *A neurocomputational perspective: The nature of mind and the structure of science.* Cambridge, MA.: MIT.

Churchland, P.S. 1983. Consciousness: the transmutation of a concept. *Pacific Philosophical Quarterly*, **64**, 80-93.

Churchland, P.S. 1988. The significance of neuroscience for philosophy. *Trends in Neurosciences,* **11**, 304-307.

Churchland, P.S. & Sejnowski, T.J. 1989. Neural representation and neural computation. In L. Nadel, L.A. Cooper, P. Culicover & R.M. Harnish (Eds.). *Neural connections, mental computation.* Cambridge, MA.: MIT. (pp.15-48).

Churchland P.S. & Sejnowski, T.J. 1992. *The computational brain.* Cambridge, MA.: MIT.

Collins, H. 1992. Will machines ever think? *New Scientist*, **134**(1826), 36-40.

Colombo, L. & Williams, J. 1990. Effects of word- and sentence-level contexts upon word recognition. *Memory & Cognition,* **18**, 153-163.

Conte, M. & Gennaro, A. 1983. Percezione inconscia, percezione subliminale, attivazione psicodinamica subliminale: itinerari e metodi [Unconscious perceptions, subliminal perceptions, and psychodynamic activation: Paths and methodologies]. *Giornale Storico di Psicologia Dinamica,* **7**, 134-158.

Cooper, L.A. 1990. Mental representation of three-dimensional objects in visual problem solving and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **16**, 1097-1106.

Cooper, L.N. 1991. Hybrid neural network architectures: equilibrium systems that pay attention. In R.J. Mammone & Y.Y. Zeevi (Eds.). *Neural networks: theory and applications.* Boston: Academic. (pp.81-96).

Coren, S., Porac, C. & Theodor, L.H. 1986. The effects of perceptual set on the shape and apparent depth of subjective contours. *Perception & Psychophysics,* **36**, 327-333.

Craik, F.I.M., & Lockhart, R.S. 1972. Levels of processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, **11**, 671-684.

Crick, F. & Asanuma, C. 1986. Certain aspects of the anatomy and physiology of the cerbral cortex. In D.E. Rumelhart & J.L. McClelland. (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.334-371).

Crick, F. & Koch, C. 1992. The problem of consciousness. *Scientific American*, **267**(3), 110-117.

Damasio, A.R. 1989. Time-locked multiregional retroactivation: a systems-level proposal for the neural subtrates of recall and recognition. Special Issue: Neurobiology of cognition. *Cognition,* **33**, 25-62.

Darly, J.M., Fleming, J.H., Hilton, J.L. & Swann, W.B. 1988. Dispelling negative expectancies: the impact of interaction goals and target characteristics on the expectancy confirmation process. *Journal of Experimental Social Psychology,* **24**, 19-36.

Dennett, D.C. 1978. *Brainstorms.* Cambridge, MA.: MIT.

Dennett, D.C. 1991. *Consciousness explained.* London: Allen Lane, Penguin.

Dennis, W. (Ed.). 1948. *Readings in the history of psychology.* New York: Appleton-Century-Crofts.

Di Lollo, V. & Dixon, P. 1988. Two forms of persistence in visual information processing. *Journal of Experimental Psychology: Human Perception and Performance,* **14**, 671-681.

Dinsmore, J. (Ed.). 1992. *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum.

Dinsmore, J. 1992a. Thunder in the gap. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.1-23).

Dodwell, P.C. 1992. Open peer commentary: unified cognitive theory is not comprehensive. *Behavioral and Brain Sciences,* **15,** 443-445.

Domjan, M. 1987. Comparative psychology and the study of animal learning. Special Issue: Comparative psychology: Past, present, and future. *Journal of Comparative Psychology,* **101**, 237-241.

Donovan D.M. 1989. The paraconscious. *Journal of the American Academy of Psychoanalysis,* **17**, 223-251.

Dorpat, T.L. 1987. Comments on Lang's communicative interactional model of the mind: a symposium. *Contemporary Psychoanalysis,* **23**, 132-145.

Dosher, B.A., McElree, B., Hood, R.M. & Rosedale, G. 1989. Retrieval dynamics of priming in recognition memory: bias and discrimination analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **15**, 868-886.

Downing, C.J. 1988. Expectancy and visual-spatial attention: effects on perceptual quality. *Journal of Experimental*

Psychology: Human Perception and Performance, **14**, 188-202.

Doyle, J.R. & Leach, C. 1988. Word superiority in signal detection: barely a glimpse, yet reading nonetheless. *Cognitive Psychology,* **20**, 283-318.

Dretske, F. 1991. Open peer commentary: conscious acts and their objects. *Behavioral and Brain Sciences,* **14**, 676-677.

Duffy, S.A., Henderson, J.M. & Morris, R.K. 1989. Semantic facilitation of lexical access during sentence processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **15**, 791-801.

d'Ydewalle, G. 1984. Motivation and information processing in learning experiments. *Autralian Journal of Psychology,* **36**, 149-160.

Egidi, R. 1987. Emergence, reduction, and evolutionary epistemology: a commentary. In G. Radnitzky & W.W. Bartley, III (Eds.). *Evolutionary epistemology, rationality, and the sociology of knowledge.* La Salle, Illinois: Open Court. (pp.157-161).

Feldman, J.A. 1985. Connectionist models and their applications: introduction. *Cognitive Science*, **6**, 1-2.

Fischbach, G.D. 1992. Mind and brain. *Scientific American*, **267**, 24-33.

Fitts, P.M. & Posner, M. 1967. *Human performance*. Belmont, California: Brooks/Cole.

Flanagan, O. 1991. *The science of mind.* (2nd ed.). Cambridge, MA.: MIT.

Flanagan, O. 1992. *Consciousness reconsidered*. Cambridge, MA.: MIT.

Flowers, J.H., Nelson, S.M., Carson, D. & Larsen, L. 1984. Automatic and expectancy-based priming effects in a digit naming task. *Journal of Experimental Psychology: Human Perception and Performance,* **10**, 65-74.

Fodor, J.A. 1968. *Psychological explanation: an introduction to the philosophy of psychology.* New York: Random House.

Fodor, J.A. 1975. *The language of thought.* New York: Crowell.

Fodor, J.A. 1981. *Representations: philosophical essays on the foundations of cognitive science.* Cambridge, MA.: MIT.

Fodor, J.A. 1987. *Psychosemantics: the problem of meaning in the philosophy of mind.* Cambridge, MA.: MIT.

Fodor, J.A. & Pylyshyn, Z.W. 1992. Connectionism and cognitive architecture: a critical analysis. In B. Beakley & P. Ludlow (Eds.). *The philosophy of mind: classical problems/contemporary issues.* Cambridge, MA.: MIT. (pp.289-324).

Forrester, J.W. 1961. *Industrial dynamics.* Cambridge, MA.: MIT.

Freedman, D.H. 1994. Quantum consciousness. *Discover*, **15**(6), 88-98.

Frege, G. 1892. Über Sinn und Bedeutung. *Zeitschrift für Philosophie und philosophische Kritik*, **100**, 25-50.

Freud, S. 1953a/1900. The interpretation of dreams. *The standard edition of the complete psychological works of Sigmund Freud*. Vol. V. London: Hogarth. (pp.339-627).

Freud, S. 1953b/1905. Three essays on the theory of sexuality. *The standard edition of the complete psychological works of Sigmund Freud*. Vol. VII. London: Hogarth. (pp.125-243).

Freud, S. 1957a/1915. Instincts and their vicissitudes. *The standard edition of the complete psychological works of Sigmund Freud*. Vol. XIV. London: Hogarth. (pp.117-140).

Freud, S. 1957b/1915. The unconscious. *The standard edition of the complete psychological works of Sigmund Freud*. Vol. XIV. London: Hogarth. (pp.166-204).

Freud, S. 1961/1923. The ego and the id. *The standard edition of the complete psychological works of Sigmund Freud*. Vol. XIX. London: Hogarth. (pp.12-66).

Freud, S. 1964/1933. New introductory lectures on Psycho-Analysis. *The standard edition of the complete psychological works of Sigmund Freud*. Vol. XXII. London: Hogarth. (pp.7-182).

Friendly, M. 1979. Methods for finding graphic representations of associative memory structures. In C.R. Puff (Ed.). *Memory organization and structure*. New York: Academic. (pp.85-129).

Fukushima, K. & Imagawa, T. 1991. Recognition and segmentation of characters in handwriting with selective attention. In R.J. Mammone & Y.Y. Zeevi (Eds.). *Neural networks: theory and applications*. Boston: Academic. (pp.113-123).

Fusilier, M.R., Gangster, D.C. & Middlemist, R.D. 1984. A within-person test of the form of the expectancy theory model in a choice context. *Organizational Behavior and Human performance,* **34**, 323-342.

Gadamer, H.G. 1972. *Wahrheit und Methode: Grundzüge einer philosophischen Hermeneutik*. 3 Auflage. Tübingen: J.C.B. Mohr (Paul Siebeck).

Gardiner J.M. 1988. Functional aspects of recollective experience. *Memory and Cognition,* **16**, 309-313.

Gardiner J.M. 1989. A generation effect in memory without awareness. *British Journal of Psychology,* **80** 163-168.

Gardiner, J.M. & Java, R.I. 1990. Recollective experience in word and nonword recognition. *Memory and Cognition,* **18**, 23-30.

Gardiner, J.M. & Parkin, A.J. 1990. Attention and recollective experience in recognition memory. *Memory and Cognition,* **18**, 579-583.

Gardner, H. 1987. *The mind's new science: a history of the cognitive revolution*. New York: Basic Books.

Garner, W.R. 1974. Attention: the processing of multiple sources of information. In E.C. Carterette & M.P. Friedman (Eds.). *Handbook of perception: psychophysical judgement and measurement, Volume II*. New York: Academic. (pp. 23-59).

Gerrards, A. 1988. Vorwissenseinflüsse auf den Erwerb und die Repräsentation von Wissen. *Zeitschrift für experimentelle und angewandte Psychologie,* **35**, 405-426.

Gibbons, F.X. & Kassin, S.M. 1987. Information consistency and perceptual set: overcoming the mental retardation "schema." *Journal of Applied Social Psychology,* **17**, 810-827.

Gibson, J.J. 1950. *The perception of the visual world.* Boston: Houghton Mifflin.

Gibson, J.J. 1966. *The senses considered as perceptual systems.* Boston: Houghton Mifflin.

Giere, R.N. 1979. *Understanding scientific reasoning.* New York: Holt, Rinehart & Winston.

Gillett, G.R. 1988. Consciousness and brain function. *Philosophical Psychology,* **1**, 327-341.

Giraudo, M. & Peruch, P. 1988. Spatio-temporal aspects of the mental representation of urban space. *Journal of Environmental Psychology,* **8**, 9-17.

Goldinger, S.D., Luce, P.A. & Pisoni, D.B. 1989. Priming lexical neighbors of spoken words: effects of competition and inhibition. *Journal of Memory and Language,* **28**, 501-518.

Goldstein, E.B. 1989. *Sensation and perception.* (3rd ed.). Belmont, California: Wadsworth.

Gorin, A.L., Levinson, S.E., Gertner, A.N. & Goldman, E. 1991. Adaptive acquisition of language. In R.J. Mammone & Y.Y. Zeevi (Eds.). *Neural networks: theory and applications.* Boston: Academic. (pp.125-167).

Gorrell, J.M. 1981. *The explanatory, heuristic and meaning-constituing functions of theoretical models.* Ph.D., Brown University.

Gourova, L.L. 1986. Processes of understanding in the development of thinking. *Vorposy Psikhologii,* Mar-Apr(2), 126-137.

Grainger, J., Colé, P. & Segui, J. 1991. Masked morphological priming in visual word recognition. *Journal of Memory and Language,* **30**, 370-384.

Grof, S. 1986. Psychology and consciousness research. *ReVISION,* **9**, 47-63.

Haber, R.N. 1966. Nature of the effect of set on perception. *Psychological Review,* **73**, 335-351.

Hample, D. 1986. Logic, conscious and unconscious. *Western Journal of Speech Communication,* **50**, 24-40.

Hanson, S.J. & Burr, D.J. 1991. What connectionist models learn: learning and representation in connectionist networks. In R.J. Mammone & Y.Y. Zeevi (Eds.). *Neural networks: theory and applications.* Boston: Academic. (pp.169-208).

Hanson, C. & Hirst, W. 1989. On the representation of events: a study of orientation, recall, and recognition. *Journal of Experimental Psychology: General,* **118**, 136-147.

Hardcastle, V.G. 1991. Open peer commentary: epiphenomenalism and the reduction of experience. *Behavioral and Brain*

Sciences, **14**, 680.

Harkins, S.G., Harvey, J.H., Keithly, L. & Rich, M. 1977. Cognitive tuning, encoding, and the attribution of causality. *Memory & Cognition,* **5**, 561-565.

Harris, M.J. 1990. Effect of interaction goals on expectancy confirmation in a problem-solving context. *Personality and Social Psychology Bulletin,* **16**, 521-530.

Hausman, C. 1983. Metaphors, referents, and individuality. *Journal of Aesthetics and Art Criticism*, **42**, 181-195.

Hausman, C. 1984. *A discourse on novelty and creation.*. Albany, NY.: SUNY.

Hausman, C. 1989. *Metaphor and art: interactionism and reference in verbal and nonverbal art.* Cambridge: Cambridge University Press.

Hawthorne, J. 1989. On the compatibility of connectionist and classical models. *Philosophical Psychology,* **2**, 5-15.

Hebb, D.O. 1949. *The organization of behavior.* New York: Wiley.

Heckhausen, H. & Gollwitzer, P.M. 1987. Thought contents and cognitive functioning in motivational versus volitional states of mind. *Motivation and Emotion,* **11**, 101-120.

Helminiak, D.A. 1984. Consciousness as subject matter. *Journal for the theory of Social Behavior*, **14**, 211-230.

Henle, M. 1985. Rediscovering Gestalt Psychology. In S. Koch & D.E. Leary. *A century of psychology as science*. New York: McGraw-Hill. (pp.100-120).

Hick, W.E. 1952. On the rate of gain of information. *Quarterly Journal of Experimental Psychology*, **4**, 11-26.

Hinton, G.E. 1981. Implementing semantic networks in parallel hardware. In G.E. Hinton & J.A. Anderson (Eds.). *Parallel models of associative memory.* Hillsdale NJ.: Erlbaum. (pp.161-188).

Hinton, G.E. 1992. How neural networks learn from experience. *Scientific American*, **267**(3), 104-109.

Hinton, G.E., McClelland, J.L. & Rumelhart, D.E. 1986. Distributed representations. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 1: Foundations.* Cambridge, MA.: MIT. (pp.77-109).

Hobson, J.A., Hoffman, S.A., Helfand, R. & Kostner, D. 1987. Dream bizarreness and the activation-synthesis hypothesis. *Human Neurobiology,* **6**, 157-164.

Horn, G. & Downey, J.L. 1990. Perception of expectancy effects. *Psychological Reports,* **67**, 651-655.

Hue, C. & Erickson, J.R. 1991. Normative studies of sequence strength and scene structure of 30 scripts. *American Journal of Psychology,* **104**, 229-240.

Hume, D. 1992. Of the connection or association of ideas. In B. Beakly & P. Ludlow (Eds.). *The philosophy of mind: classical problems/contemporary issues.* Cambridge, MA.: Bradford/MIT. (pp.255-256).

Humphrey, N. 1994. The private world of consciousness. *New Scientist*, **141**(1907), 22-25.

Humphreys, M.S. & Revelle, W. 1984. Personality, motivation, and performance: a theory of the relationship between individual differences and information processing. *Psychological Review,* **91**, 153-184.

Hunt, E. 1978. Imageful thought. In J.W. Cotton & R.L. Klatzky (Eds.). *Semantic factors in cognition.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.3-35).

Hunt, E. & Luce, R.D. 1992. Open peer commentary: SOAR as a world view, not a theory. *Behavioral and Brain Sciences,* **15**, 447-448.

Hunt, H.T. 1985. Cognition and states of consciousness: the necessity for empirical study of ordinary and nonordinary consciousness for contemporary cognitive psychology. *Perceptual and Motor Skills,* **60**, 239-282.

Hunt, H.T. 1986. Some relations between the cognitive psychology of dreams and dream phenomenology. Special Issue: cognition and dream research. *Journal of Mind and Behavior,* **7**, 213-228.

Husserl, E. 1922. *Logische Untersuchungen*. II Band. 2 Teil. Vierte Auflage. Halle: Max Niemeyer.

Husserl, E. 1928a. *Logische Untersuchungen*. I Band. Vierte Auflage. Halle: Max Niemeyer.

Husserl, E. 1928b. *Logische Untersuchungen*. II Band, 1 Teil. Vierte Auflage. Halle: Max Niemeyer.

Husserl, E. 1950. Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie. Erstes Buch. Haag: Martinus Nijhoff.

Husserl, E. 1972. *Ideas: general introduction to pure phenomenology.* New York: Collier.

Hyman, R. 1953. Stimulus information as a determinant of reaction time. *Journal of Experimental Psychology*, **45**, 188-196.

Indurkhya, B. 1992. *Metaphor and cognition: an interactionist approach.* Dordrecht: Kluwer.

Inhoff, A.W. 1991. Open peer commentary: limits of preconscious processing. *Behavioral and Brain Sciences,* **14**, 680-681.

Isen, A.M. 1987. Positive affect, cognitive processes, and social behavior. *Advances in Experimental Social Psychology,* **20**, 203-253.

Izard, C.E. 1977. *Human emotions*. New York: Plenum.

Jackendoff, R. 1987. *Consciousness and the computational mind.* Cambridge, MA.: MIT.

James, W. 1890/1950. *The principles of psychology*. Vol. I. New York: Dover.

James, W. 1992. The elementary law of association. In B. Beakly & P. Ludlow (Eds.). *The philosophy of mind: classical problems/contemporary issues.* Cambridge, MA.: Bradford/MIT. (pp.261-268).

Jenkins, G.M. 1972. The systems approach. In J. Beishon & G. Peters (Eds.). *Systems behavior.* London: Haper & Row. (pp.56-82).

Johnson, S.D. 1988. Cognitive analysis of expert and novice troubleshooting performance. *Performance Improvement Quarterly,* **1**, 38-54.

Johnson-Laird, P. 1993. *The computer and the mind: an introduction to cognitive science.* (2nd ed.). London: Fontana.

Jorna R.J. 1990. *Knowledge representation and symbols in the mind: an analysis of the notion of representation and symbol in cognitive psychology*. Tübingen: Stauffenburg Verlag.

Kanfer, R. & Ackerman, P.L. 1989. Motivation and cognitive abilities: an integrative/aptitude- treatment interaction approach to skill acquisition. *Journal of Applied Psychology,* **74**, 657-690.

Kantowitz, B.H. 1985. Channels and stages in human information processing: a limited analysis of theory and methodology. *Journal of Mathematical Psychology,* **29**, 135-174.

Kaplan, A. 1964. *The conduct of inquiry.* San Francisco: Chandler.

Karmiloff-Smith, A. 1986. From meta-processes to conscious access: evidence from children's metalinguistic and repair data. *Cognition,* **23**, 95-147.

Kast, F.E. & Rosenzweig, J.E. 1972. The modern view: a systems approach. In J. Beishon & G. Peters (Eds.). *Systems behavior.* London: Haper & Row. (pp.14-28).

Keating, D.P. & Crane, L.L. 1990. Domain-general and domain-specific processes in proportional reasoning: a commentary on the Merrill-Palmer Quarterly special issue on cognitive development. *Merrill-Palmer-Quarterly,* **36**, 411-424.

Kendler, H.H. 1985. Behaviorism and psychology: an uneasy alliance. In S. Koch & D.E. Leary (Eds.). *A century of psychology as science*. New York: McGraw-Hill. (pp.121-134).

Kerr, R. 1982. *Psychomotor learning*. Philadelphia: Saunders College Publishing.

Khanna, T. 1990. *Foundations of neural networks.* Reading MA.: Addison-Wesley.

Kihlstrom, J.F. 1992. Dissociation and dissociations - a comment on consciousness and cognition. *Consciousness and Cognition,* **1**, 47-53.

Kingstone, A. & Klein, R. 1991. Combining shape and position expectancies: hierarchical processing and selective inhibition. *Journal of Experimental Psychology: Human Perception and Performance,* **17**, 512-519.

Kinsbourne, M. 1991. Open peer commentary: Velmans's overfocused perspective on consciousness. *Behavioral and Brain*

Sciences, **14**, 682-683.

Kintsch, W. 1974. *The representation of meaning in memory.* Hillsdale, NJ.: Lawrence Erlbaum.

Kirby, N.H. 1976. Sequential effects in two-choice reaction time: automatic facilitation or subjective expectancy? *Journal of Experimental Psychology: Human Perception and Performance,* **2**, 567-577.

Kitayama, S. 1990. Interaction between affect and cognition in word perception. *Journal of Personality and Social Psychology,* **58**, 209-217.

Kittay, E.F. 1987. The creation of similarity: a discussion of metaphor in light of Tversky's theory of similarity, *PSA 1982,* (Philosophy of Science Association), Vol. 1, 394-405.

Klein, D.B. 1984. *The concept of consciousness - a survey*. Lincoln: University of Nebraska Press.

Klopfer, D.S. 1991. Apparent reversals of a rotating mask: a new demonstration of cognition in perception. *Perception & Psychophysics,* **49**, 522-530.

Koffka, K. 1935. *Principles of Gestalt psychology*. New York: Harcourt.

Kõhler, W. 1920. *Die physischen Gestalten in Ruhe und im stationaren Zustand.* Erlangen: Weltkreisverlag.

Kõhler, W. 1938. Some Gestalt problems. In W.D. Ellis (Ed.). *A source book of Gestalt psychology*. NY.: Harcourt, Brace & World. (pp.55-70).

Kõhler, W. 1947. *Gestalt psychology: an introduction to the new consepts in modern psychology.* New York: Liveright.

Kõhler, W. 1969. *The task of Gestalt psychology*. Princeton, NJ.: Princeton University Press.

Kosko, B. 1992. *Neural networks and fuzzy systems: a dynamical systems approach to machine intelligence*. Englewood Cliffs, NJ.: Prentice Hall.

Kosslyn, S.M., Cave, C.B., Provost, D.A. & Von Gierke, S.M. 1988. Sequential processes in image generation. *Cognitive Psychology,* **20**, 319-343.

Krausser, P. 1974. Kant's theory of the structure of empirical scientific inquiry and two implied postulates regarding things in themselves. In L.W. Beck (Ed.). *Kant's theory of knowledge*. Dordrecht, Holland: Reidel. (pp. 159-165).

Kuhn, T. 1970. *The structure of scientific revolutions.* Chicago: University of Chicago Press.

Kydd, R.R. & Wright, J.J. 1986. Mental phenomena as changes of state in a finite-machine. *Australian and New Zealand Journal of Psychiatry,* **20**, 158-165.

LaBerge, S., Levitan, L. & Dement, W.C. 1986. Lucid dreaming: physiological correlates of consciousness during REM sleep. Special Issue: cognition and dream research. *Journal of Mind and Behavior,* **7**, 251-258.

Lachman, J.L. & Lachman, R. 1979. Theories of memory organization and human evolution. In C.R. Puff (Ed.). *Memory organization and structure.* New York: Academic. (pp.133-193).

Laird, J.E., Newell, A. & Rosenbloom, P.S. 1987. SOAR: an architecture for general intelligence. *Artificial Intelligence*, **33**, 1-64.

Lange, T.E. 1992. Hybrid connectionist models: temporary bridges over the gap between the symbolic and the subsymbolic. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.237-289).

LaPolla, M.V. & Baars, B.J. 1992. Open peer commentary: a psychologically implausable architecture that is always conscious, always active. *Behavioral and Brain Sciences,* **15**, 448-449.

Lashley, K.S. 1923. The behavioristic interpretation of consciousness. *Psychological Review*, **30**, 329-353.

Lashley, K. 1956. Cerebral organization and behavior. In H. Solomon, S. Cobb, & W. Penfield (Eds.). *The brain and human behavior*. Baltimore: Williams & Wilkins. (pp.1-18).

Latto, R. 1986. The question of animal consciousness. *Psychological Record,* **36**, 309-314.

Lee, C. & Gasser, M. 1992. Where do underlying representations come from?: a connectionist approach to the acquisition of phonological rules. In J. Dinsmore (Ed.). *The symbolic and connectionist paradigms: closing the gap.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.179-207).

Lemonick, M.D. 1995. Glimpses of the mind. *Time,* **146**(5), 42-49.

Lettvin, J.Y., Maturana, H., McCulloch, W.S. & Pitts, W.H. 1959. What the frog's eye tells the frog's brain. *Proceedings of the Institute of Radio Engineers,* New York, **47**, 1940-1951.

Levine, R.L. & Fitzgerald, H.E. 1992. Living systems, dynamical systems, and cybernetics: historical overview and introduction to system dynamics. In R.L. Levine & H.E. Fitzgerald (Eds.). *Analysis of dynamic psychological systems: basic approaches to general systems, dynamic systems, and cybernetics*. Vol 1. New York: Plenum. (pp.1-7).

Lewicki, P. & Hill, T. 1987. Unconscious processes as explanations of behavior in cognitive, personality, and social psychology. *Personality and Social Psychology Bulletin,* **13**, 355-362.

Lewin, R. 1992. The great brain race. *New Scientist Supplement*, **4**, 2-8.

Lindauer, M.S. 1990. A failure to find an effect of perceptual set on creativity. *Bulletin of the Psychonomic Society,* **28**, 33-36.

Linge, D.E. 1976. Editor's introduction. In H.G. Gadamer. *Philosophical hermeneutics*. Berkely: University of California Press.

Lucas, C. 1985. Out at the edge: notes on a paradigm shift. *Journal of Counselling and Development,* **64**, 165-172.

Luijpen, W. 1976. *Inleiding tot de existensiële fenomenologie*. Utrecht: Spectrum.

Lukatela, G., Turvey, M.T., Feldman, L.B. & Carello, C. 1989. Alphabet priming in Bi-alphabetical word perception. *Journal of Memory and Language,* **28**, 237-254.

Lundh, L. 1979. Introspection, consciousness, and human information processing. *Scandanavian Journal of Psychology,* **20,** 223-238.

Lundin, R.W. 1991. *Theories and systems of psychology*. (4th ed.). Lexington, MA.: D.C. Heath.

Maddock, P. 1983. International Parascience Institute Conference, 1982. *Parapsychology Review,* **14**, 17-18.

Madigan, S., McDowd, J. & Murphy, D. 1991. Facilitating word-fragment completion with hidden primes. *Bulletin of the Psychonomic Society,* **29**, 189-191.

Maki, R.H. 1989. Recognition of added and deleted details in scripts. *Memory & Cognition,* **17**, 274-282.

Maki, R.H. 1990. Memory for script actions: effects of relevance and detail expectancy. *Memory & Cognition,* **18**, 5-14.

Maree, D.J.F. 1995. *Psychomotor performance.* Pretoria: Human Sciences Research Council.

Markus, H. 1977. Self-schemata and processing information about the self. *Journal of Personality and Social Psychology,* **35**, 63-78.

Marr, D. 1982. *Vision*. San Francisco: Freeman.

Marx, M.H. & Cronan-Hillix, W.A. 1987. *Systems and theories in psychology.* (4th ed.). NY.: McGraw-Hill.

Massad, C.M., Hubbard, M. & Newtson, D. 1979. Selective perception of events. *Journal of Experimental Social Psychology,* **15**, 513-532.

Mayseless, O. & Kruglanski, A.W. 1987. What makes you so sure? Effects of epistemic motivations on judgemental confidence. *Organizational Behavior and Human Decision Processes,* **39**, 162-183.

McAndrews, M.P., Glisky, E.L. & Schacter, D.L. 1987. When priming persists: long-lasting implicit memory for a single episode in amnesic patients. *Neuropsychologia,* **25**, 497-506.

McClelland, J.L. 1986. The programmable blackboard model of reading. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.122-169).

McClelland, J.L. & Elman J.L. 1986. Interactive processes in speech perception: the trace model. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.58-121).

McClelland, J.L. & Kawamoto, A.H. 1986. Mechanisms of sentence processing: assigning roles to constituents of sentences. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of* *cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.272-325).

McClelland, J.L. & Rumelhart, D.E. 1986. A distributed model of human learning and memory. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.170-215).

McClelland, J.L., Rumelhart, D.E. & Hinton, G.E. 1986. The appeal of Parallel Distributed Processing. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 1: Foundations.* Cambridge, MA.: MIT. (pp.3-44).

McGinn, C. 1991. *The problem of consciousness.* Oxford: Blackwell.

McKelvie, S.J. 1984. Relationship between set and functional fixedness: a replication. *Perceptual and Motor Skills,* **58**, 996-998.

McKoon, G. & Ratcliff, R. 1980. Priming in item recognition: the organization of propositions in memory for text. *Journal of Verbal Learning and Verbal Behavior,* **19**, 369-386.

Meinong, A. 1960/1904. The theory of objects. In R.M. Chisholm (Ed.). *Realism and the background of phenomenology.* Glencoe, IL.: Free.

Merrell-Wolff, F. 1973. *The philosophy of consciousness without an object: reflections on the nature of transcendental consciousness.* New York: Julian.

Meuller, J.H., Haupt, S.G. & Grove, T.R. 1988. Personal relevance of traits and things. *Bulletin of the Psychonomic Society,* **26**, 445-448.

Mill, J.S. 1843/1956. *A system of logic.* London: Longmans.

Mill, J.S. 1992. The principal investigations of psychology characterised. In B. Beakly & P. Ludlow (Eds.). *The philosophy of mind: classical problems/contemporary issues.* Cambridge, MA.: Bradford/MIT. (pp.257-259).

Miller, G.A. & Buckhout, R. 1973. *Psychology: the science of mental life.* (2nd ed.). New York: Harper & Row.

Miller, G.A., Galanter, E.H. & Pribram, K.H. 1960. *Plans and the structure of behavior.* New York: Rinehart & Winston.

Miller, J.G. 1978. *Living systems.* New York: McGraw-Hill.

Miller, J.G. & Miller, J.L. 1992. Cybernetics, general systems theory, and living systems theory. In R.L. Levine & H.E. Fitzgerald (Eds.). *Analysis of dynamic psychological systems, Volume 1: Basic approaches to general systems, dynamic systems, and cybernetics.* New York: Plenum. (pp.9-34).

Miller, L. 1986. Some comments on cerebral hemispheric models of consciousness. *Psychoanalytic Review,* **73**, 129-144.

Minsky, M. 1985. *The society of mind.* New York: Simon and Schuster.

Minsky, M. & Papert, S. 1969. *Perceptrons.* Cambridge, MA.: MIT.

Mouton, J. & Marais, H.C. 1990. *Basic concepts in the methodology of the social sciences.* (Rev. ed.). Pretoria: Human Sciences Research Council.

Müller, K. 1988. Gestalttheorie, Emergenztheorie und der Neofunktionalismus. *Gestalt Theory*, **10**, 46-56.

Munroe, R. 1955. *Schools of psychoanalytic thought.* New York: Holt.

Natsoulas, T. 1978. Consciousness. *American Psychologist*, **33**, 906-914.

Neisser, U. 1967. *Cognitive psychology.* New York: Appleton-Century-Crofts.

Neisser, U. 1976. *Cognition and reality: principles and implications of cognitive psychology.* San Francisco: Freeman.

Nelson, R.J. 1987. Machine models for cognitive science. *Philosophy of Science,* **54**, 391-408.

Newell, A. 1980. Physical symbol systems. *Cognitive Science*, **4**, 135-183.

Newell, A. 1982. The knowledge level. *Artificial Intelligence*, **18**, 87-127.

Newell, A. 1990. *Unified theories of cognition.* Cambridge: Havard University Press.

Newell, A. 1992. Précis of "Unified theories of cognition." *Behavioral and Brain Sciences,* **15**, 425-437.

Newell, A. 1992a. Author's response: SOAR as a unified theory of cognition: issues and explanations. *Behavioral and Brain Sciences,* **15**, 464-492.

Newell, A., Rosenbloom R.S. & Laird, J.E. 1989. Symbolic architectures for cognition. In M.I. Posner (Ed.). *Foundations of cognitive science*. Cambridge: MIT. (pp.93-131).

Newell, A., Shaw, J.C. & Simon, H.A. 1958. Elements of a theory of human problem solving. *Psychological Review,* **65**, 151-166.

Newell, A. & Simon, H.A. 1972. *Human problem solving.* Englewood Cliffs, NJ.: Prentice-Hall.

Nilsson, L. 1987. Motivated memory: dissociation between performance data and subjective reports. *Psychological Research,* **49**, 183-188.

Norman, D.A. & Rumelhart, D.E. 1975. *Explorations in cognition*. San Francisco: Freeman and Co.

Nowak, S. 1976. *Understanding and prediction: essays in the methodology of social and behavioral theories.* Dordrecht, Holland: Reidel.

Oakhill, J. & Davies, A. 1991. The effects of test expectancy on quality of note taking and recall of text at different times of day. *British Journal of Psychology,* **82**, 179-189.

Osgood, C.E. 1953. *Method and theory in experimental psychology*. New York: Oxford.

Parker, D.B. 1982. *Learning logic*. Invention Report S81-64, File 1, Office of Technology Licensing, Stanford University, Stanford, CA.

Pekala, R.J. 1991. *Quantifying consciousness: an empirical approach*. New York: Plenum.

Pekala, R.J. & Kumar, V.K. 1989. Phenomenological patterns of consciousness during hypnosis: relevance to cognition and individual differences. *Australian Journal of Clinical and Experimental Hypnosis,* **17**, 1-20.

Perdue, C.W. & Gurtman, M.B. 1988. Self-reference and evaluative biases in the perception of trait information. *Personality and Social Psychology Bulletin,* **14**, 578-586.

Peterson, R.R. & Simpson, G.B. 1989. Effect of backward priming on word recognition in single-word and sentence contexts. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **15**, 1020-1032.

Piaget, J. 1918. *Recherche*. Lausanne: La Concorde.

Piaget, J. 1952. [Autobiography]. In E.G. Boring (Ed.). *A history of psychology in autobiography*. Vol 4. New York: Russell & Russell. (pp.237-256).

Pivčević, E. 1970. *Husserl and phenomenology*. London: Hutchinson.

Pomerleau, D.A. 1991. Efficient training of artificial neural networks for autonomous navigation. *Neural Computation*, **3**, 88-97.

Popper, K.R. 1979. *Objective knowledge: an evolutionary approach.* (Rev. ed.). Oxford: Clarendon.

Popper, K.R. & Eccles, J.C. 1977. *The self and its brain.* London: Routledge & Kegan Paul.

Postman, L. & Bruner, J.S. 1949. Multiplicity of set as a determinant of perceptual behavior. *Journal of Experimental Psychology,* **39**, 369-377.

Presnell, M. 1986. Merleau-Ponty's philosophy of mind-body dialectic: a critique of computational theories of mind. *Humanistic Psychologist,* **14**, 11-21.

Pribram, K.N. 1976. Problems concerning the structure of consciousness. In G.G. Globus, G. Maxwell, & I. Savodnik (Eds.). *Consciousness and the brain*. New York: Plenum. (pp. 297-313).

Prigogine, I. & Stengers, I. 1985. *Order out of chaos: man's new dialogue with nature*. London: Fontana.

Puente, A.E. 1993. Sperry's emergent interactionism as a new explanation for dualism. *The Journal of General Psychology,* **120**, 65-72.

Putnam, H. 1960. Minds and machines. In S. Hook (Ed.). *Dimensions of mind.* New York: Collier. (pp.138-164).

Pylyshyn, Z.W. 1980. Cognition and computation: issues in the foundations of cognitive science. *Behavioral and Brain Sciences,* **3**, 154-169.

Pylyshyn, Z.W. 1984. *Computation and cognition: toward a foundation for cognitive science.* Cambridge, MA.: MIT.

Pylyshyn, Z.W. 1984a. Why computation requires symbols. *Proceedings of the Sixth Annual Conference of the Cognitive Science Society, Boulder, Colorado, August, 1984.* Hillsdale, NJ.: Erlbaum.

Pylyshyn, Z.W. 1989. Computing in cognitive science. In M.I. Posner (Ed.). *Foundations of cognitive science.* Cambridge: MIT. (pp.51-91).

Quillian, M.R. 1969. The teachable language comprehender. *Communications of the Association for Computing Machinery*, **12**, 459-476.

Raichle, M.E. 1994. Visualizing the mind. *Scientific American*, **270**(4), 36-42.

Ratcliff, R. & McKoon, G. 1978. Priming in item recognition: evidence for the propositional structure of sentences. *Journal of Verbal Learning and Verbal Behavior*, **17**, 403-417.

Ratcliff, R., McKoon, G. & Verwoerd, M. 1989. A bias interpretation of facilitation in perceptual identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **15**, 378-387.

Reber, A.S. 1989. Implicit learning and tacit knowledge. *Journal of Experimental Psychology General,* **118**, 219-235.

Rey, G. 1983. A reason for doubting the existence of consciousness. In R.J. Davidson, G.E. Schwartz & D. Shapiro. *Consciousness and self-regulation.* New York: Plenum.

Ricoeur, P. 1976. *Interpretation theory: discourse and the surplus of meaning.* Fort Woth, Texas: Texas Christian University Press.

Ricoeur, P. 1977. *The rule of metaphor.* Toronto: Toronto Press.

Ricoeur, P. 1978. The metaphorical process as cognition, imagination, and feeling. *Critical Inquiry*, **5**, 143-159.

Ricoeur, P. 1982. Imagination et Métaphore. *Psychologie Medicale*, **14**, 1883-1887.

Roberts, T.B. 1989. Multistate education: metacognitive implications of the mind-body psychotechnologies. *Journal of Transpersonal Psychology,* **21**, 83-102.

Roberts, T. & Bruce, V. 1989. Repetition priming of face recognition in a serial choice reaction-time task. *British Journal of Psychology,* **80**, 201-211.

Robertson, W.C. 1990. Detection of cognitive structure with protocol data: predicting performance on physics transfer problems. *Cognitive Science,* **14**, 253-280.

Roediger, H.L. 1990. Implicit memory: retention without remembering. *American Psychologist,* **45**, 1043-1056.

Rosenzweig, S. 1985. Freud and experimental psychology: the emergence of idiodynamics. In S. Koch & D.E. Leary (Eds.). *A century of psychology as science.* New York: McGraw-Hill. (pp.135-207).

Rottschaefer, W.A. 1987. Roger Sperry's science of values. *The Journal of Mind and Behavior,* **8**, 23-36.

Rumelhart, D.E. 1989. The architecture of mind: a connectionist approach. In M.I. Posner (Ed.). *Foundations of cognitive science.* Cambridge: MIT. (pp.133-159).

Rumelhart, D.E. 1992. Towards a microstructural account of human reasoning. In S. Davis (Ed.). *Connectionism: theory and practice.* New York: Oxford. (pp.69-83).

Rumelhart, D.E., Hinton, G.E. & McClelland, J.L. 1986. A general framework for Parallel Distributed Processing. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 1: Foundations.* Cambridge, MA.: MIT. (pp.45-76).

Rumelhart, D.E., Hinton, G.E. & Williams, R.J. 1986. Learning internal representations by error propagation. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 1: Foundations.* Cambridge, MA.: MIT. (pp.318-362).

Rumelhart, D.E., Lindsay, P. & Norman, D.A. 1972. A process model for long-term memory. In E. Tulving & W. Donaldson (Eds.). *Organization of memory.* New York: Academic.

Rumelhart, D.E. & McClelland, J.L. 1986. On learning the past tenses of English verbs. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.216-271).

Rumelhart, D.E. & McClelland, J.L. (Eds.). 1986a. *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT.

Rumelhart, D.E. & Norman, D.A. 1978. Accretion, tuning and restructuring: three modes of learning. In J.W. Cotton & R.L. Klatzky (Eds.). *Semantic factors in cognition.* Hillsdale, NJ.: Lawrence Erlbaum. (pp.37-53).

Rumelhart, D.E., Smolensky, P., McClelland, J.L. & Hinton, G.E. 1986. Schemata and sequential thought processes in PDP models. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.7-57).

Russel, B. 1940. *An inquiry into meaning and truth.* London: George Allen & Unwin.

Russell, J. 1989. Cognisance and cognitive science. Part two: towards an empirical psychology of cognisance. *Philosophical Psychology,* **2**, 165-201.

Rychlak, J.F. 1986. The logic of consciousness. *British Journal of Psychology,* **77**, 257-267.

Saab, Z., Trottier, J. & Wall, H.M. 1984. Memory for places: role of schemata-related expectancy and saliency in recall and recognition. *Psychological Reports,* **54**, 607-610.

Sandman, C.A. 1986. Circulation as consciousness. *Behavioral and Brain Sciences,* **9**, 302-304.

Sartre, J.P. 1965. *Nausea*. New York: Penguin.

Sartre, J.P. 1971. *Being and nothingness: an essay on phenomenological ontology*. New York: Simon & Schuster.

Savage C.E. 1976. An old ghost in a new body. In G.G. Globus, G. Maxwell, & I. Savodnik (Eds.). *Consciousness and the brain*. New York: Plenum. (pp.125-152).

Schepers, J.M. 1987. *Tempo van inligtingverwerking, spoed en padongelukke*. Johannesburg: Randse Afrikaanse Universiteit.

Schlechter, T.M., Herrmann, D.J. & Toglia, M.P. 1990. An investigation of people's metamemories for naturally occuring events. *Applied Cognitive Psychology,* **4**, 213-217.

Schmidt, R.A. 1988. *Motor control and learning: a behavioral emphasis*. (2nd ed.). Champaign, IL.: Human Kinetics Publishers.

Schmuckler, M.A. 1990. The performance of global expectations. *Psychomusicology,* **9**, 122-147.

Searle, J. 1980. Minds, brains, and programs. *Behavioral and Brain Sciences,* **3**, 417-424.

Searle, J.R. 1990. Consciousness, explanatory inversion, and cognitive science. *Behavioral and Brain Sciences*, **13**, 585-642.

Searle, J. 1992. *The rediscovery of the mind.* Cambridge, MA.: MIT.

Sears, R.R. 1985. Psychoanalysis and behavior theory: 1907-1965. In S. Koch & D.E. Leary (Eds.). *A century of psychology as science*. New York: McGraw-Hill. (pp.208-220).

Segui, J. & Grainger, J. 1990. Priming word recognition with orthographic neighbors: effects of releative prime-target frequency. *Journal of Experimental Psychology: Human Perception and Performance,* **16**, 65-76.

Seidenberg, M.S. 1992. Connectionism without tears. In S. Davis (Ed.). *Connectionism: theory and practice.* New York: Oxford University Press. (pp.84-137).

Sejnowski, T.J. 1986. Open questions about computation in cerebral cortex. In D.E. Rumelhart & J.L. McClelland (Eds.). *Parallel distributed processing: explorations in the microstructure of cognition. Volume 2: Psychological and biological models.* Cambridge, MA.: MIT. (pp.372-389).

Selfridge, O.G. 1959. Pandemonium: a paradigm for learning. In *The mechanisation of thought processes*. London: H.M. Sationary Office.

Semenov, I.N. 1989. The psychology of reflection in S. Rubinstein's works. *Soviet Journal of Psychology,* **10**, 48-57.

Shanon, B. 1990. Consciousness. *Journal of Mind and Behavior,* **11**, 137-151.

Shannon, C.E. 1948. A mathematical theory of communication. *Bell Syst. Tech. J.,* **27**, 379-423, 623-656.

Shannon, C.E. & Weaver, W. 1962. *The mathematical theory of communication.* Urbana: University of Illinois Press.

Sharkey, N.E. 1988. A PDP approach to natural language understanding. In I. Aleksander (Ed.). *Neural computing architectures.* MA.: MIT.

Shepard, R.N. 1989. Internal representation of universal regularities: a challenge for connectionism. In L. Nadel, L.A. Cooper, P. Culicover & R.M. Harnish (Eds.). *Neural connections, mental computation.* Cambridge, MA.: MIT. (pp.104-134).

Sherman, R.C. & Lim, K.M. 1991. Determinants of spatial priming in environmnetal memory. *Memory & Cognition,* **19**, 283-292.

Shiffrin, R.M. & Schneider, W. 1977. Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review,* **84**, 127-190.

Shinar, D. 1985. The effects of expectancy, clothing reflectance, and detection criterion on nighttime pedestrian visibility. *Human Factors,* **27**, 327-333.

Shoben, E.J., Sailor, K.M. & Wang, M. 1989. The role of expectancy in comparative judgements. *Memory & Cognition,* **17**, 18-26.

Shor, R.E. 1959. Hypnosis and the concept of the generalized reality-orientation. *Amer. J. Psychother.*, **13**, 275-286.

Simon, J.R. 1988. A 'priming' effect in a choice reaction time task. *Acta Psychologica,* **69**, 45-60.

Simon, H.A. & Kaplan, C.A. 1989. Foundations of cognitive science. In M.I. Posner (Ed.). *Foundations of cognitive science.* Cambridge: MIT. (pp.1-47).

Singer, J.L. & Kolligian, J. 1987. Personality: developments in the study of private experience. *Annual Review of Psychology,* **38**, 533-574.

Singer, R.N. 1980. *Motor learning and human performance: an application to motor skills and movement behaviors.* (3rd ed.). New York: Macmillan.

Slife, B.D. 1987. Can cognitive psychology account for metacognitive functions of mind? *Journal of Mind and Behavior,* **8**, 195-208.

Smolensky, P. 1988. On the proper treatment of connectionism. *Behavioral and Brain Sciences*, **11**, 1-59.

Smolensky, P. 1989. Connectionist modelling: neural computation/mental connections. In L. Nadel, L.A. Cooper, P.

Culicover & R.M. Harnish (Eds.). *Neural connections, mental computation.* Cambridge, MA.: MIT. (pp.49-67).

Soetens, E., Boer, L.C. & Hueting, J.E. 1985. Expectancy or automatic facilitation? Separating sequential effects in two-choice reaction time. *Journal of Experimental Psychology: Human Perception and Performance,* **11**, 598-616.

Spendel, Z. 1985. Psychologia jako nuaka historyczna i humanistyczna [Psychology as a historical and humanistic science]. *Przeglad Psychologiczny,* **28**, 319-331.

Sperry, R.W. 1964. *Problems outstanding in the evolution of brain function.* James Arthur Lecture. New York: American Museum of Natural History.

Sperry, R.W. 1965. Mind, brain and humanist values. In J.R. Platt (Ed.). *New views of the nature of man*. Chicago: University of Chicago Press. (pp.71-92).

Sperry, R.W. 1969. A modified concept of consciousness. *Psychological review,* **76**, 532-536.

Sperry, R.W. 1970. An objective approach to subjective experience: further explanation of a hypothesis. *Psychological Review,* **77**, 585-590.

Sperry, R.W. 1980. Mind-brain interaction: mentalism, yes; dualism, no. *Neuroscience*, **5**, 195-206.

Sperry, R.W. 1981. Changing priorities. *Annual Review of Neuroscience*, **4**, 1-5.

Sperry, R.W. 1987. Structure and significance of the consciousness revolution. *The Journal of Mind and Behavior,* **8**, 37-66.

Sperry, R.W. 1993. The impact and promise of the cognitive revolution. *American Psychologist*, **48**, 878-885.

Spiegel, D. 1991. Dissociating consciousness from cognition. *Behavioral and Brain Sciences,* **14**, 695-695.

Spiegelberg, H. 1969. *The phenomenological movement: a historical introduction*, Vols. I & II. (2nd ed.). The Hague, Netherlands: Martinus Nijhoff.

Stern, D.G. 1991. Models of memory: Wittgenstein and cognitive science. *Philosophical Psychology,* **4**, 201-218.

Stillings, N.A., Feinstein, M.H., Garfield, J.L., Rissland, E.L., Rosenbaum, D.A., Weisler, S.E. & Baker-Ward, L. 1987. *Cognitive science: an introduction.* Cambridge, MA.: MIT.

Stone, G.O. & Van Orden, G.C. 1989. Are words represented by nodes? *Memory & Cognition,* **17**, 511-524.

Strange, J.R. 1978. A search for the sources of the stream of consciousness. In K.S. Pope & J.L. Singer (Eds.). *The stream of consciousness: scientific investigations into the flow of human experience*. New York: Plenum. (pp.9-29).

Stubbs, D.F. & Webre, N.W. 1985. *Data structures with abstract data types and Pascal.* Monterey, California: Brooks/Cole.

Swerdlow, J.L. 1995. The Brain. *National Geographic*, **187**, 2-41.

Taborsky, E. 1985. Syntax and society. *Canadian Review of Sociology and Anthropology,* **22**, 80-92.

Thompson, J.G., Cornell, J.H. & Kirkpatrick, C. 1980. The role of pre-experimental set in adult concept formation. *The Journal of General Psychology,* **102**, 167-174.

Thorndike, E.L. 1949. *Selected writings from a connectionist's psychology*. New York: Appleton-Century-Crofts.

Titchener, E.B. 1898. The postulates of structural psychology. *Philosophie Review*, **6**, 433-439.

Titchener, E.B. 1899. *An outline of psychology.* New York: Macmillan.

Titchener, E.B. 1910. *Text-book of psychology.* New York: Macmillan.

Tolman, E.C. 1948. Cognitive maps in rats and men. *Psychological Review*, **55**, 189-208.

Toskala, A. 1986. The development of cognitive therapy. *Scandinavian Journal of Behaviour Therapy,* **15**, 143-162.

Toulmin, S. 1982. The genealogy of "consciousness." In P.F. Secord (Ed.). *Explaining human behavior*. London: Sage Publications. (pp.53-70).

Tryon, W.W. 1993. Neural networks: I. Theoretical unification through connectionism. *Clinical Psychology Review,* **13**, 341-352.

Turvey, M.T. 1977. Contrasting orientations to the theory of visual information processing. *Psychological Review,* **84**, 67-88.

Vandervert, L.R. 1990. Systems thinking and neurological positivism: further elucidations and implications. *Systems Research*, **7**, 1-17.

Vandervert, L.R. 1991. On the modelling of emergent interaction: which will it be, the laws of thermodynamics, or Sperry's "Wheel" in the subcircuitry? *The Journal of Mind and Behavior,* **12**, 535-540.

Vandierendonck, A. & Van Damme, R. 1988. Schema anticipation in recall: memory process or report strategy? *Psychological Research,* **50**, 116-122.

Varela, F.J., Thompson, E. & Rosch, E. 1991. *The embodied mind: cognitive science and human experience.* Cambridge, MA.: MIT.

Velmans, M. 1991. Is human information processing conscious? *Behavioral and Brain Sciences,* **14**, 651-669.

Vere, S.A. 1992. Open peer commentary: A cognitive process shell. *Behavioral and Brain Sciences,* **15,** 460-461.

Von Bertalanffy, L. 1968. *General systems theory.* New York: George Braziller.

Von Bertalanffy, L. 1972. General systems theory - a critical review. In J. Beishon & G. Peters (Eds.). *Systems behavior.* London: Haper & Row. (pp.29-49).

Voss, J.F. 1979. Organization, structure, and memory: three perspectives. In C.R. Puff (Ed.). *Memory organization and structure.* New York: Academic. (pp.375-400).

Wagman, M. 1993. *Cognitive psychology and artificial intelligence: theory and research in cognitive science.* Westport, Connecticut: Praeger.

Wall, H.M., Karl, K. & Smigiel, J. 1986. Use of contextual information in the formation of cognitive maps. *American Journal of Psychology,* **99**, 517-558.

Watkins, M.J. & Gibson, J.M. 1988. On the relation between perceptual priming and recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **14**, 477-483.

Watson, J.B. 1929. *Psychology from the standpoint of a behaviorist.* Philadelphia: Lippincott.

Watson, R.I. 1968. *The great psychologists from Aristotle to Freud.* Philadelphia: Lippincott.

Weisberg, R.W. 1969. Sentence processing assessed through intrasentence word association. *Journal of Experimental Psychology*, **82**, 332-338.

Werbos, P.J. 1974. *Beyond regression: new tools for prediction and analysis in the behavioral sciences.* Ph.D. Dissertation in Statistics, Havard University.

Wertheimer, M. 1923. Untersuchungen zur Lehre von der Gestalt. II. *Psychologische Forschung*, **4**, 301-350.

Wertheimer, M. 1938. The general theoretical situation. In W.D. Ellis (Ed.). *A source book of Gestalt psychology.* NY.: Harcourt, Brace & World. (pp.12-16).

Wertsch, J.V. 1990. A meeting of paradigms: Vygotsky and psychoanalysis. *Contemporary Psychoanalysis,* **26**, 53-73.

Wessler, R.L. & Hankin-Wessler, S.W. 1989. Nonconscious algorithms in cognitive and affective processes. *Journal of Cognitive Psychotherapy*, **3**, 243-254.

What is consciousness? 1992. *Discover*, **13**(11), 95-100.

Wheelwright, P.E. 1962. *Metaphor and reality*, Bloomington, Ind.: Indiana University Press.

Whitlow, J.W. 1990. Differential sensitivity of perceptual identification for words and pseudowords to test expectations: implications for the locus of word frequency effects. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* **16**, 837-851.

Wickelgren, W.A. 1979. *Cognitive psychology.* Englewood Cliffs, NJ.: Prentice-Hall.

Wieder, C.G. 1984. The left-brain/right-brain model of the mind: ancient myth in modern garb. *Visual Arts Research,* **10**, 66-72.

Wiener, N. 1948. *Cybernetics.* Cambridge: Technology.

Winnick, W.A. & Penko, R. 1989. Encoding effects in one priming paradigm. *Bulletin of the Psychonomic Society,* **27**, 413-416.

Wundt, W. 1894. *Lectures on human and animal psychology*. New York: Macmillan.

Zadny, J. & Gerard, H.B. 1974. Attributed intentions and informational selectivity. *Journal of Experimental Social Psychology,* **10**, 34-52.

Zeeman, E.C. 1977. *Catastrophe theory: Selected papers, 1972-1977.* Reading, MA.: Addison-Wesley.

Zlate, M. 1988. Locul si rolul euli in structura personalitatii: Probleme controversate [The place and the role of the self in the structure of personality: Controversial problems]. *Revista de Psihologie,* **34**, 305-317.