Chapter 3 Delineation of the meta-theoretical framework

3.1 Introduction

To mindfully place dynamic assessment and intelligence into an explored meta-theoretical framework, meta-theory as a concept and received view of theorising will now be considered. However, before meta-theorising can commence, surety is sought about the meanings inherent in the concept of theory and so down the hierarchical scale through to models and frameworks. These all have as a basic point of departure some sort of theory-laden assumptions of what it is these frameworks, theories and models seek to investigate. Theories, models and frameworks pervade all areas of human understanding, and are not relegated to only the natural and social sciences[1] but to the arts and humanities alike. Theory development progresses through each school of knowledge in disparate ways often resulting in heated debates between "opposing" schools of knowledge-procurement. As disciplines differ in their areas of knowledge gathering, so to do their methodologies. Once theories coalesce into more meaningful units of known facts within any discipline, meta-theory may serve as foundation upon which newer theories are anchored. It is to these issues that focus is now turned, initially as pertains to the subject matter of the history and philosophy of science and social science and then more specially as it pertains to dynamic assessment and intelligence within psychology.

Whether it is accurate or not to state that dynamic assessment finds itself in a state of crises regarding underlying aims, theory and model development, it is maintained that it is doubtful whether this field can rise to greater prominence without re-evaluation of its basic philosophical stance on a number of issues (Hughes, 1980). Philosophical issues pertinent to such enquiries include assumptions which are implicitly held but are not explicitly stated, implications of models which are incongruous with purported points of departure, fundamental issues which are not questioned,[2] assumptions which are believed to be commonly held by researchers within a field but are in fact not, misconstrual of terms, unclear usage of concepts, differing methodologies of inquiry (Fiske, 1986) and blurring of the boundaries of investigation into various areas of research within the field. The afore-mentioned list would, at first glance, appear harsh and unfair in the sense that given the nature of social science research, such vague, ill-defined and broad renderings of the meanings of research (Smedslund, 2000) is in fact very characteristic of this area of investigation into human beings. A contentious issue at the very least this may be, but it is one such issue for which some attempt at resolution must be made within dynamic assessment specifically if this field is to prosper.

3.2 Science

The fundamental question of how we know what we know (theory of knowledge) is the area with which epistemology concerns itself (Harré, 1988; Mouton & Marais, 1988). That any area as such exists (what there is) in the first place would be the domain of ontological discussion (Beatty, 1995; Delius, Gatzemeier, Sertcan & Wűnscher, 2000; Fetzer, 2002; Hughes, 1981; Mautner, 2000; Scruton, 2004). Epistemology as a branch of study on its own does not posit forth a list of criteria delineating what is considered tools to knowledge but rather seeks to "describe the conditions which must be satisfied if there are to *be* any criteria of understanding at all" (Winch, 1970, p.21). Broadly defined, epistemology and ontology pertains to the theory of knowledge and how it comes to be that something can be known, if at all (Dennett, 1981; Faust & Meehl, 1992; Smullyan, 1981; Von Foerster, 1985).

This area is primarily concerned with the origins, principles, methods and limitations of knowledge and can be applied in very specific contexts (such as physics for instance) (Abercrombie, Hill & Turner, 2000; Eddington, 1939; Hőffding, 1955; Delius, et al., 2000) although such ponderings were originally not part of the positivist agenda which seemed to claim that such metaphysical aspects were not important to theorising (Tolman, 1987).[3] Philosophy of science may not necessarily question the nature of knowledge but epistemological enquiries into the nature of knowing does indeed question the very foundations upon which assumptions are made and as such the epistemological and ontological endeavour itself cannot be empirically self-validated (Hughes, 1981).

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[1] One of the most succinct definitions of what science is, is that offered by Rogers (1992,p.495): "science is, among other things, scepticism of attitude" and is the closest to the definition endorsed by the author.
[2] Williams (2003) concurs when he states that psychology as a discipline is still struggling to come to grips with its subject matter; "we are engaged in work to which ontology is central, but we lack ontological commitment or even consensus" (p.2) yet Watanabe (2003) states that psychologists are indeed starting to acknowledge philosophical concepts "as not the objects, but the presuppositions, of empirical studies" (p.132).
[3] Please note that the author is not being inconsistent here when it is stated that hers is a predilection for positivist-type philosophies, even though there is a necessary warrant for a meta-theory of sorts dealing with subject matter deemed unnecessary by these very same positivist philosophers. In a sense, it is a step further along the road from strict positivism to constructionism of a kind (although the latter is not endorsed).

By extension then, no epistemological or ontological method can be said to be valid and true.[4] Also, no conclusions can be logically deduced from its own predicates. This is very similar to the axiomatic system of hypothetical-deductive models of explanations so often utilised within the natural and social sciences and which via a process of deducing causal explanations empirically verify (only increasing the theory's probability of being correct) or falsify hypotheses (Popper, 1965; Radnitzky & Andersson, 1978).

A relativism of sorts is not employed in this argument; but that an epistemological and ontological system cannot be self-validating is not equated with relativist philosophies, these two arguments are entirely separated. Seeking alternatives for the nomological mode of explanation does not mean that an argument succumbs to a relativist one. As highlighted in chapter 2, dichotomous views poised on a continuum is a rather unfortunate analogy to use when discussing alternatives to various issues and as such attenuations of the nomological model for instance does not necessarily result in the acceptance of a relativist framework. Dynamic assessment within intelligence research has developed within a nomological-deductive system of predicates and conclusions. As such, it has a history of measurement spanning the twentieth century which had as its foundations measurement ideals emanating from natural science models from the late nineteenth century. Unsatisfactory as this might be for some more progressive philosophers the situation can only be remedied with due consideration of what it is the various models of explanation seek to explain. Jumping from one extreme to another will only incur further philosophical animosity between the so-called ends of the explanatory continuum.[5] The Newtonian models are not perfectly accurate (in fact they are incorrect in non-absolute space-time but for all intents and purposes on our macro-scale they prevail in today's space programmes; Greene, 2004) and neither are psychological models; which as with statistical models utilised in psychology are approximations to reality only (Browne & Du Toit, 1991). A pertinent example is the Rasch model of probabilistic measurement applied with great success and since improved upon in the area of ability assessment (Rasch, 1980) (see chapter 4). Regarding such psychological models, the mathematician Rasch (1980) states "models should not be true, but it is important that they are applicable, and whether they are applicable for any given purpose must of course be investigated. This also means that a model is never accepted finally, only on trial" (pp.37-38).

Science, as some relativists would have it, is another form of religion, a system religiously followed and applied, assuming common understanding by like-minded peers resulting in publishable accounts of knowledge-gathering activities and a system incomparable in getting to the truth of the matter. This statement wavers between truth and falsehood and assumes a middle ground not unlike the grey murky areas in which science is at times practised. In contradistinction to religion yet playing on a similar sentiment a credo may well be "they are here not to worship what is known but to question it" (Bronowski, 1974, p.362). Of course the one time dominant version of what science purported to be was that it was just another form of common-sense and that the scientific attitude was merely an outgrowth of an attitude shared by most people in the first place; a way of pursuing ideas which were rational, testable and legitimate for further study (Schaffer, 1997). There are a number of inescapable facts which cannot be swept under the carpet, and one major bug-bear for social science as a whole is that sub-disciplines are purported to be scientific, as the case may be today ca. 2006. That this will forever be the case is an historical anecdote with which future generations will have to content themselves. What trajectory psychology as sub-discipline and intelligence as further sub-discipline will follow is anyone's guess.

That it vies for current scientific status is not in question; unfortunately how this term "science" is construed and interpreted is open to question. Psychology is a fragmented (or faculty) discipline[6] (Koch, 1985; Scarr, 1998b) just as the study of intelligence is and has been (Detterman, 1979) so much so that many a psychologist will be unable to converse with another so-called

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[4] As it is captured in its own system in which primitives are accepted in order for consequent statements to be made; of course these primitives cannot be defined within the system it purportedly explains as one of two consequences emerge, namely, definitional circularity and definitional regress in which the former merely uses the same language to define other states and these states are in turn used to define them and the latter in which new definitions will have to be continuously sought to define a new word or state and in order to adequately define the new word or state another new definition is employed and so *on ad infinitum* (Fetzer, 2002). Dictionaries are definitionally circular but we can get by with them.

[5] It is perhaps easier for the human brain to conceptualise of a linear continuum, a line spanning the extremes of view points. Is this truly the case though? Perhaps this analogy has failed as mechanism of explanation and as such does not further the cause of viewing particular views as sharing many features. Perhaps overlapping Venn diagrams would be a better-suited alternative.

[6] A clinical psychologist schooled in qualitative narrative techniques might not understand the importance that neural networks play in cognitive science studies of the brain; likewise, the neurobiological psychologist might be similarly at a loss to converse with the clinician about single case-studies dealing with life experiences from an ethnographic point of view. Yet the two are both psychologists; the chasm it seems is too wide for both types to be included in one single discipline (a chasm which is becoming increasingly fragmented, "because it addresses increasingly isolated subspecialties and because it fails to take into account the theoretical themes and problems that motivate the enterprise of psychology as a whole" (Slife & Williams, 1997, p.118). It is routinely accepted that disparate disciplines such as biochemistry and art history for instance have little in common and do not share the same language of research; but it seems that inter-disciplinary fragmentation too is the order of the day. Blurred as this analogy may be, the case for dynamic assessment in intelligence could find itself in a similar situation, with clinically-oriented case study approaches vying for acceptance in stark contrast to computer-mediated statistically valid and highly replicable approaches. Clearly the two approaches spring from fundamentally different philosophies. An extreme view would be a calling for the dissolution of psychology as a discipline and to "reapportion its empirical results to other sciences that carve nature more closely to it joints" (Kukla, 1992).

psychologist. In a manner of speaking, the two are at ends of a continuum which appears to be evidencing an unwholesome crack. Figure 27 illustrates just such a continuum.

Figure 27 (i) Placement of psychology as discipline in between varying poles of methodology and areas of concern (Royce, 1973, p.16)

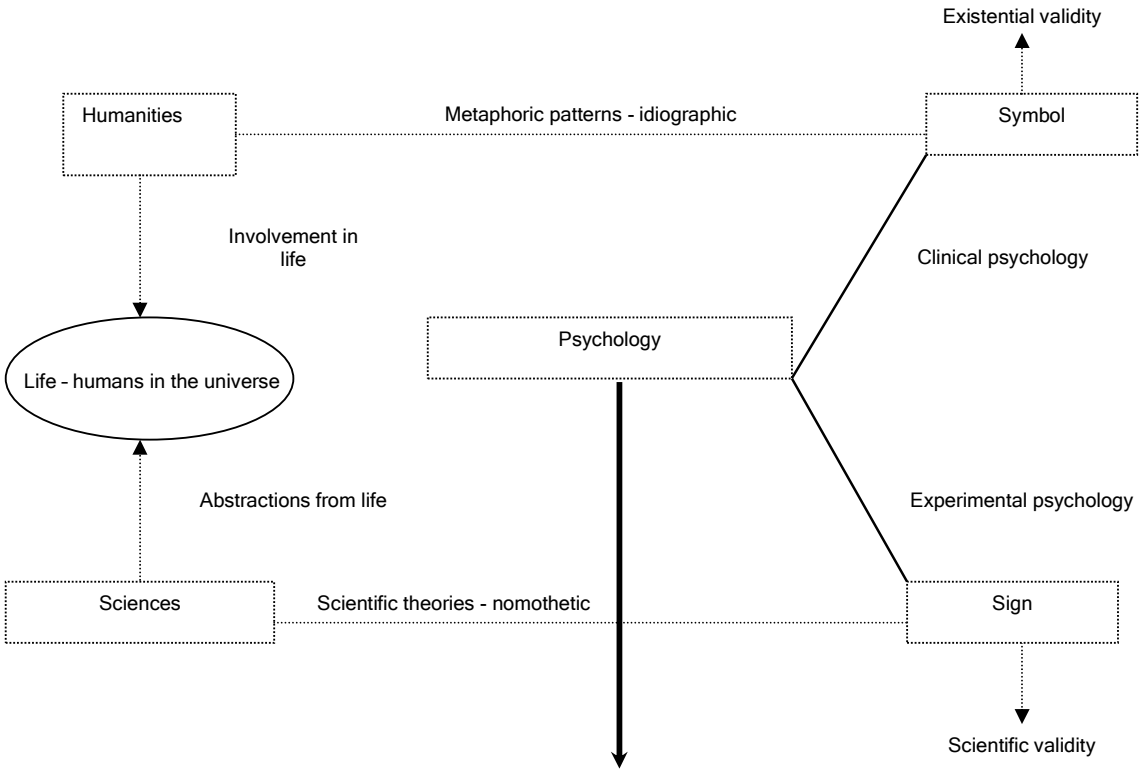
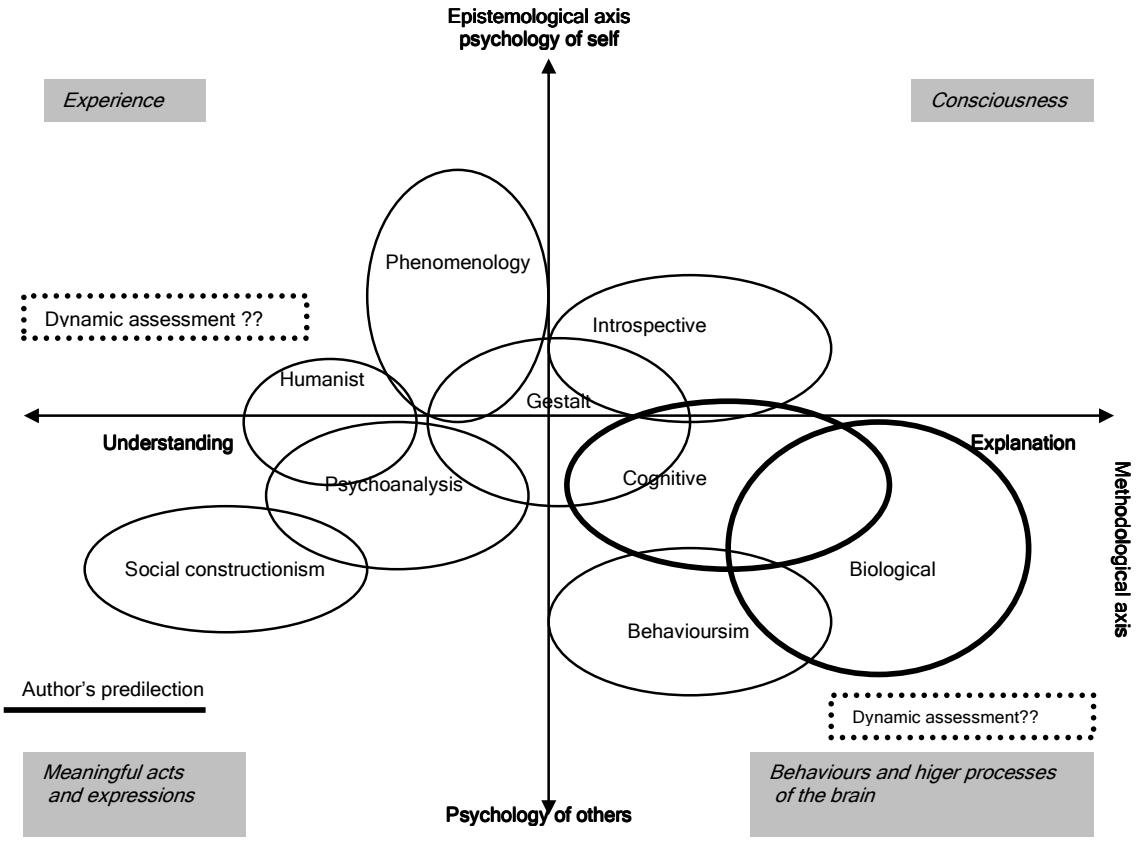


Figure 27 (ii) Trends in psychology with placement of dynamic assessment along axes of epistemology and methodology (Watanabe, 2003, p.131)



Mere conjecture hints at a future with myriad research areas in which the current discipline of psychology will have dissolved into subsumed sections of other disciplines. No value statement can be added to this sentiment; it is akin to the question of whether humans are born good or bad, they are neither - they simply are. This state of affairs should neither shock nor please anyone as such, for it is a statement of the continuing development and progress (also not to be value-construed) of this particular branch (or branches as the case may be) within the social sciences.

Formal recognition of science as a rigorous approach towards the understanding of how things are cannot be exactly dated[7] but can be divided into specific periods spanning time since Greek scholars, flowing along through the Renaissance, Newtonian revolution, the Enlightenment, Darwinian era and in onto the modern atomic era (Gribbin, 1998, 2003; Schwartz & Bishop, 1959a). Lest this list seem somewhat too aligned to physics, astronomy and biology it cannot be underestimated that these explorations and discoveries are due primarily to the luminaries working in these areas throughout these various stages (Asimov, 1987; Ergang, 1967; Hawking, 2003; Schwartz & Bishop, 1959a, 1959b; Uglow, 2003). The trajectories on which they placed ensuing science[8] and the preceding as well as subsequent technological innovations intermingled within the history of science (Cossons, Nahum & Turvey, 1997; Segré, 1980; Snow, 1981; Weber, 1980) and also their impact on the path followed by psychology (Robinson, 2000) can also not be underemphasised. Recall also the number of luminaries within psychology who were originally trained within the natural sciences; and that the period from the 1930's till the 1940's was deemed psychology's immature physics period (White & Pillemer, 2005).

3.2.1 Explanatory mechanisms in science

Explanation in science can roughly be divided into three approaches, namely the deductive-nomological (DN model), causal and pragmatic approaches (Leahey, 2000). Also known as the covering-law model, the deductive-nomological model can be traced

[7] Gribbin (2003), although conscious of the arbitrary dating of the start of the scientific method utilises 1543 as his starting point.
[8] Of course for a more balanced and equal-assignment-of-credit view, Murray (2004) offers a tantalising romp through history and focuses on the luminaries within global philosophy as well the arts.

back as far as Aristotle (Bechtel, Mandik & Mundale, 2001; Robinson, 1985) and has developed and been formulated into its modern form (1948) by Carl Hempel[9] and Paul Oppenheim. It remains the model adhered to in current scientific and social science explanation (Bechtel, 1988; D'Andrade, 1986; Mouton, 1993a; Nagel, 1979;) as it seeks to not only logically deduce arguments and observables (via premises that state sufficient conditions for the truth of the explanation) but also to predict.[10] Although utilised for theory testing it is not as useful for theory construction (Smedslund, 2000) but has proven its worth in areas such as physics in which logically-deductive arguments are predicated on sound laws[11] from which a deductive argument can reach a conclusion that is also sound and perhaps more importantly, valid (Woodward, 2002).[12] Nagel (1979) maintains that probabilistic explanations can be construed as temporary halfway stations to the ideal of deduction in which explanatory premises contain statistical assumptions about elements while the resultant explanation contains just a singular statement about an element. A well-known theory of this DN type, considered also as a "strong"[13] theory is that of Newtonian gravitation (Eysenck, 1985). It ties in well with positivist thinking whilst offering explanatory functions and its results can said to be useful. This type of explanatory model is satisfied with predictions and law-like control of nature (considered as the main aims of theories in general; Reynolds, 1971) yet does not have as a goal explanations into how and why things work the way they do. The tension arising from the need to predict as opposed to explain has permeated through to the foundations of test theory and measurement within psychometrics (see chapter 4) (Das, Naglieri & Kirby, 1994; Meier, 1994). However, lest we should go astray and erroneously think that empiricism has been the goal always striven for it should be noted that Newton's law of gravitation as well as Mendeleev's periodic table are conceptualisations based partially on presuppositions and hypotheses (hence *a priori* ideas) (Emsley, 2003; Niaz, 2005) mingled with experimental data (the quantitative imperative; see chapter 4).[14]

The sharp distinction between pure empiricist natural science and fuzzy social science is a myth. This attribute is emphasised in causal models of explanations which seek something beyond utility; that of truth.[15] Early crude empiricists maintained that the truth can be obtained via an objective study of phenomena, that this can concluded with certainty and due to lack of error inherent in the deductive method the conclusions would be valid and objective and thus not open to interpretation (Doyal & Harris, 1986). Of course it is these very four issues which became rather problematic for some natural science disciplines and more so for the social sciences. As Secord (1986) argues, Bhaskar maintains that egregious errors emanating from just such a model creates more problems than it solves. Firstly, the world is not a closed system but open and thus extremely difficult to express in terms of law-like governance; secondly, observable regularities are confused with the abstract entities of science; thirdly, concomitant events are often misconstrued as cause and effect thus resulting in the incorrect inference that laws govern systems whereas they in fact restrain the system and lastly, the task of the social sciences is not to determine regularities in behaviour but to discover their nature and effects. Clearly psychology was following the dictates of a severely limiting and possibly altogether incorrect framework for conducing its own research.

Clark Hull's reliance on the inductive hypothetico-deductive method of theory development was strongly positivist influenced and thus influenced many psychological experimentalists. Taking "primitive" theoretical statements (although supported by physical fact) as his starting point he was able to manoeuvre through a system of protocol sentences and arrive at conclusions based on induction and hypotheses testing (of which the limitations will be discussed in chapter 4) (Reber & Reber, 2001; Sanders & Rappard, 1985; Turner, 1967). Testing in this model is absolutely contrary to Popper's view on testing (Sanders et al., 1985) but

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[9] Who later adapted the DN model to allow for inductive-statistical explanations in which events could be highly probable (Bechtel, 1988). And so the pieces of the puzzle are being put together, where in 2006 psychological assessment has as its historical origins logical positivism, hypothetico-deductive, inductive and nomological-deductive as well as statistical inferential foundations. It has a lot to contend with especially if it now seeks to re-establish itself within a broader emancipatory and critical framework. If this is where it belongs then so be it. If it belongs to the stratum of reductive psychology then so be it. The issue here is that is has to sort itself out before it can continue on a trajectory of stagnation. See chapter 4 in which Hempel's paradox is viewed from a mathematical point of view thus linking certain aspects of chapter 3 to those in chapter 4.

[10] Turner (1967), however, questions the similarity of logical structure between scientific explanation and scientific prediction. Prediction is not only the hall-mark of the scientific quest but reflects an almost too human character trait as humans regularly employ methods of prediction - whether they be accurate or not (Ravenscroft, 1993). Scientific prediction then, is really only an extension of this intuitive behaviour. Thankfully, our intuitive appeal for prediction has matured into a matter of scientific prediction overlaying our inaccuracies in predictions which in everyday life do not consider prior probabilities inherent in the logic of statistical prediction (Kahneman & Tversky, 1973).

[11] Science is peppered with laws and include among others electromagnetic field theory of light, Richter's law of reciprocal proportions, Charles' law of gases, the law of combining volumes, the Zeroth law, the valence concept and the laws of mass actions (Bryson, 2004, p.153).

[12] It must be stressed that although this model appears logical and straightforward it does distinguish between the context of discovery and the context of justification in which the former need not be conducted in any logical manner at all (much of dynamic assessment's roots are not so-called logical discoveries) but in which the latter is placed under scrutiny and it this context of justification with which the positivist model of deductive-nomology concerns itself (Bechtel, 1988).

[13] It is considered "strong" due to the large number of independent observations made over time which have concluded similar findings (Eysenck, 1985).

[14] Niaz (2005) draws a further comparison between the strategies deployed by Galileo and Piaget; both utilised idealisations based on presuppositions characteristic of constructivist-rationalist theories as opposed to the naïve falsificationist strategy employed by the quantitative imperative - an issue to which we shall return in chapter 4.

[15] Something which is hardly ever attained nor attainable in the social sciences (Faust & Meehl, 1992). Is this really the case though? The supposedly "purest" of scientific disciplines, namely mathematics, is itself not consistent within its own tenets of truth or indeed can even determine what a truth might be; in this regard see chapter 4's dealings with the mathematical realm.

as Meehl (1990) fervently states, Hull's now dead theory did highlight the lengths to which research psychologists needed to go if indeed their chains of logical deduction were to in any way be considered rigorous. If this monumental effort was necessitated by a "simple" theory of rote learning what hope for the more complicated and auxiliary-filled "soft" theories permeating psychological discourse? Along with this psychological experimentalist trend, inferential statistics became institutionalised in American experimental psychology during the 1930-1950's paving the way for novel cognitive concepts to arise out of various statistical inferences from experiments (Gigerenzer, 1991; Porter, 1997; Schmidt & Hunter, 1997). A reason given for the use of such generalising statistics is due to the inherent complexity of the social sciences (Lykken, 1991) in deriving exact causes and consequences of various behaviours, thus relying on statistical aggregates (Nagel, 1979). This so-called monumental confluence of hypothetico-deductive, nomological-deductive and inductive method of hypotheses confirmation or disconfirmation along with the overwhelming influence of inferential statistics[16] and the need for quantification arising from the empiricist programme[17] (Gergen, 1987a) as utilised within psychology, led this discipline down a path of scientific technique enabling (or granting) it a status alongside that of natural science disciplines (Rozeboom, 1995). Surely this is hard-core science? So it would seem. Throw into this mix strides made in cognitive psychology and cognitive neuroscience (with all its attendant problems) and one can immediately understand the attraction of reducing psychology to its more physical counterparts.

Causal explanatory models can be considered as traversing a step further along the path of understanding, as it applies positivist rigour with contemplation of how truth can be attained and does not merely focus on the attainment of law-like structures purporting to control and predict (Leahey, 2000). In other words, correlations obtained within the explanatory system of nomological models can be turned into causal models within the latter approach and this model attempts a finer-grained understanding of the varied causal features in a system (Woodward, 2002). Criticism is again at this latter view, as it cannot objectively state that a system in its entirety can be known (akin to the relativist qualm that we can never truly understand ourselves if we are to be the investigators within the system; see chapter 2 in which this view is severely tempered by its own limitations and constraints). It is virtually impossible to trace all possible causal mechanisms working in and on the system. Pragmatic models of explanations maintain that explanations are neither correct nor incorrect but should be considered as temporary satisfactory answers depending on the nature of the context. In sum, deductive-nomological accounts of science are often construed as anti-realist in which the observation of a system is enough for its theories to be useful, whereas the casual-realist accounts are inferred from the observations of the system and hint at the truth of the system (Leahey, 2000).

3.2.2 Scientific theories

The nature of natural science theories can be broadly divided into reductionist, realist and instrumentalist accounts of explanations (Brody & Capaldi, 1968) and these demarcations of science method are also applicable to models within test theory in psychological measurement (Borsboom, 2005). Reductionist trends, as exemplified by physicists such as Ernst Mach[18] (1838-1916), (although Mach could also be classified as an instrumentalist) (Campbell, 1989; Mautner, 2000) and William John Rankine (1820-1872) seek to reduce explanations to more basic theories of explanations and when applied in very specific contexts afford a workable manner of explanation (Meehl, 1986). When taken over into the social realm however, problems arise. In its most extreme (and at times absurd) form, reductionism strives to explain phenomena in ever-decreasing scales of explication (Gell-Mann, 1998; Seager, 2001; Wimsatt, 1986) and in so doing explains aspects at one level of description in terms of another level (Dupré, 2001; Hempel, 2000; Quine, 2000; Ryan, 1970) hoping to have as a result the unification of science (Cronbach, 1986; Eysenck, 1987; Hooker, 2001). This not only occurs across disciplines but within disciplines too such as the ever finer grained or reduced scaled version of the particle nature of reality (in which tinier particles are explained within even briefer intervals of time; Gleick, 1991[19]). Human behaviour can be traced to neuronal firing patterns evidencing sequences of such-and-such a nature (Wilczek, 2002), in turn these firing neurons are controlled by neurochemicals which are themselves constituted from molecules (Kalat, 2004) which are in turn made up of atoms which are reduced still further to quarks which can be reduced into vibrating strings,[20] and as with many a slippery-slope argument, the initial statement is bounded to the last statement thus concluding that vibrating strings are related to human behaviour. This is denoted as being rather absurd but similar attempts to simplistically reduce human behaviour are the hall-marks of extreme reductionism. The interactions between microlevel patterns of neuronal functioning and macrolevel behavioural responses has been posited as a neuronal theory of personal identity (akin to the reductionist trend to identity consciousness with brain occurrences) and has been employed as explanatory mechanism to describe neural Darwinism (Sacks, 1995).

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[16] Is it true that "numbers, massaged with statistics, become facts" (Gazzaniga, 1995, p.165)? Is this psychology's legacy? Should it be?
[17] Leading psychology "to an inverse relationship between the growing precision of its analysis and the shrinking significance" (Shames, 1987, p.26). Psychology also took its lead from the logical positivists and paved the way towards operationism as exemplified by S.S. Stevens (see chapter 4) in psychology (Grace & Farreras, 1998).
[18] To offer a rather tentative but direct link with one of psychology's founding scientists, William James in fact encountered Mach in 1882 and was quite impressed with his expansive knowledge of most things (Bernstein, 1993).
[19] How far can physics take us on a journey through lower-level descriptions? What lies beyond string theory and its latest incantations such as M-theory (Kaku, 2006)? These are indeed exiting questions. Sterile neutrinos are the latest of a long line of particle offings (Muir, 2006).
[20] String theory (Greene, 2004; Kaku, 1999); a proposal for uniting "quantum and relativistic physical theories that have resisted, since Einstein's day, all efforts to knit them into a unified theory" (Hébert, 2005, p.488).

A tempered view consists of taking the behavioural aspect and treating it as an already reduced phenomenon akin to a physics-envy view of sorts (Midgley, 1999) although this too runs into its own problems. The boundary between ontological and epistemological reduction needs to be drawn as the case may be with physical entities such as real-world items (ontological realism might posit that reality is at its most minimalist a real thing and is explicable in terms of fundamental physics) as opposed to representational items such as theories or frameworks (epistemological, in which theories and laws in one science can be explainable in terms of laws from another science) which are reduced (Silberstein, 2002; Tipler, 1996). Are we seeking to reduce behaviour to brain or a theory of behaviour to a theory of brain? If so, according to methodological realism, this would be a good path to follow (Tipler, 1996). The two are distinct and this study focuses almost exclusively on epistemological reduction, in other words studying theories/models as they pertain to dynamic assessment within intelligence. This is the case with some evolutionary psychologists positing just such a reduction from behaviour to biology (mind-brain to adaptive functioning),[21] invoking lawfulness where there perhaps is none, after all biology is a case in point in which few laws are in fact known (Looren De Jong, 2003). It was thought prudent at the outset (chapter 2), however, to argue the author's predilection for ontological reducibility.

Realist trends within physics are exemplified by the theories of Arthur S. Eddington (1881-1944), Werner Heisenberg (1901-1976) and the philosopher of science, Emile Meyerson (1859-1933) for instance. Realism purports to verify, develop and prove for and within theories actual real world entities that can either be directly or indirectly observed or at least inferred (Erwin, 1985). It seeks to describe reality (Preston, 2001) in as truthful a manner possible seeking this truth from phenomena accessible to experience (direct or inferred) (Fetzer, 1993) and to make manifest (at least theoretically) that which is unobservable (Achinstein, 2001; Trout, 2001a). Some philosophers (Van Fraassen for instance) temper this strict realist notion by stating that science should aim for empirical adequacy only and that there need not be a complete correspondence between theory and empirical models (Giere, 2001b; Sklar, 2001). This account of reality is undoubtedly successful, as technological advancement has evidenced (Leplin, 2001) which cannot be denied; what is in question is its application within the social sciences. Broadly, realism can be sub-divided into among others (Mautner, 2000)[22]

- category independence (subsumed within this are realist trends such as ontological, conceptual, scientific modal and moral realism) which posits that reality as such exists independently of our knowing
- semantic realism in which every declarative statement has a truth value even though we might not know this value
- epistemological realism in which mind (read brain) and world co-exist in explanation

As progress in technological advancement has shown, what was once considered a representationalist view of a realist account of nature (in other words certain subatomic particles were thought to exist as hypothetical constructs only) has now been reified into manifest entities (these said subatomic particles actually exist), in other words, some realist accounts of science which were previously representationalist are now manifest reality (Hacking, 2000). This increasing empirical content within science, which sought to advance rationally, was at odds with the notion of science advancing as a psychological or social enterprise (Giere, 2001a). Realist accounts of psychological constructs such as intelligence propound that, as a construct, it exists in some manner which can be indirectly accessed via scores on intelligence tests. One might not be able to see or touch or otherwise sensorily perceive "it" but it exists as a relevant concept. It exists via its causal relation to instruments that find it (Borsboom, 2005).

Instrumentalist accounts within physics are exemplified by, among others, Nicolas Copernicus (1473-1543), Isaac Newton (1642-1712) and Pierre Duhem (1861-1916) (Brody & Capaldi, 1968). Philosophers included in this category include the pragmatists (and in some instances positivists, the movement from which it sprang) William James, Ernst Mach, Moritz Schlick, C.S. Peirce and John Dewey (Leplin, 2001; Mautner, 2000). Instrumentalist accounts of science view theories as neither right nor wrong but as tools towards better understandings of how things are (Borsboom, Mellenbergh & Van Heerden, 2004; McErlean, 2000; Misak, 2001). Subsequent technology arising out of instrumentalist theories are considered merely as artefacts and devices which themselves embody no value as such but are valued for their utility only (Tiles, 2001). Theories are thus denied truth-values (Musgrave, 1985) (according to strict anti-realists though as there are tempered views concerning this issue). They assist in prediction and are considered more for their utility value than for any supposed truth although in some instances their utility value is considered as truth (Lakatos, 1993; Mautner, 2000). Their lack of falsity or truth implies that they cannot be held up to refutation as they cannot be tested. They are instruments describing ideal situations not accounts of how things actually are hence they are not empirically observable (Nagel, 2000; Popper, 1993). In its strictest form, what matters most to the instrumentalists is the predictive value of their theories (if it works what does it matter whether the theory is a true account of what is actually happening?) (Healey, 2001; Kincaid, 2002; Michell, 2002; Newton-Smith, 2001b) and not the truth

[21] Although there is much to attract one to evolutionary psychology (as a researcher who in fact leans towards a reductionist agenda, various arguments posited by the evolutionary psychology discipline are compelling), a case can be made in favour of a less restrictive account of human functioning in present-day society.
[22] Other sub-divisions include legal, political and literary realism with which this study does not concern itself (Mautner, 2000).

nor falsity of the theory per se.[23] Such a view, seems to pervade the literature on intelligence assessment and research in which predictive validity is paramount to substantive theory progress, moreover, the particular semantics chosen in any particular theory of mental test measurement is likely to change depending on the chosen theory (Borsboom, Van Heerden & Mellenbergh, 2003). Instrumental accounts of intelligence for instance are not as concerned with the existence of the construct as are realist accounts of intelligence. Instead, the instruments utilised to interpret what manifests as intelligence are part of the theoretical workings of such accounts of intelligence. Truth is not of concern but the usefulness of the theory is of prime concern for instrumentalist accounts. Instrumentalist accounts "licence inference to as yet unobserved data" (Borsboom, 2005, p.103).

For instance, models of how forces may work in nature typically describe a system which is not a true system as found in nature. A rock hurtling through the air will slow down due to friction but in a pure model (not an ideal body) this is not the case which may illustrate all the forces acting upon the rock without that of friction. Likewise, in social psychology theories, "laws" of behaviour prescribe certain actions that will occur when certain conditions are met (Kelly's causal attribution theory;[24] in which behaviour of self and others can be determined via causal mechanisms which can be precisely identified) (Baron & Byrne, 1997) but do not result under different conditions and so is not truly a law[25] as commonly understood in the deductive nomological account. Just as in the descriptions of ideal bodies in ideal conditions, theories in psychology too are ideal systems (Converse, 1986; Niaz, 2005). In order to make more law-like the psychological phenomena warranting explanation, the collection of large-scale statistical information was originally viewed as a step it the right direction (Danziger, 1990), securing for psychology a place on the stage alongside science. This is an issue with which researchers are currently saddled, namely statistical aggregation derived from an individual difference model of human functioning (itself being predicated on Galtonian psychology as opposed to other initial branchings within psychology as evidenced by Wundt and Binet) (Danziger, 1990). As opposed to realist accounts of occurrences in nature which maintain a correspondence of terminology and actual physical entity (there truly does exist such a thing as an electromagnetic field), instrumentalist accounts will acknowledge that any explanatory model will merely serve to elucidate the functioning of a system. In other words depending on the nature of the context, liquids can be treated as compounds of discrete particles but in order for other hypotheses to be granted explanatory status this same liquid can be treated as continuous (McErlean, 2000). Symbolic representation[26] of instrumentalist theories provide heuristic value of how to calculate and infer from and predict certain outcomes (Nagel, 2000) but reject semantic, epistemological and ontological realism in the conventional sense (Tuomela, 1973). Although there are innumerable laws in physics for instance, the same cannot be said of psychology which only evidences a few general laws (Reber & Reber, 2001). Not all instrumentalists (like with any movement or philosophical affiliation) can of course be blanketed under the same term and the world can be viewed simultaneously as sets of signs as well as real-world things (Hughes, 2001).

3.3 Social science

How natural and social sciences are bound or not is a contentious and heated debate. The arguments are even considered stereotypical (Gould, 2001a) and McErlean (2000) offers an illustration of how the two may be related in various manners. As (i) a continuum of knowledge gathering, (ii) building blocks, (iii) developmental branches and (iv) non-hierarchical overlapping schemes. Each of these illustrations have their own merits but do not consider the entire relation in its totality. It seems that an

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[23] For instance, nature's constants are very precisely determined but physicists are unable to determine why they yield the values they do; the fact that these constants cannot be explained yet form the edifice upon which science is based could be crudely considered an instrumentalist account of such constants (Barrow & Webb, 2005). To add fuel to the fire it is a perfectly plausible notion entertained in the scientific literature that so-called "laws of nature" may only be applicable to this particular universe that we happen to inhabit at this time. So, laws of nature too are a relativist notion, of course chapter 2 summed up the argument for a realist and objectivist stance regarding just such issues (Tegmark, 2003). If taken to its logical conclusion one might be forgiven for thinking that if even the bastion of all natural sciences is an inconstant and variable field of study what of the rest?

[24] Interestingly enough, Gigerenzer (1991) states that Kelly's causal attribution theory and theoretical development proceeding it in fact followed a naïve manner of experimental design, a sort of folk Bayesian statistics in the brain (as opposed to Fisherian). In a way this makes sense, seeing as causal attribution mechanisms do indeed work, as theorised, in everyday life. Are we, as evolved beings, more attuned to Bayesian statistics as opposed to other types of statistics?

[25] Perhaps the closest approach to lawfulness of sorts achieved within psychology is the phi-gamma law pertaining to stimulus-response behaviour (McDonald, 1999). This law's underlying function in addition to Spearman's common factor model resulted in item factor analysis or commonly known today as item response theory (see chapter 4 for more on IRT).

[26] Ramsey sentences (a technique devised by Cambridge philosopher Frank Ramsey) are just such an example in which theories are "deflated" by virtue of eliminating concepts and circular definitions from the theories and replacing them with symbols or variables instead and in philosophy of mind mental concepts can be done away with entirely (Maslin, 2001; Mautner, 2000; Meehl, 1992; Nagel, 2000). Such semantic instrumentalism is thus without meaning (Tuomela, 1973). Theories are "axiomatised in first-order predicate calculus using proper axioms and hav[e] distinct observational and theoretical vocabularies which are related to each other via a dictionary of correspondence rules" (Suppe, 2001, p.390). Similar to this is Craig's theorem which seeks to vindicate instrumentalist accounts of science by proving that theoretical terms are not essential in specifying a theory's observational variables (Erwin, 1985; Hempel, 1970; Suppe, 2001b). Such predicate calculus along with syllogistic reasoning and inductive logic (exemplified by Mill's principles of experimental reasoning and Bayesian statistical inference) all make for the hall-mark characteristics of positivist tools of science-practice (Shweder, 1986) which of course has plied its way through psychology and on into assessment which is where this sub-discipline how finds itself located. Ramsey was a modern exponent of the logicist movement within mathematics (Eves & Newsom, 1965) and first put forward "the subjective interpretation of probability theory" (from Bayes' theorem) in 1931 (http://en.wikipedia.org/wiki/Bayesian_probability). See chapter 4.

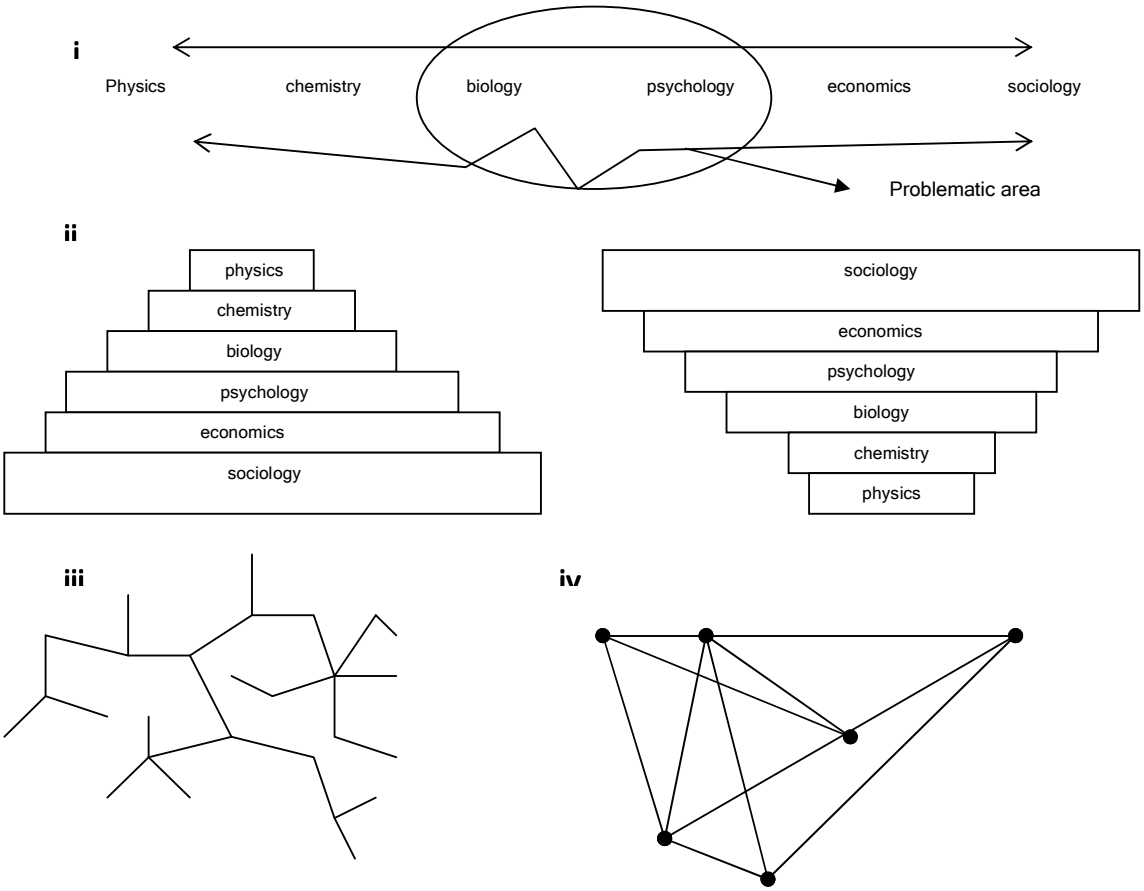
amalgam of these descriptions would best capture the link between the types of sciences. Both natural and social sciences can be layered in parallel as the following table depicts:

Table 5 Conventional hierarchical arrangement of disciplines, in which physics is considered the ultimate as reductionist explanatory mechanism (McErlean 2000)

Entities	**Disciplinary parallels**
Social groups and multicellular living things	Sociology, psychology, economics
Cells	Biology
Molecules	Chemistry
Atoms	Macro physics
Elementary particles	Micro physics

Economics is reduced to the psychological; psychology is reduced to the neurobiological; biology is reduced to the chemical; chemistry is reduced to the physical until such time that economic behaviour is treated as a result of cascading cause and effect. Why are the natural and social science so divided? It cannot be that the subject matter is in any measurable way to "blame" as such for the extent to which knowledge acquisition is scientific is not determined by the problem's origin (in this regard Wilson; 1999 firmly maintains that the social and natural sciences are indeed compatible). What can be apportioned "blame" is perhaps the manner of investigation (Sanders & Rappard, 1985) notwithstanding psychology's long utilised model of the natural sciences as *the* model (Van Strien, 1987). Therein lies the issue at hand. Are the social sciences really predicated on axioms of determinism (prediction and control), atomism (reduction and parsimony) and universalism (replication) (Kristensen, Slife & Yanchar, 2000)? Are new axioms warranted to the extent that the social sciences are no longer classifiable as science? Eysenck (1987) states that lack of theoretical foundation is in fact an "unverbalised axiom" of social sciences and underlies much of psychologising (p.49). Figure 28 illustrates the relations between varying disciplines; a manifold of knowledge acquisition seemingly disparate and at odds but also conciliatory if given the right conditions (Wilson, 1999). Gould's (2001a) sentiment wraps up the case for a stereotypical rendering of the polarity of both the hard and soft sciences; "we have, on the one hand, the "hard", or physical sciences that deal in *numerical precision*, prediction, and experimentation. On the other hand, "soft" sciences that treat the complex objects of history in all their richness [which] must trade these virtues for "mere" description *without firm numbers* in a confusing world, where as best, we can hope to explain what we cannot predict" (own emphasis) (p.496).

Figure 28 Relations among scientific disciplines, (McErlean, 2000)



It can be stated that psychology should or should not be classified as a science but it can also conceivably be stated that as human beings undertake the study of physics, chemistry, geology and so on that science itself is a psychology of sorts which is why it becomes difficult to determine which "layer" of a discipline supersedes any other layer as is commonly understood to be the case (Stankov, 2005a) in illustration number ii above in figure 28. Essentially all scientific activity is undertaken by human beings and hence is "contaminated" by human flaws in whatever manner speaking. The retort to this might well be that despite all human failings and subjectivities, the colour blue can still be measured as 480 millimicrons on the light spectrum no matter what. The big question then is thus: can the social sciences be referred to as such? Firstly one needs to establish what it means to refer to something as a science. Depending on the definition one assumes this question can be answered in many different ways. Newell (1990) highlights the difference between theorists and theories stating that the latter are approximations yielding answers which the former do not do; "theory gives the answers, not the theorist" (Newell, 1990, p.13) but this can be disputed within the social sciences where knowledge is said to be constructed by the theorist. It is precisely for this reason then that chapter 2 was thought integral to this study, as the author's leanings in many regards will undoubtedly influence the outcome of just such a study. Wilson's (1999) treatise on consilience, although not free of critique conveys a strong message of the necessity to reconcile disparate and seemingly disunifying subjects of study and where natural scientists have made strides social scientists have lagged behind, "social scientists by and large spurn the idea of the hierarchical ordering of knowledge that unites and drives the natural sciences" (p.201). Gould (2000b) maintains that just this hierarchical arrangement or "the status ordering of the sciences has become so familiar a theme that the ranking from adamantine physics at the pinnacle down to such squishy and subjective subjects as psychology and sociology at the bottom has become stereotypical in itself" (p.278). Evolutionary psychology and cognitive science has been proffered as unifying or integrative disciplines for cross disciplinary social sciences (Kenrick, 2001) including serving as unifying theory within psychology (Newell, 1990) but others state that these subjects are themselves in need of taxonomic models (Bowman, Markham & Roberts, 2002)! These domains are not, however, without their detractors but when their subject domain is considered it is understandable at certain levels as to why this has been suggested. It is worth citing Lehman, Laird and Rosenbloom (2006, p.2) and their appraisal of Newell's concerns for cognitive unification as it resonates so well with this thesis' concern for similar unification or at least the building of a unificationist framework in which to serve as possible meta-theory for dynamic assessment

> If we think about cognition as a big picture, then a microtheory is a way of cutting a portion of that picture into a jigsaw puzzle. Each theory may cut up its own portion, even a portion that overlaps with another theory's, in a different way. So, when each discipline throws its set of pieces out on the table, how do we know that there is any set of pieces that will allow us to recover the big picture? The only way, Newell argues, is to go ahead and try to put the whole picture together, to try to build unified theories of cognition (UTCs) (Newell, 1990).

Strict behaviourists assumed that laws had in fact stated generalities which could be replicated in other similar contexts such as the law of effects, with Thorndike later producing variants on this law (Reber & Reber, 2001; Thorndike, 1981). However, even this seemingly scientific law in the sense of strict correspondence between language and entity (extensional context) is not what it appears to be as the behaviour of many an organism is not a straightforward law-like one. Moreover this law is tinged with slight teleology (or "functionality", where the role an action plays brings about its goal, Nagel 1979; Van Hezewijk, 2003) and it represents a law more to do with the intention within the organism than the behaviour as such (Lillegard, 2004). Despite the law's hypothetical-deductive veneer it still is not strictly a law as understood in the natural sciences.

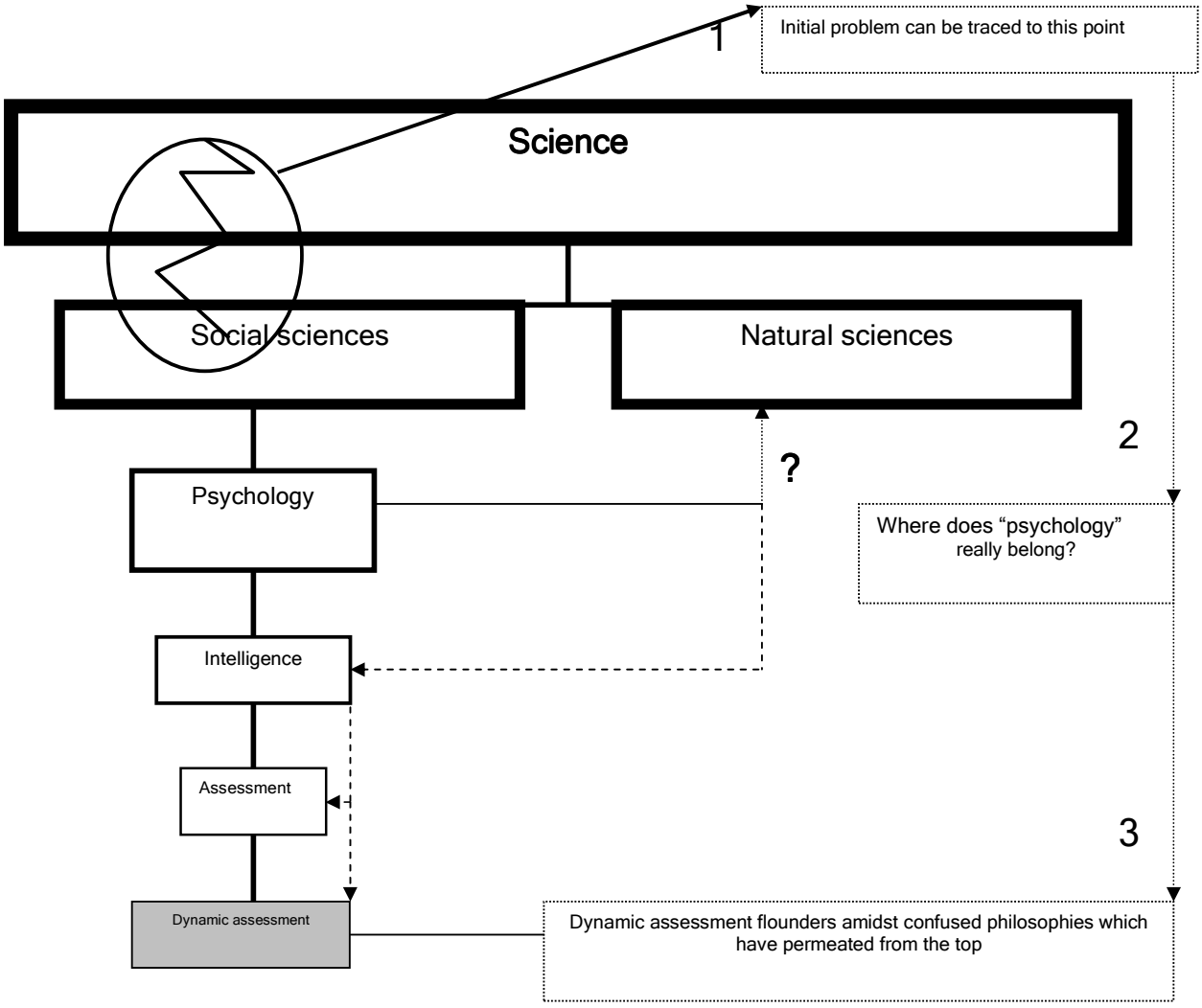
Once again it would seem that a dichotomous continuum looms ahead on which must be placed the practice of social research and the methodology utilised to do so. Need there be such a dichotomy? Social science in its currently accepted form will never truly be scientific in the sense that it pertains to the natural sciences, this much is clear; and yet, it need not conform to a strict natural science methodology in the first place. But then it surely cannot refer to itself as a science. Thus we have a divided camp of social studies researchers who profess to work in one and the same area but make use of at times opposing methodologies. Society demands of a discipline that it avail itself of predictive cause and effect mechanisms, as most often is the case, research is conducted in order to clarify how things happen the way they do and how better we can predict things in general. This is in addition to the pragmatic need to aid humankind to do its work in everyday life (Dilthey, 2000). Much of social science research does not even attain minimal levels of predictive success however much it admits of explanatory and understanding value (Kellert, 2000). Philosophical debates ensue however whenever it is purported that explanation inevitably leads to prediction, yet if much of social science research can stand up and be counted as explanatory mechanisms surely they fail somewhat miserably as predictive vehicles? This brings into question the deductive-nomological model of explanation and its supposed explanation-prediction symmetry (Kellert, 2000). Models of learning and the tests that are subsequently devised to test for learning and potential to learn are all predicated on some sort of model or theory which states its explanatory power, yet many of these devised tests are unable to predict results in any meaningful way. They explain but cannot predict and this, it seems, is odd. The question of natural science explanatory model fit within the social sciences becomes suspect; not the model per se but its application.

Rosenberg (2001) asks the simple question of why the methods employed by the natural sciences are so unsuccessfully employed by the social sciences and offers four tentative answers:

i. the social sciences have not sufficiently progressed due to not having applied the methods well enough
ii. the methods which the positivists employed for the natural sciences were in fact flawed from the start and these flawed methods were simply carried over into the social science arena
iii. the social sciences are in fact on the right track, are using the correct methods and are progressing well enough but due to the inherent complexity of the subject matter progress is slow ("hypercomplex"; Wilson, 1999, p.202)
iv. the social sciences have indeed made strides but different standards need to be utilised when judging the social science enterprise

In tracing back the philosophical dilemma in which it is hypothesised dynamic assessment finds itself, it is not unreasonable to suggest that the method of assessment is not entirely to blame for its predicament, if as has been stated above, the larger context in which it is placed is itself muddled and confused. The inability to distinguish methods and the difficulties which the social sciences in general face merely compounds the problems that lie ahead for the various sub-disciplines which are cloaked thereunder. This methodological and philosophical muddle seeps down through to the various disciplines. Exploring the meta-theoretical background and underpinnings of not only dynamic assessment within intelligence but the spectrum of the social sciences is warranted when it is understood that there is a basic tension underlying the social sciences. Psychology is merely one of the disciplines which finds itself on a tight rope betwixt and between various methodologies. Intelligence assessment is a subsidiary of psychology and dynamic assessment is itself a manner of assessment and so right down to the core of the approach this basic tension is found. How should this tension be addressed? From the bottom up or from the top down? Possibly both avenues can be pursued but it is contended here that a bottom-up approach would most likely succeed as individual disciplines will have to figure out a way of solving their own dilemmas and so individually manoeuvre themselves without being given a mandate to do so from above. Dynamic assessment in this regard can be viewed as being situated at the bottom of the pile and this is just as good a place to start sorting out fundamental issues as anywhere else. Figure 29 illustrates the level at which dynamic assessment is placed and how initial problems become magnified later on down through the sub-levels.

Figure 29 Permeating tension: how an initial higher-level problem becomes manifest at lower levels



Machlup (2000) offers a framework[27] from which comparisons can be drawn between the natural and social sciences and concludes with a score card enumerating the results achieved from this comparison. The grounds of comparison include the following:

- invariability of observations
- objectivity of observations and explanations
- verifiability of hypotheses
- exactness of findings
- measurability of phenomena
- constancy of numerical relationships
- predictability of future events
- distance from everyday experience
- standards of admission and requirements[28]

[27] The astute reader might well note that the list itself is very "natural-science biased"; in other words conclusions can already be formulated long before any comparisons are made by mere fact that the grounds for comparison are criteria that are routinely utilised within the natural sciences as a given. The list could look radically different if viewed from an hermeneutic vantage point for instance. But the point within this chapter is to analyse just this issue: the social sciences as compared to the natural sciences as well as the practice of the social sciences within a milieu of natural science biased views and opinions.

[28] A slightly more pragmatic concern which, in a manner, stands apart from the previous criteria which are more general and abstract in nature.

Invariability of observations

Are natural science observations as homogeneous as conventionally accepted? Is invariance not present to a greater degree than is commonly accepted? Likewise, are observations within the social sciences as heterogeneous as conventionally accepted? These are the questions asked by Machlup (2000) in defence of social science when accused of inferiority. The fact that words are coined which have generally accepted meaning ascribed to them attests to some social science endeavours attempts at explanation. Nomothetic and idiographic explanations of phenomena evidence the degree to which explanations are generalisable or individualising; the former being aligned to the natural sciences and the latter to the social sciences. Both spheres of science employ nomothetic and idiographic explanatory powers. Surely biology is clearly far more idiographic in explanation than physics for instance and social science explanations often extrapolate across times, for instance in terms of the predictive formations of human cultures across the globe (Coertze, 1977; Haviland, 1991; Howard, 1989) and so are more nomothetic than previously thought. Due to the larger number of intervening variables within the social sciences then, there is thus less chance for recurrence of precise sequences. This is an inherent and intrinsic part of the social system and something that cannot be done away with.

Objectivity of observations and explanations

Considering value-neutrality and the stance taken by the social sciences, Machlup (2000) delineates four different meanings of the word "value" and how they impinge on the objectivist/subjectivist debate within the social sciences, namely;

- proper scientific detachment is interfered with due to possible pecuniary interests that the researcher might have or his view on the "good" that his research may do
- without biasing the results certain issues can cloud the investigative process, such as ethical considerations with which the researcher has to contend (an issue not problematic for the geologist or molecular chemist for instance)[29]
- the social scientist often confronts research because of the belief in the possibility of having problems solved and the value that these results might have for human beings in some or other way
- often results are only explicable with reference to subjects' values and thus the entire enterprise is value-ridden

All this leads to the inevitable "subjective difficulties of maintaining scientific detachment in the study of human affairs" (M. Cohen, 1931, p.348 in Machlup, 2000). Although naïve in its sentiment, is it not possible to objectify our subjectivities? Pie in the sky perhaps but Machlup (2000) maintains that "scientific objectivity" is not affected by subjectivities. In agreement with Maree (2003), it is maintained that objectivity is still possible even within a post-modernist stance on what it means to do science. Here one does not necessarily absolutise objectivity; and phenomena can be viewed from multiple angles in an objective manner. Radnitzky (1970) admits as much when he cautions against neglecting the objective and objectifiable processes inherent in natural sciences which has its place surely but simultaneously states that implying that all such processes are equally objectifiable is unwise.

Verifiability of hypotheses

High-level hypotheses reign in the natural sciences in comparison to low-level generalisations which are more common in the social sciences resulting in much testing and appraising of theories within the social science domain where it is often possible to delimit an area of investigation and study it. The nature of some natural science investigations may prohibit any attempt at confirming or disconfirming various postulates due to many unverified and possibly unverifiable hypotheses.[30] The issue of verifiability within the social sciences in terms of controlled experiments for instance, is not reflective of the methodology itself but more so a reflection of the subject matter of the discipline, which brings one back to the original issue of the need for another methodology for the social sciences or a resultant subsuming of disciplines into other disciplines. In sum though, the social sciences and specifically hypotheses resulting from research questions are indeed less verifiable than the natural sciences and their hypotheses.

Exactness of findings

Exactness can mean many things; accuracy of prediction, measurability or reduction to mathematical language (Machlup, 2000). Is it precisely these characteristics which currently define assessment within intelligence which conveys its attempts at a nomological-deductive framework within which to work, a striving towards a natural science model of investigation; yet this is at various junctures within psychology, condemned. Dynamic assessment in its most clinical of forms is precisely opposed or

[29] At least not in the sense generally referred to in the social sciences.
[30] Of course current unverifiable hypotheses may become, over time, verifiable or not as our understanding and technology allow us the luxury of pursuing investigations hitherto unreachable.

counterintuitive to this type of model and so attempts are made to objectify and make more robust its techniques in the hope that it will be more acceptable within mainstream psychological assessment. Once this is achieved, critics decry its statistical and natural-science biased approach. If interpretative models are utilised instead to gainsay this type of model, accusations of subjectivity, non-normativity and lack of predictability are hurled at the approach. Society demands objectivity, norm-based measures and predictive success in many areas of social science research, none more so than in assessment and evaluation. Researchers and practitioners are pulled and yanked from one side to the other. Is there a solution?

Measurability of phenomena

Espousing the quantification of data is indeed laudable if indeed it works, which of course it does in many instances, but in areas such as societal "measures" one is dealing with data of another type. Machlup (2000) states that natural science quantification of data is conducted in two steps; obtaining the data and numericising the data concluding with a result. Achievements in science are most often evidenced (and hence restricted) to areas where quantification is paramount (Osborne, 2000). However social science cannot avail itself of such a luxury as it necessitates at least two steps (with intervening variables); observation, data, numericisation, interpretation and result. Economics is a science which has as its raw data experience a numerical form as this field concerns itself primarily with numerical data.[31] Physicists are able to measure various phenomena via equipment in which there really is a one-to-one correspondence with real-world data. Psychometrics too utilises various instruments which purport to measure various psychological phenomena; but unlike physics there is no one-to-one correspondence between reality and the measure as there is a process through which a theory yields concepts which are operationalised (via intervening variables) for the purposes of the specific theory (note that these purposes will change from situation to situation and thus are not uniform between studies[32]). This is precisely the route followed by representational measurement theory concerning mental test scores (Borsboom, 2005). Measurement and quantification within psychology is discussed at length in chapter 4.

Constancy of numerical relationships

As alluded to above, even the constants of nature are subject to change over space and time, but for the present purposes, it is assumed in general that constants in nature remain unchanging. Many such constants exist such as the velocity of light, Planck's constant of angular momentum, the gravitation constant and the fine-structure constant among many others, yet no single constant is known to the social sciences even though economics regularly computes ratios (Case & Fair, 1996a; 1996b) and sociology can account for certain ratios such as accident rates and epidemiological forecasts which simulate spread of diseases (Cockerham, 1998) and so on. These do, nevertheless, vary across time and place as well. There are no constants in the social sciences. Moreover, numerical assignments to constructs within psychology is a contentious area (see chapter 4).

Predictability of future events

Machlup (2000) states that it is unfair and unreasonable to even compare predictive abilities between the natural and social sciences. The main reason is that controlled laboratory experiments differ in quite radical ways in both sciences. Unorganised and unmanipulated reality yields to natural science predictive models quite a fair number of misses in comparison to the number of times predictions are accurate. As tools and instruments become more finely attuned towards those aspects that are to be measured so too do predictions become more accurate. Many of natural science's efforts do not work very well such as weather forecasts, stock market fluctuations, lunar exploration and the history of science which is indeed filled with blunders and futile predictions (Youngson, 1998) yet "social scientists, for some strange reason, are expected to foretell the future and they feel badly if they fail" (Machlup, 2000, p.271).

Distance from everyday experience

Although not entirely in agreement with what Machlup (2000) has to say about natural and social science jargon the author does point out the nature of jargon and its distancing effect. Talk of electromagnetic fields, quarks and genotype-phenotype interaction is bound to impress on the layperson a view of science as evidentially correct. Since the social sciences deal almost exclusively with humankind as its data, many conclusions may seem false when compared to the layperson's folk psychology knowledge of these same accounts resulting in discordant accounts and hence leading to a rejection of unscientific claims; a non-science posturing as science.

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[31] This is actually an ironic if not somewhat amusing statement, seeing as the one and only driving force behind stock exchanges is greed; a wholly and most human trait.
[32] Of course it has recently come to light that even the so-called constants of nature are not constant or uniform across time and space (Barrow & Webb, 2005); just another progressive step towards greater enlightenment within science in general.

Standards of admission and requirements

Machlup (2000) is blunt and to the point when he states that regarding average IQ scores, natural science students on average outperform their social science counterparts, although generalisations such as these have to be interpreted with caution. Depending on college and university graduation requirements various disciplines expect varying standards. Prestige is linked to those disciplines which attract the higher performing IQ individuals and it is a common phenomenon that natural science students on average perform better than social science students; "many sociology departments have been notorious for their role as refuge for mentally underprivileged undergraduates" (Machlup, 2000, p.272). This is a social phenomenon dictated and mediated by the society in which students function. A counterargument might well be that high school and college examinations are attuned to a natural science curricula and that skills within these disciplines are what are needed in society in general. One may choose to look at this situation from a relativist stance and comment on the relative notion of what is considered required skills, but the truth of the matter is that fundamental skills within technological and natural science areas of study are most often the most demanded by society. One often hears about the lack of skills in natural science areas in South Africa for instance, and hardly much mention is made of the lack of skills within sociology or psychology. Could it be that more people take to social sciences because they are simply easier to study? It would seem that the answer to this is affirmative and Machlup (2000) certainly makes a compelling case for this conclusion.

It would seem from the above that the social sciences are considered inferior to the natural sciences but is this truly the case? Machlup (2000) maintains that it all depends on what questions are asked and the kind of answers one seeks. In stating that "sandpaper is inferior to velvet in smoothness" or that "biology is inferior to physics in internal consistency" one is not really stating that any one field of inquiry is less robust than the other, after all, it is desired that sandpaper be inferior to velvet, seeing as that is what is needed to sand wood for instance. One could quite easily turn the situation around and state that physics is inferior to psychology in determining the likelihood of success of cognitive behavioural therapy on certain patients. To state this is absurd. Yet it is often the case that two methodologies are compared in this manner; perhaps the comparison is unfair. Faust and Meehl (1992) offer six general working assumptions, the use of which seeks to enable the resolution of questions in science (and are here applied to the social sciences as well):

- science is the best available method for acquiring knowledge[33]
- best available and optimal should not be conflated
- the scientific game is one of probability
- the human brain has a limited capacity in terms of integrating data
- description can help inform prescription
- small increments can have large pay-offs
- meta-theory may be difficult but is not impossible

Naïve or folk psychology, however palatable and accessible it is to the lay person does not have a proven track record of veracity and sound provable claims. However, in contrast to this supposition, Jordaan (1989) maintains that formal psychological theory originally emanates from common sense and so distinguishes between formal and informal psychology. This somewhat files in the face of all that has preceded this discussion in terms of objectivity of concepts and terminology. Relativist understandings of concepts, it seems, will never be entirely eliminated, one can however control the degree to which they impinge on understandings within theories. Considering all that has gone before, the scientific method as such is the most consistently applied tool in the knowledge-acquisition game to date. However apt the scientific method is in ordering and logically deducing theories from hypotheses, it cannot be maintained that it can test the veracity of scientific theories itself. Although meta-analytic studies seek to cumulate findings across independent studies it is not necessarily a tool for theory verification. Faust and Meehl (1992) state that although the scientific method often utilises logical and verifiable steps in its procedures, science is itself often a game of chance in which the best strategies are employed to minimise such chance effects. Succeeding only some of the time is perhaps the best that can be achieved in a stochastic system such as the real world. Limited human capacity precludes exact detailing of synthesised undertakings, the more information to be cumulated the less accurate are the final renditions of what is supposedly reality. Science after all is a very human undertaking, but there are systems and limits in place which seek to control those aspects. Yet the psychology of science cannot turn away from the fact that this system too is faulty by mere fact that it is a human system; there is "mind in society" (Meehl, 1992, p.340). Just because the past has yielded instances of descriptions which can be utilised as predictive scenarios for the future does not necessarily mean that "is" now becomes "ought". Science has not always proceeded along a course of optimal functioning and surely never will. In some areas of science, progress is slow, but what might be considered a small step forward could in turn be described as fairly large gain in total. Psychology might be considered just such a discipline in which small progressive steps are construed as very unlikely and the probability of success is pinned at a very low base. Even small steps are thus large in an area with very

[33] This is contentious; however if an argument is to conceivably get anywhere, a starting point is necessitated.

small probabilities of success. In determining the validity of scientific progress, a database of successful and unsuccessful studies and theories can be drawn up in which ratings of these theories can be conducted. Whether psychology has available such a large database is debateable, seeing that as a formal discipline it has not been in existence for all that long in comparison to some disciplines within the natural sciences. Physics had developed to a point necessitating controlled experiments in order to answer increasingly more empirical questions during the seventeenth century; in biology this occurred around 1770 but psychology is of course only 126 years old (Toulmin & Leary, 1985), so perhaps it is unfair to always compare disciplines.

3.3.1 Explanatory mechanisms in social science

If the social sciences continue to tie in with natural science methodology problems are bound to occur as there as numerous inherent differences between the two areas of study. Rosenberg (2001) cites seven main dimensions according to which an analysis can be made of the chances of explanatory successes within the social science if indeed they continue to follow the natural science agenda on methodology. These dimensions will be briefly discussed.

i. Causation, law and intentionality
ii. Regularities vs. rules
iii. Ontology in social science and biology
iv. Teleology and function
v. Reflexive knowledge in social science
vi. From interpretation to historicism
vii. Dangerous knowledge, ideology and value freedom

The main issue dominant in the first of these dimensions is one of intentionality as deductive models of explanation simply do not hold if premises are intentionally bounded (Nagel, 1979, refers to intentionality as humans' volition). In other words cause and effect are difficult to ascertain in a system which precludes viewing it as cause leading to effect. The single-most cited problem evidenced in the literature regarding intentionality is how initial physical states can originate if they are intentionally based (Doyal & Harris, 1986; Rosenberg, 2001). As this issue is paramount to the study and to the understanding of consciousness (Plotkin, 2003) much philosophical work in this area is carried out by the phenomenologists (Maree, 1995; Mautner, 2000; Rosenberg, 1985). Intentionality "ruins" linear cause and effect experiments and is almost impossible to eliminate altogether. With such a predicament even the basics of nomothetic-deductive explanations runs into problems – the perceived cornerstone of scientific methodology as understood by the author.

Secondly, the seeking of lawful relationships within natural science investigations led social scientists to attempt similar endeavours in establishing law-like statements about occurrences on the behavioural front. Such naturalist attempts fostered an outlook which was based on natural science models of science. However no such law-like postulates could be found even though behaviour was often rule-bound and fixed in certain contexts, the boundaries of what constituted rules and regularities were often blurred and adapted to suit the ever-changing human science landscape. No predictions could be based on a system of rules or regularities unlike those predictions within the natural sciences which regularly yielded laws with a proven track-record of predictability. Anti-naturalists maintain that the aim of the social sciences is not to predict behaviour but to understand it and because of its inherent lack of fit with traditional nomothetic-deductive ideals and unlaw-like status it is maintained that it will never be a predictive science as understood in the natural sciences (Rosenberg, 2001). Eliminativism goes one step further and seeks to do away with intentional states undergirding behaviour and aims to study behaviour from neuroscientific non-intentional perspectives.

Thirdly, in keeping with McErlean's (2000) illustration of the hierarchical arrangement of disciplines, Rosenberg (2001) compares biology and psychology in terms of how they manage to successively explain away individuals (one cell or one human being); smaller functioning groups (groups of cells or groups of human beings); larger groups (molecules or tribes of human beings) right through to larger and more expansive groupings (biological species or the human race). Similar mechanisms are utilised to analyse various sizes of groups. Due to the similarities evidenced between the two disciplines an argument of further similarity ensues which states that if biology can explain away larger group functioning (evolutionary mechanisms) in terms of holistic smaller group functioning (family groupings, breeding populations) which are themselves independent of the smaller entities within them then so too can the social sciences explain in similar fashion.

Fourthly, causal explanations become confusing if teleological arguments are brought into the fray of debate. Rosenberg (2001) states that within biology where certain organs are explicable in terms of their functioning (kidney's exist in order to remove soluble wastes) so too can certain societal institutions be explained away by stating the functions they perform. Such purposive or teleological explanations are dubious at best according to the more empiricist philosophers primarily because it reverses the order of cause and effect, i.e. "something exists because it has a function to complete" is often the not so subtle error made when considering the workings of evolution; there simply is no teleological end-point in sight, it is a "blind mechanism" which does not favour one outcome over the other (Fearn, 2001) and is often referred to as the teleological fallacy (Feldman, 1997).

The white coat of an arctic rabbit is not white *because*[34] of the snowy background, it is white purely due to random genetic mutations which occurred and through which enabled the successful adaptation and breeding of these white-coated rabbits. It is an ability, for want of a better expression, that ensures its successful replication in the gene pool (Fearn, 2001). Likewise, human beings did not evolve a large brain in order to facilitate our endeavours into abstract mathematics (Gould, 1998). However, recent studies do suggest that evolution does tend to favour those with higher levels of intelligence over time within the larger population[35] (Van Schaik, 2006). As time progressed, fewer darker coloured rabbits managed to breed successfully due to predation and thus left a gene pool of active breeding white-coated rabbits.[36] Cause and effect can be muddled quite easily, although Nagel (1979) maintains that by giving teleological explanations one is not necessarily implying that the "future is an agent in its own realization" (p.25). At times the white rabbit is still eaten despite its adaptive advantage, but it did not sprout a white coat to avoid predation in the first place; that "event" was purely pot luck and as Rosenberg (2001) states citing an effect to explain its own cause is hardly much of an explanation. Social sciences tend to want to explain things in holistic fashion citing the tendency in biology to explain phenomena at group levels (eco-systems for instance) but often the case is such that the argument for the existence of phenomena and their properties is the explanatory role of these phenomena and their properties. There are views however which contest the role that science has to play in explaining away what is often perceived to be purposeful mechanisms at work in nature.

Fifthly, social science arguments, theories and predictions are often reflexive and by this is meant that by nature social science's subject matter can be influential to itself due to the ability to self-fulfil or disconfirm findings while in the process of being developed. Rosenberg (2001) uses the example of the broadcasting of voting results thus far attained during an election campaign, but in doing so potential voters can change their vote depending on the nature of the count to date. This is a reflexive process and a process not often seen in the natural sciences. There lies a special kind of responsibility within the social sciences when formulating and building theories and models; theories and models of a different kind are thus necessitated by the social sciences. Critical theorists for instance maintain that the aim of social science is not to predict nor explain but to emancipate the very people it seeks to study. Surely intelligence assessment and included in this dynamic assessment, is hardly emancipatory? It subscribes to rigorous empirical nomological-deductive explanations of functioning, claims predictive success and is a field rife with statistical manipulations and significant differences - so much for the reflexive emancipatory outlook envisaged by the above stance on the social sciences.

Sixthly, fully determined cause and effect reign supreme in the natural sciences in which laws are considered fundamental across time and space, antecedent causes result in future effects and any retrodictive causes can be found because any intervening variable is linked via a causal chain of cause and effect. Not so with the social sciences in which historicity often casts a different colouring of interpretation on events occurring during certain periods in history, the source of which is the above mentioned intentionality of human beings. Had humans not intended that feudal systems take root in civilisation then socialist political movements would not have resulted for instance. Historically, conditioned actions result because of intentional stances and social sciences do not work according to strict causal laws but according to historicised explanations; each historical period thus harbouring its own unique explanatory mechanism. Psychology, as with many other social science disciplines, infuses theory with observation language and is often unable to disentangle the two aspects due to the very historicised nature of the subject matter. In other words the language used to describe theory is itself a product of yet more theory, unlike physics for instance in which observational terms are clearly separated from theory (Sanders & Rappard, 1985).

Lastly, a most vexing issue is that of the value-ladeness of value-neutrality of the social sciences and the answers it seeks to certain questions. Certain subject areas, no matter how well conducted the studies are, are simply considered too inflammatory for results to be disseminated. What then is the role of the social scientist? Gatherer of information, objective scribe of societal functions and phenomena, emancipator and liberator or knowledge broker? Intelligence testing is one of a few issues discussed by Rosenberg (2001) when detailing the agenda of the social scientist. Despite years of research and literally thousands of research papers documenting and debating the heritability of IQ, there is as yet no conclusive answer or solution to this question, mainly because of its incendiary nature. Dynamic assessment could be considered an emancipator of sorts, seeking to cut through what is considered unfair and discriminatory assessment practices, yet also having to fulfil the need of rigorously

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[34] This "because of" notion is often cited as clear evidence of a "weak relation of partial causal contribution" (Woodfield, 2001, p.493).
[35] Note that the dinosaurs reigned supreme for well over 160 million years without ever notably increasing in intelligence, at least not what can be inferred from the fossil record. Once mammals got a toe-hold into the environmental niche created by the mass extinction of the dinosaurs there seems to have taken place an ever-increasing propensity for mammalian brains to yield to environmental press. The fact that humans exist in their current form attests to this. However, had the dinosaurs continued unabated (however unlikely this scenario would have proven) mammals might never have taken hold. There is no teleological argument here: it just so happens that individuals with "higher intelligence" (as we perceive it to be) have, on average, tended to remain in the gene pool.
[36] Of course random drift as mechanism of selection can also be argued; such that despite any advantage conferred upon white rabbits, it may be that predators are in any event unable to tell the difference between white or brown rabbits and the choice of predation is not causally linked to the colour of their coats but by random causes (Millstein, 2002).

tested, veracious and empirically verifiable method of assessment; in other words emancipate in as scientific a manner as possible! A contradictory and ambiguous instruction at best.

3.4 Psychology

Psychometrics, in its attempts to measure certain aspects of behaviour, necessitated that these aspects be operationalised which some might view as the first step down a slippery slope for the very act of operationalsing is subjectively and interpretatively approached (Govier, 2000). The terms aggression, intelligence, patience and so on can all be radically operationalised in any amount of ways depending on the criteria utilised and stipulated; unlike natural science counterpart terms such as pressure, velocity and wave length. Moreover, the price incurred by operationalising concepts such as intelligence within every test labelled as such, is that the concept or construct is defined differently for each test. The end result is a concept which is clearly defined but is defined in limitless ways which of course is not progressive (Borsboom, Van Heerden & Mellenbergh, 2003). One need only contemplate the chaos that would ensue if "the speed of light" was defined differently (yet accurately within each test built to measure it). Wundt's disciplinary split between the natural and mental sciences resulted in psychology straddling a middle-way between the two branches of knowledge acquisition (Miller, 1985; Robinson, 1985; Tweney, 1989). This necessitated that psychology choose for itself, from natural science methodology, the requisite tools warranted by certain types of experimental programmes as well as tools chosen from the social sciences enabling the study of particular social phenomena dependent on mediatory experiences on the part of the researcher (co-creating the experience along with the "subject"). Wundt distinguished this difference in 1896 and the discipline still straddles the demarcation point 110 years later (Giorgi, 1985).

Defining terms and how they are operationally put to use contextualises the terms within any particular study and thus its explanatory powers are more obvious. Yet stability of terminology between studies is not an easy task to accomplish and hence the lack of predictive power within such a discipline as psychology, a discipline without appreciable movement and lack of cumulation in the last 400 years in comparison to that of physics (Faust & Meehl, 1992; Rosenberg, 1985; Rossi, 1997; Shadish, 1989). Govier (2000) maintains that adding statistical "talk" to vague operationalised terminology merely adds to studies' pseudoscientific[37] status upon which much attention is lavished due to the figures employed in these studies' findings. They are hence accorded more "scientific" credibility. All these concerns would undoubtedly lead to social scientists feeling inferior in terms of the veracity of their claims. An inferiority complex (Machlup, 2000) has often been associated with social science endeavours when held up alongside their natural science counterparts in terms of funding and prestige for instance. Why the need to write about the social sciences in this way then? If, as it has come to be expected, the social sciences do not resemble the natural sciences in a methodological manner (Cohen, 2000), what does it matter whether the social sciences do not proceed along a course equivalent to that of the natural sciences? The only answer to this question is another question: why the need to proceed along lines similar to that of the natural sciences within psychology? Why the need for statistical inferential studies? Why the need for predictive validity at all? Why the need for a call for figures in place of narrative? Why the preference for empirical research as opposed to theoretical research? It seems that the discipline is its own worst enemy and those practicing within it are predisposed to think of natural science models when conducting studies yet seek to criticise the models to which they adhere (Campbell, 1986; Eysenck, 1985; Secord, 1986).

Kukla (2001) envisages the roles of theory (ratiocination) and empiricism (observation) within psychology as paralleling the roles these endeavours play in physics. Theory bequeathing an infrastructure for empiricists to follow which in turn mediates theory so as to better reflect empirical reality and both strands are necessary for "the business of science" (Pascual-Leone & Sparkman, 1980, p.89). That the two methods have received unequal attention from psychological practitioners and researchers alike goes uncontested mainly due to the perception of theorising as minor ingredient in the larger recipe of a functioning psychological discipline. The perception of theorising within the area of physics is one of almost adulatory awe at the, at times, astonishing findings which result from "armchair theorising". Theoretical physics encompasses a vast array of tantalising areas, among others, the role of mathematics within electrodynamics, the electromagnetic theory of light, electromagnetic waves, general relativity, wave mechanics and microphysics much of which has since been empirically validated and has often shed light on matters that neither observation nor empirical studies could. These areas have at times lead to unexpected discoveries and technological advancement (D'Abro, 1952; D'Agostino, 2000; Einstein & Infeld, 1961; Harré, 2002; Pavitt, 1997; Petersen, 1969; Slife & Williams, 1997). Perhaps it is just this: the very medium through which theoretical and applied physicists are able to communicate with each other is clearly understood by all parties concerned, that of mathematics for instance; yet psychology is

[37] Akin to Popper's demarcation dispute as to what constitutes science and non-science (Chalmers, 1999; Eysenck, 1985, 1987; Faure & Venter, 1993; Radnitzky, 1970). It is more often the case that treatises on pseudoscience are aimed at the natural sciences in which false accounts of theories are dispelled (for instance see Dawkins, 1999a; Gardner, 2003; Sagan, 1997; Shermer, 2001 and although not levelled as an affront on pseudoscience, Dawkins, 2004 goes to considerable lengths to rectify certain pseudoscience notions). There are fewer such works dealing with pseudo-social science an area that would prove ripe for scepticism in its most productive form. Gould's (1997a) now notorious attack launched at intelligence measurement is one such book. Meehl (2002) refers to incomplete theories as "apseudo" if they do not evidence false postulates.

lacking such a common mode of expression resulting in miscommunication and talk at cross purposes (Weems, 1998). The form that such a consensus mode of communication would take is another issue.

The ever-swinging pendulum[38] still sways the way of rationalism only to reverse full thrust back to empiricism and is currently mid-swing between the two poles. The consensus view today reflects a compromise between objectifying subjectivities and allowing due credit to the role of theory as category within the greater method of science; empiricism being yet another such category (Kukla, 1989, 2001). To ignore or underestimate the theoretical contributions that have been and are being made within the social sciences, with emphasis on intelligence research would be tantamount to ignoring the mammoth contributions made by theoretical physics to the study of physics in general. In receiving recognition for the scientific validity of theoretical physics, a fundamental change occurred in the latter half of nineteenth century physics (D'Agostino, 2000).[39] Gustav Fechner's experimental psychology (considered the founder of modern quantitative psychology; Michell, 2003) and Wilhelm Wundt's laboratory on focused psychologising paved the way for a more scientific study of the mind (David, Miclea & Opre, 2004; Sahakian, 1981). This in turn allowed for the study of cognition within controlled environs in the late nineteenth century making, along the way, many presumptions about measurement not yet verified or debated (Michell, 1999). Having thus burgeoned from a scientific platform, it is hardly surprising that investigations into human behaviour have since relied on methodology borrowed from the natural sciences (Michell, 1997). Cognition and the field of cognitive science has been lauded throughout the expansive literature on cognition as *the* field with which much of the social sciences should align (if many sub-disciplines are indeed to survive) (Turner, 2001). Theoretical psychology as a discipline within psychology is not the thriving sub-discipline (Looren De Jong, Bem & Schouten, 2004) that theoretical physics is to physics and the most cited reason for this is the immaturity of psychology as a science (Dawson, 1995).

What is the model of good psychology espoused by social science? Does it differ and if so how and what are the implications for theories and models within the social sciences? Robinson (2000) succinctly sketches the development of psychology at the advent of the twentieth century and captures the essence of this new psychology by describing it as an amalgam of experimental science, Darwinian theory and positivism. At first, evolutionary theory played a predominant role in securing standard notions and criteria for theory building and served to tie together the underlying rationale for both natural science as well as the newly forming "moral science" (psychology) whilst simultaneously offering credibility to this new endeavour.[40] Proponents of a human psychology cautioned against the insufficient framework offered by evolutionary theory stating that it was both incomplete and misleading.[41] The fact that behaviourism was to become a dominant force in psychology having been informed by functionalist biology attests to the strength of the scientific enterprise and its all-pervasive influence on the direction that psychology was to take (Robinson, 2000) even though behaviourism's "downfall" in the 1960's and 1970's (mainly due to the rise of a competing information theory paradigm) lead to a decreased emphasis on many of its tenets (Green, 2001; Harnish, 2002). Regarding learning disability research, Swanson (1988) finds fault with the basic framework upon which this science rests, relegating it to the status of normal science as opposed to mature science status. A mature science, he states, is one in which there is an agreed-upon framework, in which re-thinking of assumptions takes place as well as a recognition of the change in reality which it has undergone since its inception. Dynamic assessment could perhaps be classed as applied research as it seeks to solve immediate real-world problems and attempts to answer the "how" questions within the field, i.e. how testees respond to assessment, whereas basic research seeks to contribute knowledge to a field without necessarily having any immediate relevance, i.e. asking "why" questions such as why respondents answer the way they do (Swanson, 1988). However, both inform the other at some time. Basic research may have applied value later on, as has been the case with the development and later deployment of item response theory, a model whose time has now come regarding the available computational power (Embretson, 1997b) (see chapter 4). Applied research can inform the knowledge base in a more general manner. Dynamic assessment's status as model and/or theory attests to its undefined status as basic or applied science as the two have seemingly divergent agendas.

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[38] This over-used analogy does seem nevertheless to capture the essence of fluctuations between rival views on many a matter within knowledge gathering.

[39] It has been argued that the mathematical sciences are perhaps the most detached and value-free of all the scientific enterprises (Livio, 2003) although the discipline of ethnomathematics will most likely advocate an alternative point of view. Mathematics is a field as diverse as any other (Fuchs, 1967) but invariably mathematical concepts have predicted manifest reality such as Maxwell's "purely mathematical description of electromagnetic fields" (Hey and Walters, 1997; Millar, Millar, Millar and Millar, 1996, p.221) with scientists happily disregarding currently available empirical evidence to the contrary but ultimately being vindicated in their original mathematical stances. Quantum research is just such a field of enquiry (Al-Khalili, 2003). Radical as such an approach might be, it "can be deduced from Maxwell's, Hertz's and Boltzmann 's convictions that *experiment was not a crucial test for theory's validation*" (own emphasis) (D'Agostino, 2000, p.xiii), as was the case with quantum electrodynamics which was rendered theoretically inconsistent prior to Feynman's contribution (Kukla, 1995a).

[40] "New endeavour" does not necessarily indicate that psychology as a field of interest suddenly became apparent. Up to the time of Darwin, philosophers had long debated the need to study human beings, but it was only during the latter half of the nineteenth century that psychology established for itself a separate recognised domain of enquiry. Helmholtz had as far back as 1862 argued that science and philosophy had already become divorced (Robinson, 2000).

[41] In this vein it is ironic then to think that evolutionary psychology has grown to such proportions.

3.4.1 Explanatory mechanisms in psychology

The traditional formal presentation of how a scientific investigation proceeds is illustrated in figure 30 below. Following this figure is an overlay of central tenets pertinent to the study which can be viewed in figure 52. From this can be seen how closely the enterprise of psychological research mimics the methodology followed in the natural sciences, an area upon which initial psychological studies were largely predicated and still are today. It comes as no surprise then that early psychophysics in the tradition of Fechner (who was a retired physicist)[42]would be so natural-science orientated (Leahey, 2000). It is interesting that notable committees instituted throughout psychology's early formal history were partly chaired by natural scientists. The 1940 Ferguson committee instituted to question measurement within psychology was headed by A. Ferguson who was a physicist (Michell, 1999).[43] In fact the history of psychological measurement is peppered with individuals, now chiefly remembered for their psychological contributions, but who were originally natural scientists. The origins of psychological methodology are almost entirely presupposed by natural science technique in order for it to be accepted and be proven more relevant (Meier, 1994). The reigning methodology has perhaps had its greatest lasting influence within the area of individual differences, notably intelligence assessment. Physiological psychology and behavioural psychology have what is seen to be mixed agendas with cross-pollination occurring throughout the varied discipline's history. Pertinent to this study is the influence from natural science methodology regarding measurement. Measurement is a manner of numericising constructs which are supposedly quantifiable (Wille, 1994) and it is quantification which is considered the hall-mark of scientific progress. Few areas within psychology are so riddled with a strict positivist outlook as testing under which is housed dynamic assessment. In essence the main aims of a psychological science in it nascent days was to infer, predict, decide, understand probability through the utilisation of precise statistical techniques as well as to rely on models and connect such models to the requisite techniques (De Leeuw, 1994) so as to ensure a robust scientific discipline (Schönemann, 1994). The entire research process is paralleled to much of natural science methodology beginning with hypotheses which are formally set out, followed by experimentation in one form or another resulting in theory-consistency or divergence depending on the statistical or measurement techniques deployed (Mouton & Marais, 1988). Aspects and notions such as rationality, pragmatism, law-like concerns for an apt description of behaviour, early mechanistic interpretations, nomological approaches, empiricism, verifiability, reliance and valid accounts of measurable phenomena, reduction, realism and universal ascent of such findings make for a science-oriented psychology (Leahey, 2000).

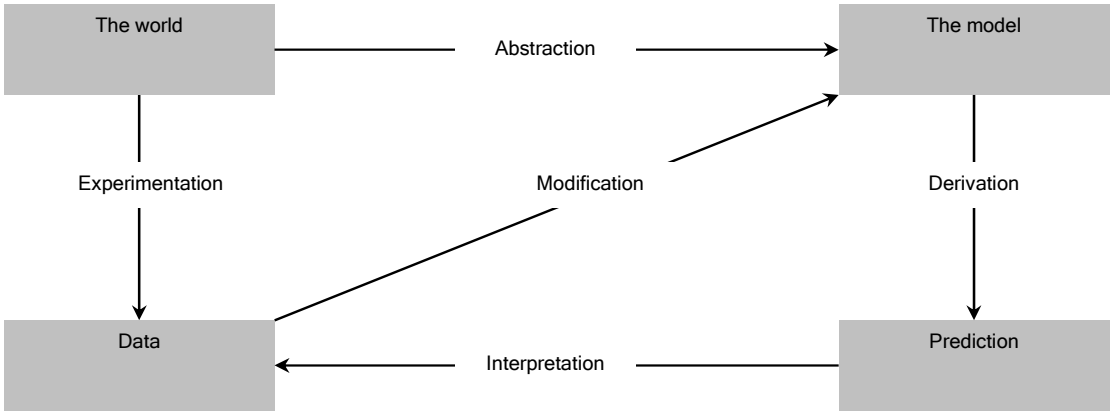
Is psychology's explanatory concern more in keeping with theories, models or paradigms? Looking more specifically at cognitive psychology, David, Miclea, and Opre (2004) state that the terms paradigm, framework, theory and model are often used interchangeably by cognitive psychologists which does not make for an easy time when attempting to allot, categorise, label and effectively 'place' theories and models. Theory and model as concepts too are utilised interchangeably within educational research (Haertel, Walberg & Weinstein, 1983). This statement is to be considered over-and-above the fact that the construct "model" is itself problematic and open to various interpretations (Craver, 2002). Within the realm of cognitive psychology then, paradigms may be construed as overarching collections of theories themselves consisting of explanatory models. A paradigm is judged according to the number of successful theories it generates and cannot itself be assessed in the same manner that its theories are assessed. Several models may emanate from a theory, a single theory forming part of many theories generated from within a paradigm. Theoretical stances may be confused with paradigmatic approaches towards phenomena thus furthering confusion as to a framework's approach towards its area of interest. A theory can be defined as a set of formal expressions which enables the development of axioms which dictate allowable theories. Truth and validity are ensconced within these formal systems which allow for a certain degree of prediction and control over phenomena they purport to study (Mautner, 2000). However, the social sciences and indeed psychology cannot with surety sate that this is indeed the path it traverses when forming its theories. These theories are of a more generalised type of guiding principle.

Psychology and indeed the purview of intelligence research including dynamic assessment research must be mindful of theory-begging, which is inconsistent with good science practice of first establishing the fact and then the theory as opposed to conferring fact upon a theory (Mautner, 2000). Is psychology largely a collection of naïve theories derived from hypotheses which are themselves based on propositions which consist of various constructs which are in turn visualised in the form of schemata and models? Or are models, schemata and constructs derived from theory? Observation leads to formulation of ideas which in turn drive tentative constructs and hence hypotheses and theory. But observation is itself theory-laden which results in a theory-laden view. This theory-laden observation colours the theory, hypotheses, propositions, constructs, schemata and models. A recursive feedback loop ensues in which designation of a beginning and an end is blurred and vague. The contentious debate between theory-laden observation and observation neutrality has passed down through the ages without being adequately resolved. On the one hand any and all observations are tinged with subjective accounts of how any

[42] The first thing that comes to mind when considering direct importation from physics into psychology of terminology is the term "vector" utilised specifically in intelligence assessment. Such vectors provide information on magnitude and direction, as is commonly understood in fundamental physics (velocity is a vector but speed is not). Response vectors within IRT models (see chapter 4) include magnitude as well as direction of responses.
[43] The famous Louis Thurstone of primary mental abilities fame was an electrical engineer as well as a psychologist. Is it any wonder that early quantification in psychology traversed the path it did? (Wright, 1997b).

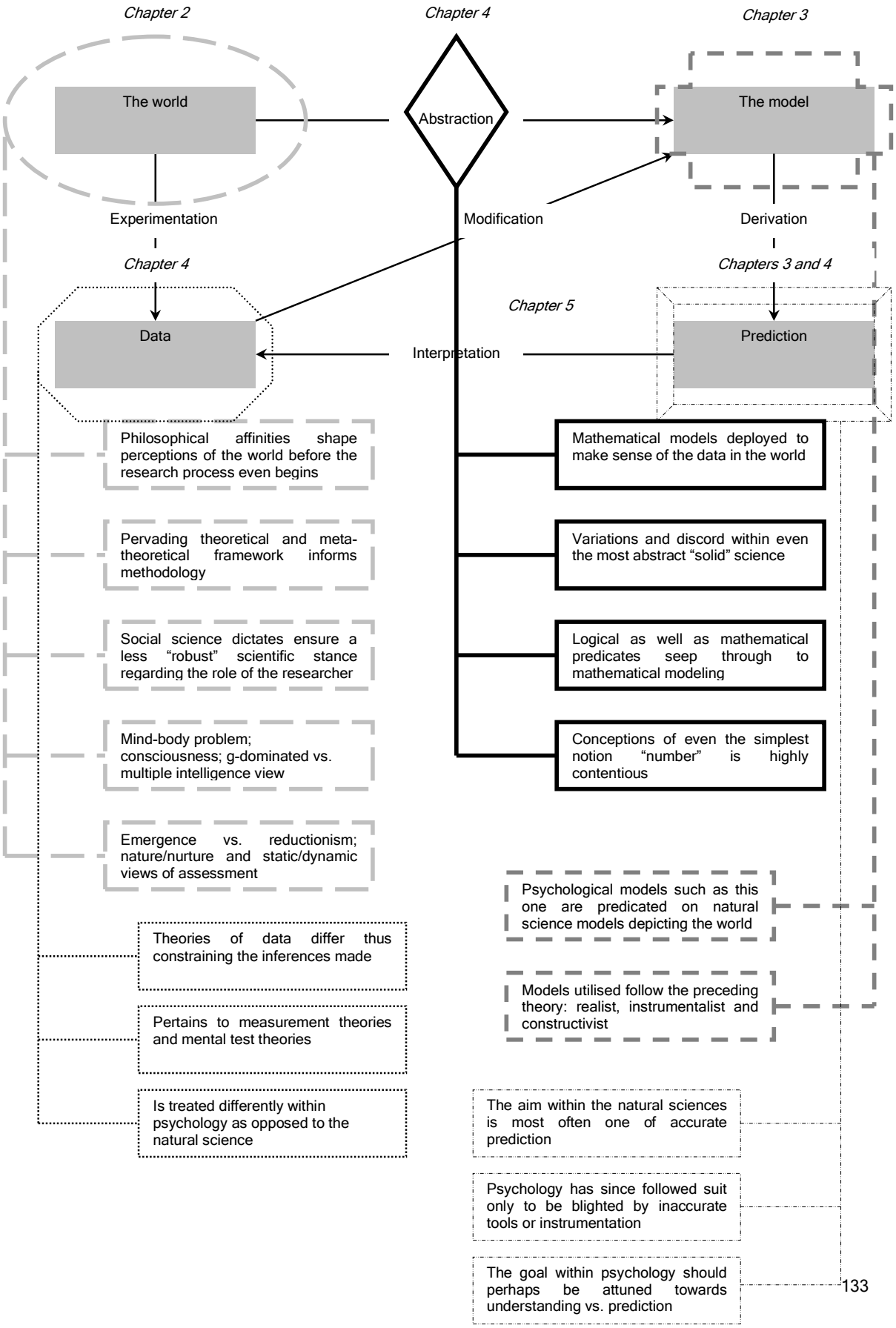
information is transmitted and interpreted. It is nigh impossible to discard innate prejudices as these are bound up with our perceptions. Opposing this view is one of being able to muster objectivity even though background interpretations and "influences from the perceptual system" may play a role (Estany, 2001)[44] (see chapter 2). It is upon such a foundation that theories are generated within the social sciences and permeate the field of intelligence research and thus in its turn subsumes dynamic assessment research. Are most explanatory mechanisms within dynamic assessment theoretical in nature or do they reflect models, as there is a difference between the two? Theories offer depth explanations, heuristic value and classificatory functions whereas models provide these aspects bar explanatory functions. Are "laws" and "rules" akin to theories? Is dynamic assessment a theory at all? Theories and models are not necessarily synonymous terms as they may engage different levels of conceptualisation and ultimate manifestations of their ontology and epistemology (the nature of what is and what can be known). Firstly, the philosophy of science has more often than not engaged the subject matter of the natural sciences in determining the role played by theories and models. As such, it is not always possible to draw direct inferences from natural science philosophy and apply analogies in an appropriate and workable fashion to the social sciences (Outhwaite, 1987).

Figure 30 The nature of scientific investigation (Coombs, Dawes & Tversky, 1970, p.3)



[44] In this long-raging debate philosophers of mind and science have been at odds concerning how perception is influenced by theory commitment and how the two are inseparable (Churchland, Hanson, Kuhn and Feyerband for instance) or how they are in fact two systems which co-exist but do not necessarily influence the other (Hempel and Fodor's modularity of mind for instance and Gardner's vertical representation of mind; Anderson, 2005; Raab & Gigerenzer, 2005).

Figure 31 Utilising Coombs, Dawes and Tversky (1970, p.3) and overlaying central tenets pertinent to the study

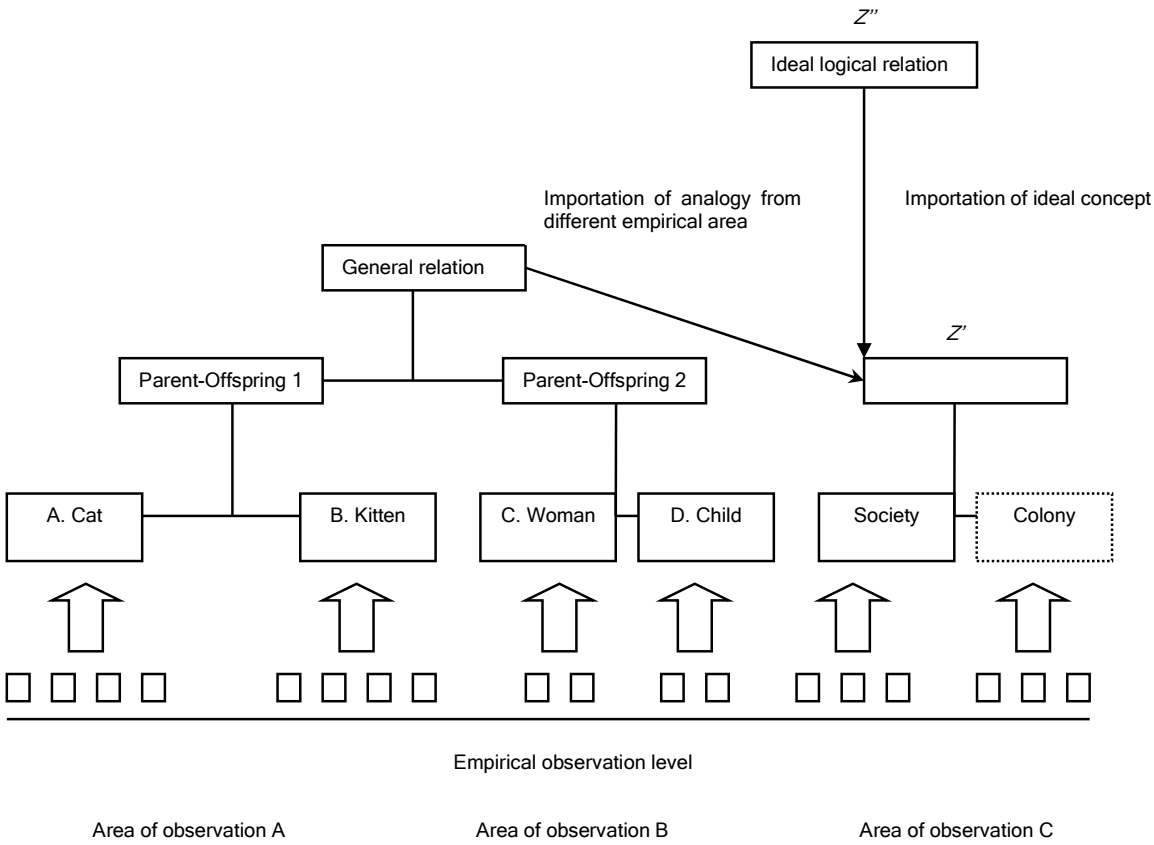


Notwithstanding, there are key differences between the roles played by theory and models. For instance, Atkinson & Shiffrin (1968) emphasise the need to distinguish their framework and model from theory. Among the myriad information processing models, an example from stage-theory models is given. Exponents of stage-theory type of models include Atkinson and Shiffrin (1968) as well as Craik and Lockhart (1972) who have built upon the theories and frameworks of others (Broadbent, 1987; Miller, 1956) and concern themselves with the workings of memory, as memory is thought to be "tied to levels of perceptual processing" (Craik & Lockhart, 1972, p.676). Of note is that both sets of authors make explicit their stances towards a deployment of frameworks and models as opposed to prescribing theory in their papers. The "stage" referred to in stage models of information processing assumes that information is initially processed at a level discriminating between lines, angles or pitch for instance and later processed at a level more discriminating in terms of depth of processing i.e. matching input against information already stored, hence information processing occurs at various levels (Craik & Lockhart, 1972). Eventually information is compared with prior experiences and may thus be 'coloured' to a degree through interpretation. In their oft-quoted paper, Atkinson and Shiffrin (1968) set forth a general theoretical framework for understanding memory and proceed to garner support for their various models within this framework by describing a number of experimental results. Of note is their categorisation of the memory system into two main divisions, namely; permanent structural built-in physical features in which impermanent control processes play an important role in allowing for flexibility within any given situation and secondly, memory which is divided into three structural components including the sensory register, short-term store and long-term store. The authors typically explain their model of memory by referring to the at-the-time dominating computer analogy.[45] Working within the confines of any operating system, the programmer writes code instructing the hardware as to its functioning, which is reflected back in their model as the ever-changing control processes which adapt to differing situations and in so doing instructs the permanent features to carry out tasks. In essence, their proposed model illustrates the route of information processing, initially traversing the sensory register following the path to short-term storage and eventually long-term storage. Decay and loss of information occurs on route but the process is largely controlled by the individual's control processes. One well known form of short-term memory control process includes the chunking or grouping of information which facilitates recall of information that is grouped together. Atkinson and Shiffrin (1968) emphasise the fact that their framework encompasses models which are derived from a general framework and is thus not a theoretical model of memory functioning.

Theoretical models can be construed as models of the presupposing theory which serve in the capacity of demonstrable prototypes of theories. In other words models are workable prototypes of theories which may or may not always concede to reality. In attempting to construct a model which will be based on theory (a natural out-flow of theory construction), the model can later be tested, enhanced, changed and adapted based on the empirical findings of reality. Theories are based on loose model conceptions or observations (which themselves are "permeated by theory"; Chalmers, 1976, p.33). 'Theory' and 'model' are intertwined as models are changed in order to better reflect reality and hence alter the underlying theory. Thus a cycle ensues: ensuring ultimate fit between theory - model - reality. Models classify and suggest new relationships in an heuristic manner whereas theories classify, define relationships as well as explain and interpret but the defining borders between models and theories are often vague (Mouton & Marais, 1988). Models serve to reify theoretical concepts (Wimsatt in Fiske & Shweder, 1986) and facilitate the understanding of theory (Hempel, 1970) which is in turn informed by models' engagement with reality and hopefully elaborates on the real construct. This crucial difference between empirical construct and theoretical concept is paramount to the discussion on test theory and measurement (as well as its mathematical underpinnings which will be discussed in chapter 4). To prime for this discussion, Cattell's (1988b) illustration is itself a good analogy of what is referred to here (an analogy depicted within an analogy!). See figure 32 below where the ideal logical relation would retain theory-reality isomorphism but due to reality as is does not. The use of analogy importation from across disciplines also serves as psychology's foundation for much of its ideas and methodologies. There are however two problems with just such a scheme; firstly the ideal relation is not manifest as such and secondly the importation of "other" methodology is a luxury not necessarily appropriate. Nevertheless this is the situation with which psychologists are currently saddled. These ideas are commonly interrelated and utilised along with "maps", "analogies" and "metaphors". Analogies perhaps being the more oft-repeated term when comparing the theory/model to something else. Ryan (1970) equates theories with attempts at making claims, whereas models make no such attempt. In other words, models highlight the way something may/may not work whereas theories purport to explain why the mechanism works and how in fact it does work.

[45] Of note is their use of the term "buffer" (although not coined by them) which refers to the amount of information that can be stored at any particular time in short-term memory, although not indefinite, maintenance of a set amount of information is stored, which allows for the loss of items only to be replaced by new incoming information. This is similar to what occurs in printers for instance, where printing jobs are spooled to the printer buffer and stored in memory.

Figure 32 Cattell's (1988b) depiction of the basis of distinction between theoretical concepts and empirical constructs



Within and between disciplines and how the notion in the above figure permeates this study in a number of areas

The bridging within and between disciplines is problematic but not insoluble. Isomorphic renderings within psychology as when neural speed (empirical construct) is related to intelligence (theoretical concept) poses just as much a problem as when the bridging principles involved relate natural science methodology to social science methodology. The isomorphic bridge in this instance happens to be constructed on an analogy or on the importation of such analogies. One could in all reasonableness refer to the latter as a meta-bridge in keeping with the theme of this treatise. See figures 2 section 2.4.5.3.2; 24 and 25 section 2.8.6; 28 section 3.3; 33 and 34 section 3.4.2.1 for more on this and how it relates to other areas within this study. There is a particular need in this study to be keenly aware of the arguments, figures and issues discussed in each chapter as they play forth on the larger issue at hand

3.4.2 Psychological theories

Empiricism and rationalism as basic philosophies within science always co-occur and attempts to discredit either will forever result in a stale-mate of sorts. The crux of the matter is that both are necessary contributors to the development and eventual progress of formal science as understood to be the case in mainstream Western science.[46] To imply that observation be the only means towards understanding would be to contradict the history of science, especially the history of physics from the late nineteenth century. Without guidance from formal theory many "discoveries" would either not have been made or would have lingered in their eventual manifestation. Theory of course without accurate observation and inferential observation[47] as the case most often presents stands on its own neither to be proved nor disproved, verified nor falsified without the requisite tools to test its credibility. Science 101: theory informs observation which informs theory. However a less futile discussion focuses on the manner in which theory and observation can work to the advantage of scientists and social scientists (specifically psychologists). Cattell (1988a) delineates a division of psychological progress with the Wundt-Pavlov tradition advocating laboratory-like progress on the one hand and the Galton-Spearman tradition on the other hand traversing the terrain in more exploratory fashion. The former heeded natural science methodology and so imported its scientific tenets whereas the latter adapted to the needs of the discipline without fear of recrimination (Cattell, 1988a). It is from the Galton-Spearman tradition that psychometric measurement proceeded and which rendered itself amenable to mathematico-statistical treatments of analyses (Catell, 1988b).

Theories and models are manifest constructions of happenings which are difficult to observe and ascertain in terms of the mechanics of how things function. Their heuristic value is most evident as simplified versions of reality, versions which are more amenable to understanding and by reduction (their reason for existence) are able to facilitate the transition between humans' ideas of reality and reality as is.[48] Realist and anti-realist accounts of models yield varying explanatory power depending on how they are deployed (Green, 2001). Mentalistic models of human cognition and human behaviour could not truly subscribe to realist accounts of explanations as there is no purported one-to-one relationship between what is being explained and what in fact is trying to be explained. If a theory designates the existence of electrons then such entities exist and are not inferred models of what might constitute an electron per se. However its existence is inferred from more indirect means than pure observation and as Carnap (1993) states, there is no line or demarcation as to what constitutes a direct observation and an indirect observation, for it often happens that existence of entities is so evidently obvious but only so through indirect means that it becomes increasingly difficult to state its existence via direct or indirect means. This is much the same as claiming the existence of neurons from which a neuronal model can be built unlike the mentalistic model of how short term and long term memory works which is clearly not an isomorphic representation of what constitutes memory (Worrall, 2002). The greater the move away from material physical constructs the less realistic the model accounts become and vice versa. Of course this has a bearing on the level of description one has taken of the system. For instance, modelling the cognitive system through means of diagrammatic illustrations consisting of flow-charts is much less a real account of how the brain works than a model in which actual neurons are discussed.

Much has been written and debated about theory construction as it pertains to sociology (Abercrombie, Hill & Turner, 2000; Agassi, 1981; Berger, Wagner & Zelditch, 1989; John, 1980, Hughes, 1981; Riggs, 1979; Ritzer, 1992; Ryan, 1970; Skinner, 1986; Turner, 1993; Weinstein & Weinstein, 1992; Zhao, 1991). The waxing and waning of attempts to devise for it a more robust and scientific theory having passed through successive theory construction phases emphasising either mere speculation or theories emphasising data collection. Sociology like psychology travelled through qualitative and quantitative phases throughout its development acquiring for the discipline a quantitative mantle shirking the more qualitative aspects of theory development and growth. A number of researchers within science have lamented the lack of overarching frameworks within which to unify or at least to attempt to bring to their respective fields some sort of unification process[49] (Swanson, 1988; Smedslund, 2000; Vosniadou, 1996a). Runyan (2005) refers to unifying notions between theories within psychology as "cooperative empiricisms" in which there is no substantial progress or development towards a greater similarity to natural science models but a wealth of theories emanating from various strands within the larger discipline of psychology. Theory construction was at a time synonymous with the quantification of the social sciences (an issue which will be looked at in chapter 4) operating from the bottom-up as opposed to the more recent additions to this repertoire of top-down theorising characteristic of meta-theorising (Madsen, 1988, Radnitzky, 1970). John (1980) traces the development of theory construction and cites three main competing approaches within sociology, namely

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[46] The author feels the need to qualify this sentence in this manner in order to avoid any relativist attacks on how science is practised and to avoid such confrontation which is deemed unnecessary and inhibitive of how science is in fact practised.
[47] The fact that the presence of electrons, mass of photons and even black holes for instance has to be inferred and cannot be directly observed (MacKay, 1995; Rossi, 1997).
[48] See chapter 2 in which I state my predilection for a realist view although being very cognisant of the relativist claim.
[49] It is a somewhat misguided notion that the natural sciences are unified. The social sciences too are not unified, what hope for a unification of all knowledge procurement activities?

- prepositional theory (advanced by Blalock), in which the core propeller is the generalisability of empirical findings where the system is predicated on axioms, also referred to as primitives (Hempel, 1970; Reynolds, 1971). These are of course not testable and are taken as a given within a mathematical system for instance and are synonymous with "initial conditions"[50] in astrophysics (Barrow, 1992; Smedslund, 2000). They can perhaps be empirically identified by the circular definitions which start to occur when attempting to define them (De Grolier, 1990) and theories, which when taken as a whole can be logically deduced within the system. Hypotheses are testable as they are operationalised as are the eventual theories. Proceeding on a basis of verificationism will flounder however as there is no real progress towards suitable theory selection but a mere trimming down of those theories already available. This type of theory construction also belongs to the falsificationist school in which all theories are merely temporary explanations proceeding along a continuum of ever-increasing explanatory prowess (Bohm, 1997) but never really achieving all-knowing status. Generality and empirical support are the main drivers of this type of theory construction and due its confluence of positivism with advances in logic and mathematics this was typically referred to as "the received" or "standard" view (Capaldi & Proctor, 2000; Craver, 2002; Leahey, 2000; Lohman, 1997b; McErlean, 2000; Outhwaite, 1987; Shadish, Houts, Gholson & Neimeyer, 1989). This view greatly influenced psychology from the 1930's - 1960's, although there were bourgeoning movements away from the "restrictive" account of science in the 1950's (Outhwaite, 1987). Propositional and predicate logic (inductive and confirmatory; Salmon, 2001) enabled the clarification of explicated systems and as such logico-mathematical language, due to its precision, became the preferred choice among early philosophers of science (Machamer, 2002). As philosopher Dennett (1999) states, for good science, logic needs to be assessed at the most fundamental level, "down in the trenches, where the data are gathered, where the details matter, where relatively small-scale hypotheses about fundamental phenomena can be actually tested" (p.266). Logic is of two types, deductive and inductive, the latter emphasising the classification of arguments as valid or not whilst the former measuring the inductive strength of arguments (Skyrms, 1993) which is a logic most often associated with the social sciences, yet very problematic (Shames, 1987a). McMullin (1978) cautions against the unrestrained use of logic in all matters scientific by referring to philosophers' hubris in attempting to dictate theory of science solely from the logical standpoint and advises that logic should only be employed when and if scientific practice becomes side-tracked or "corrupted" and "degenerated" (p.222). A science, any science for that matter cannot only be predicated on logic alone, for reality surely does not conform to logical dictates at every turn, however it is a very useful tool for counteracting ilogicalities within explanations and as logic is the "study of the canons of principles of correct reasoning" (Harré, 1988) it has much to offer theory development and science as a whole. Logic was once thought to undergird mathematical foundations, an issue discussed in chapter 4. Logical predicates seem not only to pervade science as method but mathematical deduction too; areas which both play important roles in how psychological assessment has proceeded throughout the twentieth century. The logic of null hypothesis significance testing utilised to extremes within psychological research echoes the perceived utility of logical deduction and thought process and this too is discussed in chapter 4
- grounded theory (advanced by Glaser and Strauss), which also seeks to generalise findings from the empirical data but does so in a more phenomenological manner. Although touted as emergent and grounded, the approach is quite objective with *a priori* assumptions pervading this approach, making it at times, less phenomenological than initially described
- exact theory (advanced by Willer), advocates that, unlike prepositional theory construction in which phenomena are considered as ordering the experiences of the observers, the theorising orders the phenomena and is akin to much of natural science theorising. The theory guides the understanding of the phenomena (Quinn, 1998). Scope and isomorphism (a one-to-one mapping of levels, see chapter 2) are imperative to this type of theory construction in which theoretic calculus for instance, is used to map and predict the model which in turn is compared to the empirical data. Empirical and rational orientations are somehow bridged in Willer's exact theory approach but cannot be equated with either of the afore-mentioned two approaches

This list is similar in nature to the three forms that social science enquiry takes; namely, empirical-analytic, historical-hermeneutical and critically orientated views (Shames, 1987b). Simplified models have been construed as theories serving to explain the functioning of a system in its most idealised way ignoring factors which would merely upset the model. Yet it's main aim is to provide adequate explanations at a level more understandable than the level at which the observations in fact take place (Leahey, 2000). Intricately involved in theory and model development are a number of terms which are loosely defined within these larger systems and include among others, terms such as hypothesis, proposition, schemata and concept. Gerstlé (1989) questions the origin of concept formation as emanating from theory or as becoming theory itself. In other words are they independent terms or are they dependent on the theory itself?

[50] The Big Bang.

3.4.2.1 Concepts, definitions and propositions

If concepts are considered as elements of theory is it necessitated of them that they be clear, concise and must strive to delimit extraneous meaning which will only serve to confuse any meaning inherent in the term. "Ambiguity, homonymy, synonymy, existential vagueness, opacity and contradiction must be done away with by means of conceptual and terminological analysis and, in particular, through the process of formation and reconstruction of concepts" (Gerstlé, 1989, p.608). This take on what a concept should be is by extension a positivist one which highlights the need for closure and stability of concept terminology. In stark contrast to this definition of what constitutes a concept, the more essentialist and interpretative approach towards concept definition and understanding is less confined and constricted by the framework in which it operates, here it is more open to change and not stifled by the inherent limitations in language.

If concepts are considered dependent on theory, theory is foremost as any observation will be inherently theory-laden and hence theory is prime followed by the enclosed concept which is then utilised by theory. Gerstlé (1989) maintains that from this viewpoint words and meanings should not take away from the ideal of truth within theory. If this be the case, concepts are constrained by the level of theorisation and even by the general conception of scientific work. Gerstlé (1989) compares the two origins of concept formation and is illustrated with slight attenuation in Table 6 below.

Table 6 The relation of concept to theory (Gerstlé, 1989)

Concepts (as words)	Resulting in	Theory
Designation or terms or concepts		statements or propositions or theories
Words	may be formulated in	assertions
Meaningful concepts	which may be	true
Meaning	and their	truth
Definitions	may be reduced by way of	derivations
Undefined concepts	to that of	primitive propositions
Meaning	is	truth

Riggs (1979) designates for the area of concept study a term devised by linguists, known as "terminology" and is a necessity if researchers between and within disciplines are to understand jargon-filled research papers often pertaining to very similar areas of concern. Dissenters are against such a view of course, denouncing the lack of metaphorical writing within the social sciences, stating that this aspect is what makes the sciences social in the first place. Once again, there is a continual tension between what is construed as science and what is not. Three modes within the terminological approach each emphasis a different strategy towards concept formation and understanding, namely the analytic mode which investigates the lexicographic characteristics of terms, the normative mode which attests to the one-word-one-meaning idea and the synthetic mode which, according to Riggs (1979), overcomes the limitations imposed within the former two modes by advocating a stance evidencing a mix of both modes whilst allowing for greater range than either of them. Semantic and conceptual problems which plague the social sciences (see chapter 2) are thought of as severe limitations in developing some sort of consistent and consensus-forming dictionary for the social sciences (De Grolier, 1990). That various strategies have had to be abandoned can be considered as neither "good" nor "bad" for a science of social enquiry. Yet the point here is not only that there is frequently a lack of consensus towards terminology and concepts across the social sciences but that this is a hallmark feature arising from one single discipline as well, such as psychology.

If concepts are dependent on theory and as such yield arrays of meanings what is to become of the theories? Following on from this argument, then what is to become of the hypotheses and underling implicitly stated meta-theories? Vague and ill-defined concepts where authors do not explicitly state what exactly they mean by these words (De Grolier, 1990) does not auger well for future inter-disciplinary collaboration which will of course become necessary as time progresses (this might be akin to the "levels of description" problem across which scientists will have to forge conversations with one another). With regards to this terminology, "what matters is not the words we use but the distinctions which they mark, and it is important that there should be agreement on which distinctions we have to mark" (Ryan, 1970, p.94). Fawcett and Downs (1992) state that once concepts have been highlighted they need to be classified on the basis of their variability (uni-dimensional versus multidimensional concepts such as gender and degree of aggression for instance), extent of their observability (concepts which are directly or indirectly observable, inferred constructs and theoretical terms) and measurement characteristics (enumerative, associative, relational, statistical and summative units of measures).

Harré (1988) distinguishes two broad categories into which scientific concepts can be placed, namely, material concepts (or concrete as described by Reynolds, 1971) which include terms and concepts such as mass, force, length, charge and are utilised as descriptions of things, materials and processes and formal concepts (organizational or structural concepts) which include terms such as causation, existence and identity as well as spatial and temporal concepts. These terms are viewed as

relations of things to other things, in other words, something is termed as existing now or before and nothing new is learned from this term other than its placement within space and time (referred to as abstract concepts by Reynolds, 1971). Can this distinction be drawn in psychology for instance? Intelligence is a reified construct and can be determined via material concepts such as scores in tests of intelligence[51] and its reified existence as "something" measurable in time and space co-exists as formal concept. Yet, Harré (1988) probably did not have this in mind when he classified concepts into these categories. So much has been written on the philosophy of the natural sciences, that when employing arguments in favour or in contradistinction, very few examples arise when discussing similar issues within the social sciences.[52] Fawcett and Downs (1992) are quite explicit about how carefully concepts and propositions should be constructed and analysed in theory, as ill-defined concepts with poor operationalisation connecting them to empirical data merely serve to blur the understanding of what it is that is trying to be derived within the theory. As discussed in chapter 1, Sternberg and Grigorenko (2001a) maintain that current conceptualisations of dynamic assessment often results in ill-defined conceptualisation, operationalisation and the subsequent analysis of the construct. Regarding specification of propositions in formalised theory, table 7 illustrates the typology of propositions.

Table 7 Typology of propositions (Fawcett & Downs, 1992)

Types of propositions		
Nonrelational	**Relational**	
Existence propositions	Existence of relationship	Direction of relationship
Definitional propositions	Shape of relationship	Strength of relationship
Empirical indicators	Symmetry of relationship	Concurrent and sequential relationships
	Deterministic and probabilistic relationships	Necessary and substitutable relationships
	Sufficient and contingent relationships	

The following discussion on propositions follows Fawcett and Downs (1992) discourse very closely. Propositions are declarative statements incorporating concepts and seek to assert statements. Statements linking or describing concepts are either of the nonrelational or relational type. Nonrelational propositions state something about a concept and either state that the concept exists or defines the concept and consists of the following sub-types:

i. existence propositions state that a concept such as learning potential exists and existence propositions can also explicate the level at which the concept functions, such as low or high learning potential;
ii. definitional propositions actually involve descriptions and characterisations of the concept. Convention often drives the acceptance of definitional statements and is thus not verifiable but accepted as such by the community of researchers for instance. In order for the theory to be testable however, such definitional concepts will need to be constitutive (a definition is clarified by means of other concepts, i.e. learning potential is the degree to which improvement is evidenced from mediation) and operational (a definition is clarified by means of empirical or observational data which now involves rules of correspondence, i.e. learning potential is derived from subtracting the pretest score from the posttest score). Operational definitions are either derived from measures or experiments. Correspondence rules are necessary to link concepts to their real world counterparts and is illustrated in figure 33. The often tenuous link between theoretical entity and empirical construct manifests too within dynamic assessment's conceptualisation of the concept of learning potential which is yet another term without clarity and can also be defined in very much the same way that intelligence is defined by the manner in which it is assessed (Elliott & Lauchlan, 1997). As intelligence is varied in its multitudinous manifestations, psychometric measures will thus only "pick" up on measures amenable to such testing whereas other forms of intelligence manifestation necessitate other mechanisms of elicitation (Fuster, 2005). In chapter 2, it was mentioned that bridge principles could be equated with correspondence rules and this is diagrammatised in figure 34 below
iii. empirical indicators are the instruments used to derive measures from concepts which are in this manner operationalised. Although not a part of the theory as such, these are part and parcel of the research design process (Fawcett & Downs, 1992; Kerlinger, 1981).

Relational propositions link two or more concepts and as with nonrelational propositions also declare a statement but include various associations between the concepts. (See section 4.4.1.3 in which measurement of constructs is based on rules of representation via relations "among objects which are reflected by the corresponding relations among the numbers assigned to

[51] The author realises that Boring's circular and not very helpful definition is being employed here.
[52] Once again, a retort to this would be that social sciences should not predicate themselves upon natural science foundations of explanatory mechanisms. Well then, what is one to do? Devise and invent a new framework of explanatory criteria? Perhaps.

them" (Coombs, Dawes & Tversky, 1970, p.29). Patterns of co-variation between concepts occur and various relations can be identified. Types of relations include:

i. the existence of a relationship merely states that some relation exists which is usually a recurring relation and hence not a once-off phenomena. For instance, mediation co-occurs with increased posttest scores (note that at this stage no directionality is given to the relation, only that it exists)
ii. the directionality of the relation asserts the degree to which two or more phenomena co-occur and how they manifest in this co-occurrence. For instance, mediation resulted in increased posttest scores
iii. the shape of the relation indicates the nature of the mathematical function of the relation; be it linear, quadratic or cubic. For instance, graduated prompts as mediation strategy might rely on an index of hints given and can perhaps be said to link to posttest score results, however with less strict definitions of mediation (more clinical approaches), this becomes increasingly difficult and at times impossible to calculate
iv. the strength of relation concerns the degree to which two or more concepts are linked and how they are linked via a scale delineating the strength of these relations. Effect sizes are often utilised to illustrate the strength of these relations; appendix 1 evidences meta-analytic effect size results for a number of studies utilising dynamic assessment as strategy as opposed to normal static based assessment approaches and yields information regarding the strength of the cumulated relation
v. the symmetry of the relation refers to the manner in which two or more concepts (which are at times referred to as variables) are related. There may be a strict asymmetrical relation between two concepts resulting in a one directional interaction. For instance, after mediation a difference in posttest scores will result but if there is no mediation there might still be a difference in posttest scores; i.e. nothing conclusive can be stated about the posttest scores in relation to the mediation (it could be that practice effects result in changes in the posttest scores, or other extraneous factors such as fear, anxiety and other non-cognitive impingements). Symmetrical relations evidence a circularity of sorts, with two or more concepts falling back on each other; i.e. reduction in anxiety leads to better posttest scores and better posttest scores lead to reduced anxiety
vi. concurrent and sequential relations evidence when one or more concepts is followed by another concept either simultaneously or at a later time. Increases in posttest scores result after mediatory interventions, thus the one follows sequentially from the other. If both concepts appear at the same time, the two are said to co-occur; for instance, anxiety and pretest scores might co-occur if respondents have not been told about the testing procedure, i.e. writing a test results in immediate anxiety
vii. deterministic and probabilistic relations refer to the degree of certainty that a relation will occur; for instance deterministic relations are often referred to as laws (Cattell, 1988b) or universal truths with one concept always preceding another or vice versa. For instance, lack of parental and/or cultural mediation can result in poor performance on various psychological assessments and can even result in maladaptation to any one specific culture (of course the more social-psychological the arguments become the less likely they are to ascribe to such lawfulness). Probabilistic relations state that there is a chance of a co-occurrence of variables given certain conditions. It is possible that there is a greater likelihood of increased posttest score if mediation precedes posttesting. This is not always the case, but it is more probable if no mediation is given. Rasch (1980) points out the trend away from strong determinism within physics towards more probabilistic models as encompassing more relativistic and accommodating models. Such probable models are better able to explain certain anomalies far better than models previously relied on (for instance Rasch cites radioactive emission). Rasch (1980) maintains that, similarly, probabilistic models can be successfully utilised within psychology in an attempt to better explain certain findings on tests of achievement for instance as human behaviour is far more complex than even models of radioactive emissions (see chapter 4). Rasch, who contributed his probabilistic model to psychometrics, was first and foremost a mathematician (Wright, 1980). Moreover, Cattell (1988b) maintains that models are by their nature theories reduced to some mathematical, physical or symbolic essentials
viii. necessary and substitutable relations refer to the need for certain or specific co-occurring variables within a relation. For necessary relations specific variables need to occur for the relation to manifest; i.e. if and only if mediation takes place will an increase in posttest scores result (this is not an instance of what truly does occur in reality, but this example is employed merely to illustrate the meaning of this type of relation). Substitutable relations occur when either of two variables can result in a relation manifesting the same thing, i.e. either practice effects or mediation effects can result in increased posttest scores
ix. sufficient and contingent relations refer to the conditional nature of a concept on the relation; i.e. reduction in anxiety before writing a posttest is sufficient to aid in the increase of posttest scores but not necessary. Pretesting can result in increased posttest scores, but an intervening third variable, namely mediation, can contingently alter the relation in a positive or negative manner

Figure 33 Concept-empirical indicator link via operational definition with example (Fawcett & Downs, 1992, p.28)

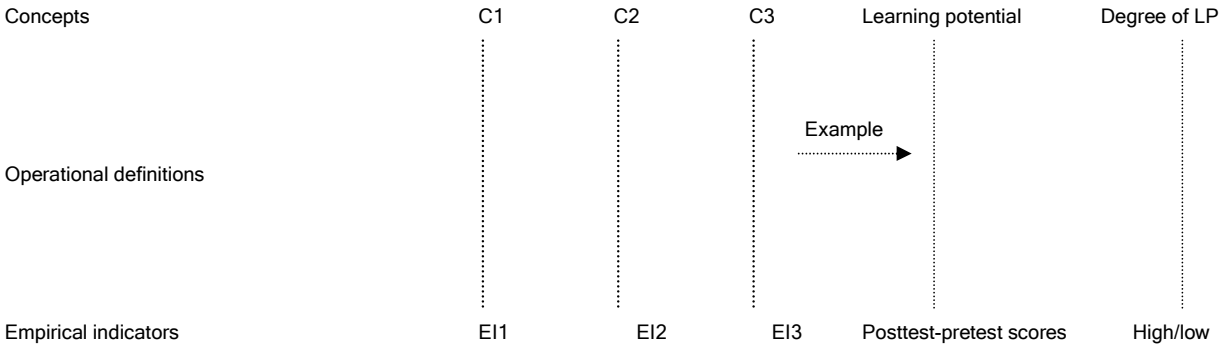
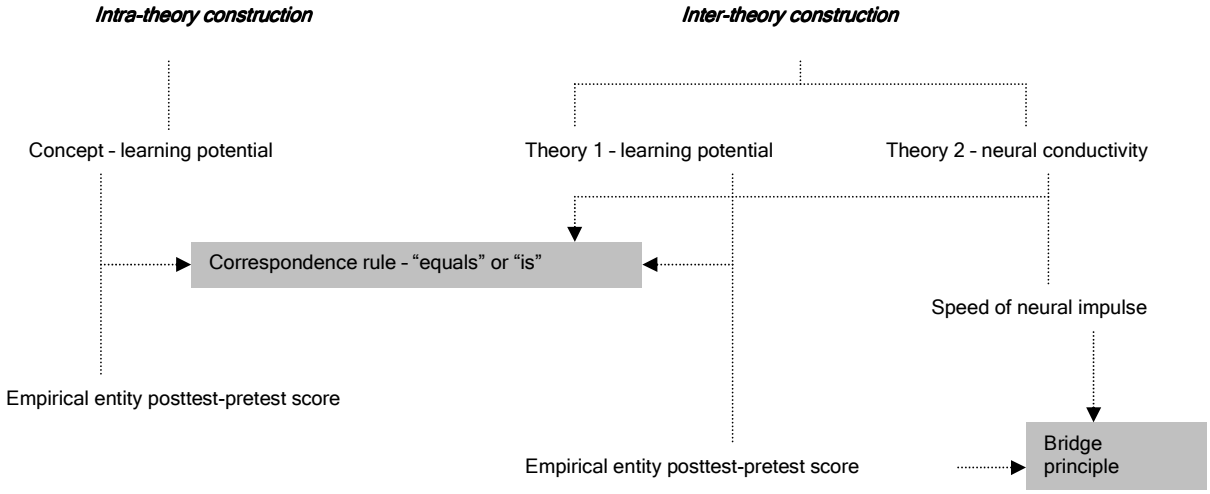


Figure 34 Relation between intra and inter-theory correspondence rules and bridge principles



Intra-theory construction correspondence rule can be equated with Inter-theory construction bridge principle

Propositions can also be classified according to the degree of abstraction involved and range from restricted concretised propositions which are very specific in nature to unrestricted abstract propositions which are more general in nature (Gibson, 1960 in Fawcett & Downs, 1992). An illustration will suffice:

- Abstract proposition - learning potential is evidenced via mediatory interventions
- Concrete proposition - Increases in posttest scores often result from two-way communication processes during which various mediatory interventions are employed in assisting the learner with problematic areas of cognitive processing
- More concretised - posttest raw scores are higher than pretest raw scores after an intervention strategy aimed at improving certain cognitive functions (such as helping the learner to become less impulsive when answering or working out problems)

3.5 Theory appraisal

Methods of knowledge acquisition are only as good as their theoretical guides and theories are only as good as what precisely? How does one determine whether or not a theory is considered "good" or "bad"? (Eysenck, 1987). Unfortunately there simply is no universally agreed upon list of definitional criteria against which to score or "grade" various theories (Michalos, 1971). Any attempt is itself predicated on a theory of growth! (Serlin & Lapsley, 1990). This is neither good nor bad, for it is not a value-loaded statement. In fact critics of theory appraisal have referred to theory appraisal criteria as banal (criterion of parsimony) and misleading (criterion of empirical validity) (Gergen, 1987b). Such extreme views should, however, be tempered for due regard for how theories are in fact rated in reality. That the list of such criteria should be malleable is perhaps closer to what can be expected from theories within varying disciplines. The underlying assumption is, for the moment, that such a list is in fact warranted. Such lists' usual reliance is upon logical positivist approaches towards theory appraisal and due to the rejection of strict logical positivism within psychology (having gone out of favour). Eysenck (1987), taking his lead from Lakatos states that a theory is good or bad if the former advances progressively and the latter degenerates progressively and so puts and end to the need for any list at all. Even naïve views concerning theory would advocate (perhaps simplistically but not altogether incorrectly) that natural science theories are somehow more robust than their social science counterparts. Psychological theories are more often than not a bit wishy-washy and ill-defined, or at the very least, not very generalisable beyond very narrowly specified contexts. Von Bertalanffy (1970) states in this regard that psychological theories which are mathematically formulated and which permit quantitative prediction are more viable as opposed to the loosely constructed verbal models and theories. Positing point estimates (as in null hypothesis significance testing) is often viewed as more scientific than conjectures utilising ranges (Meehl, 1997). It is this very issue which is criticised in psychological research in which point estimates are unreliable due to the complexity of the subject matter which prefer to make use of composites (see chapter 4).[53] There will of course be opposition to this sentiment from many corners of the discipline. So then, how to define what a makes a theory worth its status as theory? The literature on this topic frequently cites a number of guiding principles, at times applicable only to natural science disciplines, at times attenuated for the social sciences and yet in some instances it remains ominously silent on how to adjust the list for the social sciences. Broadly speaking, McMullin (1978) defines four main logical modes of theory appraisal that have made their presence in the history of science, namely the

i. intuitive-deductive model – deductive arguments are drawn from plausible axiomatised sets of intuitively derived assumptions and theory results, of which these axiomatised truths are beliefs in phenomena (based on the historical record of their occurrence or not; i.e. the sun rises every morning and sets each evening,[54] therefore stating that the sun will rise tomorrow is merely playing to past occurrences). These *a priori* principles become established as truths (Hempel, 1970). This Aristotelian ideal was focused upon by Descartes and found its way as ideal method in some parts of science (Moring, 2002). However no generally secure principles exist from which to deduce, unless one can prove the axioms, which one cannot as they are intuitive! (akin to transcendental argumentation which relies on *a priori* conditions of knowledge; Mautner, 2000; something which Hume argued vehemently against; Delius, Gatzemeier, Sertcan & Wűnscher, 2000; Royce, Coward, Egan, Kessel & Mos, 1978; Shames, 1987b and who also referred to as unconscious statistical inference). This ties up with the discussion on null hypothesis significance testing which, as a tool of inductive inference, cannot be logically defended but can stand up to practical scrutiny even though effects are due to probable and possible causes (Krueger, 2001; Mislevy, 1995)
ii. inductive strategy – commonly referred to as the "Baconian method" in which there are no precisely defined formal rules dictating this method and generalisation can be plausible at best. Modern renderings of Baconianism include exploratory descriptive statistics which can be traced back to K. Pearson, Galton, Quetelet and Laplace (Mulaik, 1988). Bacon coined

[53] Although not discussed in this thesis, the works of Dawes (1971, 1989, 1995) offers further insights into the nature of clinical and statistical decision making, which has pertinence to the domain of dynamic assessment due to its reliance on both qualitative and quantitative methodology. See chapter 5 section 5.2.11 where this issue is brought up in relation to one dynamic assessment model in particular.
[54] Of course this does not even happen, but it becomes cumbersome to state the case by referring to "the earth rotates every 24 hours and will do so in the next 24 hours"!

the term in 1620 and although he[55] advocated other methods in addition to the inductive (Harré, 1988; Reynolds, 1971) he ironically put forward his appeals against such a method (Shames, 1987b). Bacon's appeal that the tempered nature of Greek contemplation to be infused with the nature of experience (Bacon, 1959) is perhaps such an old notion today that it is difficult to appreciate the leap that was made at the time of his writing. The line of thought proceeds from observation-statements to some sort of generalisation without producing concepts that were not stipulated in the original observation-statements (Bacon, Mill, Herschel and Ockham). There is the danger of ignoring possibly relevant phenomena during an experiment and thus excluding possible variables which might enhance the theory. Also this type of reasoning is nondemonstrative since it will always remain a possibility that an hypothesis is false even though the data are correct. This is so because the truth of the data does not necessarily entail the truth of the hypothesis (Lipton, 2001) and inductive conclusions go beyond the evidence yielded by observations (Brown, 2001). The data elicit inductive implications and simultaneously endow the data with evidential support (Rozeboom, 1970). Inference to the best explanation then becomes a partial solution to the problem of inductivism (otherwise referred to as abduction or retroduction; Lipton, 2001; Mautner, 2000). How does one go about choosing this so-called best explanation? Surely this very much depends on the nature of the criteria at hand, which has already been shown to be a matter of taste and difference. Rozeboom (1970) states that this approach, although probably nearest to a scientific method per se, is still "naïve and hopeless" (p.91)[56]

iii. hypothetico-deductive model – also referred to as the retroductive strategy in which the hypothesis is warranted on the basis of logical deductions made from it (Carnap). All else besides verification and refutation (itself based on testability criteria) are unnecessary and superfluous (Rozeboom, 1970). Doubt of course will remain as one can never be entirely sure of the veracity of the claim but this strategy does not rest on secure axioms yet inferences from this model are suspect. Even though it is saddled with fallacious issues, it is considered as more versatile than the remaining three models or strategies

iv. negative hypothetico-deductive model – which is a falsificationist take on the hypothetico-deductive model, permitting the negation of a deductively derived assertion, in other words it does not allow for positive assertions to be made (Lakatos and Popper; Nickles, 2001; Stewart, 1990). The more falsifiable a theory the better it is and the greater the challenge to falsify the theory. It may well be that a genuinely "true" theory will not be falsified at all, but the point is that it should leave itself open to falsifiability (Chalmers, 1999). There are cases in the history of science where, had theories been rejected on the basis of false findings rejection would have been inevitable but they remained to be vindicated at a later stage (Royce, 1978). This is similar to what Eysenck (1987) refers to as weak theories which are unable to explain fully all phenomena but remain good theories for decades. This brings into question of course the counter claims or competitor theory claims (see discussion on competitor theories). Naïve falsificationism tends to treat singular accounts of theories as opposed to more sophisticated falsificationism which investigates competing theories and research programmes and as such concerns itself with the growth of science as a whole. However, predicating the growth of science on the falsificationist criterion alone is somewhat misleading. Little is learned from the falsification of a bold conjecture and likewise little is learned from a confirmation of a cautious conjecture (Chalmers, 1999)

The first three can be classified as verficationist models and the fourth as falsificationist in strategy. Necessary knowledge is obtained in the first mentioned model but this strategy relies on intuitively forming first-order assumptions or axioms which are open to debate. However, the falsificationist strategy is not a strategy often followed in working science. As much has been said and aimed at decrying the need to falsify when in fact the business of science is to verify something, not falsify it. Some regard the inductive and hypothetic-deductive strategies as two aspects of the same underlying reasoning procedure or as two fundamentally different ways of explanation (Harré, 1988). Rozeboom (1970) adds another model, namely, the omnitheoretic model in which a Feyerbandian theory-free base of observation is assumed. Figure 35 illustrates the difference between inductive and deductive explanatory mechanisms in science in which theory-generating or theory-testing propositions take the form of inductive and deductive reasoning strategies respectively (Fawcett & Downs, 1992). The scientific method necessitates both inductive as well as deductive processes (Kline, 1998) as exemplified within the inductive-hypothetico-deductive method of science as discussed above. The spiralling effect which is both engulfed by and is perpetuated by the scientific method is illustrated in figure 36 below.

[55] Bacon is in fact referred to as a "metascientist per excellence" as he contributed to knowledge about science more so than in science (Oldroyd, 1986, p.59)

[56] This is viewed as the closest model to a science method per se and simultaneously viewed as hopeless. Where does this leave us? Science proceeds with noticeable effects yet philosophers and scientists are unable to agree as to the method of its momentum; this all seems rather odd to say the least.

Figure 35 The basic difference between inductively and deductively derived theory (Oldroyd, 1986, p.62)

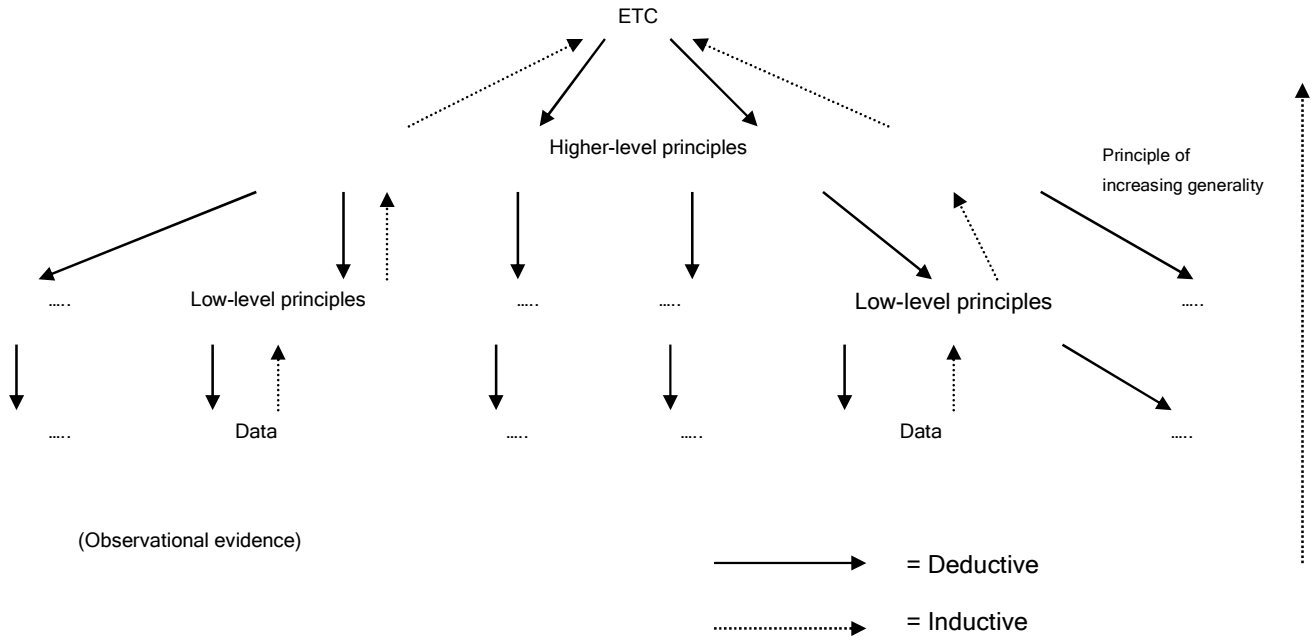
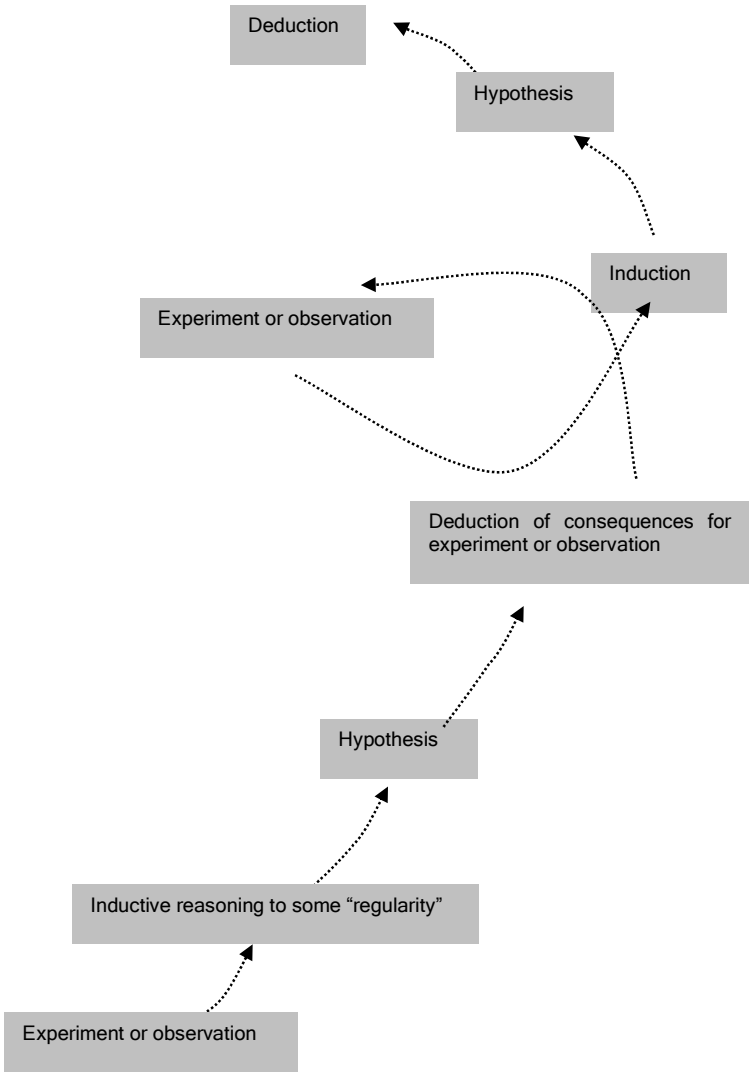


Figure 36 Cattell's (1988a, p.17) inductive-hypothetico-deductive spiral



There are of course various problematic issues surrounding inductively and deductively derived knowledge. Logically deducing a valid explanation from valid premises does not mean that the conclusion reached is true, no matter how valid the structure of the argument is. Inductive "deduction" is likewise saddled with problems, namely that in order for a conclusion to be reached an argument necessitates premises that are wide ranging, numerous in scope and applicable in as many contexts as possible and of course, there is no logic involved as such (not valid; Hájek & Hall, 2002) in inductive arguments as with deductive arguments (Chalmers, 1999). Inductive arguments can never be "proven" as such, as the method employed to do so is itself an inductive one and such circularity is doubtless erroneous, as originally formulated by Hume (Mautner, 2000; Shames, 1987a). Popper alternatively stated that science is inevitably carried on in an hypothetico-deductive manner and not in an inductive manner (Mautner, 2000). Errors in science abound, flops are universal yet there is progress, slow at times, but technological advances and numerous examples of success is everywhere evident and can attest to the limited veracity of the general claim of science. What is going on? Do the methods work or don't they? Can we successfully apply these methods to the social sciences? Negative hypothetic-deductive or falsificationist accounts of science are not impressed with yet more empirical evidence in favour of a theory. This is so because it simply does not leave itself open to falsification, which is the whole point with this method and as a result inductivists are at odds with falsificationists as they regard an ever increasing platform of empirical results as evidencing greater probability that their theory is correct (although not logically deducible) (Chalmers, 1999; Hájek & Hall, 2002; Trout, 2001b). Yet can a theory ever be completely falsified if, on account of some extraneous variables within the test situation, the result becomes coloured due to the impediment of the experiment? So it is not one theory per se which is tested but rather clusters of similar theories (Chalmers, 1999; Mautner, 2001),[57]attending to the holistic version of research programmes (Hookway, 2001).

Not only are there intractable and at times insoluble problems within the practice of science itself, but these problems then cascade down through to the level of empirical data collection and observation; which, when mixed in with the often intractable problems facing dynamic assessment become almost overwhelming. The theory is problematic; the guiding meta-theory is problematic, the omnipresent epistemological and ontological issues are problematic, the nature of this type of knowledge acquisition is problematic and so on. Is there a way out?[58] Matters pertaining to natural science philosophy and what is considered "science" have not yet been agreed upon, much less have any agreements within the social science as to what "science" is been reached. If the latter is to assume the cloak of the former, it too will be burdened with just the same baggage (Turner & Roth, 2003). Lakatos' methodology of scientific research programmes finds a midway mark between Popper's negativist account of falsificationism and Kuhn's view of scientific change which advocates that if a research programme working though auxiliary assumptions is able to generate new theories or changes to existing theory and so evidencing novel predictions then this is construed as progressive. Yet modifications which offer no new predictions and close off the theory to falsification are degenerate. Research programmes whose theories are able to make novel predictions and that also outrun empirical growth are construed as progressive. Yet lags in theory growth and development whilst accompanied by strides in empirical development are seen as stagnant (Nickles, 2001). The latter is reminiscent of the current state of dynamic assessment.

Philosophers of science busy themselves with what constitutes theory, be it good or bad, useful or not. More often than not theories are credited with no more veracity than the intuitive appraisals which scientists invoke for them. A theory has to have a point of origin somewhere and this demarcated line comes into existence in a rather clinical fashion (Kukla, 1990a) and subsequently analysed as such but in an attempt to order and objectify a process of theory appraisal, Meehl (1992) develops a statistical framework for such an endeavour, a quantitative framework which aims to appraise theories in terms of verisimilitude (McMullin, 1990). The plight of theory is similar to what constitutes fashion, at times certain looks are in and during others they are out. Certain theories perennially make their appearance only to disappear again. It is perhaps a "good" thing that no one specific theory remain in existence for too long, as this would seem to indicate almost perfect knowledge on the topic (which is of course not unreasonable per se, but highly unlikely in the social sciences as it has thus far evidenced) and as history has illustrated theories grow and develop (Whitt, 1988). This reminds one again of the falsificationist/verficationist account of science attributable to Popper. Strict positivistic-like theory criteria simply will not do for a social science endeavour, and this much has been acknowledged. However (and here a big however is warranted), this point is seemingly either missed or ignored by a very considerable majority of social scientists, especially those within the psychological assessment sub-discipline, who stubbornly resist a revised theory appraisal framework and insist on continuing on a trajectory planned and followed by natural science models. Who or what is the cause of this?[59] Nevertheless without neglecting the object of this study and veering off on a tangent let the situation rest there as we move on to what constitutes a statement becoming classifiable as theory.

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[57] Known as the Duhem/Quine thesis (Chalmers, 1999; Hookway, 2001; Mautner, 2001).
[58] This study has often had the nasty side-effect of producing more questions that answers.
[59] An area that is ripe for debate and open to recriminations and firm rebuttals. Science (natural and social) is a sociological and psychological endeavour after all and open to all manner of abuse emanating from various hidden agendas, already alluded to in this study.

Kordig (1971) posits six guiding principles, themselves invariant across time, which seek to determine the characteristics of a good theory:

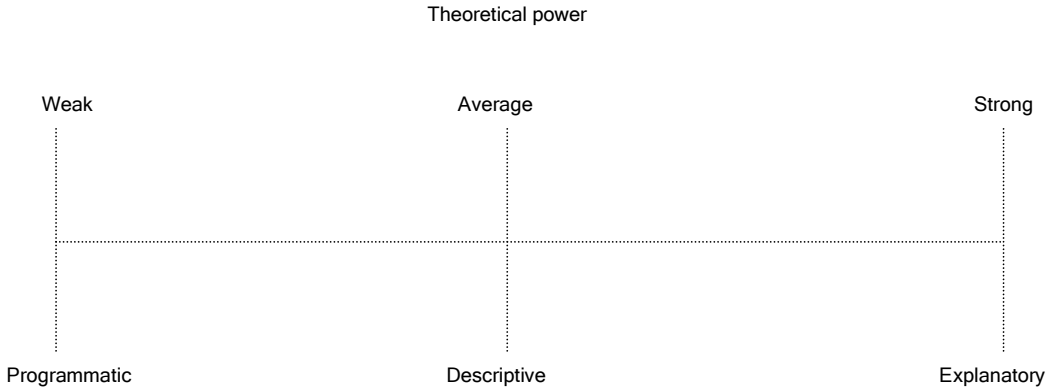
- empirical confirmation
- logical fertility
- extensibility
- multiple connection
- simplicity
- causality

A theory is deemed plausible and valid if the consequences are, via correspondence rules, in agreement with the protocol observations and facts; that is, if the theory is empirically testable (Gergen, 1986; Mouton & Marais, 1988). Correspondence rules are techniques for reifying the constructs and assigning partial observational status to theoretical terms (Suppe, 1993) depicted via the perceptual process and are equivalent to "operational definitions" utilised in the social sciences (Mouton, 1993a). In other words, intelligence as a construct might for the sake of the argument be reified as speed of neural conductivity and hence be physically measurable on a numerical scale which evidences a one-to-one correspondence between speed and accuracy on the one hand and intelligence on the other. Or it can be reified via a score on a test and is regarded as an empirical indicator (Mouton, 1993a). This is indeed how nascent views of intelligence evolved especially within the works of Galton, Cattell and Spearman (Vernon, 1986). The term intelligence is meaning variant as discussed above and thus each definition (an area with many attendant problematic issues of its own; Hempel, 1993) and its associated observation will in turn ascribe to different correspondence rules. This makes this area within the social science quite cumbersome (and simultaneously casts a shadow over the received view of theory development). Nevertheless subsequent confirmations bode well for the veracity of the theory which also ties in with a theory's past track record, in which past instances of success bodes well for the continued use the theory in future (Faust & Meehl, 2002). Meehl (1992) refers to this theoretical criterion as consisting of the "number of corroborating facts derived and the number of discorroborating facts derived" (p.346). Closely linked to this is the criterion of historicity or the historical criterion, which McMullin (1978) highlights as an often utilised criterion in science and theory development. If it has worked in the past then it has been validated by scientists and accepted as such. This is of course a dangerous route to follow as blind acceptance of this criterion might well lead theorists astray in what they presume to be a faultless scientific past. More errors are made than is usually stated in scientific texts.

Logical consistency is regarded by many scientists as pre-requisite for a sound theory, yet the extent to which this can be utilised as criterion for sound theory within psychology for instance is questionable. If logical coherence is an aim of regulative science (Kordig, 1971) then social science theory might well flounder in this area, although psychometrics has indeed made a valiant effort in this regard. The dynamic assessment movement may not perform well in this regard due to its context-boundedness and critical stance on normative assessment. Logic may well aid in studying the soundness and veracity of inferential claims, but as Goldman (1985) states, logic is silent on cognitive states, and can say nothing about psychological states. Secondly, formal logic itself does not consist of rules. McMullin (1978) asks whether logical rules are accepted as *a priori* principles carrying total conviction in their own right simply because they have worked in the past or do they themselves necessitate some form of practical sanction? Logic is also not equivalent to epistemic rules. It bestows on theory development a framework which aids in proper and valid rules of deduction and inference but cannot rule on inner psychological states as such. This domain is better looked at from a theory's heuristic value which lies in the affordance of empirical results being utilised in order to refute or uphold such a theory (Archer, 1996).

Perhaps the most glaring difference between natural and social science theory is the degree of generalisation that theories evidence (but models are usually more generalisable due to their more imprecise nature; Mouton & Marais, 1988). The greater the area (space and time) covered by any one theory the better the theory (Wilson, 1999). However most tentative law-like theories emanating from psychology are not generalisable at all over and above the very specific situation to which the theory pertains. Does psychology need a list of different criteria for the determination of what is considered a good theory? Or at the very least a good model? Is a list necessitated at all? This all very much depends on where the discipline is allocated within the grander scheme of science. Newton-Smith (1981) maintains that theories ought to preserve prior observational successes and incorporate these instances into the prevailing dominant theory which is obviously more robust in terms of predictive success and even better for theories is if they can attempt solutions confronting rival theories (Lamal, 1988). In connection with this attribute of theory appraisal, theories should provide scope for future development and findings and should serve to guide, control and describe future research (Swanson, 1988). Newton-Smith (1981) refers to this as a theory's fertility and Meehl (1992) refers to this as a theory's deductive fertility of fruitfulness. Royce's (1978) concurrence with the notion that psychology as a discipline "should drop the scientific charade" (p.262) and enter into discourse seeking psychological explanations is maintained when it is highlighted that psychology's greatest contribution to date has been statistical, observational and methodological (Shames, 1987b) but it has been held back due to its unsophistication in theory development. Royce (1978; 1987) presents on a continuum, a scale illustrating the range of theoretical power that theories in general posses and is illustrated in figure 37a below.

Figure 37a Continuum of theoretical power (Royce, 1978, p.262)



Likewise, Royce (1978) offers a continuum on which metatheoretical reification ("getting close to the way things are" p.264) can be placed and takes his lead from Nagel (1961)[60] who delineates a four-fold categorised taxonomy of theories; analogical, descriptive, instrumentalist and realist. In contemplating this metatheoretical continuum, analogical theories are heuristic (and not yet "the thing itself"; Royce, 1973, p.14). Descriptive theories gain credence from their empirical data reality, and the realist and instrumentalist accounts are massive theoretical undertakings and seek to maintain logical consistency as the "nomological net expands and [seeks] to maintain contact with an expanding reality" (Royce, 1978, p.265). Less developed theoretical explanations lie at the left hand side of the continuum and merely serve as aids, to "metamorphosing" into reified constructs of actual things being evidenced by realist or instrumentalist forms. This is illustrated in figure 37b below. The most obvious inference states Royce (1978) in the comparison of the two continua is that greater theoretical power leads to greater meta-theoretical reification. One can, in a manner then, compare inter-theoretical bridging principle accounts between two theories at different levels of description[61] to that of a move from analogical and descriptive theories. For instance learning potential in which theoretical constructs are, via correspondence rules, identified as empirical entities; towards theories which seek to reify certain theoretical constructs via their own correspondence rules such as learning potential being expressed as neural speed of conductivity for instance (Reed & Jensen, 1992) or as a measure of utilising the brain more efficiently (Neubauer & Fink, 2005). Such construal of theoretical constructs (or statistical constructs such as fluid *g*) via operationalisation (as evidenced from the links between *Gf* and prefrontal cortex structures) can indeed be fuzzy at best within the domain of intelligence research (Kane, 2005; Wilhelm & Engle, 2005). It is at least possible to speculate about the changes in brain functioning before and after mediation in which the brain can account for more effective processing of information after having received mediation of some sorts. Learning potential as described in various dynamic assessment models is at one end of the metatheoretical continuum considered as analogical or descriptive entities moving along towards more reified concepts of learning potential as expressed by physiological programmes. Royce (1973; 1978) attenuates this model with his own terminology and is illustrated in figure 38 below. In addition to this, the levels of theoretical power are examined as ogive curves along an axis of conceptual linguistic precision and theoretical power, see figure 39. This entire account is a thesis put forward in this study, and is a thesis very much in contestation.

[60] The author has utilised Nagel's 1979 text (chapter 6: The cognitive status of theories) - merely a later addition. Reference will be made to the 1979 text when Royce makes reference to the 1961 text.
[61] In chapter 2 it was mentioned that theories at different levels of explanation need not seek unification due to the fact that they seek to explain phenomena at these different levels and can do so quite without the need to bridge to another level of description. Cognisance is taken of this, but this discussion merely illustrates how such inter-theoretic reduction takes place.

Figure 37b Continuum of metatheoretical reification (Royce, 1978, p.262)

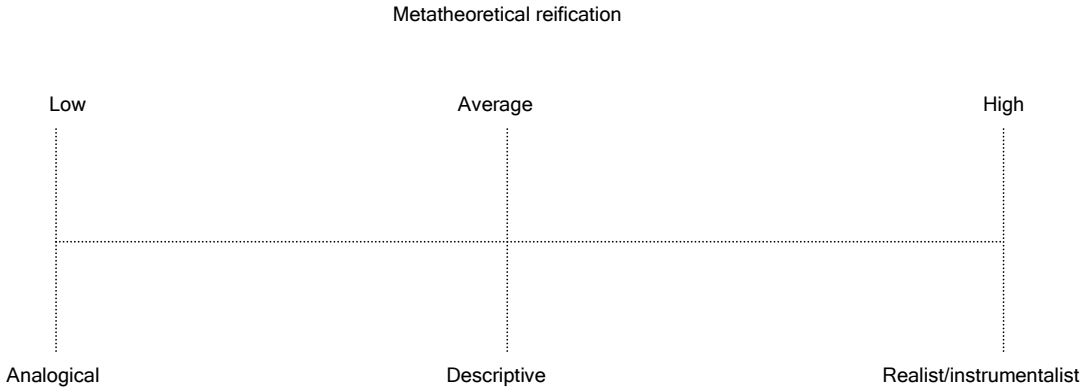


Figure 38 Continuum of metatheoretical reification with additions by Royce (1978)

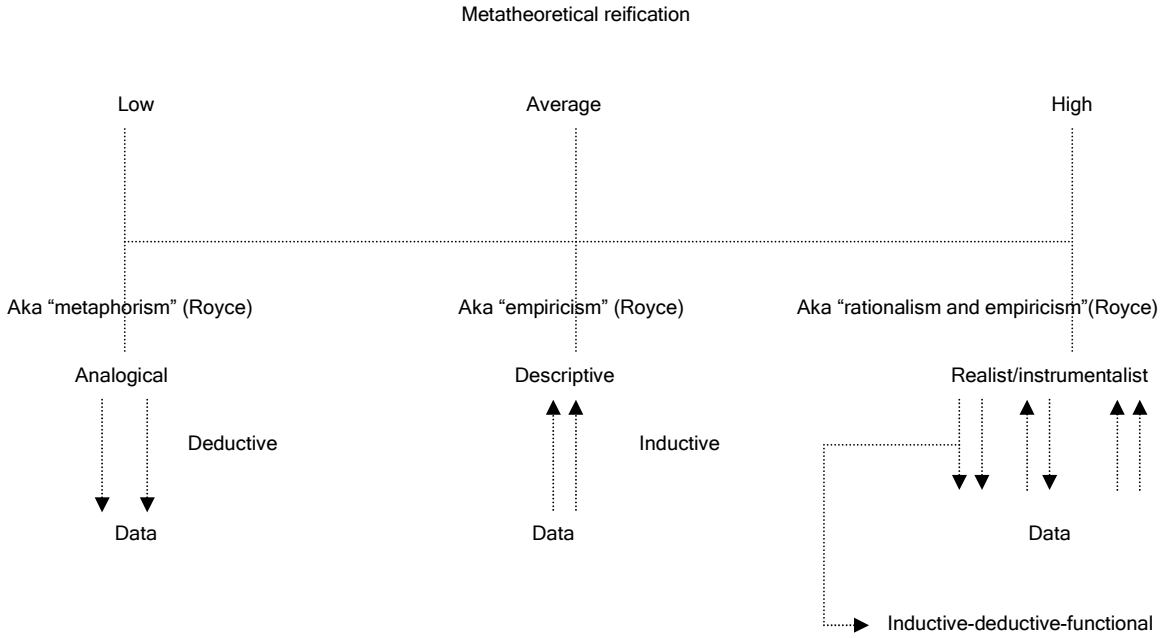
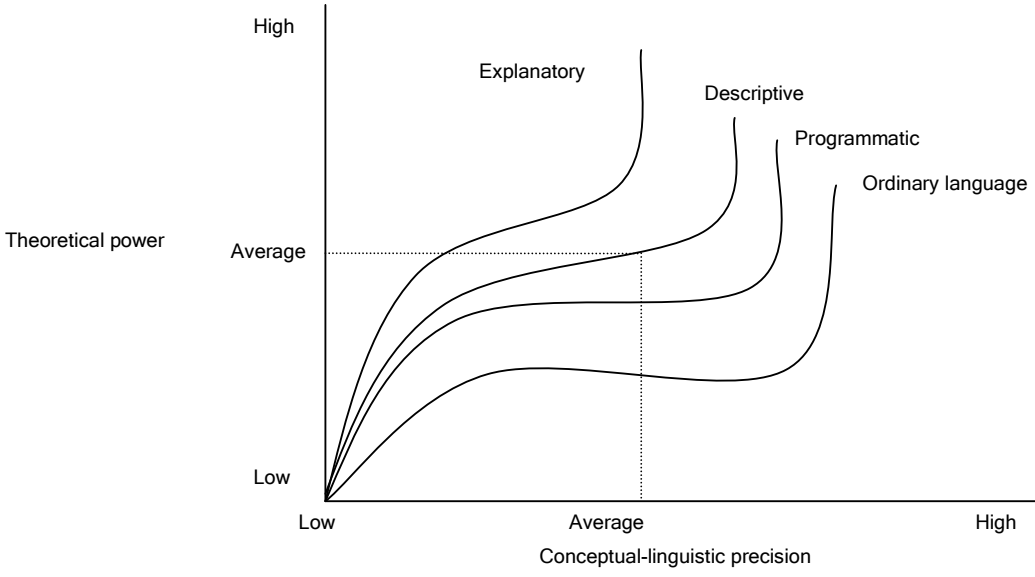


Figure 39 Dependency of theoretical power upon conceptual-linguistic precision (Royce, 1978, p.268)



Considering figures 38b and 39, the following can be stated regarding the level of understanding in a theory depending on the nature of its maturity (its maturity status being effected mainly by the complexity of the subject matter; Royce, 1987). Explanatory theories need not be as precise in linguistic formulation as programmatic theories need to be, due to the fact that the former evidences higher levels of theoretical power as it becomes more reified. In comparison, programmatic theories due to their analogical nature remain purely descriptive and do not express much theoretical power at the same level of conceptual-linguistic precision that explanatory theories manifest for instance. Ordinary language formulations of theories need to attain extremely high levels of conceptual-linguistic precision before they can even reach the low level conceptual-linguistic precision evidenced by explanatory theories. These ogive curves are worked out and conceived as such by Royce, (1978). Royce (1978) maintains that Madsen's classic on comparative motivational theories is levelled at the programmatic stage and as such Madsen is able to illustrate the "conceptual chaos" at which these theories operate (p.269) (see discussion on meta-theory). Are dynamic assessment theories manifest at programmatic levels too reflecting the broader vista of psychology as discipline in which it is still at the empirical and experimental stage?

Simplicity, parsimony or verisimilitude has often been construed as a hallmark of theory credibility (Archer, 1996; Boyer, 1995; Chaitin, 2000, 2006; Fawcett & Downs, 1992; Horwich, 1978; Kuhn, 1977; Meehl, 2002; Newton-Smith, 1981; Pascual-Leone & Sparkman, 1980; Royce, 1978; Wilson, 1999). It would seem on the face of it, that the fewer elements contained in the theory the better it is (Cohen & Nagel, 1949). Why the need for parsimony in the first place[62] (Lohman, 1997b)? Surely two theories advocating the same correct principles are similar in terms of their being correct despite the explanatory variable utilised within the explanation? Many theories of nature posit complicated renditions of explanations and as Meehl (1992) states, are hardly ever simple either conceptually or formally. Parsimony cannot always be logically justified but defended perhaps, from a psychological position (Brandt, 1984). As Fearn (2001) states; "one must take care to use Ockham's Razor only to prune the expendable element of an explanatory theory – that is, those which do not do any useful work in explaining phenomena" (p.59). This Razor advocates a method of time saving only, and is not necessarily an insight into the world. Deployment of Ockham's parsimonious suggestion is blamed for the unrestrained use of null hypothesis significance testing (Rindskopf, 1997). Eliminating non-effectual hypothesis maintains the status quo of simplicity, it being the most admirable level at which to operate within the natural and social sciences. However, this is problematic and will be duly discussed in chapter 4. The case might well be that two theories account for the same phenomena but the one fails in terms of empirical computability from results (Horwich, 1978). Is parsimony truly a litmus test for the survival of a theory (Meehl, 2002)? Philosophers of science have not in general agreed on reasons as to why this characteristic is so important or what in fact this ideal entails (Musgrave, 1985). Conceptual confusion might arise when there are too many simultaneous variables to consider when fewer will do the job just as effectively and there have been tentative frameworks proposed for certain areas such as cognitive science for which simplicity could serve as unifying principle (Chater & Vitányi, 2003). It makes the system altogether easier to understand. Meehl (2002) states that many criteria scientists utilise to appraise theory can be correlated with verisimilitude and offers an actuarial basis for theory appraisal entitled "cliometric metatheory". Verisimilitude is important for yet anther criterion in theory appraisal and that is internal consistency, for, if a theory is to be internally consistent, it would need to be remodelled if it, for instance, contained negations. This aspect of internal consistency is an *a priori* concern and needs to be ironed out before the theory is complete (Newton-Smith, 1981; Pascual-Leone & Sparkman, 1980). The value in parsimony lies in the economical use of terms and sparse or no use of theoretical leaps when presenting such as theory (Archer, 1996) an echo of Robinson (2000, p.1020) who states that "the search for the most economical description is the goal of science that, when reached, subsumes the greater number of observations under the fewest and simplest concepts". Moreover Meehl (2002) delineates four types of parsimony, namely,

- parsimony 1: simplest curves (allowing the data observed to fit the most likely statistically derived curve possible in attempting to move closer to the truth as exemplified by how the data do in fact statistically fit the theory). When various curves fit the data it is impossible to determine the correct one (after all they were inductively determined) and hence the reliance on parsimony becomes a logical next step (Harré, 1988; Sober, 2001)
- parsimony 2: economy of postulates (the one most often referred to when discussing parsimony in general)
- parsimony 3: economy of theoretical concepts
- parsimony 4: Ockham's razor (don't invent a theory to explain a new fact explainable by ensconced theory)[63]

In fact, Chaitin (2000) offers a unique perspective on the issue of parsimony although he does so from a metamathematical position encompassing the area of computer programme structure (Casti, 2000). Chaitin (2000) maintains that the size of a

[62] Newton-Smith (1981) poses this very question to the reader. "Relative simplicity to a large extent lies in the eyes of the theoretician and not in the theory" (p.230).
[63] Contrary to Feyerband's proclivity to sustain as many theoretical attempts to explain the same phenomena as possible (Meehl, 1992) but the author is agreement with Meehl (19920 on this issue, maintaining that it is more economical to stick with the theory already in place that adequately does the job. There are sufficient other theories to work on without ceasing to work on a problem which already employs a governable theory.

computer programme is equivalent to the concept of entropy and that the smaller and more elegant a programme to describe a system the better. Writing a programme for the properties of a gas, say, would be far more complex than a programme written for a crystal for instance and he states that the idea of programme size complexity is connected with the philosophy of scientific method. The smaller the programme for describing a system the better it is at explaining the phenomena[64] (Chaitin, 2006; Coveney & Highfield, 1995). However once a point of maximal complexity is reached (infinite entropy) there is no parsimonious method of describing the system and hence the system becomes its own description which nullifies the whole idea of having a theory in the first place! Is this perhaps not akin to the area of intelligence research in which the human being in interaction with the environment behaves as a maximally complex system; one which cannot be reduced to theoretical principles? And hence, the only tool useful in describing the system is the system itself? Perhaps the study of intelligence then, should end? Perhaps. Or perhaps different questions should be asked. Another allied issue to this one highlighted by Chaitin (2000) is that one can never be sure of how simplified a theory can be. When a programme is written to describe a phenomenon, a simple programme might be in the waiting; a smaller more elegant programme; how can one be sure that the current programme is the smallest one available? The answer is that one can never know; an issue which is beyond mathematical reasoning.[65] McMullin (1978) concurs with other philosophers of science when discussing theory appraisal. Issues such as simplicity, coherence, consistency, elegance and the elimination of inexplicable coincidence cannot be classified as a criterion of appraisal as such. They are therefore categorised as a systemic criterion as they are often assumed to be criteria due to their historical role in science and theory appraisal and simply because it has become conventional to do so. Hence, these criteria are classified as quasi-formal properties of theory. In fact verisimilitude, simplicity and parsimony have been viewed as aesthetic criteria, somewhat less important in comparison to other criteria which have an impact on the scientific community and society in general as well as the heuristic value of a theory (Royce, 1978). In conclusion Royce (1978) sums up various theory appraisal criteria into three broad categories which reflect different aspects of theoretical power, namely

- its cognitive and knowledge generating capacity - empirical testability, degree of empirical-formal fit, comprehensiveness of scope, parsimony, depth of penetration, degree of formalisation, degree of cohesiveness and explicitness of conceptualisation
- the social or communicational impact of the theory – impact on both the scientific community and the culture in general as well as the heuristic value which leads to more research
- the theory's aesthetic value – simplicity and parsimony (akin to the notion of mathematics' aesthetic qualities, often utilised for its heuristic power; Farmelo, 2002b; Miller, 2002; Wilczek, 2002)

Kordig (1971) maintains that causality really is a property of physical laws and is not merely regulative. In other words causality is not merely a clear stable path of cause and effect which follows in deterministic fashion but is part of the law itself. Contextual and universal causality should be also be captured within a sound theory (Mouton & Marais, 1988). Theories within the social sciences are perhaps bereft of linear causality thus making the job of theorists increasingly difficult (Wilson, 1999). The web of interacting variables with which psychology has to contend, makes the case for causality all the more complicated. To this list Newton-Smith (1981) adds that a theory's track record is important as a continuing corroboration of observations and facts bodes well for future success. Inter-theoretical support is another criterion which adds credence to a theory, yet the obvious example within physics (the incommensurable theories of General Relativity and Quantum Mechanics) seems to be at odds with this criterion. The one theory being unable to explain phenomena in terms of the other. Likewise a similar situation arises in intelligence assessment in which *g* loaded tests become less *g* loaded through mediation. Can the one theory of *g* loadedness explain the observational facts encountered in test-mediate-retest situations? This leads on to another theory appraisal criterion put forward by Newton-Smith (1981), namely that of theory smoothness which amounts to a theory's ability to adjust when it encounters failure. The greater the ease with which this is conducted, the greater the veracity and soundness of the theory.

In sum, when viewing the preceding six criteria it seems almost hopeless that psychology and its subsidiary disciplines will ever attain a state in which these criteria will apply. Either the list needs drastic revision and attenuation or the discipline needs to be overhauled in such a manner as to allow for the creation of a new list of criteria. Meehl's (1992) list is more comprehensive in that it includes a greater variety of criteria than those advocated above and includes criteria such as the amount and quality of facts derived from the theory, the novelty of these facts, their numerical precision, the theory's passive or active reducibility (theory as reduced or theory as reducer); initial plausibility (which might not be easy to detect without sufficient scrutiny of

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[64] Complexity, *K*, of an object, *x* is described by the length of the shortest programme that can be written for that object in any standard universal computing programme syntax (Chater & Vitányi, 2003).

[65] One can clearly see the progression of ideas from Gödel's incompleteness theorem, through to Turing's halting problem and on into Chaitin's theory of randomness (explicated here by computer programme problems) (Coveney & Highfield, 1995; Stewart & Golubitsky, 1993). But this does tie up with the idea of the need for parsimony, especially in the fields of computational programming, where the need is perhaps greater than in the social sciences. However, this is not to say that the same principles cannot be utilised within intelligence assessment research for instance and the need for parsimonious theories. At least this may be one tentative answer to the question of why there is a need for parsimony in the first place.

course); computational ease and somewhat less rigorous, the beauty, depth and elegance of a theory[66] (similar to Royce's, 1978 aesthetic criterion).

There is also the issue of theory as derived from data and theory as driving data which has not yet been mentioned. The necessity of initiating theoretical research with a collection of data which refutes or confirms prior renditions of theory is not in fact a necessary requirement; as a plethora or mass of data may often be quite useless without the accompanying theory behind it (Kukla, 1995a, 1995b; Strube, 2000; Swanson, 1988). This "autonomy from the data" (Kukla, 1995a, p.201) might seem an unscientific enterprise but if theory is able to grow from logical suppositions and predications which allow for the fostering of new ideas (which can be tested), then as an enterprise it should receive accommodation from practitioners of both basic (which is theory-driven) and applied research, especially within the field of intelligence research (and its varied and allied sub-disciplines) which abounds with theoretical models.

A similar set of criteria for judging the worth of hypotheses in general is delineated by Copi (1972) and includes:

- relevance
- testability
- compatibility with previously well-established hypotheses
- predictive or explanatory power

An hypothesis is only relevant to the fact that it supposedly helps explain. These facts need to be deduced from the hypothesis either directly or from a combination of causal laws. Hypotheses which are not amenable to testing (whether it be falsifiable or confirmatory testing) in either direct or indirect inferred manners cannot be considered a scientific hypothesis. It is preferable that the current hypothesis is in keeping with previously acceptable hypotheses and also that it be self-consistent. Radical departures from accepted hypotheses are suspect, at least within the natural sciences, however the same cannot be said about the social sciences, especially in an area in which there are few proven theories, hardly any laws and overwhelmingly numerous hypotheses. The number of deducible observable facts from an hypothesis credits the hypothesis' explanatory power base. The more facts that can be deduced from the hypothesis the more powerful the hypothesis. Added to this are a further four criteria advocated by Kuhn (1977) and Lamal, (1988), namely, accuracy in that consequences of the theory should be in agreement with experimental findings and observations; consistency, both internally and with other related theories; should evidence broad scope in extending beyond the strict delimited confines it originally sought to explain (referred to as progressive theories by Pascual-Leone & Sparkman, 1980) and lastly theories should prove fruitful in endeavouring to explain as many new and known variables and relations as possible. Among various theses concerning theory appraisal lurk a number of salient issues which may well render the criteria suspect. Who, after all, is to say that criteria are indeed laudable in all circumstances (Lamal, 1988)? Of course this leads down a relativist path in which criteria will have to be stipulated for each and every research programme thus nullifying their impartial and objective characteristics.

Before science can be conducted a list of criteria is necessary to determine the relative strength or weakness of theories and hypotheses, but this cannot be done if the list is not a true reflection of the prevailing conditions inherent in each programme. Are there simply no objective and all-encompassing theory appraisal criteria? Eysenck's (1987) list is perhaps one of the shortest lists and evidences only five basic and broad criteria for appraising theories, namely that a good theory should be progressive, it should explain what previously was considered as anomalies, it should act in the capacity as criterion between computing interpretations, it should attempt unification of disparate disciplines and lastly it should evidence practical value. In agreement with the fourth criterion employed by Eysenck (1987), Wilson (1999) emphasises the disparate paths that both major disciplines are presently travelling along in terms of unaccommodating theoretical links. Wilson's (1999) four qualities for any good theory encompasses parsimony, generality, consilience ("units and processes of a discipline that conform with solidly verified knowledge in other disciplines have proven consistently superior in theory and practice to units and processes that do not conform" (p.219)) and lastly productiveness. In sum we cannot judge the fruitfulness of dynamic assessment theories and models within intelligence if we do not as yet possess a criteria list; for at the outset then, we will have to admit that any such list will not suffice for all theories at all times. Once again such studies are relegated to time and place and are specifically attuned to the area under investigation. How is one to proceed? Perhaps this is the feeling with which positivist-minded social scientists are confronted. These issues are not solved within this thesis; a framework is indeed chosen and attenuated and from there the procedure follows but as to a resolution of the above-mentioned issues, no solution is yet in sight.[67]

[66] The author will refrain from discussing this particular criteria as the argument can become quite lengthly and convoluted.
[67] Another topic worth pursuing then.

3.6 Towards a meta-theory

Various authors posit varying views as to what they perceive meta-theory to be. Some advocate that it is indeed a theory of theories or the study of such theories and scientific tools (Faust & Meehl, 2002; Weinstein & Weinstein, 1992). Others maintain that it is more of an overarching framework and serves guiding parameters from which to view and study other theories in a reflexive manner (Abrams & Hogg, 2004; Bjorklund, 1997; Cervone, 2000; Ritzer, 1996). It is viewed as a set of epistemological and ontological assumptions which orient and direct theorising as well as limiting the nature of psychological accounts (Gergen, 1987a; Lawler & Ford, 1993) but not necessarily prescribing new theory (Stam, 1987). Theoretical psychology as subdiscipline has even been described as a meta-discipline (Slife & Williams, 1997). One can study all theories within a discipline,[68] or theories specific to a sub-discipline[69] (Madsen, 1988). Ritzer (1996) maintains a distinction between two courses according to which meta-theorising can proceed; meta-theorising in an attempt to re-visit extant theory in order to gain a greater understanding and meta-theorising as a function of theory development. The main point of concern is of course the legitimacy of such a meta-theory, in other words is it itself an empirical exercise? Meehl (1992) claims that it is. Berger and Zelditch (1993) are of the opinion that meta-theories are nonempirical structures as opposed to testable theories (Lawler & Ford, 1993). Meehl (2002) contends that as far as meta-theory's own theory appraisal is concerned (and in keeping with the sparse literature on workable meta-theoretical frameworks), it "is surprisingly thin as to criteria" (p.345). Can it too be scrutinised along with other theories? These are difficult questions to answer especially as the enterprise of meta-theorising is not really a developed one, which is obvious when one views the myriad definitions of what constitutes a meta-theory in the first place. Does meta-theory precede theory development and act in a capacity of guider or does it seek to rectify after the fact (Berger & Zelditch, 1993)? Deliberating about such meta-scientific issues is not a seemingly straightforward one and "disciplined thinking *about* science appears to be much more difficult to achieve than disciplined thinking within it" (emphasis in the original) (Rozeboom, 1970).

Lawler and Ford (1993) state that meta-theory busies itself with both, in that it "not only initiate(s) theorising but often guide(s) extensions of extant theories in implicit, unacknowledged ways" (p.174). One can of course argue that there are no presuppositionless theories and as such are either implicitly or explicitly guided by some sort of metatheory, this type of meta-theory is of course not a formalised one (Lawler & Ford, 1993). A parallel between theory/experiment and meta-theory/theory can perhaps be drawn in which experimentation is the test and theory the driving force for theory development (Willer & Markovsky, 1993) where theory becomes the test and meta-theory the driving force within meta-theory development. Bjorklund (1997), in devising for cognitive development a meta-theory concerning developmental biology, contends that his is not a theory of theories but rather an overarching framework with principles and assumptions which may or may not be subject to empirical validation. His argument for a necessary framework for cognitive development is warranted at a time when in this field there is "an overabundance of details about children's performance on trivial tasks in unreal situations" (p.144), a common lament within the discipline of assessment as a whole (John, 1980) and similar in sentiment to what Turner and Roth (2003) refer to as "large body of practical activity, but not successful theory" (p.5). Diversity and specialisation can both be accommodated within an overarching framework. The rationale underlying the attenuated Madsenian metatheory framework (to be discussed below) is similar in sentiment to that written by Abrams and Roth (2004) "a metatheory should provide an alternative framework for asking particular questions, not a complete explanation for all phenomena" (p.100).

However, before embarking on a 'metaforay' it will be necessary to first highlight the differences between three interrelated meta concepts; metatheory, metamethod and metadata (Zhao, 1991).[70] What is the point of theorising about extant theories? Within metatheory, three avenues to pursue according to Zhao (1991) are the needs to further develop and attain greater insight into theories within specific research areas, to serve as prelude to new theory development and lastly to overarch some or all theories within any particular discipline. Metamethod, is the study of methods used within the specific research area and Zhao (1991) relates three types of studies that emanate from metamethodological endeavours; methodological presumptions necessary to carry out studies, evaluations of the strengths and weaknesses of various methods used in research as well as the systematising of procedural rules. Lastly, meta-data-analysis is the study of results of various studies, collating findings (the raw data) into one grand result (the meta-data). Meta-data-analysis consists of understanding the underlying assumptions utilised in analysing various data sets (as differing statistical assumptions may well result in divergent conclusions), the comparison of different forms of data as well as synthesising the results from a spread of studies (Zhao, 1991). This has resulted in the appended meta-analysis in this study although methods have been devised which synthesise narrative or qualitative results too. In contrast with Zhao's (1991) opinion in which he states that meta-studies are often confused with philosophical studies on epistemology and ontology, the author maintains that, in keeping with Madsen's metatheory fundamental epistemologies are paramount to the understandings of various models and theories and can be comfortably accommodated in a development of a

[68] Although as time progresses this seems less likely as all disciplines are so rich and varied in the branching of sub-discipline areas of expertise and specialities. It is hardly conceivable that such an undertaking would be lightly entered into to.
[69] Referred to as minitheories by Faust and Meehl (2002). There is no standardised definition of what meta-theory is and hence synonyms of this sort arise.
[70] Much of the 'meta' literature has as its focus, sociological metatheory. Zhao (1991) is one such example, for whom meta-studies centre around sociology.

meta-theoretical framework devised for the purposes of situating dynamic assessment within intelligence. Rozeboom (1995) highlights three levels from which a scientific meta-theory can be successfully conducted:

I. the substantive level in which existing theories are critiqued. The aim is to evaluate and improve on these theories (akin to Madsen's HQ calculation discussed below)
II. methodological meta-theory attempts to build an appraisal system of sorts according to which varying theories can be compared and analysed, thus bringing a semblance of empiricism to the technique
III. the foundations level is concerned with basic operational questions about fundamental issues (the philosophical levels which predicate many theories either implicitly or explicitly)

According to Aldridge, Kuby and Strevy (1992, p.683) "a metatheory is a paradigm or world view" in which the social sciences are more closely tied to general views about the basic nature of human behaviour (hence the need to discuss the role of fundamental epistemologies and ontologies as they pertain to theories in general and also the need to state the author's own epistemological and ontological leanings in chapter 2). Of note here and reason for inclusion of this quote is to highlight the blurred boundaries which are often encountered in the social science literature. Is a meta-theory a paradigm? Are the two concepts to be used interchangeably? Perhaps a more accurate rendition of what a meta-theory is as conceptualised for this study is one that "gives the big picture or may be described as the umbrella under which several theories are classified together" (Aldridge et al., 1992, p.638). These authors equate meta-theory to paradigm[71] and mention four such paradigms which effect educational psychology in particular; the organismic paradigm in which person is considered paramount and includes notables such as Piaget, Janet and Gesell; the mechanistic paradigm; in which process as mechanism is paramount and includes among others Galton, Hall, Watson, Skinner and Thorndike; the dialectical paradigm; in which individual-environmental interaction is considered as propeller of conflict and change and is exemplified by, among others, Vygotsky, Luria, Hegel and Marx and lastly the contextual paradigm in which pragmatic concerns are voiced in a milieu of eclecticism and methodological pluralism and include among other pragmatics Peirce, James, Dewey and G. Mead.

This strict demarcation of people into categories, is of course, almost a past-time for philosophers! When viewed in this manner it becomes increasingly difficult to link certain theories with certain proponents of the broader movement, and often the case may be that, as is clearly illustrated within dynamic assessment, models and presuppositions are encased within dialectical, organismic or contextual frameworks only to be delivered using a mechanistic world view (Aldridge et al., 1992). What can one conclude from this? Possibly that the mechanistic paradigm is considered more worthy of scientific status as regarded within the natural science model of conducting good science. What message is this sending out to practitioners and researchers? Possibly that it is worthwhile (perhaps even noble) to theorise and understand phenomena within a progressive framework[72] but that the method used as ultimate arbiter of the theory or model's veracity is one of mainstream understanding of what it means to conduct science. Hence the need for statistical manipulations, robust measures and empirical verifiability. What happened to the ensconced framework within which the theory was originally embedded? Not to worry, at least it looked good![73] Swanson (1988) refers to this pluralist scenario in a critical way in which incommensurable orientations are mixed without due consideration for the, at times, contradictory claims underlying these various affinities in an effort to offset the inherent weaknesses evident in any one theory.

Meta-theory may also refer to the second-order approach to the study of theories developed within dynamic assessment in this instance (Mautner, 2000; Zhao, 1991). It is a view from above, so to speak, a higher order appraisal of theories aiding in the direction and guidance of the construction of empirical theories, also referred to as orienting strategies (Berger & Zelditch, 1993a).[74] Dynamic assessment theories and those encompassing models or precursor models (Mouton & Marais, 1988) will be assessed. Swanson (1988), in attempting to move towards a metatheory of learning disabilities, states the need for meta-theories as they provide the framework necessary for continued research and offer services such as the understanding of events, provision of an organising framework (Berger, Wagner & Zelditch, 1989) and revelation of the complexity of performance within seemingly simple tasks. Viewing the meta-theoretical landscape from a view above, below and around the theories and models that make up such a vista, allows one the luxury of a fuller scope of what is going on within the field, but simultaneously confounds such a straightforward attempt to order the theories into some sort of workable framework. Weinstein and Weinstein (1992) detail types or ways of conducting meta-theorising and differ in terms of their reflective practices:

- meta-theory seeks to achieve a deeper understanding of theories;[75]

[71] Used interchangeably with the term research programme (Berger & Zelditch, 1993a; Turner, 1993).
[72] Social constructionist, feminist and other such critical views.
[73] The author states this with some jest and tongue-in-cheek, but sadly this is an all too common phenomena.
[74] Some philosphers have used the phrase "grand theory" when obliquely referring to what at times seems to be a meta-theory of sorts but do not advocate it as such or much less develop some sort of formal or systematic framework for it.
[75] Not much of an empirical approach one might add; contrast this to the meta-theoretical framework or systematology offered by Madsen as well as the use of his hypothesis quotient (HQ) in determining the numericised empirical value of theories.

- meta-theorising serves as prelude to new theory construction
- meta-theorising strives to create perspectives that overarch theories seeking novel theoretical integrations
- contrasting agendas for meta-theorising which include meta-theories. These seek to prescribe the prerequisites for theory generation and meta-theorising that seeks to study existing theories (Swanson, 19898; Turner, 1986 in Weinstein & Weinstein, 1992)

In sharp contrast to the authors' predilections in terms of philosophical leanings towards certain issues as elaborated upon in chapter 2, yet in keeping with progressive trends within the reality of how science is conducted (as opposed to any prescriptives), Weinstein and Weinstein (1992) uphold the notion that meta-theorising cannot be undertaken by those remaining firm to foundationalist views on science because the undertaking as such "elucidates the structure of difference, not the unity of differences" (p.141). Through the clarification of suppositions inherent within any theory, meta-theory aims to dismantle such (latent or manifest) alliances in order to bridge or separate those theories that are in need of such restructuring. The manner of such restructuring is, of course, open to debate. Whether or not such an endeavour is an "anti-dote" to abolitionist theorising can likewise be debated. There is no tension here between a positivist type stance in studying social phenomena and doing so in various means, some of which are construed as post-modern, and this is due to the affirmation of the notion that objectivity can be enclosed in a subjectivist psycho-social realm.[76]

Berger, Wagner and Zelditch (1989) maintain that theoretical work starts with either implicit or explicit adoption of a metatheoretical position which in turn is re-negotiated depending on the verifiability of the theories subsumed within it and in this sense it is a reflexive process. In their view, the growth of theoretical knowledge and not merely the relation of theory to observation is intertwined with its predecessors, theoretical alternatives available and competitor theories. Five relations between theories within any one theoretical research programme (or paradigm[77]) can be expanded upon and include:

- elaboration – which entails the growth, development and increase in scope, precision and empirical adequacy of a theory. A theory is more elaborate if it is more comprehensive or possesses greater analytical power or has a firmer empirical grounding but still shares the same basic concepts and principles of the theory it is trying to replace (Berger & Zelditch, 1993). Elaboration consists of three main goals; theoretical goals in which the explanatory domain is larger than the domain originally covered by the initial theory, analytical goals in which the theoretical structure and model is formalised and empirical goals in which observational corroboration and empirical consequences are increased (Berger & Zelditch, 1993). Theory growth occurs and results in the growth of its "assumption and prediction sets" (Jasso, 1993) but presumably due to the criterion of parsimony (discussed above) a smaller assumption set and larger prediction set would be advisable. However, a monotonic scale is evidenced for assumptions in which early theories are characterised by numerous and ever-increasing sets of assumptions as observational data is encompassed within any given theory, only to be trimmed and pruned later on as certain postulates become redundant or simply prove to be incorrect. Thus fewer postulates evidence a more mature theory. On the other hand, an increase in predictive power is an ever-increasing phenomena and thus theory growth regarding postulates and predictions operate in different manners (Jasso, 1993)
- proliferation – in which a theory is deployed in novel terrain and encompasses new concepts and assertions. In other words the range of explanatory power increases beyond the range originally explicated by the initial theory. The initial theory's concepts and principles might be carried over into the new theoretical explanation and modified to suit the new theory (Berger & Zelditch, 1993)
- competition – in which a theory is able to lay claim to territory already claimed by another theory and to subsequently explain the same phenomena in new ways. Competitive theories offer explanations about the same explanatory phenomena but differ widely in their explanatory mechanisms and their chosen concepts and theoretical principles. Faced with contradictory predictions, competitive theories serve theory growth in a manner in which opposing plausible explanations might well co-exist in time yet be reformulated at a latter stage (Berger & Zelditch, 1993). Barendregt (2003) is at pains to delineate competitor theories which seek to eliminate other theories with co-explanatory theories which do not seek to eliminate but to merely offer alternative renditions of the occurrence of phenomena. For instance, as with the case discussed in chapter 2 concerning bridge principles and intertheoretic reduction, it is maintained that there is a difference between intralevel and interlevel theory explanation. Intralevel theories can either evidence theory reduction in which bridge principles are in fact accommodated and theory replacement in which one theory is able to explain away facts and concepts at its own level taking into account the explanation yielded by another theory. Dawson (1995) discusses competitive theories by noting five variations on this theme; intertheoretical entailment in which one theory is logically entailed by another; intertheoretical inconsistency in which one theory logically entails negation of the other;

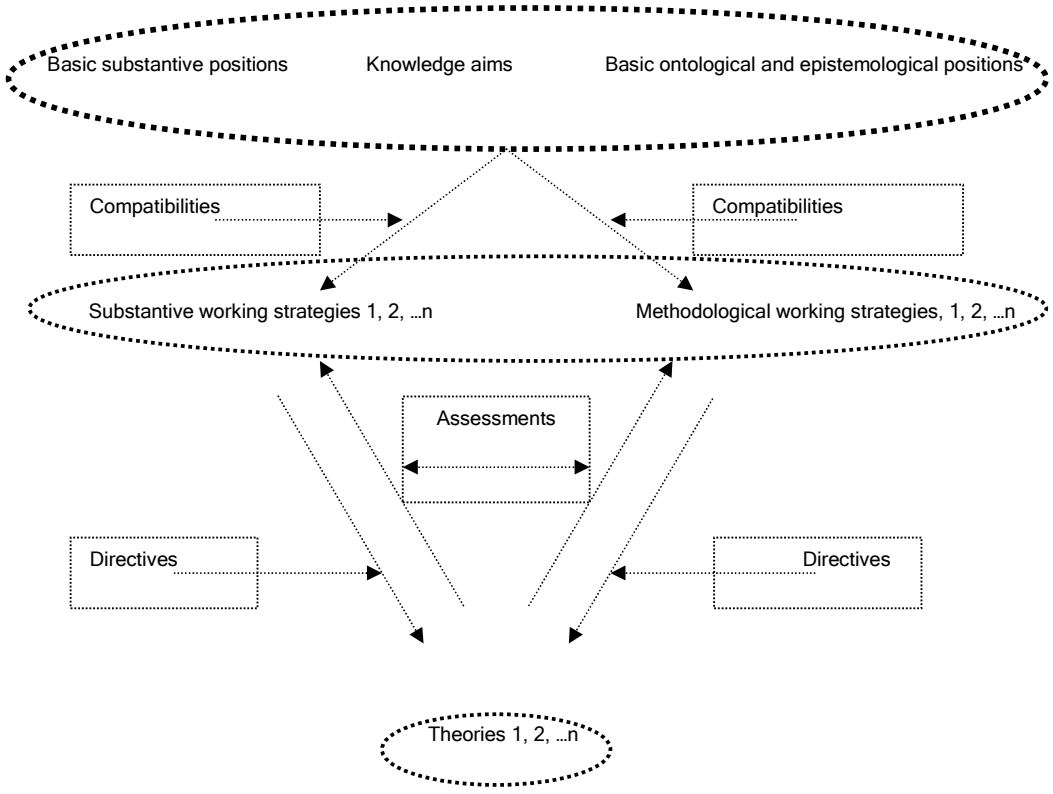
[76] Positivist objectivity maintains that objectivity can be achieved; postmodern thought says otherwise, nothing is what it seems to be, and has to be contextualised before it can even start to resemble something coherent. A middle-range stance is preferred, perhaps close to the views espoused by critical realism (it's developer and most vocal supporter being Roy Bhaskar) which places more emphasis on ontological properties as opposed to epistemological properties in the understanding of how science is conducted (Maree, 2003; Outhwaite, 1987).
[77] Typically Kuhn's terminology yet contested as a reliable term which is considered by some as too vague (Stegmüller, 1976).

intertheoretical complementarity in which the negation of the one theory implies the other; independence arguments in which proofs are warranted if no logical relations are said to exist between the two and lastly, conjunct deletion which entails the deletion of propositions in the one theory and in so doing transforming it into the other theory yet simultaneously maintaining the empirical consequences. However, as it at times the case with psychology, interlevel theories operate at different levels of explanation and can both be considered as explaining correctly the same phenomena albeit at different levels, hence they are not competitive theories

- variation – involves the construction of closely related theories which although similar on many accounts, puts forth different mechanisms of explanations on certain issues. Theories are variants of one another if similar concepts emanate from shared concepts and if they address similar explanatory problems. Although very similar in the domains about which they theorise, variant theories often employ different explanatory mechanisms in describing similar processes. It often occurs that variants will replace initial theories or integration results as the one theory is subsumed by the variant theory (Berger & Zelditch, 1993)
- integration – in which at least two different theories or theoretical arguments are able to combine into one coherent account the details of partially overlapping areas of concern. Given two theories and their respective explanations concerning phenomena, a third theory might well integrate both explanatory mechanisms into a third unique yet more powerful explanation. Three types of integration serves theory growth and concern the aforementioned relations; integration of variants in which conditionalisation is utilised to specify the conditions under which each variant theory's process operates; integration of proliferants, in which the different interrelations of the different theories are consolidated; and integration of competitors in which two competing theories are combined into a novel third theory harbouring concepts not found in either one of the original two theories (Berger & Zelditch, 1993). The authors also make a case for the integration of independents in which two competing theories neither share nor make use of similar explanatory mechanisms and principles. Integrations represent major leaps in theory growth, however losses too are incurred when concepts from initial theories are left out during integration

Berger and Zelditch (1993) illustrate their conceptualisation of elements within an orienting strategy (meta-theory) and is reproduced here in figure 40 below. Notice the similarities this shares (especially the feedback process between the third and second levels) with the overarching taxonomic systematology framework devised by Madsen below.[78]

Figure 40 Elements in an orienting strategy (Berger & Zelditch, 1993, p.18)



[78] Once again, no mention is made of K.B Madsen's work in meta-theory development which does strike the author as odd, especially since this framework had been developed in the late 1950's.

3.7 Summary

Dynamic assessment is to be placed within an overarching meta-theoretical framework in order to appreciate the path it needs to follow if it is to remain a fruitful field within the broader discipline of psychology. However, before meta-theory is critically evaluated, notions of theories, models and the progress of science needs to be viewed. Psychology, as with any formal discipline has arisen in contexts which have ineluctably formed much of its core armament and the deployment of such armament has had profound effects on the manner of its methodology and its subject area. Science has a long informal history and spans time since Greek speculation through to more formally recognised flourishings emanating during the Enlightenment. The history of natural science is very much a history concerned with explanation into the why and how of nature. Scientific explanatory mechanisms can be largely grouped according to ontological and epistemological concerns and include the deductive-nomological, causal and pragmatic approaches. Law-like models of explanation were sought in investigations allowing for a rendering of nature that was clearly comprehensive. Such core approaches to the understanding of reality finds its way into subsequent psychological areas of concern. Causal explanatory models became the modus operandi of many psychophysical experimentation which employed robust measurement techniques. Through such mechanisms psychology was understood to be causal, law-like and knowable where truth could be accounted for. Scientific theories blossomed forth from reductionist, realist and instrumentalist accounts of nature which likewise found conduits pliable enough in psychological research.

Social sciences, in an attempt to emulate their natural science counterparts, strove to become relevant, timely and progressive resulting in the many branching avenues pursued by various sub-disciplines within the ever-bourgeoning field. Early on, the disparate areas of interest were to spread off into directions necessitating different techniques of meaning extraction and understanding, thus dividing the field into “hard” and “soft” areas. The continuing crisis of identity pervaded many research programmes resulting in a backlash of criticism of methodology purportedly narrow and close-minded. The “science” in social science was being questioned. The necessary hierarchy of phenomena to be studied and those deemed fit to be studied was and still is a contentious debate. Clear dichotomies polarising niche areas were an unfortunate consequence of the need to re-dress essential areas of concern. Tension from atop this false hierarchy permeated down to the lowest rungs resulting in the discipline’s ill-defined status as science. Objective observations, hypotheses, precision, verification of findings, measurability and prediction (Barker, 2001) were the benchmarks of a progressive science and fields which did not avail themselves of such techniques were considered as non-science. In this manner, psychology has never really made for itself a unique development and progressive path to follow. Dynamic assessment, it is argued, can in fact do so as it consists of a number of elements in its favour as a new sub-field within psychology. Historical contexts, philosophical preoccupations and critical notions of what it meant to practice psychology were developed alongside the mainstream culture of psychology.

The realm of pseudoscience cannot be equated with the aforementioned non-science as psychology might well develop in a non-scientific manner, or rather it should be stated in a non-natural science manner. The role of theory and model too have been uneasily displaced from one context to another and this is no more clearly seen than in the rationalisation utilised within experimental designs and research hypotheses in many psychological fields but most specifically within psychological assessment. The very elements of theory, concept and terminology development are paralleled along natural science concerns. From psychophysical research to areas of environmental concern, psychology has travelled a varied path in trying to obtain a unique progressive identity which it has hitherto not been very successful in attaining. A tentative remedy for this situation can be seen in the works of theoretical psychologists which can aid and guide the development of the discipline along a new trajectory but is a field not strongly supported by the majority of practitioners. Explanatory mechanisms are still by and large natural science oriented and this state of affairs is reflected in the literature where a disproportionate number of treatises argue the debate of philosophy of science as it pertains to natural science with a resounding emptiness in the social science disciplines. An area rife with contention within psychological theorising is the question of theory appraisal which as with the above mentioned aspects takes much of its argumentation from natural science theory appraisal. Hardly anywhere in the literature is psychological theory appraisal discussed without due recognition of natural science theories. Has psychology not cast itself a role in singular status discipline without need to continually go back and compare itself to natural science models? Philosophers of natural science are routinely brought in to discuss the pertinence of theory appraisal and theory discussion in general within the social science realms. Before meta-theory can develop as a tentative framework, theory itself needs to be discussed. One can see the social sciences continued identification with natural science and as such a meta-theory will have to take into account this relationship as past theories have been built with a natural science framework in mind. Meta-theory seeks to achieve greater understanding of extant theory, serves as an introduction to new theory construction (without the need to utilise natural science models), to create areas of mutual integrative concern for various schools within psychology, specifically assessment and to set agendas for further theorising. Such a meta-theory will now be looked at.

3.8 K.B. Madsen

K.B. Madsen (d. 2004) was a professor at the Laboratory of General Psychology at the Royal Danish School of Educational Studies (now amalgamated with other institutions and as such no longer exists as an independent unit) in Copenhagen, Denmark. A school psychologist, having taught and lectured he was the author of numerous texts in psychology written and

translated into Norwegian, Swedish and Danish[79] (Madsen, 1971; Royce, 1975). Thankfully some of his work was written in English. That Madsen's model of meta-theory was chosen was due primarily to the scarcity of *psychological* models of meta-theory in the literature and the close affiliation that his model evidenced with the naïve views originally conceived by the author (as noted above, theoretical psychology itself as sub-discipline within psychology is not at present universally formally accepted as being mainstream). It is once again of interest to note that Madsen among others was influential in establishing meta-theory within theoretical psychology as a discipline within the larger subject matter of psychology and that this effort was largely but not exclusively backed by researchers from the Netherlands and Scandinavian countries.[80] In this regard, dynamic assessment as an assessment model within intelligence research may be geographically more aligned with just such a meta-theoretical approach (since many researchers emanate from Germany and the Netherlands). As has been noted, scientific traditions emanating from specific geographic locations mould, to a certain extent, researchers' conceptions of their field of study (Li & Kunzmann, 2004). Learning potential as understood by the writings of Vygotsky and Binet both espousing intellectual growth and modifiability of the individual (Sternberg & Jarvin, 2003) with a move away from static assessment and meta-theory seeking to bridge both disparate and similar theories can be viewed as movements away from the traditional, conventional and mainstream focus that psychology has exemplified throughout its history with emphasis being placed more on the physiological aspects of the discipline. Critics of both dynamic assessment and meta-theory development alike caution researchers embarking on excursions taken down either path.[81] Criticisms of dynamic assessment will be discussed at length in chapter 4.

Madsen concentrated on psychology as a discipline and originally closely studied over 20 theories of motivation within psychology utilising his "systematology" taxonomical approach (1968; 1973).[82] He conducted a comparative study of theories of motivation, culminating in his "Theories of motivation". Madsen regarded his treatise as an application of the philosophy of science specifically the meta-science of psychology. He later added over 20 more theories of motivation in a revised book entitled "Modern theories of motivation" (1974) yet he did not relegate his framework to theories of motivation only as can be evidenced in this historical rendition of psychology as discipline as viewed from a meta-theoretical perspective (Madsen, 1988). One possible reason as to why Madsen's work is not more often cited within the current literature may be that much of his work was not written in English and possibly that he conducted much of his research from the 1960's till the late 1980's. Madsen's systematology, a framework he employs throughout his analysis of various schools of psychology, is a theory-focused framework and fits well within his purported structure of theory analysis within psychology. However, this particular study does not concern itself with a broad range of theories within psychology, but a range of models within dynamic assessment and intelligence. The framework as formed and set-out by Madsen then will have to be attenuated to suit the purposes of this study. Before attenuating his framework, however, it will need to be presented in its original and unadulterated Madsenian form.

The youthfulness of theoretical psychology as a (contentious) scientific enterprise might also be a contributing factor towards this lack of interest.[83] This study could possibly serve another subsidiary function – the resuscitation of Madsen's work confined not only to North European psychology but to a wider Western audience, more specifically a South African audience. Madsen (1985, 1987b, 1992) in his systematology relies upon the philosophical works of Kuhn (1962)[84] in his development of a meta-theory within psychology (Brandt, 1984) and also acknowledges the influential works of other notable philosophers of science among them Lakatos, Hanson and Popper as well as the Swedish meta-scientists Radnitzky and Törnebohm (Madsen, 1971; 1976; 1984a; 1985; 1987a; 1987b; 1988). However, it was the work of Sigmund Koch who inspired Madsen to a large extent in the rendering of his systematology approach (Madsen, 1987a; 1987b). Koch's theoretical studies resulting in the edited six

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[79] Intelligence assessment within the Nordic countries (Sweden, Denmark, Finland and Norway) has been influenced by European and American psychometry where measurement and empirical research have received much attention (Carlstedt, Gustafsson & Hautamäki, 2004).
[80] In order to avoid confusion, Scandinavia is, strictly speaking, the combination of Norway and Sweden but culturally this extends to Denmark, Finland and Iceland with the Netherlands referred to as Holland. Also of note is the long history of content analysis in Scandinavian countries which is a technique utilised in appendix 2 of this study (Rosengren, 1981).
[81] No-where in the literature so far surveyed has it become evident that a link has been established between dynamic assessment and meta-theory in terms of basic philosophies underlying either academic pursuit. Appendix 2 details the formal content analysis of completed questionnaires that were returned to the author in which question eight asked for opinions on the matter of meta-theory development for dynamic assessment.
[82] Fourth edition. The first edition appeared in 1959 (Madsen, 1971).
[83] It is nevertheless curious that treatises such as Gholson, Shadish, Neimeyer and Houts (1989) fail to mention Madsen. This edited volume can in many ways be construed as a work which sought to place the psychology of science on the map so to speak and nowhere is Madsen cited as a contributor in helping to establish psychology of science as part of the data level of his metascience. Royce who previously cited Madsen in other works and vice versa is cited in the edited volume however.
[84] The author has expressed her views regarding the utility of Madsen's framework, a framework to be refined for use within this study. Madsen's penchant for the works of Kuhn might seem to be at odds with the original philosophical leanings discussed in chapter two in which it was asserted that personal preferences sway towards realist interpretations of reality and the search for scientific "truth" which seem to stand in stark contradiction to the relativist views propounded by Kuhn (Scruton, 2004). However, Madsen's choice is made. Of course it is an inescapable fact that many contradictory views espoused by many eminent philosophers do nevertheless yield such insights that are difficult to ignore and although the author tends to lean in one direction as opposed to another, this does not imply that many useful insights emanating from these opposing views are simply ignored. Much of what Kuhn, Hanson and Feyerband have to offer are so insightful that is at times extremely difficult to offer counter-arguments in the author's favour. Having said that, the preferred philosophical positions on many issues are traceable to Hempel, Oppenheim and E. Nagel (although as with the aforementioned statement there are a few issues with which the author takes exception and can legitimately employ arguments from the opposing camps).

volumed "Psychology: a study of a science" (1959) was considered by Madsen a major endeavour in theoretical psychology (1985; 1990). Unbeknownst to Madsen at the time of writing his classic on motivation in 1962, the word systematology had already been used as far back as 1782 by a German philosopher and later in 1929 by an Austrian philosopher (1987b). Madsen's overview of theories of motivation was eventually published in Wolman's 1973 book "Handbook of general psychology".

Although Madsen himself does not mention dynamic assessment nor learning potential per se in his writings[85] his ideas and frameworks concerning models, theories, meta-theories and overarching philosophy of science are malleable in terms of its applicability to this area of assessment. The original notation utilised throughout Madsen's work is reminiscent of the times during which he worked (typical stimulus-response nomenclature is used) and may be considered as too reductionist by current and more phenomenologically inclined scholars. Madsen's terminology and discussion of systematology and other taxonomic schemes is at times puzzling as various models at times overlap in terms of labels, meanings and functions between and within books and articles but the author feels that this might be due to language translation from the original Danish and at times one feels awash in the hierarchical chains that he constructs. For instance in discussing three major issues Madsen will plunge into these separate issues each with an additional four sub-issues and in turn these issues contain their own sub sub-issues till one is so far down the hierarchy that the point of origin has been lost somewhere at the top. As such it is deemed necessary to tabulate his views on certain issues in order to bring a sense of coherence to his ideas. These tables (or organograms) are presented throughout this section. Nevertheless, specific and singular attempts are made to develop for psychology specifically, a meta-theoretical framework from which to view its multitudinous theories and models of which dynamic assessment is used in this particular study.

3.9 Madsen's meta-science and meta-theory

This section will focus exclusively on how Madsen envisioned, conceptualised and eventually realised his own understandings of meta-science and meta-theory within science and specifically within psychology. The choice of Madsen has been outlined above and although innumerable studies conducted within the philosophy of science have been penned, viewpoints concerning the growth, development and progress of theories per se will have a Madsenian flavour and cognisance is taken that his approach and emphasis on many issues within this area are open to debate. Before attention is give to Madsen's definition of science and meta-science his scheme of how science progresses[86] is discussed. Science is not practised in a vacuum and although the impression is often given that science as an enterprise grinds onwards towards improved explanations of how things are, science is really the accumulation of many individuals pursuing knowledge-gathering functions in various guises for various reasons. At the heart of the scientific enterprise is the individual personality placed within a specific scientific community itself housed within the broader governing general scientific community which is vulnerable to the time and location of its particular setting within history (a relativist tinge is evident here with influences from the meta-science branch of the psychology of science, Feist, 1995). This placement of individuals and scientific practises contextualises scientific practise[87] and leads to a better understanding of how and why theories and models are conceived as they are. This nesting of hierarchies is typical of Madsen, a technique he so often utilises throughout his writings. Table 8 presents Madsen's scheme of embedded scientific practice.

Table 8 Classification of the three sub-systems within which theories are produced (Madsen, 1987b, 1988)

Systems level	**Historical meta-theory**	**External history of science**	**Combined external and internal history of science**	**Internal history of science**
Cultures and societies[1]		Cultural history of science and socio-economic history of science		
Scientific community[2]			History of the scientific community	
The researcher[3]				Biographical history of science

1 = Sociology of science 2 = Social psychology of science 3 = Psychology of science

[85] As far as this author is aware.
[86] Progress here connotes the development of the method and does not necessarily indicate that current findings are any "better" than previous findings. The term "progress" merely indicates change through time. A hint of relativism creeps in here.
[87] Which is why the author felt the need to include her own predilections and leanings on various issues in chapter 2. It is thus in keeping with Madsen's approach of understanding how and why theories develop as they do.

3.9.1 Madsen's definition of science

Before meta-science can be disclosed as a definition, science as a concept needs to be unpacked and as such Madsen (1985; 1987a; 1988; 1990; 1992) delineates the three components or processes contained within the definition, namely;

- Empirical research
- Theoretical thinking
- Philosophical thinking

Radical empiricist philosophers of science have advocated that *empirical* observation via the senses be the key to the practice of science (Smith & Katz, 1996). Among many such positivist empiricists are included Comte and Mill followed in turn by the less restrictive empiricism of a later age exemplified by the neo-positivists such as Russell, Wittgenstein and Carnap. *Theoretical* thinking was included in the arsenal of techniques used to derive the truth by the logical empiricists and as such included aspects such as hypotheses testing and explanatory modelling of data and is evidenced by philosophers such as Hanson, Popper, Bunge, Radnitzky and Törnebohm. *Philosophical* thinking was melded into this mix and was introduced in order to provide a philosophical framework encompassing the empirical and theoretical aspects and such frameworks include the paradigms of Kuhn and the metaphysical research programme of Popper. Madsen (1985; 1987a) includes in this level the philosophy of the world (which includes the ontological world hypotheses and overall meta-model) and the philosophy of science which encompasses epistemological, metatheoretical and methodological issues. In sum, Madsen concludes a definition for science as follows "the social-cultural system of individuals who are engaged in empirical research, theoretical and philosophical thinking" (1985, p.4).

3.9.2 Madsen's definition of meta-science[88]

As with the definition for science, Madsen expostulates his framework for meta-science in similar vein. The classification follows three levels of abstraction namely; the empirical, theoretical and philosophical levels (1985; 1987a). The *empirical* or data level of this science of sciences (meta-empirical level) include several disciplines such as the history of science and a sub-discipline within this area of the history of psychology. Another meta-discipline within this empirical meta-level is the comparative study of theories which formed the basis of Madsen's 1959 original treatise on the comparison of theories of motivation. It important to note at this stage that Madsen's terminology of this comparative study of theories is located within the empirical meta-level and contributes to the overall general meta-science of the discipline being studied, in this instance psychology. To illustrate: the empirical level of a study deals with the data gathering of an experiment for instance and the theoretical levels deal with the hypothetical details concerning the nature of the data and the results that are yielded in this process. The meta-level would be when more than one such theory is combined with others of similar nature and an overall result is obtained.[89] Imagine this scenario taken one step higher in a hierarchy where the empirical data now becomes a meta-empirical data level consisting of comparisons of theories where the data are already formulated theories. In other words the theory becomes the data. Madsen is careful to delineate exact differences between historical studies and comparative studies (which are by nature historical). Studies of historical theories also make use of other material in addition to the texts used with the purpose of explaining the development of such theories, whereas comparative studies make use of only the theoretical text and in so doing contribute to the meta-theory of that discipline. This comparative study is termed "systematology".

The *theoretical* level of the meta-level of the meta-theory level refers to the varying types of theories of particular disciplines, so instead of dealing with one theory on the ordinary level, the meta-level tackles many theories simultaneously as its theoretical level (in comparison to the one theory dealt with at any one point in time for ordinary level theory). Madsen (1985) cites the theories of Kuhn (1962), Lakatos (1970) and Hanson (1957) as examples of meta-theory level concerns. Being theories of science rather than philosophies of science, states Madsen (1985), results in these theories being more testable as opposed to more prescriptive philosophies of science. Theories of science then belong to the meta-theory level of meta-science. The philosophy of science is housed within the *philosophical* meta-level of science and is derived from the philosophy of knowledge or epistemology. Philosophy of science emerged after the advent of science during the Renaissance as formal discipline and as such it is a newer discipline. This level of science is predicated on prescriptive activities for the deployment of scientific ideals in terms of how science should be practised (1987b). Ways of doing science, methodologies utilised and conclusions reached

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[88] The reader may experience the same confusion often encountered in texts dealing with extra dimensions in space. For instance we know what a four-dimensional object looks like via its "shadow" in three dimensions. But to imagine what the object looks like in four dimensions we have to strain somewhat to conceive of what it might possibly look like. So it is with the meta-level of science, which looks exactly like its normal theory counterpart but has added dimensions to it.

[89] It is hoped that the reasons behind conducting a meta-analysis on South African studies within dynamic assessment is becoming clear (see Appendix 1). This statistical approach is more in keeping (at least philosophically) with the nature of this study and with Madsen's meta-theoretical approach.

should be governed by rules and norms which are partially established by fundamental philosophies.[90] The next levels of meta-scientific inquiry deal with similar issues but on a more hypothetical level and is not as prescriptive as the meta-level; prescriptive meta-science hoping to explicate the process necessary for proper knowledge acquisition as opposed to more descriptive meta-science with less emphasis in this area of concern (Houts, 1989; Shadish, 1989). Figure 41 illustrates the framework of ordinary science discourse as commonly understood. This figure is followed by Figure 42 which in turn illustrates the framework of meta-science discourse as understood by Madsen.

Figure 41 Illustration of ordinary science discourse with examples

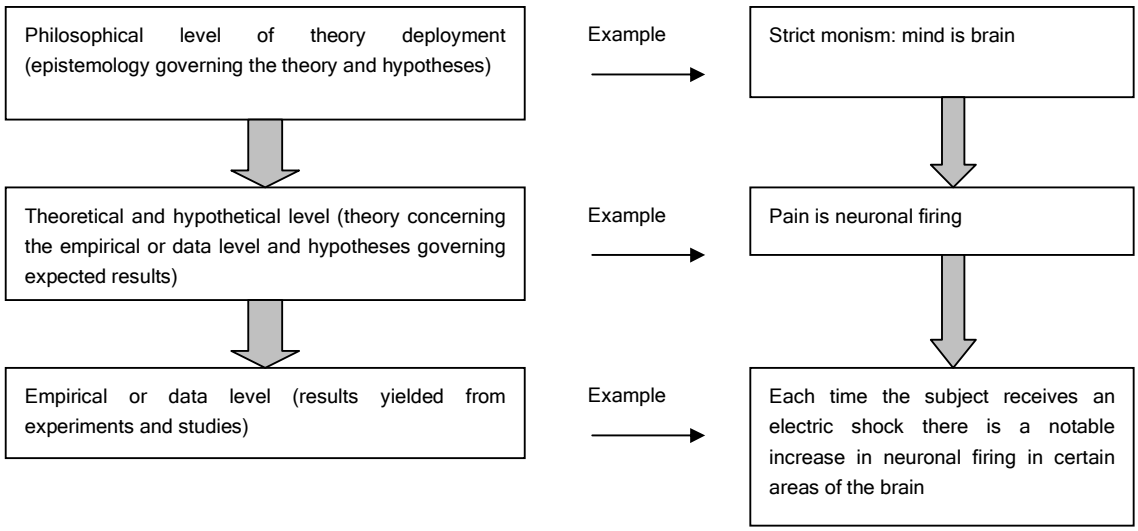
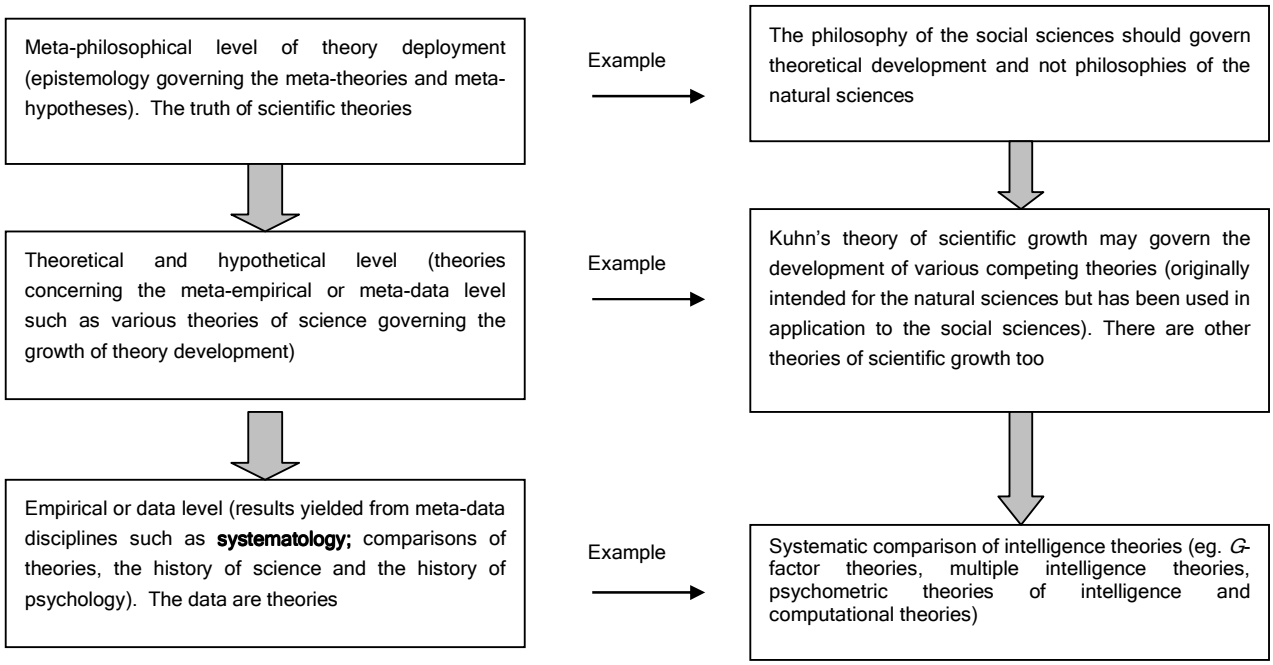


Figure 42 Illustration of meta-science discourse with examples



[90] It is just such basic epistemological queries which plague dynamic assessment within intelligence research and if proper care is taken to place dynamic assessment's forebears in terms of philosophies perhaps the field would not be quite so saddled with methodological and empirical problems.

3.9.3 Madsen's view on theory

Whilst discussing at length the history of psychology within a meta-scientific perspective, Madsen (1988) views a theory as both

1. a narrowly defined set of hypotheses with associated models and
2. as a broad scheme encapsulating a fully-fledged scientific text including

    a. meta-theses or a set of deeper philosophical issues
    b. a set of hypotheses related to the model via explanatory statements
    c. a set of descriptive data-theses

The latter definition of expanded theorising functions along three axes (or expanded discourse), namely the process yielding the theses, the linguistic category utilised in the theses and purpose (or function) of the theses and is illustrated in table 9.

Table 9 Level of discourse according to classification scheme from Madsen (1988)

Classification / **Level of discourse**	**Meta-theses**	**Hypotheses or model**	**Data-theses**
The processes	Product of philosophical thinking often divergent in nature	Product of theoretical thinking often convergent in nature	Systematic observations, tests or experiments
Linguistic categories	Philosophical and scientific hypotheses, the former not capable of verifiability or falsifiability but the latter indeed so. Includes epistemological, meta-theoretical and methodological statements about science	Propositions or hypotheses consisting of empirical and theoretical terms. Can refer to unobserved processes therefore constructed descriptions of concepts	Purely descriptive statements
The purpose (function)	To provide and create a basis for understanding a conceptual framework for both the hypothesis and data levels**	To systematise information via explanations (causal and functional) and/or to interpret coherent meanings	To present data, knowledge and information which includes both specific (isolated data) and general information (relations between data)

** Madsen (1988) supports the notion that for any length of time, certain implicit assumptions and meta-models are not directly stated due to large-scale acceptance of these views, until that is, a crisis emerges in which these very implicit assumptions need to be stated and aligned within the larger arena of research (in whatever context) (Lichtenstein, 1980). The fact that dynamic assessment finds itself at just such a juncture in its history is testament to the need for such a revision of basic assumptions which will no longer suffice as implicit but need to be made manifest in order for progress to continue. Kuhnian influence is quite evident in Madsen's conception of the above framework.

3.9.4 Madsen's view on models[91]

Employment of analogous explanations of the functioning of human beings within larger contexts was originally the technique utilised in early models of human behaviour (Madsen, 1988). To simplify understandings of how humans functioned it was necessary to ground the comparisons in everyday experiential contexts, thus was borne the system of metaphors widely employed as explanatory mechanism throughout formal psychology's history as well as that of science in general (Bailer-Jones, 2002; Brooks, 2003; Cervone, 2000; Crosson, 1985; Dawkins, 2001; De Mey, 1989; Draaisma, 2000; Jordaan, 1989; Penrose, 2002; Woolley 1933). These explanatory mechanisms were offered to suit the reigning paradigm and adapted as knowledge

[91] This discussion on models is placed here in order that flow of thought is preserved. Models will again be discussed under section 3.5.2 below as it pertains to the hypothetical stratum within Madsen's systematology.

improved about certain phenomena (Daugman, 2001). Before returning to Madsen's view on models within the history of psychology a brief digression into the role of metaphor as foundation for model development and heuristic for consequent theory development is warranted. A variety of metaphors of epigenesis for instance, render scientific explanations of intellectual growth. Metaphors have served formal science in general for over 150 years often resulting in prescient veridical theories, among others the following is a brief list offered by Draaisma (2000):[92]

- John Newland (1837-1898), English chemist; his analogous piano keyboard metaphor was utilised as heuristic for the grouping of elements into groups of eight (octaves) as each eighth element was a repetition of the first. This system was presented before Mendeleyev's compilation of the periodic system of elements
- Elie Metchnikoff (1845-1916), Russian biologist who utilised the analogy of how larvae wrapped themselves around wood shavings and ingested them to aid in the explanation of how the immune response to infection was explained leading to the discovery of the body's immune response to infection (phagocytes consuming bacteria)
- Albert Einstein (1879-1955), German-Swiss theoretical physicist, who, by employing a thought experiment was able to analogise the relativity of light through ideating on what it might be like to hold up a mirror to one's face during a speed-of-light travel on a ray of light
- William Harvey (1578-1637), English physician, who described the heart as a pump and thus developing the theory of blood circulation

Within psychology the role of metaphor too as has had profound consequences for theory development

- Various metaphors permeate psychological theorising (Leary, 1990a) as well as intelligence assessment (Carlson, 2002) and include among others the view of the mind as understood from the view of a machine (although Gergen (1980) is of the opinion that mechanistic metaphors have severely impeded the growth of psychology as a discipline as it splits the organism from its environment and thus concentrates on the mechanics of action versus person), an electronic computer, a homunculus, a mirror or blank slate and so on (Boden, 1988; Daugman, 2001; Groome, 1999; Leary, 1990b; Pribram, 1990); William James' stream of consciousness and Freud's ice-berg analogy of the conscious and unconscious (Madsen, 1988).

These forms of heuristics are divided into two types, namely theoretical and empirical, the former playing the role of organiser, systematiser and bringer of coherence to contradictory empirical findings whilst the latter yields new fruitful avenues of further research. The former notion is often decried as not sufficiently "scientific" within the field of psychology (Feist, 1995; Kukla, 2001) yet has had profound consequences in the realm of the natural sciences. Madsen (1988) refers to pre-scientific cognition as analogous in explication but these types of comparisons are not always considered "scientific" (Draaisma, 2000). Analogies and metaphors are helpful aids in seeking an initial explanatory mechanism within any domain of knowledge acquisition but as Gentner and Jeziorski (1989) caution, analogies like the phenomena they seek to describe involve a certain degree of skill when utilising them. Human brains are better equipped at handling data in pictorial or visual form similar to pattern recognition (Dwyer & Dwyer, 1987; Kline, 2004) and thinking about phenomena in terms of similar phenomena might ease the understanding of what is being explored (Eysenck & Keane, 1993; Mayer, 2002, 2003; Shermer, 2005). There is however a fine-grained difference between the roles of analogy, simile, model and metaphor with metaphor considered by some philosophers (Indurkhya 1992 in Maree, 1995) as encompassing an unconventionality when interpreting or understanding a phenomenon. Metaphors can be similarity-based (the comparison view; Montuschi, 2001) or similarity-creating (the interactive view of metaphors; Montuschi, 2001) in which the former are based on already known similarities whilst the latter create the similarities between phenomena not hitherto seen or understood (Maree, 1995). Models, are seen by some as special types of metaphors (Crosson, 1985) which are more developed in terms of bridging explanatory predicates to mathematical or logical theories.

Models can also be classified according to a framework set out by Madsen (1987) and is illustrated in table 10 below.

[92] Dates from Porter (2003) as well as Millar, Millar, Millar and Millar (1996).

Table 10 Framework for model abstraction and function

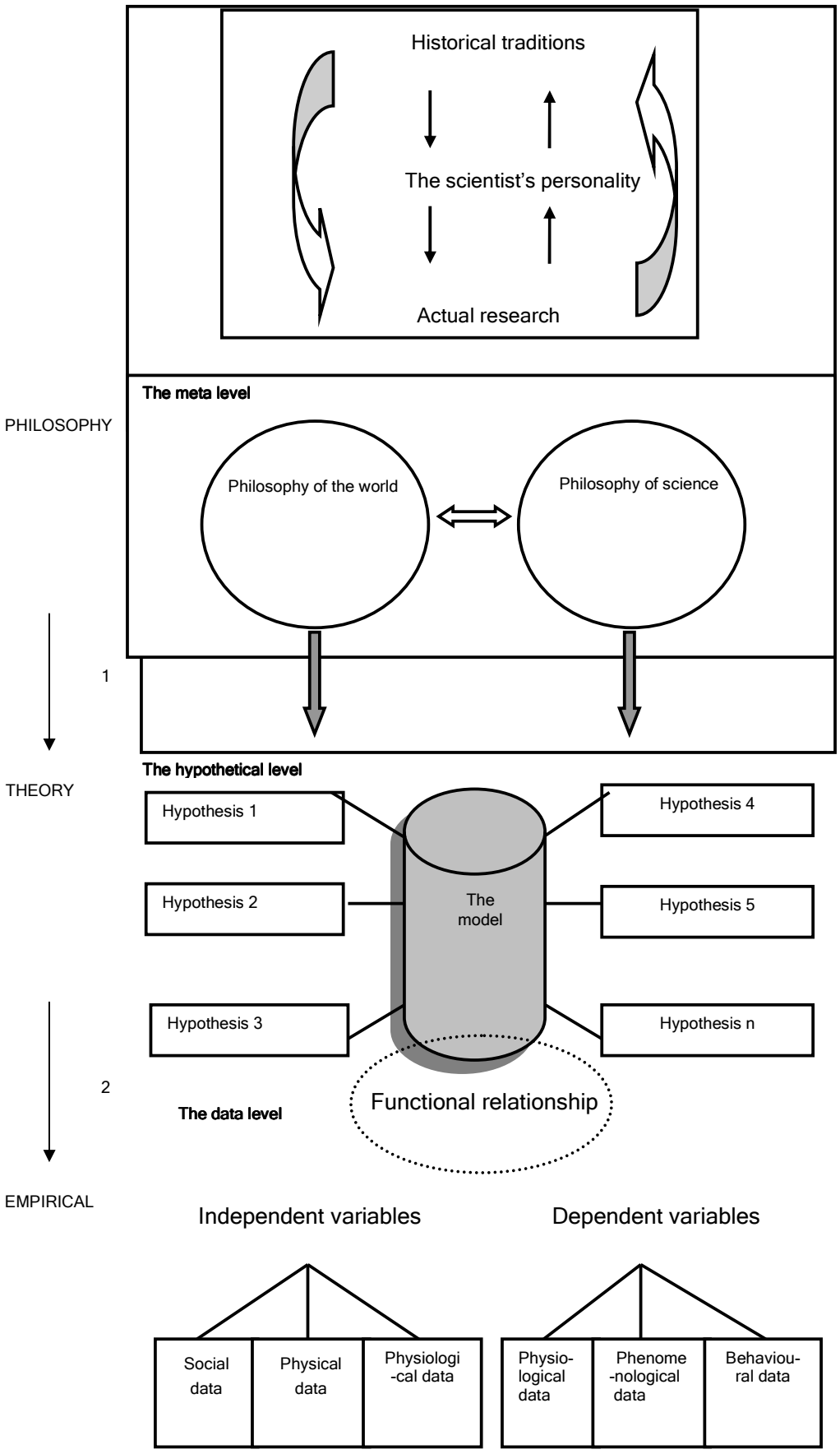
Degree of abstraction	Purpose (function)
Material - three dimensional	Descriptive – schematic descriptive representation
Graphic – two dimensional	Explanatory incorporating hypothetical variables: • Constructive models • Physiological models • Mentalistic models
Simulation (computer programmes)	Meta-models (ontological)
Mathematical (symbolic systems)	

Regarding the degree of abstraction Madsen (1988) uses the globe as an example for material three dimensional models and a map as instance of a graphic two dimensional model. He states, moreover, that descriptive-schematic model representations belong to the data level as they are often of the "black-box" type as they contain no hypothetical variables. Explanatory models on the other hand provide instances of hypothetical variables which are classifiable as constructive (containing pure thought hypotheses), physiological (containing surplus physiological meaning) and mentalistic (containing surplus mentalistic meaning). Meta-models, states Madsen (1988), are typically implicit "global models" and provide the background framework for the understanding of the presuppositions inherent within the models. The word systematology has been highlighted above in Figure 42 as this is where this study has positioned itself. The various theories and models within dynamic assessment now become the data in this meta-theoretical exploration of dynamic assessment and intelligence. This systematological approach itself becomes an area of inquiry to which attention shall now be turned.

3.10 Madsen's overarching framework: Systematology - a comparative meta-theoretical taxonomy

This section will study Madsen's overarching framework for viewing theory within meta-theory. In essence, three levels form the basis of this framework, namely, the meta-stratum, the hypothetical stratum and the data-stratum. Each level will be discussed in turn. Figure 43 presents Madsen's overarching scheme of science within society. Madsen (1987b, 1988) devises this classification scheme in which three system levels interact with three types of historical meta-theory. The system levels include cultures and societies, the scientific community and the researcher. Historical meta-theory engirds the external history of science, the combined external and internal history of science and the internal history of science.

Figure 43 Madsen's overarching scheme. From Madsen (1971), p.7; (1973), p.698; (1976), p.301; (1984), p.201; (1985), p.3 ; (1987a), p167; (1987b), p268; (1988), p.29; (1992), p504.



Systematology is used as a synonym for meta-theory is the writings of Madsen (1968) and becomes the level at which empirical data gathering is conducted. Madsen (1971; 1976; 1984a; 1985; 1987a; 1987b; 1988; 1992) is of the opinion that in order to be classed as empirical meta-data, theories need to encompass three levels of abstraction, namely the;

i. The meta-stratum-theses such as propositions about the philosophy of the world[93] and philosophy of science
ii. The hypothetical stratum consisting of hypotheses and explanatory models[94]
iii. The empirical of data stratum which consists of data theses such as general functional relations between dependent and independent variables as well as consisting of propositions

3.10.1 The meta-stratum

As is the case with theory and data, the one influencing the other in order to better inform; so too does this feedback take place within meta-theory and meta-data models (recalling the fact that this meta-model is merely one place higher in the hierarchy of the practice of science). Meta-data feeds back information to the meta-stratum which directs and steers meta-empirical findings. "This interaction between the overall philosophical steering and the rectifying empirical research lies at the heart of scientific growth" (Madsen, 1988, p.30). The theses at this level can be divided into meta-theses about the world (ontological meta-theses) and meta-theses about science (philosophy of science).

Ontological meta-theses

Theories of human behaviour (in all their generalities and scope) often do not make explicit their underlying implicit assumptions governing belief in fundamental issues about the nature of human-kind, a cautionary note taken heed of, hence the need for Chapter 2 so as this author is not similarly accused. Madsen (1988) maintains that as a result of the reigning philosophy of science and the practise of psychology as discipline within a positivistic framework during the early rise of the subject, many thorny issues were simply not dealt with or at the very least were only partially formulated as these issues were not considered scientific enough. These issues consisted of, among others:

- The conception of man[95]

Humans can be divided according to many conceptual classifications, but among those included by Madsen (1988) are the biological, social and humanistic conceptions. These conceptions tie in well with the current debates in the intelligence and dynamic assessment literature and have formed the bases of questions included in the questionnaire in appendix 2. That man is a product of his genetic heritage is without question, the emphasis to be placed on this dimension is however questionable. Is man resultant from environmental and societal impingements? Man can be considered a product of his own unique culture that he builds around him.

- Psycho-physical theory

Madsen (1988) employs a sliding scale to illustrate the various classifications according to which the mind-brain debate can be exemplified. On the extremes of this scale lie the materialist (mind is matter) and spiritualist (mind is spiritual substance) conceptions and placed squarely in the middle is dualism (consisting of both mind and matter). Both substances co-occur and are manifest in the body and its consciousness[96] and the relation between the two can be divided into interactionism, parallelism (interacting in synchrony) and identity (neutral monism where the two supposedly opposing substances are regarded as the same type of substance). Between the outer limits of materialist and spiritualist views on mind-brain and the middle-of-the-road views lie intermediate views referred to as epiphenomenalism (consciousness is considered an emergent property of the system[97]) and hyperphenomenalism ("animism" in which physical brain processes are considered as a result of the spiritualist substance).

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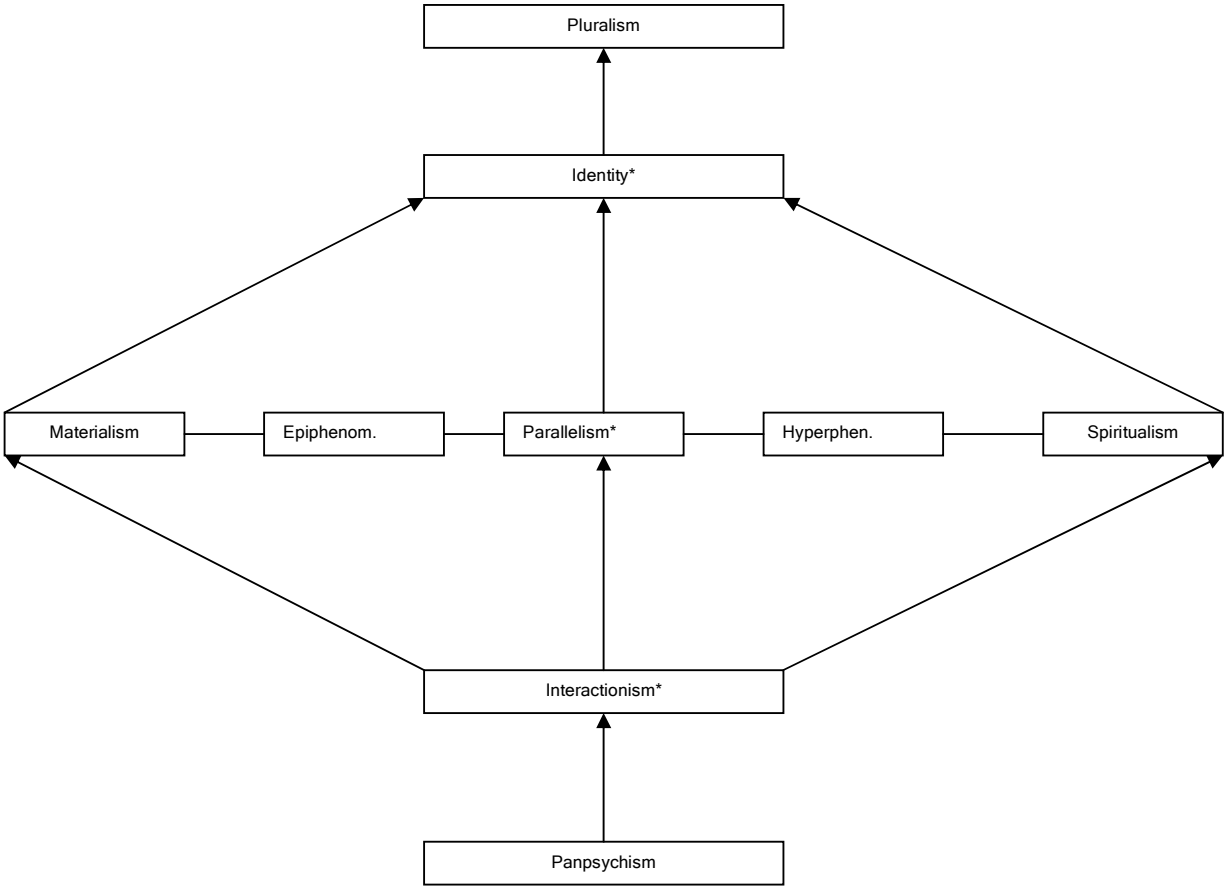
[93] Which is why the nature of the questions in the questionnaire sent to 100 dynamic assessment practitioners across the globe contained the specific blend of questions it did, a blend which was construed as " too difficult" in some instances to be answered. See Appendix 2 for further information pertaining to this endeavour.
[94] Where dynamic assessment may often be found as these models cannot not always be considered fully-fledged theories.
[95] Madsen utilises terms such as mankind as opposed to humankind. The author has decided to leave it as such as it becomes too cumbersome to continuously make the changes required to suit more modern tastes. Expediency dictates this choice.
[96] Chapter 2 briefly outlines the debate within this particular area of concern.
[97] Madsen (1988) refers to this emergentist view as "bi-phenomena".

Two other conceptions which are mentioned but are not included in Madsen's sliding scale are panpsychism (in which animate and inanimate objects are considered conscious) and pluralism (encapsulating systems-theoretical notions and ideas[98]). Madsen's psycho-physical theory is illustrated in figure 44.

Figure 44 Madsen's (1988) conception of psycho-physical theory within the ontological meta-theses as part of the meta-stratum



*Dualism

[98] Such as larger systems subsuming smaller systems; for instance, the eco-system includes human beings which are made up of smaller systems such as organs, themselves made up of cells which are in turn made up of DNA which are made from proteins and so on (Capra, 1997). Pertinent to this issue of consciousness is the conceptualisation of consciousness as neural mechanism in which a synchrony of neural firing evidences a pattern of firing sequences which is what constitutes the basis of memory. It is not the firing per se which is memory or consciousness but the order, pattern and interconnectedness in and with which these firing sequences take place "a brain-wide synchrony" (Zimmer, 2005, p.288) (Calvin, 1997; Capra, 1997; Greenfield, 1997, 2001). This is an idea stretching back to Donald Hebb's (1949) cell-assembly hypothesis (Calvin, 1997) which, although insightful, did not predict the true trajectory of the course of events (Corballis, 1985) but did manage to synthesise both localist and holist tendencies in his work (Harnish, 2002). It did give to the intelligence debate views on intelligence A (innate and unknowable) and B (phenotype) (Elliott, 1988) (see chapter 2) .

- Human freedom of action

Whether human actions are free or causally determined yields two opposing arguments which seek to settle the dispute, that of determinism and indeterminism. Determinism includes mechanical determinism in which a single cause results directly in an action and dialectical or dynamic determinism in which actions are a result of varying interactions between causes. Indeterminism includes probabilism (in which actions are random but can be predicted with the use of stochastic rules and classical indeterminism in which actions are determined by free will and are thus unpredictable).

Philosophical meta-theses

As opposed to ontological meta-theses, philosophical meta-theses usually receive more explicit coverage within psychology theories but this is not to say that all such philosophical issues are likewise explicitly stated. Philosophical meta-theses can be divided into the following theses:

- Epistemological theses

Epistemological theses are of the more abstract type and are usually the ones which are implicitly assumed or implied within theories. Regarding the philosophy of science and its relation to psychology, two issues within epistemology have been investigated, namely, the origin of cognition and the relation of cognition to reality. Two major theories concerning the origin of cognition include empiricism (observation is paramount) and rationalism (thinking is paramount). Combinations of these abound, the most popular being logical empiricism, a product of the analytical philosophers' Vienna Circle (who held in favour both theory and observation; Outhwaite, 1983) and Karl Popper's critical rationalism (Machamer, 2002; Van Lil, 1987). Oriental philosophy has bequeathed a third dominant epistemology, namely, intuitionism[99] (described by Madsen as more holistic yet ascribing right hemispheric dominance to this type of thinking as opposed to left hemisphere dominated rational thinking). The relation of cognition to reality attends to the issue of the existence of reality and its independence from human knowledge about it. Three main views include (i) realism - reality does exist independently of our knowledge of it and through naïve realism man can achieve the goal of objective truth and the more tempered consideration of critical realism which advocates knowledge of reality but knowledge which is achieved through the faculties of the brain and sense organs (ii) idealism - one such independent reality exists outside the cognising agent. Realism and idealism are often correlated with the extreme views on the mind-brain debate, namely realism with materialism and spiritualism with idealism although such a relation is not logically necessary (iii) instrumentalism - which is poised between realism and idealism. It is a view which acknowledges an objective independent reality but that the only "truth" available to us is pragmatic truth, i.e. truth that is useful for our actions and in a manner very similar to Popper's critical realism.[100]

- Meta-theoretical theses

Meta-theoretical theses deal with the hypothesis stratum and concentrate on scientific cognition, dealing with the function and purpose of theories. Madsen serves an eclectic mix of the "ideals of science" by synthesising the different meta-theory ideas of Habermas (naturalistic, hermeneutical and critical sciences), Maslow (controlling and taoistic sciences) and Allport (nomothetic and idiographic theories). The result is a coverage of all three scientists' thoughts concerning the ideals of science and is considered below:

a) Nomothetic ideal

These ideals are based on natural science laws (nomos referring to law) of nature, which, when translated to meta-theory, become highly probable hypothetical contenders for how things work and was the ideal adopted in the early foundational stage of psychology as scientific discipline. Predictability and explanation are prime considerations in this ideal.

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[99] These epistemological categories are aligned to those advocated by Royce (1964, 1973) as well as Royce, Coward, Egan, Kessel and Mos (1978) as utilised in chapter 2 as second axis when describing the author's philosophical leanings.

[100] Much like the world we inhabit in which it is hypothesised that multitudinous dimensions pervade our space-time reality but as we are simply not attuned to such dimensions by virtue of our present evolutionary make-up these dimensions are not available to us in the sense of our observing them in any measurable way. That they cannot be hypothesised about (such as string theory for instance) does not limit us in trying to think about them at least. Our four dimensional self-hood is constrained by its own existence, very much like the brain trying to understand itself; it is an encapsulated system. A retort to this would be for another brain to investigate my brain, but this system too is self constrained by virtue of the fact that the "brain observing the brain" system occurs within a larger yet contained system. And so on down the spiral. Can reality ever be known in such constrained systems? If this argument is taken to its logical conclusion then the answer has to be "no". However that this type of argument is valid is a question that needs to be asked. A slippery slope argument if ever there was one.

b) Hermeneutic ideal

The hermeneutic ideal seeks to interpret and understand texts (be they biblical, legal, philological or psychoanalytical in nature) and is mainly concerned with intentional relations whereas the nomothetic ideal strives for causal relations which are sought for as an ultimate end-point explanation. Both nomothetic and hermeneutic, although distinctly varied in goal, strive for coherence and a need to add to the total system of information.

c) Idiographic ideal

The idiographic ideal takes its cue from humanities disciplines such as biographical history and seeks to analyse and describe unique and individual case-studies.

- Methodological theses

These are perhaps the most explicitly stated and formulated theses in this framework. Methodological theses are concerned with the choice of methods and the choice of data language to be used. They include the following:

a) Research methods

Wundt's Leipzig laboratory bequeathed to psychology its scientific disciplinary status just as Galton's method bequeathed a test method to the discipline (although as will be evidenced in chapter 4, the experimental nature of the research design within psychology was to change, specifically with the introduction of the treatment group as variable and was to impact on the future development of the discipline in terms of the statistical techniques utilised). Psychology developed in tandem with natural science methodology, namely, the experiment and the degree of variable control manifested in varying degrees ranging from strict experimental designs through to more qualitative designs. The degree of quantification of results in part also determined how robust results were. The test method was regarded as variant of the experimental method.[101]

b) Data language

Just as close philosophical affiliations predispose researchers to define and research their area of interest in manners differing from their counterparts advocating other philosophical affiliations, so too is this reflected in the data language employed to discuss the research results. Ranging from highly subjective qualitative phenomenological descriptions of results to strict objectivist and empirical descriptions of results, the data language will often mimic the research design. Fundamental philosophical issues regarding mind-brain, consciousness, dynamic vs. static assessment, nature-nurture issues and more besides filter through most often in implicit fashion resulting in assumptions which pervade subsequent models and theories. The meta-stratum level thus far discussed is illustrated in figures 45 (a) and 45 (b) below.

[101] Perhaps this was the logical limit of this newly found discipline, an issue of contention today.

Figure 45 (a) Madsen's (1988) meta-stratum (A) Ontological meta-theses

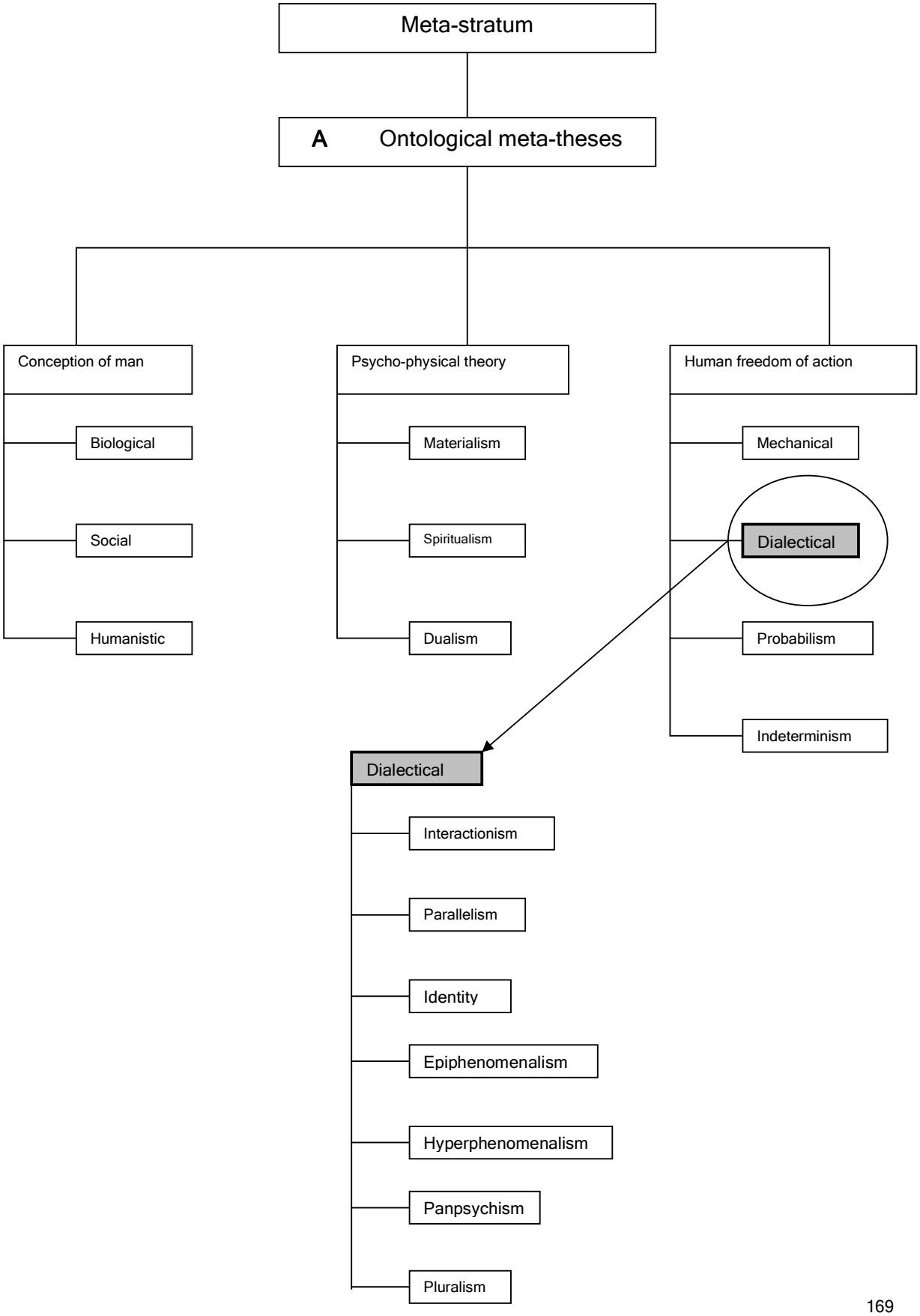
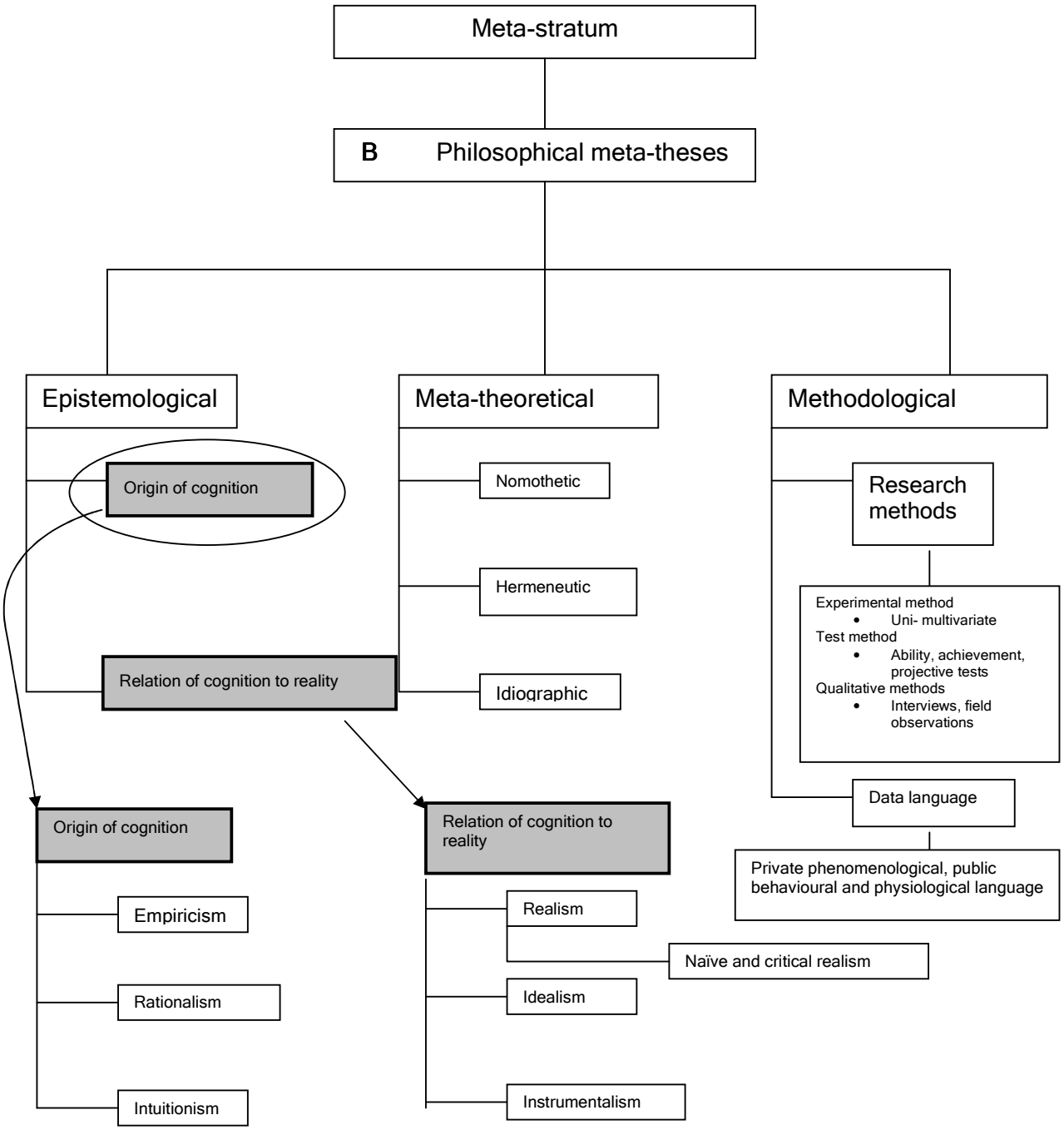


Figure 45 (b) Madsen's (1988) meta-stratum (B) Philosophical meta-theses



3.10.2 The hypothetical-stratum

The next level consists of H-level formulations of hypotheses and constructions of models serving as explanatory agents of the data level. This level is the constituent of theory (Madsen, 1992). The overarching meta-level is dominated by M-type methodology and principles regarding empirical data as well as meta-theoretical principles governing the theory one level down. Philosophical, epistemological and ontological presuppositions form part of this level of abstraction within the model (1985; 1987a; 1987b; 1992). Madsen contends that it is often the case that these presuppositions are not explicitly formulated but remain implicitly hidden within the principles and hypotheses. The hypothetical stratum forms the centre of Madsen's systematological framework and mediates between two levels, the overhead meta-stratum and the lower data-stratum. It consists of constructs employed as explanatory mechanisms seeking to shed light on observables within a system. This level consists of the following:

- Hypothetical terms
- Scientific hypotheses
- Hypothesis system

each of which will be detailed below.

Hypothetical terms

Hypothetical terms are employed to provide coherence to a system of observables for which there is no current explanation. Providing some sort of linkage between dependent and independent variables, hypothetical terms are often placed in the position of intervening link. For instance, during a dynamic assessment intervention, it is hypothesised that mediation is the intervening variable (a construct hitherto ascribed to some measurable and quantifiable intervention), a causal link tying the pretest and posttest scores in a causal loop. Intervening variable and hypothetical link are somewhat different in meaning, the former referring to empirical and operationally defined link; the latter referring to hypothetical constructs which have what is termed "surplus meaning" over and above that which is accounted for by the intervening variable. In order to better classify hypothetical terms Madsen structures these terms into three main sub-classifications:

- The ontological reference of hypothetical terms

Knowledge of the intervening variable is invariably coloured by the researcher's ontological assumptions whether they be made explicit or not. Background knowledge (conscious or unconscious awareness) and assumptions filter through to the nature of the hypothetical variables and can be classified into three categories:

a) Mentalistic hypothetical terms (H_m)
b) Organismic hypothetical terms (H_o)
c) Constructive hypothetical terms (H_c)

Mentalistic hypothetical terms refer to constructs concerning the brain or mind; behavioural outcomes of mental states such as "consciousness", "intelligence" and "potential" and are typically employed by researchers and psychologists whose meta-model is of a dualistic, hyperphenomenalist or spiritualist type (refer to the meta-stratum above). Organismic hypothetical terms refer to processes and structures in the brain within the organism as a whole and might include such terms as "impulse control" and "patience" and are typically employed by researchers and psychologists whose ontology is materialistic, epiphenomenalist and neutral monistic (refer to the meta-stratum above). Constructive hypothetical terms are analogised versions of explanatory systems and can be construed as crude metaphors as was discussed above in Madsen's conception of model and are chosen by researchers and psychologists whose ontology is pluralistic or neutral monistic.

- The existential form of the hypothetical variables

Hypotheses may take on various forms and can include:

a) Process terms
b) Structure terms

Process terms are hypothetical terms which serve as explanatory mechanism for some sort of change occurring within the organism and include processes such as changes in perception, thinking and planning for instance. These process terms refer to features which are often of brief duration as opposed to structure terms which refer to features which can span a life-time.

Structure terms are a hypothetical terms which serve as explanatory mechanism for structural features of a system such as factors of intelligence, knowledge and acquired skills.

- The function of hypothetical variables

Hypothetical terms may have various functions and include

a) Dynamic variables

Dynamic variables are mobilising (process and functional) variables which activate or seek to mobilise energy in some manner, such as understood by terms such as “needs”, “ drives” and “motives”.

b) Directive variables

Directive variables are those which have organising, controlling and regulatory effects and include cognitive processes and structures and include terms such as “thinking”, “memory” and “perception”.

c) Vector variables

Vector variables are a combination of dynamic and directive variables which result in functional and process variables which seeks to activate and control. Constructs such as “instincts” would be an example of such a vector variable.

Scientific hypotheses

Hypotheses are underlying assumptions and scientific hypotheses seek to add credence to such terms by validating the hypotheses with scientific explanations. Hypotheses in general are abstract and pertain to levels of explanations which may or may not be empirically validated. However, this is not the case with scientific hypotheses which are formulated in such a way as to make them testable. The same cannot be said of general hypotheses which is what distinguishes the scientific hypothesis from the general hypothesis. Two types of scientific hypothesis are pertinent to the study of psychology in Madsen’s scheme, namely,

- the ontological classification of scientific hypotheses

Ontological scientific hypotheses can be further divided into

a) existential hypotheses

Existential hypotheses are hypotheses which proffer the existence of some sort of hypothetical construct which later assumes a more functional and structured role within the hypothetical system. Learning potential as hypothesised construct might begin as existential hypothesis only to assume a functional role in the model.

b) functional hypotheses

Functional hypotheses proffer the existence of a function or effect of some hypothetical construct and form functional relations between two or more sets of hypotheses. Functional hypotheses postulate either causal or stochastic processes between hypothetical variables and Madsen is of the opinion that functional hypotheses form the most important category of hypotheses in general psychology.

c) historical hypotheses

Historical hypotheses follow the historical development of a system and include the many and varied hypotheses concerning human development and various developmental intelligence models.

- the meta-theoretical classification of scientific hypotheses

According to Madsen, there are two types of scientific hypotheses (meta-theoretically speaking) and include:

a) theoretical hypotheses

Theoretical hypotheses contain only hypothetical terms and as such do not relay information about relations and functions in and between empirical data and hypotheses. They are by virtue of their nature untestable as they offer no means for evaluation. Such terms are notated as H-H and refer to hypothetical (transempirical) terms (see the section dealing with Madsen's HQ system in which this is employed).

b) empirical hypotheses

Empirical hypotheses offer at least one descriptive term which refers to either an independent or dependent variable along with an hypothetical term. Such terms are notated as H-S or H-R referring to stimulus and response hypotheses respectively (see the section dealing with Madsen's HQ system in which this is employed).

The hypothesis system

The role of the hypothesis system is to mediate between the data-stratum level and meta-stratum level and to systematise information in a number of ways already mentioned above in the meta-stratum discussion. As discussed, three types of systematising explanations can be employed, nomothetic, hermeneutical and idiographic. Madsen extrapolates within the nomothetic explanatory sub-system and be formed in one of two ways:

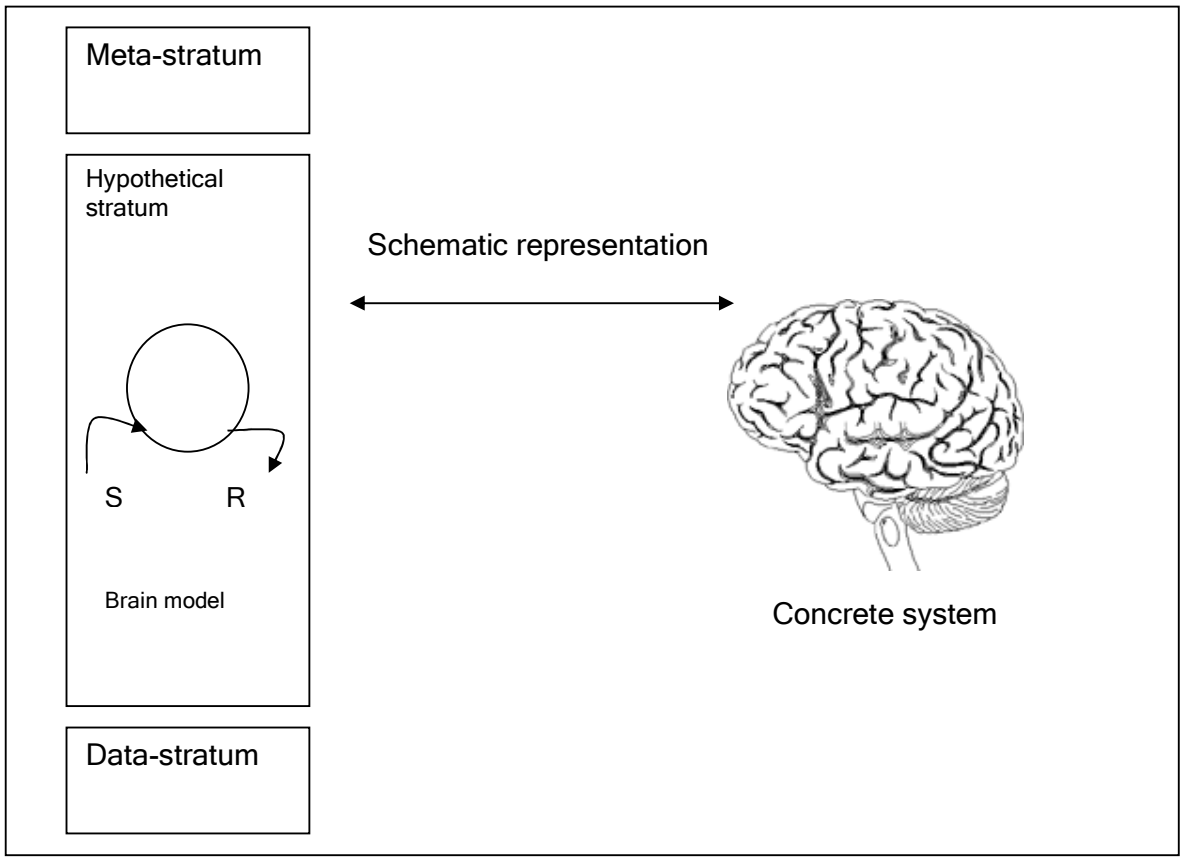
- deductive explanatory systems

This system utilises deductive arguments in a logical deductive structure common to most scientific arguments and takes the usual form of at least two premises followed by a truthful and valid conclusion. Madsen cites Hempel's deductive explanatory system as the standard account lauded by the logical empiricists which has become mainstream practice within psychology and intelligence research more so. Madsen's affiliations with relativist philosophers and theorists (Kuhn, Feyerband Hanson) do seem odd then when supporting such a nomological-deductive account of science (Estany, 2001).

- model explanations

Models serve to explain the functionings of other systems by means of schematics which often take the form of two and three dimensional illustrations. Figure 46 illustrates the level at which models function.

Figure 46 Schematic representation of model functioning, after Madsen, 1988



Brain picture courtesy http://www.cccn.stir.ac.uk/brain.gif

Interestingly enough, Madsen (1988) conceptualises mathematical (formula) deductive systems as special instances of analogy-model explanations. Hence simulations as well as graphic models suffice as explanatory mechanisms and it is at the level of model that dynamic assessment most often finds itself lodged. Models can be classified according to their

a) degree of abstraction

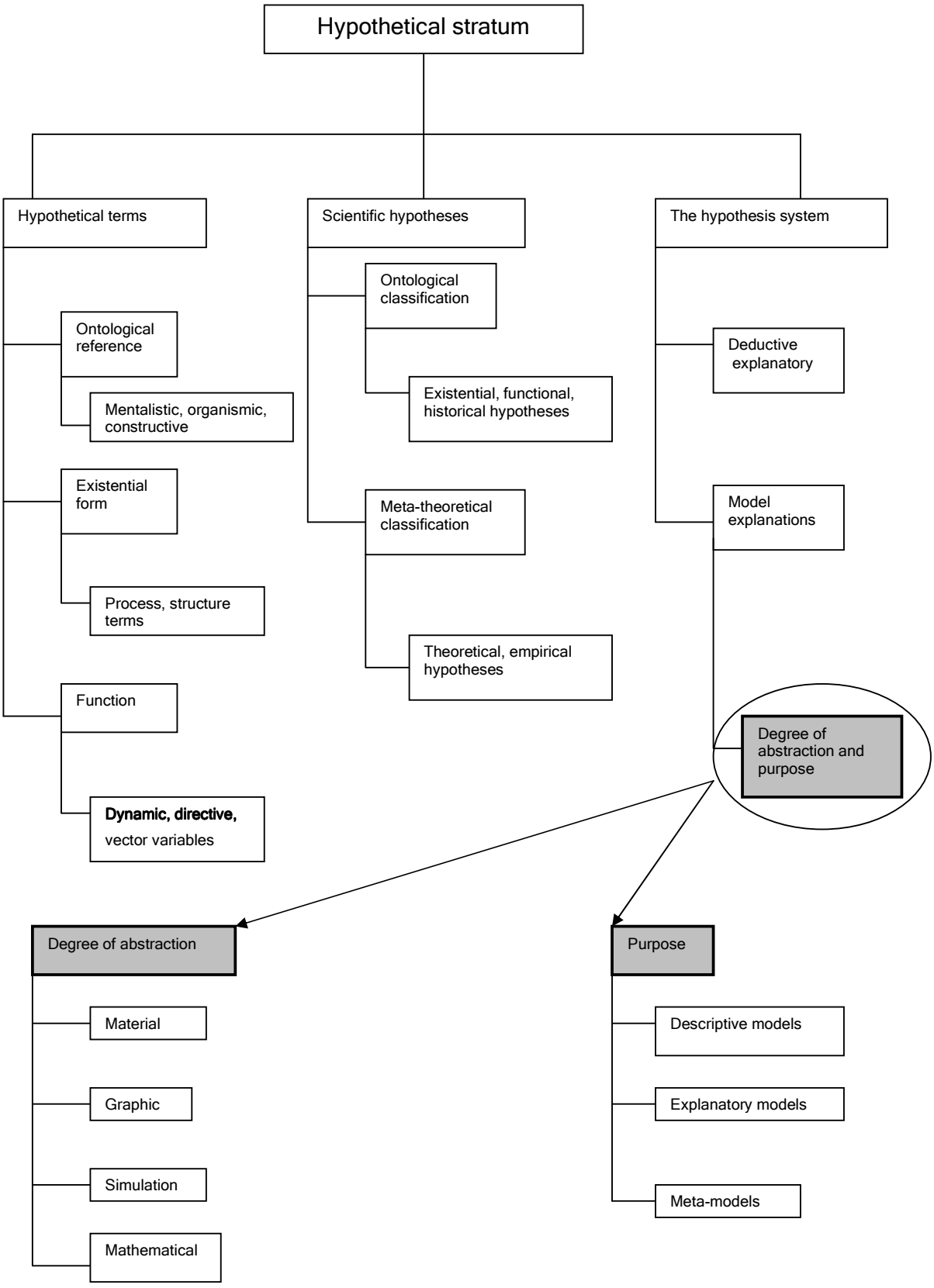
Levels of abstraction include the material three dimensional (globes to describe the earth), graphic two dimensional (maps to delineate the lay-out of land), simulation (computer software programmes) and mathematical models (symbolic deductive systems).

b) purpose or function

Models' purposes range from providing a schematic descriptive representation of a part of the world, through explanatory models employing constructive models, physiological models and mentalistic models through to meta-models where they are usually implicitly implied throughout the explanatory system as global models.

The hypothetical-stratum level thus far discussed is illustrated in figures 47 below.

Figure 47 Madsen's (1988) hypothetical-stratum



3.10.3 The data stratum

The data stratum is no different from the preceding stratum descriptions in terms of the composite blend of both abstract and concrete aspects but is, as a whole, the most concrete of the three levels. The data stratum can be divided into:

The abstract data-stratum

The general data theses are contained within this section and contain exclusively descriptive terms which are highly abstract but contain no hypothetical terminology, and Madsen cautions the reader as to the somewhat confusing make-up of very abstract data terms in comparison to more concrete hypothetical terms and that the same term can be employed in both meaning categories depending on the context and usage. The empirical or data level forms the lowest level in this diagram and includes concrete descriptions from experimental trials and observations and also includes abstract relations which exist between various data. Madsen's short-hand describes this as the D-level. The data level stratum within this meta-science model is the core or essence of how science is practised within the socio-cultural milieu. The data stratum itself is divisible into more and less "abstract concretisation" of empirical information depending on the nature of the datum, either referring to something observable such as impulse control during a test situation or an aspect much less observable and hypothesised to exist such as the construct of potential as assessed during dynamic assessment. The abstract data theses are enmeshed with empirical relations which play out in one of two relations, namely, functional relations and correlational relations. Functional relations detail the interplay between dependent and independent variables and can be illustrated thus: pretest result (independent variable) in addition to intervention (independent variable) leads to a posttest result (dependent variable). In psychology there are two kinds of empirical relations, namely:

a) functional relations

These are relations between dependent and independent variables, notated as follows:

S ⟶ R

The functional relationship within a dynamic assessment set-up can be viewed as:

Pretest ⟶ Intervention ⟶ Posttest

b) correlations

Correlational relations relate two or more dependent variables in a manner in which the relationship is statistically measurable but not necessarily causal. The relation between performance on an intelligence test and performance on a mathematical test may be correlated due to the possible *g*-loading of both types of assessments and can be illustrated as:

R----------R

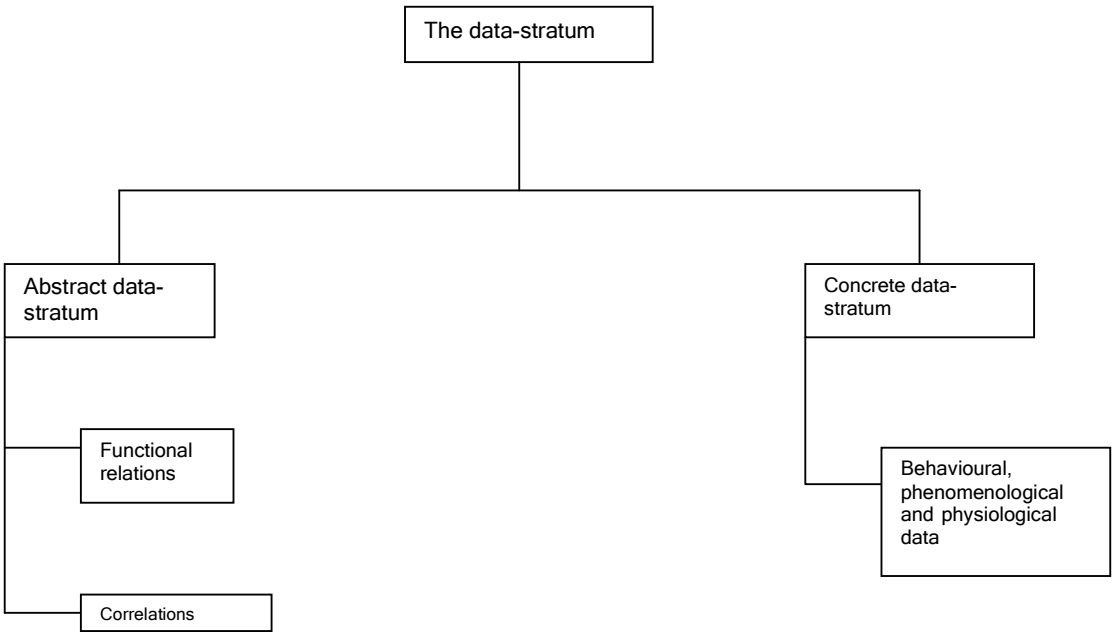
The concrete data stratum

Specific data theses reflect observables in the system and included among others descriptions of behavioural, phenomenological and physiological data. Madsen's firm contention of science as proceeding from top-down as opposed to bottom-up may be unjustified as both manners of approaching any discipline are necessitated, yet this is his contention when he states:

> Modern meta-science does not regard science as built up from the bottom but rather from above - from the meta-stratum. It is the meta-stratum that governs the formation of the hypothesis-stratum and the methods for collecting the data that is then used in the revision of the hypotheses or still better, science has arisen and developed in an interaction between philosophy and the empirical facts (1988, p.59).

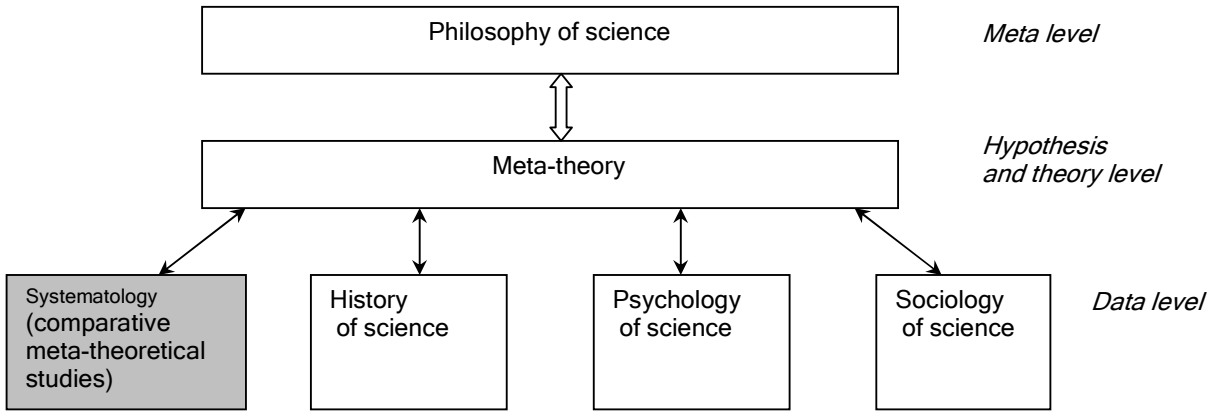
The hypothetical-stratum level thus far discussed is illustrated in figures 48 below.

Figure 48 Madsen's (1988) data-stratum



The composite scheme highlighted in the various figures above culminates to form Madsen's systematology. This is itself positioned within another larger encapsulating system and can be seen in figure 49 below. Systematology (shaded in this figure), forms one designated area of study alongside studies of the history of science the psychology of science and the sociology of science each of which belongs to the data stratum of this meta-theoretical conceptualisation. This data-stratum itself is placed below the meta-theoretical level which is superseded by the philosophy of science.

Figure 49 Diagrammatic illustration of the interrelations between various meta-scientific disciplines



The philosophy of science inspires theories about science (the theory level) which in turn produces data and can be empirically tested under various disciplines of scientific research. From Madsen (1987a), p.170; (1987b), p.263; (1988), p.12.

3.11 Considering the whole text

Many philosophically-inclined writings, schemes, models and theories are written in formats in which clear systematisation of these texts is not explicitly delineated and compartmentalised. In order for such texts to be numerically quantifiable and in order to determine its testability Madsen developed what he refers to as the hypothesis quotient (HQ) facilitating the quantification of ratios. Hypothetical theses as well as empirical hypotheses are counted and summed in a fairly straightforward equation. However limiting this approach may at first glance appear, it does capture the essence of the leaning of a theory in terms of its affiliations with data, hypotheses or philosophies. Various theories (or models as the case may be) emphasise one or more of the three strata discussed above in varying detail and hence display different levels of testability. Philosophical texts are by their

nature irrefutable and however incontestable their advocates may be, no serious attempt can be made to prove any claim emanating from the text (logical analyses aside). Texts emphasising hypothetical constructs without the requisite data to support these conjectures avail themselves of testability criteria, but once again only to a point, as they highlight models and hypotheses more so than testable data. The most testable would of course be theories with larger bases of data. Madsen works towards hierarchically arranging theories within the discipline and has chosen for his efforts a scheme which is commendable although could be construed as flawed depending on the view taken towards science as whole and psychology as sub-discipline within science. These objections have been noted above in this chapter. Nevertheless Madsen offers a point of departure which, however reductionist, is unconvoluted and thus easy to replicate.

3.11.1 The testability of theories - hypothesis quotient (HQ)

Natural science dictates ensure that theories are testable and in the process of constructing hypotheses in order to further this goal, quantifiable results[102] make manifest something intangible in terms of perceiving a result to be either confirmatory or not. Psychology's hard science approach following in the wake of natural science advancements initially hoped for an empirical, quantifiable and verifiable heritage to which later was added Popper's falsifiability as further criterion (a criterion which has had serious argumentative flaws lodged against it, Worrall, 2002). To add credence to the theories of motivation Madsen set about devising a "quantitative estimation of the testability of a theory" (1984a, p.185) and labelled this approach the hypothesis quotient. As this approach forms the bedrock of his systematology it is considered prudent to briefly outline the process.

Madsen (1984a) acknowledges his indebtedness to philosophers of science who preceded him in terms of studies regarding testability criteria seeking to advance science in general. Among these giants are cited Popper, Bunge, Radnitzky, Törnebohm and Kuhn (granting the tension between Kuhn, Bunge and Popper). Madsen attests to the greater affinity Kuhn's theory has to reality (factual development) as opposed to the Popper and the logical positivists preceding him. The testability of an hypothesis or theory itself is prone to error[103] and as such Madsen (1984a) states that just as with all testability criteria his own can be considered as merely preliminarily acceptable.

Defining HQ

An hypothesis according to Madsen (1984a) is a formalisation of the functions between two or more variables, at least one of which is an hypothetical or transempirical variable (an unobserved intervening variable) and "is based on the proportionate relation between theoretical and empirical hypotheses" (Madsen, 1988, p.61), the method through which theories are numerically tested. Two types of hypotheses present: a theoretical hypothesis and empirical hypothesis. Theoretical hypotheses include the functional relations between two hypothetical variables and are designated as H-H hypotheses. An empirical hypothesis includes the functional relation between at least one empirical and one hypothetical term. The empirical term can be one of two conditions, namely dependent (response variables) or independent (stimuli variables).[104] Hence, empirical hypotheses constitute one of two types, H-R and H-S hypotheses. In the present scheme no place is allowed then for purely empirical hypotheses as the definition has to include one hypothetical construct. To accommodate relations between two or more empirical variables then, the term datathesis is added. This subsumes the functions between S and R variables as well as the correlation between two or more R variables.

Interpreting HQ and it's calculation

Due to the lack of explicit laws[105] (which resulted in incomparable theories) within the various theories of motivation surveyed by Madsen, HQ was redefined as an estimation of the potential explanatory power of the theory. Theories with greater explanatory power, writes Madsen (1984a), is in keeping with Popper's conclusion that this leads to better testable theories and so explanatory power is directly related to testability. HQ can be calculated by summing all theoretical hypotheses and dividing it by the sum of both dependent and independent partly empirical hypotheses and looks as follows:

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[102] See chapter four which discusses this quantitative imperative.
[103] Relativism, it seems, forever lurks under the surface. The author's avowed dislike of relativistic stances has already been stated in chapter 2 but she also acknowledges that it is an inescapable fact of science and scientific discovery.
[104] It is clearly evident here that Madsen deployed technical terms from the prevalent literature of the time. Theories of motivation were firmly ensconced in behavioural terms. That these theories were more amenable to this type of analysis is telling of the period in which these theories were developed. These types of theories are no longer the dominant forces they once were as psychology as a larger discipline now encapsulates a much broader view of human functioning. Another reason then that the fragmentary discipline should be mindful of the role of theoretical psychology and the streamlining effect that can result from efforts in mapping out future trajectories for the discipline.
[105] Still problematic. How many laws proffered by psychology are known? After all the quantification of data is gathered psychologists sit with heaps of data. That quantification is at fault is untrue as it is merely a tool. That the wrong tool is being used may seem to be a better question to ask. Or is it the discipline as currently defined that is at fault? Is this the reason dynamic assessment sits so uneasily within the domain of intelligence assessment (itself questionably seated within psychology). And so a cascading effect ensues.

$$HQ = \frac{\Sigma(H\text{-}H)}{\Sigma(H\text{-}S) + \Sigma(H\text{-}R)}$$

The higher the hypothesis quotient the lower the testability of the theory and is evident from the equation. The fewer hypothetical terms the better in terms of the theory's testability. For explanatory purposes Madsen's calculation of HQ as applied to two of Freud's theories[106] will be briefly discussed.

Madsen (1984a) utilises Freud's chapter 7 in his "Interpretation of dreams" (1900/1953) as basis of HQ determination of Freud's theory by analysing the text and thus extracting theoretical (H-H symbol) and empirical (H-S/H-R symbols) constructs. Firstly, there is a well argued rationale surrounding the choice of Freud's particular theory, followed by a systematic deconstruction of Freud's passage in which identification of constructs is made based on quotations taken from the passage and lastly a formulation is evidenced in the form of the HQ equation. Madsen concludes with a calculated HQ of 2 for this particular theory detailing six theoretical constructs, two stimulus empirical constructs and one response empirical construct;

$$HQ = \frac{\Sigma(H\text{-}H)}{\Sigma(H\text{-}S) + \Sigma(H\text{-}R)} = 6/(2+1) = 2$$

This HQ is one of the higher among HQ's that Madsen (1984a; 1987) has investigated (an HQ of 0 has been calculated for Skinner's theory, which when viewed from this perspective is an obvious score) and is testament to the lower testability of the theory, although being one of Freud's many theories it is not indicative of the testability of his other speculative theories. This theory is contrasted with Freud's theory of anxiety (theory presented in Freud's "Problems of anxiety" 1926) in which Madsen (1984a) evidences an HQ of 1.2, thus allowing for greater testability when compared to his above-mentioned topographical (structural) theory. The nearer the theory is to the empirical level the greater the testability and hence the lower the hypothesis quotient. An example of the derivation of this HQ utilising Freud's theory of anxiety is given:

1. H (anxiety) - S (trauma)
2. H (perception) - S (danger)
3. H (perception) – H (expectation)
4. H (expectation) – H (anxiety)
5. H (anxiety) – H (defence)
6. H (defence) – H (change of perception)
7. H (drives) – H (perception)
8. H (super-ego aggression) – H (perception)
9. H (anxiety) –R (flight)
10. H (anxiety) – R (conscious experience)
11. H (anxiety) – R (organic processes)

There are two stimulus empirical statements, Σ (H-S) = 2; Σ (H-R) = 3; Σ (H-H) = 6. Therefore

$$HQ = \frac{\Sigma(H\text{-}H)}{\Sigma(H\text{-}S) + \Sigma(H\text{-}R)} = 6/5 = 1.2$$

In essence both the chosen theories evidence higher quotients when compared to the average HQ of other theories analysed by Madsen. The closer Freud's alliance to empirical bases though the higher the testability and lower the HQ become. The mistake of confusing testability with heuristic value should not be made, cautions Madsen, since un-testable theories are often superseded by their guidance values. HQ is a measure of a theory's testability and not of its heuristic value (Madsen, 1984a). It is hypothesised that this might well be the case with various dynamic assessment models within intelligence research. The notion of the methodology of the science-model as closely followed within natural science disciplines comes into question in areas in which this model may not necessarily be the best available model to follow. The case for theorising thus leading to empirical validation is stated in this chapter. Arguments against this reductionist exercise might well be grounded in the dissatisfaction of reducing complex theorising which may well not yield to quantification. Yet if a study such as this is to progress with even a tentative explanation of where dynamic assessment finds itself within the broader intelligence field, such reductionism is at times warranted.

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[106] In agreement with Brandt (1984); Ettin (1984) and Schaeffer (1984); the author also thinks that had Madsen chosen another theory with which to explain the derivation of HQ, it would have been initially better received than in fact it was. Madsen (1984b) in his retort to commentaries makes this admission though; but defends other critiques about his systematological approach.

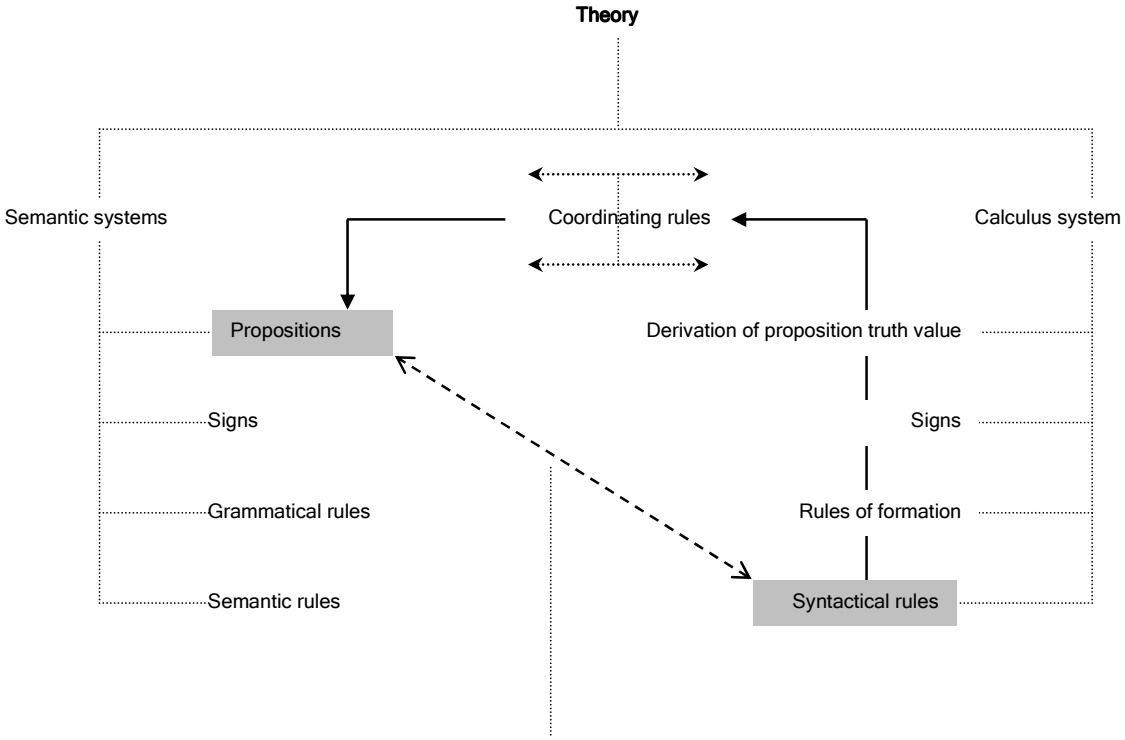
Madsen's HQ will be employed as a guideline only along which to estimate the plausibility of various dynamic assessment theories and models within intelligence assessment. Knowing that various strands of thought within these defined areas (dynamic assessment in intelligence research) are theories and models, this equation cannot necessarily be applied directly to all manner of dynamic assessment intervention models. As has already been mentioned such theory/hypothesis testing within theoretical psychology and specifically within meta-psychology is not often cited in the literature. The study does not concern itself directly with the tools of analytical philosophy[107] nor with the philosophy surrounding theory confirmation but considers a smaller area of investigation - dynamic assessment theory/model within intelligence research and the degree to which these theories/models are testable and their subsequent placement within a meta-theoretical framework.

However, a very brief explanation of theory formation is now addressed, but is done so from an analytical positivist view (Ross, 1964[108]). Theories are customarily made up of a semantic system and a calculus system and are linked via co-ordinating rules. The semantic system concerns itself with general propositions of the theory whereas the calculus system concerns itself with the derivation of these propositions in terms of their logical truth value. Rozeboom (1970) refers to the calculi system as the uninterpreted theory and by assumption implies that the semantic system is the interpreted system. The system is diagrammatised in figure 50 as follows:

[107] The calculus of which is beyond this text. The logic involved in theory analysis, confirmation and revision can be sought in the following texts: Chalmers (1999); Harré (1988); Hempel (1970); Hempel and Oppenheim (2000); Howson (2001a); Huber (2002); Meehl (1992; 2002); Nagel (1979); Oldroyd (1986); Ross (1964); Suppe (2001a; 2001b; 2001c); Trout (2001b); Tuomela (1973) and Wilson (1985). For a very brief introduction to the types of logicism (verficationist and falsificationist) involved in theory appraisal McMullin (1978) offers a comprehensive overview.

[108] Inspired mainly by Hempel, Copi and Carnap who were concerned with, among other things philosophical, the logical analysis of language in which metaphysical statements are regarded as meaningless due to the lack of empirical refutation and lack of confirmation as well as concerned with the logical positivist criterion of meaning and the defining of theory as a formal calculus in addition to meaning (Mautner, 2000; Rozeboom, 1970). Upon further reflection, it may well prove fruitful "to have a go" at just such an analysis pertinent to dynamic assessment theories at some future date. Were the thesis of reductionism as set out in chapter 2 to become a reality in the future, there might well be a place for the logical positivist account of theory deployment, although currently, "the dream of the logical positivists that theories should have finished formal architectures has practically never come true in psychology" (De Jong, Bem & Schouten, 2004, p.280). It does seem rather ironic that analytical philosophical renderings of psychological theories have not really become routinely accepted within the broader discipline of psychology as this method is deemed as exemplifying the tools of philosophy - clearly at odds with current mainstream natural science approaches and methodologies within psychology (Jordaan, 1989). If analyses of this type is a rigorous a task as purported to be, what better complement of tools to utilise along with a natural science approach? "By and large conceptual housekeeping in mainstream psychology is directed/overshadowed by methodological considerations" (Jordaan, 1989, p.54). Chapter 4 discusses this in greater detail.

Figure 50 Formal analytical view of theory constituents (Ross, 1964)



Provided the theory is true, members of the syntax rules of formation are transferred into true propositions in the semantical system via the coordinating rules

In deploying his own framework for the express purpose of deriving a numerical quantity for testability, Madsen investigates the major theories throughout the history of psychology such as classical experimental, Gestalt, reflexology and classical behaviourism, psychoanalysis, humanistic, Marxist, contemporary behaviourism and mainstream psychology. The work culminates in hypothesis quotients for each major theoretical school or paradigm within the various branches such as chosen theories representing each school; a theory of learning, a theory of motivation, a theory of personality and a theory of cognition each subsumed within the greater school or paradigm of mainstream psychology.

3.12 An amalgamated Madsenian framework

The Danish meta-scientist, K.B. Madsen developed for psychology a suitable framework from which to numerically assign values of comparative worth and testability so that the discipline would in some measurable manner become more suited to empirical investigation. That this quest be considered ignoble by some anti-reductionist psychologists is an issue with which these said psychologists will have to grapple. The obvious advantages and disadvantages have been highlighted and will not be looked at again. His devised systematology offers an integrated and tightly packed consideration of how theories should be assessed and was himself very much influenced by various meta-theorists and philosophers of science. The appealing aspect of this framework is his frank contention that theories cannot be developed without due consideration for fundamental and underlying (and at most times, implicit) affiliations. Ranging from the greater historical and geographical areas of theory origin to the most minute datum detail, Madsen's systematology evokes appreciative applause for his attention to these wide ranging concerns from which the framework is built. His systematic and reductionist trends are in fact what makes this framework tenable in the first place. It is not a purely philosophical system entreating the researcher to ensure governability of thought and neither is it a purely data-orientated closed system in which theory development is considered isolated from the larger environmental systems. This framework has found for itself a niche for which this study offers fertile grounds for its own development and deployment of a meta-theoretical framework for dynamic assessment and intelligence. However, in its current form, the framework will need tweaking and realignment of sorts if it is to wield even greater impact for dynamic assessment models and theories. As befitting as Madsen's framework is to a study quantifying theory testability across the entire psychological spectrum, a similar framework is warranted for model and theory testability within dynamic assessment. The point of concern for this study when seeking such a framework as offered by Madsen is that the field of dynamic assessment is itself

unsure as to its theoretical/model/schematic status.[109] Consequently any framework built for the express purpose of comparing various models will have to concede to the field's rather blurred status in this regard. Now that Madsen's framework has been delineated the next step will be to attenuate the framework somewhat so as to allow for the utility of another framework developed for dynamic assessment. However, before Madsen's framework is attenuated for this study's purposes, chapter 4 and its focus will need to be considered. The framework will thus appear at the end of chapter 4 in an amalgamated and attenuated format.

3.13 Conclusion

This chapter has sought to make clear that underlying fundamental explicit but usually most often implicit assumptions predominate within a theory or model to the extent that original conception of an idea, the choice and implementation of a methodology, and the final analysis of data are all influenced by these assumptions. Depending on the nature of the study, various tools can be utilised to realise certain outcomes but more often than not, such assumptions form the study and thus partially form the outcome. Epistemological and ontological psychological positioning of theories and models propel the nature of ideas concerned within the theories and models. Due to psychology's scientific past and ever-increasing scientific present, natural science based approaches to the study of phenomena have largely overshadowed other ways of gaining access to knowledge. However, the more recent past (within the past two decades) bourgeoning ideas within epistemological and ontological alignments (which have thus become more manifest as researchers have taken to understanding their positioning better) have started to rear their heads in a number of research areas and concern themselves with issues of constructing the reality as it is researched for instance. This is an idea which has woven its way through the fabric of many psychological sub-disciplines, including psychological assessment.

Such renewed attention to underlying philosophies concurs with concomitant changes in research domains (what can be researched) and how such domains are studied. Natural science's contribution to the study of the world (in any form) is breathtaking and wholesale importation of ideas, methods and ways of understanding has been partially successful within areas most aligned to physiological psychology. It is maintained that this method of gaining knowledge is a worthwhile endeavour and should be encouraged. However, within the same large domain rests avenues of pursuit within psychology that have not flourished to the same extent as the former. This is most likely due to the thoughtless importation of natural science methods into areas not akin to such analysis. Dynamic assessment is one such area of concern. The scientific status of this sub-discipline is not in any danger of being toppled because a scientific manner of such assessment is tenable – just not in the manner as described within the natural sciences model. The continuous overlap between domains has resulted in various fractures within the discipline leaving a trail of misguided epistemologies. Explanatory mechanisms within science, social science and psychology were discussed. A running concern within each of these areas was the nature of the theory and its verifiability in terms of its being falsified or verified (Popper's concerns). What counts as a science? What counts as a scientific idea, notion or finding? Natural science philosophy (whether scientists are implicitly or explicitly aware of it) seems to work for the vast majority of studies. As mentioned, technology attests to at least a partial amount of success: no science – no technology. Can the same be said of psychology though? This was highlighted and debated within the discussions.

A scientific psychology need not lend itself to a pure realist/rationalist approach because as is known, natural science studies themselves do not always progress on a firm footing of realist foundations. Relativist approaches appear everywhere within science and should likewise be an accepted feature of a scientific psychology without necessitating the strict rules and regulations that govern most natural sciences. Psychology as a broad discipline is fragmented partially owing to its mixed status as natural science / social science being predicated on natural and social science models simultaneously. It is suggested that if it is to remain in any manner a directed research area worth pursuing it should refocus and align itself according to the specificities of subject area. Hence, certain types of research can move into dedicated natural science domains and others can, for instance, move into more qualitative social domains (they need not necessarily be qualitative). A split would not be an entirely bad thing. This will go a part of the way in trying to dislodge psychology from a strict and essentially overly simplistic model of being "at the bottom of the pile" so to speak, allowing it more room to develop and become a more credible knowledge gathering enterprise without having to dance to the tune of natural science rigour.

Psychology theories are notoriously more difficult to define, analyse and interpret due to the overwhelming number of impinging variables, which is not to say that natural science theories are not likewise swamped with impinging variables; psychology's variables are overly intractable. In order to overcome such stalemates, techniques are employed to simplify models and theories in as parsimonious a fashion as possible which inevitably leads to reductions which are themselves questionable – but such is the nature of investigation within this realm. Definitions, concepts and propositions are necessary to make sense of raw data but

[109] One need only read the results of the informal content analysis conducted on the responses to the questionnaires in Appendix 2, which although only based on a small sample and thus not in anyway appreciably generalisable, does not allow for a conclusive conclusion to be drawn regarding dynamic assessment's status as scheme, model or theory.

are far more layered in terms of meaning than is the case within the natural sciences (an electron, although not yet observable, can be detected in a bubble chamber; Close, Marten & Sutton (2002); so even as a concept it is understood - in fact it was understood long before it was ever detected; Gribbin (2003); however, ID, ego and superego are not as easy to understand for obvious reasons). Just as theories in psychology are difficult to define, so to are they difficult to appraise, for the most part, because they are usually not tested in replication studies if at all. No replication, no theory proof or disproof. Just a remaining theory at the edge of the discipline. Do psychological theories strive for parsimony as conventionally understood in the natural sciences? Or do they make for themselves their own framework of parsimony? Is parsimony even attainable in complex theories? These issues among others were discussed before attention was shifted to the meta-theorist's work with which this study concerns itself.

Meta-theory is not a developed science within the social sciences much less within psychology. Many notions of what constitutes a meta-theory exists but very few carefully worked out models rendering an effective service exist. One thoughtful exception is the meta-theoretical framework devised by K.B Madsen. The framework cannot be imported without judicious consideration for the reasons necessary for utilising the framework, moreover, the framework needs to be attenuated for the purposes of this study. Various ideas concerning meta-theory exist; it serves to cumulate and study whole fields of endeavour; it serves in a constraining capacity; it allows for recommendations to the existing repertoire of theories in order for the discipline to progress further and it makes available insights gleaned from a view from above so to speak as opposed to views within from the morass of activity down below. Some posit that such endeavours are doomed from the start and that no such study can take place until the field under investigation has reached a necessary level of maturity. This thesis takes the opposite view by stating that it is precisely this view that is needed at dynamic assessment's juncture in history in order to offer it guidance in its future trajectory. Dynamic assessment, although youthful is most certainly not a novel set of theories and methods.

The singular taxonomic systematology devised by Madsen spans a great deal of what is considered important for epistemology and ontology within psychology and although Madsen focused on theories of motivation, his framework can nevertheless be utilised for the study of dynamic assessment. His encapsulation of governing cultural environments, scientific communities and the individual researcher in tandem with external histories of science (socio-economic), the combined external and internal history and the individualised biography of researchers attest to this breadth of scope of concern. Madsen's views on science and meta-science consist of empirical research results, the theory behind these results as well as the reigning philosophical thinking. He subsequently viewed theory as a set of defined hypotheses with requisite models accompanying them as well as a broader understanding of more mature scientific theories; i.e. his scope included developed and developing models and theories. In pursuance of a fully inclusive meta-theoretical model, he considered the meta-level, the hypothesis/model and the data with each level adhering to specificities of their own. Madsen views models as differing on the nature of abstraction and resultant purpose (or functions). Are models descriptive, explanatory or meta in nature? The discussion on Madsen's systematology included his views on the meta-stratum including ontological meta-theses and philosophical meta-theses. His hypothetical stratum consists of hypothetical terms, scientific hypotheses and the hypothesis system. The data stratum is described through considerations of abstract data and concrete data. His writings, although consistent, are quite nebulous in terms of an order to his work and the discussion on Madsen's meta-theoretical framework is a more concise effort in attempting to order it. To test theories and thus assign a numerical value to various models and theories, Madsen devised a simple formula for assessment, which may at first glance seem oversimplified especially for less defined theories and models such as evidenced in dynamic assessment. Nevertheless his attempts are laudable. The hypothesis quotient includes two dimensions; the hypotheses and empirical instantiations (independent or dependent variables) of these hypotheses as reflected in the specific theory at hand and is only an estimation of the potential offerings a theory can tentatively make. The calculation in no way attests to a theory's absolute quantified status as law-like. Fewer hypotheses indicate a more testable theory and thus a lower quotient and vice versa. As mentioned Madsen's HQ will be utilised as a guide only in an attempt to build for dynamic assessment a similar type of rating system.