Essays on Cognitive Physical Science
Essay 3 Short Version - Edition 1 - 30 Oct. 2015
University of Pretoria Repository UPSpace

A Physicist's Model of Mind [1]

Werner H. Gries [2]

Dept. of Physics, University of Pretoria, South Africa

PREFACE

The original incentive for the work reported here came from my (a physicist's) conviction that advances in physical science are hampered to an ever-increasing degree by the enormous lack of physicists' knowledge about the working of the human mind. When turning, more than a decade ago, to the various cognitive and related sciences (psychology, neuroscience, evolutionary biology, sociology, anthropology, and others) for an answer to my questions, I realised after a while that the vast amount of knowledge available within these sciences, though indispensable for my research, is not of a type which helps a physicist to understand the mind, the problem being that 'understanding' to a physicist means something quite different than to a cognitive scientist. Apart from this problem, it also became clear to me that mind is enigmatic not only to physicists, but to all and everyone engaged in unravelling the secrets of the human brain, which is generally considered as the seat of mind.

The widespread desire for understanding the human mind becomes particularly apparent in the launching of major research efforts towards getting clarity about how the elementary building blocks of the brain (of which much knowledge has been gathered) combine into a functional system capable of managing the life of man. I am referring here to three research projects in particular, viz. (1) the (European) Human Brain Project funded by the EU with well over one billion (10^9) Euro over a ten year period (launched 2013), (2) the (US) BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies, also referred to as the Brain Activity Map Project) funded by the US Administration with about 3 billion US Dollar over a ten year period (launched

[1] It is recommended that this Essay 3 be read in conjunction with Essay 2 of December 2014. Essay 3 serves also as a script of two lectures: (1) South African Association for the Advancement of Science, Pretoria, 28 October 2015, and (2) University of Pretoria, 29 October 2015.

[2] Honorary Professor

2013), and (3) the (US) Human Connectome Project, a (US) National Institute of Health multi-contributor project, launched in 2009 for a five-year period (and, hence, close to a final report).

These projects aim (Project 1) at simulating the brain on a supercomputer based on the contributions by more than 80 research institutions, (Project 2) at mapping the structure and activity of the brain down to the last of the roughly 100 billion neurons in the human brain, and (Project 3) at mapping the functional connections between parts of the brain of a person and relate these to the person's behaviour, for a total of 1200 "healthy" adults. Clearly, the successful conclusion of these projects will be but a first step towards understanding the working of the human mind.

The prospect of having to wait many more years or even decades for an answer to pressing questions about human (and hence also physicists') reasoning and behaviour seeded the idea of attempting a shortcut by means of a physicist-typical approach to the problem. Typical for a physicist's approach is the development of a model of the entity under investigation, here the human mind, according to the Ansatz concept, i.e. by the "establishment of starting assumptions and/or propositions into an educated guess about a problem and its solution that is verified later by its results". Appropriate starting assumptions and/or propositions are more easily found for developing models in physical science than for developing a model of the human mind, at least for a physicist. But it is not impossible, as shown in this text.

In fact, it turned out that the cognitive and related sciences, together with findings from philosophy, did provide sufficient material for the Ansatz concept to yield a model of the human mind which complies with the requirements of physical science, provided one discards a number of humanism-related philosophical positions while introducing new visions about certain functions of the human mind, such as about consciousness and about the seat and sense of self.

The model of mind which arose out of this Ansatz is presently being written up in stages, presented stage by stage to an audience of students and university personnel of the University of Pretoria, as well as to a wider audience of the Pretoria Branch of the South African Association of the Advancement of Science (S_2A_3). Scripts of these presentations are available in the University of Pretoria Repository UPSpace, the present one under the title "A Physicist's Model of Mind", a previous one under the title "Re-philosofying physical science and other heresies" (http://hdl.handle.net/2263/43388). A 56-page precursor essay of 2010, titled "Traditional Thinking, Physical Science, and the Brain", focussed on a "Parallel-Systems Mind Model" of the author is also

available in UPSpace (http://hdl.handle.net/2263/16600). The idea of a modular structure of mind dates from this 2010 essay.

The model which arose from the Ansatz, which I am calling the Modular Mental Structure Model, or the Model for short, is written up in an essay style so as to appeal also to readers unfamiliar with the formal style of scientific publications. Furthermore, the arguments are presented in a simple, yet scientific, way (i.e. in accordance with scientific principles as well as Ockham's razor), so as to get these across not only to my colleagues in physical science but also to a readership who may not have had a thorough priming in the physical and cognitive sciences or in philosophy.

In the current short-version text, the focus is on key elements of the model. Additional elaborations are reserved for a longer version.

Throughout my text, I want the reader to remember that I am describing a model of mind, nothing more, nothing less. This model is an intellectual exercise by a physicist, likely to be superseded in time either by a different model or by an improved model.

INTRODUCTION

What a physicist means by 'understanding'. A physicist's understanding of mind.

After having read the Preface, the reader is likely to ask the question why a physicist's model of the human mind should be able to explain human reasoning and behaviour so much better than, for instance, psychology, which is focused on the "inquiry into and theory of mental phenomena". The key to an answer lies in the earlier statement that 'understanding' to a physicist means something quite different than to a cognitive scientist. This different notion of 'understanding' has obviously been key to the enormous advances of physical science and to progress in all areas of technology, so why not also in a study of the mind. Let me explain this different notion by way of a comparison between engineering properties and atomic properties of materials.

What a physicist means by 'understanding'

Taking steel as an example, its selection for a particular engineering application (such as a steel structure or part of an automobile) requires little more than the specifications of the so-called engineering properties of the various types of steel on the market, i.e. properties such as tensile, compressive and yield strengths (to quote only three of many). These engineering properties allow the in-service behaviour of a particular steel component to be predicted without

however being able to explain how the engineering properties come about, or how these properties can be changed for the better in the manufacture of steel. The latter becomes possible only by looking at the atomic architecture of the steel and how this atomic architecture can be changed during manufacture, according to physical science means, so as to optimise the product's in-service behaviour. This is when physicists speak of *understanding* the behaviour of a steel.

Applied to what is known about the behaviour of man, I conclude that the large majority of findings of psychology about human behaviour can be likened to the findings about the engineering properties of steel in physical science. This is so because in both cases the focus is on the outward manifestations of the hidden inner workings; in the case of steel that of the hidden atomic architecture, in the case of a person that of the hidden architecture of that person's mind. In the case of steel, this hidden inner working has become "revealed" by the invention of an atomic model which has been modified over time so as to link all outward behaviour of a steel to assumed actions taking place within the atomic model. In this sense, the term "revealed" is not to be understood as referring to the real steel, but only to its atomic model. But the correspondence between the behaviour of real steel and the assumed action in the atomic model is meanwhile so good that the distinction between the two fades into the background.

A physicist's model of mind

I am positing that for an understanding of the behaviour of man, and his/her reasoning, one requires a model of the architecture of the mind (viz. the Modular Mental Structure Model), just like the understanding of the behaviour of steel has required an atomic model. Just as in the case of steel, this model of the mind must be able to explain the psychological equivalents of the "engineering properties" of steel. This is what the current text is about.

KEY ELEMENTS OF THE MODULAR MENTAL STRUCTURE MODEL

Levels of logic. Physical and mental modules. Least effort principle. Types of mental modules. Routing of learning-related signals. Private-paradigm modules. Generation of mind. Least mental stress principle. Complex-system behaviour. Consciousness and the seat and sense of self. Signal routing by tagging. Group think. Summary of key features.

At this stage one may become optimistic about the chances of success for such a model on account of the fact that neuroscience is focussed on the study of all components of the brain (cf. the projects mentioned in the Preface). While this is true, and a tremendous quantity of findings is available, we have two major problems. One is that the relationship between the architecture of the brain and

that of the mind is far from being fully understood. The other is that, in order for the model to serve its purpose, one must be careful in selecting the correct level of logic for the model to be of value.

Levels of logic

The levels-of-logic idea is of the utmost importance in the model and is explained at great length in the above-mentioned previous short-version essay titled "Re-philosofying physical science and other heresies" (http://hdl.handle.net/2263/43388). Here a short exposition must suffice.

A key finding of the levels-of-logic idea is that its application for understanding a certain natural phenomenon first requires an analysis of this phenomenon for an identification of its most immediate constituents. It is these constituents, rather than the constituents of these most immediate constituents, which are key to understanding the phenomenon in a physicist's sense. For example, it does not help to have a model of the neuron (i.e. the nerve cell of the brain), if ever so realistic, for understanding the working of the brain, never mind the working of the mind. This would be like trying to understand the behaviour of steel from the architecture of the atom itself rather than from certain assemblies of atoms which form architectural components of the steel (such as crystallites and dislocations, to name but two of many [3]). In other words, for understanding the working of the brain one has to look primarily for certain assemblies of neurons which form architectural components of the brain, in the following referred to as the physical modules of the brain. The architecture of the individual neuron is of secondary importance [4].

Physical and mental modules

As far as I could ascertain, pretty little is known about how varied the architecture of the physical modules of the cognitive part of the brain can be, and how their architecture relates to their functions in the brain. These things will hopefully be revealed by the projects referred to above. Meanwhile, I shall simplify my task by positing that it is the configuration of the network of synaptic linkages between the neurons in a physical module which determines a module's function. And I further posit that the specific configuration of a physical module represents its mental contents (e.g. a memory). In other words, I posit that individual mental modules reside in as many physical modules. And

[3] These are two of the architectural components of materials, like steel, which serve to explain the materials' behaviour.

[4] The (unintentional) violation of this levels-of-logic rule has been the reason for the enormous hype about the alleged importance of mirror neurons for the development of theory of mind, empathy, social awareness, appreciation of music and the arts, autism, and even speech (cf. Gregory Hickok, *The Myth of Mirror Neurons*, W. W. Norton, 2014).

if these mental modules are the result of learning (as is assumed throughout this text), then the implication is that learning determines the neuron network configuration of these modules, and that these modules are situated in the cognitive parts of the brain.

The total of these mental modules form the learning-induced part of my model of the human mind, i.e. of the Modular Mental Structure Model [5].

The implications of this model are far-reaching. Viz., that a physical module has to be reconfigured whenever its mental contents is superseded by new sensory input, and also those physical modules have to be reconfigured which provide or receive information to/from this module. And since a reconfiguration of a module involves physical transport of atomic and molecular material as well as of energy for bringing about the reconfiguration, the availability of resources of material and energy are essential boundary conditions for the development and upkeep of an efficiently functioning mind.

A derivative of these implications is that, since in nature only those species have a reasonable chance of survival which make the most out of limited resources, also the model must reflect this evolutionary principle. In other words, the modular mental structure of the model must, of necessity, be such as to minimise the effort for both the development of a mind and for its upkeep under constant pressure for its modification.

Least effort principle

I shall, in the following, refer to the underlying principle as the 'least effort principle' [6] and I posit the Modular Mental Structure to be such as to be in compliance with this principle.

It is rather obvious that the positing of a modular structure of brain and mind is in compliance with the least effort principle, because the modification of one or a few modules is more resources-saving than that of a large entity. This, by the way, is also the basis of all human technology.

The question arises as to how small the modules can be in order to comply with the least effort principle while maintaining a highly efficient, rapid processing of challenges and threats to one's life. This is something, which I can, obviously, not answer; not before neuroscience has an answer. But I can posit the modules

[5] In my 2010 essay, titled *Traditional Thinking, Physical Science, and the Brain*, a similar model was referred to as the Parallel-Systems Mind Model, and the mental modules were referred to as 'conceptual subsystems of mind'.

[6] I am not the inventor of this principle, but I am using it my way.

to be small rather than large, whence I shall speak of many thousands, maybe millions, of modules.

The least effort principle implies also that no incoming information goes to waste if there is any chance of it becoming useful at a later stage, but that there must also be a mechanism whereby this information is analysed, categorised, and integrated into existing knowledge.

The least effort principle also implies the avoidance of peaks in the consumption of materials and energy resources. Hence, the analysis, categorisation, and integration process must be deferred to times away from periods of preoccupation of the brain with challenges. In other words, daytime experiences are processed at night.

Is there evidence in support of my consumption-peaks-avoidance hypothesis? Yes, there is indeed evidence from everyone's own experience, viz. when a problem has been solved "in one's sleep" (not necessarily after the first night, but also several nights on). And sleep researchers are certain that the brain reworks at least some of the wake experiences during sleep [7]. And then, there is the discovery (in 2001) of a highly intense cortex-wide activity, called "default mode activity", which neurologist Marcus E. Raichle [8], reports to be "preferentially active when individuals are not focussed on the external environment", but when "your mind is at rest - when you are daydreaming in a chair, say, asleep in a bed or anesthetized for surgery".

In the Modular Mental Structure Model, this default-mode activity of the brain is regarded as generating knowledge from information, viz. by starting a new knowledge module (the major type of mental module, elaborated below), by rendering this module compatible with existing knowledge modules, by fitting new information into existing knowledge modules, and by rendering everyone of these modules self-consistent. In other words, consumption-peaks-avoidance by default mode activity is in compliance with the least effort principle.

Least-effort-principle supplement

The following text adds some essential information to the foregoing:

The Modular Mental Structure Model posits that evolution must have favoured all possible means of saving resources for creating and maintaining minds that are fit for a survival job. In other words, the model presupposes that the brain of *homo sapiens* is genetically primed to choose the most consumption-optimal

[7] Psychologist Jan Born in an interview with *Psychologie Heute*, Sept. 2015.
[8] Marcus E. Raichle, *The brain's dark energy*, Scientific American, Febr. 17, 2010.

means available for the development of mind prior to adulthood, but also for the mind's further development at any time thereafter. This idea finds expression in the least effort principle. One cannot overestimate the importance of this principle, and it may even be one of the key reasons why only one of the three homo species - Modern Man, Neanderthal Man, and Denisova Man - who coexisted 30000 years ago in overlapping areas of the globe, survived to this day [9]. Modern man was more successful in applying the least effort principle.

Foremost among the consumption-optimal (i.e. resources-saving) means for developing and upgrading a mind is that of communicating experiences from adult to minor, but also between adults which share a common origin, common language, common environment and common challenges, i.e. within a group. The communication is particularly optimal if the narrative about an experience is accompanied by an interpretation of the why and how of the experience as well as by a detailed description of a successful warding-off of a challenge. This type of communication is a fast-track consumption-optimal means of developing the mind of a child, as well as for the updating of an adult's mind. Optimal conditions for this type of fast-track development of mind are found in groups, whence the least effort principle is, obviously, a key factor in group formation.

This fast-track consumption-optimal means of development of the mind does not, of course, cause the brain to relax in its mind construction and reconstruction efforts. The mind simply jumps ahead in a direction pointed out by the communicated knowledge, provided the latter is not totally incompatible with a pre-existing knowledge module of private paradigm status (cf. *Private-paradigm modules* below).

Returning to the fast in-group development of mind, I wish to add: Where something is to be had for almost free, there may be more. I.e., the most profuse source of mind-building information is likely to become the focal point of the group; in tribal society the elders, the headman, and the shaman. These have various equivalents in modern society. Their followers pay with loyalty, fan culture, adoration, submission and obedience, unknowingly guided by the least effort principle.

But the least effort principle does not only account for the followers in a group. The principle accounts also for the rise of leaders, simply because potential leaders soon realise that their profuse mind activities, ahead of others in the group, can be turned into a coinage for buying loyalty, fan culture, adoration, submission and obedience, which, in turn, reassures these leaders of the

[9] The coexistence of these homo species is proven by the presence of DNA of both Neanderthal Man and Denisova Man in the DNA of Modern Man.

rectitude of their thinking. In other words, self-critical doubts can be dispensed with. A clear case of least effort.

But evolution must also have favoured all possible means of defending the existing mind architecture against too radical a reconstruction. In the Model, these means range from arguing in I-am-right-and-you-are-wrong style to a mind adversary's destruction. The point (made before in my 2010 essay) is that a well functioning mind is a person's most valuable possession, which warrants the resorting to severe measures against severe challenges. In consequence, the least effort principle is a key factor in both the social and asocial interaction of man.

Still on the same subject, I wish to briefly discuss the least effort principle within the context of another principle of evolution which may seem to counteract the least effort principle, viz. the principle that 'whatever an evolutionary advance allows a member of a (new) species to do, will sooner or later be done, regardless of the effort and danger involved'. Not necessarily by every member of the species, but by some. Hence, some will climb Mount Everest ("because it is there" as Edmund Hillary, the first on top, is quoted to have said), some will row across the Atlantic Ocean, some will develop weapons of mass destruction which may eventually exterminate also their progeny, some will develop IT-malware which everyone will suffer from in the end, some will lead nations into war, but some also to a peaceful united Europe, etc.. These are examples of outliers from the least effort principle, which sometimes will lead to advances of mankind, and sometimes to catastrophes. I posit that these outliers are limited to individuals or small groups, whereas the least effort principle applies to the species as a whole.

Evidence in support of this view comes from evolutionary biologist Edward O. Wilson, who, in his book *The Social Conquest of Earth* (Liveright, 2012) says about the organisation of humans in groups (p. 244): "Every person is a compulsive group-seeker", and "the joining of groups [is] one of the most powerful human impulses".

Wilson explains this compulsive group-seeking not as I do, i.e. as a consequence of the least effort principle at the physical-module level of the brain, but, as can be expected from an evolutionary biologist, as a consequence of evolution acting at the behavioural level. Wilson's argument: In prehistory, man learned to satisfy his/her needs within the particular group that he was born into and lived in throughout his/her life. Nowadays, he has a wide choice of groups, and "he satisfies his need variously in an extended family, organised religion, ideology, ethnic group, or sports club". Wilson's explanation is an "engineering properties" type of explanation and does not, of course, lead to an understanding in a physicist's sense.

Finally, now another aspect of the least effort principle which may be easily overlooked, viz. the implication that the principle essentially derives from a scarcity of resources, i.e. resources for building and maintaining the human body and its control centres. I am speaking of the latter in the plural because medical science has discovered that the digestive system very much controls itself, to the extent that its controlling system is sometimes referred to as a second brain, the belly brain. The function of this belly brain is to ensure the smooth running of the conversion of foodstuff into the aforementioned resources of building material and energy. In highly active humans, the demand for these resources is so acute that there is seldom a surplus to be put aside for later use. This vision has lead some medical researchers to suggest a quite physical explanation for the often-reported "psychic" cause of certain digestive malfunctions. This explanation is that the psychic cause is but a mental stress in the head brain, which requires a heavily increased rate of consumption of resources for its relief. The belly brain has to make these extra resources available to the head brain on demand, whence the former becomes short of resources for its own operations. Hence the digestive system tends to malfunction if the mental stress in the head brain persists.

This example from medical science (reported by medical scientist Giulia Enders, *Darm mit Charme*, Ullstein, 2014) suggests that there may be many more physical explanations for enigmatic manifestations of feelings of discomfort.

Types of mental modules

The foregoing considerations have lead me to posit the mind structure to consist of two basic types of modules: (Type 1) Information-gathering modules, or *information modules* for short, are modules for recording of information only, i.e. information about any aspect of a person's environment in the widest possible sense (i.e. about person-relevant nature) as well as about the person him/herself. (Type 2) Modules for recording of knowledge about person-relevant nature as well as about the person him/herself. These modules, referred to as *knowledge modules*, are aspect-specific and assemble their knowledge from the contents of information modules [10].

I posit that every information module gathers detailed, unfiltered information about a particular experience in sequential order of sensory observation, regardless of how this information is used thereafter by the mind. I further posit that there are as many information modules as there are different objects and object interactions that a person has encountered during his/her lifetime. In a

[10] These knowledge modules come closest to the 'conceptual subsystems of mind' in the Parallel-Systems Mind Model of 2010.

second stage, the information collected in information modules is re-assembled into knowledge modules such that the 'knowledge' contained in these modules allows the mind to analyse and understand the earlier observation, as well as any future observation of similar character.

I furthermore posit that there is normally not a one-to-one correspondence between information modules and knowledge modules, because the classification and sub-classification of the latter has to be such as to optimise the processing of any challenge experienced by the mind's owner, regardless of how the original information was acquired.

At this stage a note is in order about how the types of memories as explored and defined by the cognitive sciences (such as the episodic, procedural, and semantic types) fit into the Model. The answer: I posit that both information modules and knowledge modules serve as sources of conscious memory, while leaving the major difference between the two intact, viz. that the cognitive sciences distinguish between only a few types of memories, whereas the Model works with a very large, unknown number of mental source modules.

The transformation of information to knowledge is extremely consumption-of-materials-and-energy-intensive. As mentioned earlier, this work is done - in accordance with the consumption-peaks-avoidance hypothesis - during periods of low engagement of the brain with imminent problem solving, i.e. during periods which leaves time for 'default-mode activity' of the brain. In the Model, this default-mode activity is regarded as performing tasks such as starting new knowledge modules, rendering these modules compatible with existing knowledge modules, fitting new information into existing knowledge modules, and re-rendering each of these modules self-consistent and highly functional. Small wonder then that man takes two decades to adulthood.

An important subgroup of knowledge modules are private-paradigm modules, to be described farther on. First, however, some contemplations are necessary about the signal routing from the sensory organs to information modules, thence to knowledge modules, and finally to motor modules for the final challenge response.

Routing of learning-related signals

The least effort principle obviously favours those organisms which can bring sensory information to an appropriate decision for action in the most direct, and hence fastest, way. Different from somatic information, for which there are inherited permanent physical modules with a fixed signal-processing programme initiated by signals received via "hard-wired" connections, the physical modules for processing of sensory information are neither inherited nor permanent. These

modules are generated by learning, and they are modified throughout life. In consequence, in order to comply with the least effort principle, the incoming information must be subjected as early as possible to a sophisticated routing system which ensures the most direct and fastest conveyance to the appropriate processing sites. For instance, if man is confronted by a challenge, comparison with the contents of existing information modules will tell whether the incoming information is new or a repeat of previous information. In the latter case, the signal is passed directly to the appropriate knowledge module for a decision, and, thence, to the appropriate motor module for a challenge response. If the incoming information is new, the signal is passed to several possibly appropriate knowledge modules for a consentient decision on how to react.

As far as I could ascertain, there exists no concept as to how the brain performs such a complicated task. But a similar task is known to be successfully performed by Transport Protocol Standards in IT networks. Such standards (e.g. the Open Systems Interconnection model, and the Transmission Control Protocol/Internet Protocol model [11]) describe network architectures which enable exchange of information between any two specific addresses within IT networks. I am not positing that the brain follows IT practices, but I wish to point out that if man has been able to solve the problem of network communication at the IT level, nature will certainly also have found an equivalent biological solution for the neuronal network of the brain. What nature's solution is, shall be known, maybe, once the findings of the major research initiatives become known. The discovery of a network for the default-mode brain activity, points in the direction of the IT-protocol architecture.

Private-paradigm modules

I posit that the knowledge modules necessarily form ranked sets [12], where each set pertains to a specific area of knowledge. In other words, knowledge modules form ranked knowledge module clusters, where each cluster serves a specific area of knowledge. The highest-ranked module within a knowledge module cluster may overrule the dissenting output of any lower-ranked module within the cluster, whence the set of highest-ranked modules of all knowledge module clusters taken together dominate the reasoning and decision-finding process in a person's mind. This is, obviously, another manifestation of the least effort principle (because the dominance of such modules cuts the reasoning and decision-finding process among lower-ranked modules to a minimum).

---

[11] Ida M. Flynn and Ann McIver McHoes, *Understanding Operating Systems*, Brooks/Cole, 2001.

[12] "Ranked" meaning that the knowledge modules within a set are of different importance for a decision to be arrived at. The ranking of knowledge modules is an unavoidable consequence of self-organisation of modules within any set of such modules.

In the Modular Mental Structure Model, these dominant knowledge modules are referred to as 'private-paradigm modules', or 'paradigm modules' for short. The mental contents of paradigm modules are characterisable by short crisp statements expressing a need or a private or groupthink principle (such as a discomfort avoidance rule, a conviction, a dogmatic belief, a law of physical science) [13].

The reader may have noted that I have smuggled the term 'need' into my concept of private paradigm, although the latter (private paradigm) belongs to the category of learning-induced knowledge, whereas the former (need) is inherited. I posit that needs are also housed in modules, but that these modules are not reconfigurable. In other words, their neuronal networks are unalterable, whence they form a third type of module. Put differently, inherited needs are housed in hard-wired physical modules of the brain.

Real-life experience shows inherited needs to almost always get the better of learning-induced ethics, whence needs get a private-paradigm status in my model, on the boundary condition that ethical behaviour is destined to take a backseat as soon as inherited needs become pressing. There is a similarity between needs modules and paradigm modules in that the latter, though alterable, are highly resilient to modification.

There are, per definition, as many paradigm modules as there are distinguishable knowledge module clusters, and my further hypothesis is that any decision arrived at is primarily one thrashed out between the outputs from the paradigm modules of relevance as well as the outputs from needs modules.

At this stage it is possible to formulate a preliminary definition of mind deriving from the Model, viz. the mind is constituted by the contents of the two learning-generated types of mental modules (information module and knowledge module) together with the mental contents of the inherited needs modules.

In this form, the definition is silent about the contribution of consciousness, which plays a dominant role in virtually any of the many different definitions offered by the cognitive sciences and elsewhere [14]. As elaborated a little farther on, I posit that consciousness plays no role at all in the management of human reasoning and behaviour, whence my definition of mind takes the final form "Totality of the mental contents of (1) learning-generated modules and (2) inherited needs modules as described by the Modular Mental Structure Model.

---

[13] Typical of such a principle is, for instance, a prejudice, a personal dislike of something, a fundamentalist's belief in a holy book, but also a physicist's belief in the law of entropy.

[14] For instance, "Understanding mind follows from an understanding of consciousness" (neuroscience), "Rational conscious intelligence" (psychology), "Ability to be aware of things and to think and reason" (Oxford Dictionary).

Consciousness plays no role whatsoever in the management of a person's reasoning and behaviour by this mind."

The term 'paradigm' originates from the work of science philosopher Thomas S. Kuhn in the 1960's [15], where it stood for "a way of viewing the world and of practicing science in it". Meanwhile, the term is often used to mean 'pattern of thought', which is vague to the point of being useless. Therefore, for purposes of the present model, I am redefining paradigm as a *principle thought in a specified area of knowledge* [16]. As such, a paradigm is primarily person-specific, thence *private*. If the same paradigm is shared by many, as was the implication of the Kuhnian paradigm, then it is either *public* if it is out-group, or it is a *groupthink paradigm* if it is in-group.

An important point to note is that paradigm sharing by many does not necessarily imply that the shared paradigm converts into identical private paradigms in the minds of these many. And even if it would, the ranking position of the shared paradigm would certainly differ within the set of all private paradigms from one person to the next. Just think of a god-believing physicist; his/her private paradigm of physical science would certainly take second place to his/her private paradigm of the Almighty's existence.

The real importance of paradigm sharing lies in the fact that such sharing is, in my opinion, a prerequisite for the formation of social groups. I cannot see how humans can associate with one another in the long term without a majority of private paradigms being shared (just think of the many failing husband-and-wife partnerships in Western Society). I therefore conclude that the formation of social groups can be attributed not to the least effort principle alone (as posited above), but to a combination thereof with the natural process of ranking in knowledge module clusters.

Finally, the concept of private paradigms gives rise to a type of thinking which I am calling multiple-paradigms-based thinking, to be elaborated on in a long-text version.

Generation of mind

Before the mind can serve a person to lead a self-managed life, it has to undergo a long development process between birth and adulthood, i.e. two decades on average. This rather slow development of mind is not due to the limited

[15] Republished in Thomas S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1996, 3rd edition.

[16] Examples of private paradigms are laws of physical science, but also a principle such as 'If I give-in, then I am a looser'.

availability of information for learning (there becomes plenty of it available within two decades), but it is due rather to the slow process of constructing an architecture of mind able to make unassisted use of any type of information that one is confronted with. The process of construction is slow because the process of construction consists not only of the configuration of new modules, but is accompanied by a never-ending reconfiguration of existing modules because of new input of information which is complementary to and/or deviant from earlier information. Obviously, this process of mind generation does not stop at adulthood, but continues as a process of mind adaptation for the rest of one's life.

It is not that the brain is short of neurons at birth. At birth it has all of the 100 billion (10^{11}) neurons required throughout life. It is the networking of these neurons by synaptic connections which, at birth, is still rather rudimentary, viz. only those laid on in configurations representative of inherited knowledge, and of womb-acquired knowledge. The further growth of the network is initiated by sensory input after birth.

To quote science writer Judhihit Bhattacharjee (*National Geographic*, January 2015), "The baby brain is an incredible learning machine". The author explains: Though a large number of neurons are synaptically pre-wired at birth, it is the after-birth sensory input which leads to a phenomenal increase in synaptic wiring during the first year of life, to peak values very much higher than in adult life (four to six times higher). The decline to adult-level values starts before or at age one, and is due to a specialisation process in which the regularly used networks survive and the unused ones disappear. A stable adult-level value of some hundred trillion (10^{14}) synaptic connections is reached at age three (thus Bhattacharjee).

In other words, from age three it takes more than another one-and-a-half decades of physical building activity in the brain to arrive at an architecture which enables man to lead an autonomous adult life. That is a building activity which embraces physically constructing new knowledge modules from completely new information, for modifying existing knowledge modules to accommodate deviant new information, and by-passing outdated knowledge modules, and that on a daily basis. This explains why the brain uses a quarter of man's total energy requirements.

Least mental stress principle

The continuous reconstruction of knowledge modules has to obey a rule which I like to call the 'least stress principle'. This principle derives from a key boundary condition of the Modular Mental Structure Model, viz. that in order for the mind to function as efficient (fast and decisive) as possible, the electro-chemical

signals must encounter the least possible resistance inside each module, but also the least possible resistance in the exchange of outputs between modules.

I have expressed this notion before (in 2010) by stating that every intra-module mental contents must be 'self-consistent' and that the mental contents of different modules must be 'mutually compatible'. Realising that the latter is unlikely to ever be achievable - for the simple reason that, of necessity, knowledge modules are created in parallel from birth - I have called my first model of mind the 'Parallel-Systems Mind Model' (http://hdl.handle.net/2263/16600).

I am retaining this vision for the Modular Mental Structure Model, and posit that if the resistance in the exchange of outputs between modules becomes so high as to significantly retard the decision-finding process, the most retarding modules are excluded from the process. This mechanism enables god-believing physicists to continue with their work, despite their belief in an Almighty, but it also enables a person to decide between an ethics-neglecting needs-governed behaviour and a needs-rejecting ethics-guided behaviour (such as is required before raping and killing).

Now, where does mental stress come into this picture? I make use, here, of the psychological concept of 'cognitive dissonance', which refers to a mental stress sensed by a person in a mental dilemma. I posit this feeling as deriving from the mechanism sketched in the foregoing (i.e. from the incompatibility of outputs from two knowledge modules simultaneously involved in a given signal processing act). While the exclusion of part of the mind from the decision process solves the problem of arriving at a decision, the mind as a whole remains uncomfortable with the contradiction and keeps on trying to bridge the dilemma gap [17], i.e. trying to minimise the mental stress, hence my choice of name for the least mental stress principle.

Complex-system behaviour of mind

Humans exhibit behaviour strongly reminiscent of that of the type of dynamic systems known to physicists as complex systems (i.e. dynamic systems operating far from equilibrium). Therefore, the Modular Mental Structure Model must also allow for complex-system behaviour.

In a complex system such as the weather, the behaviour arises from a number of interacting behaviour-driving weather constituents referred to as variables. The magnitudes of these variables change as a result of feedback interactions. For

[17] I was told of a religious geologist who consoled himself with the argument that it was within the Almighty' s power to make geological structures appear to be the age determined by scientific measurement.

instance, sun on the ocean surface evaporates water, which, after sunset and in the absence of wind, condenses into clouds, which, after sunrise and in the continuing absence of wind, screens the ocean surface from the sun, thus reducing further evaporation.

In the Modular Mental Structure Model I have assigned the status of variables to the knowledge modules involved in reasoning or in a decision process, or rather to the electro-chemical outputs from the physical modules which house those knowledge modules. These outputs may vary on account of varying inputs to the modules, but also as a consequence of feedback from other modules, for instance via regulatory effects on neurotransmitters in synapses within a module. This scenario is fully sufficient for causing the mind to exhibit complex-system behaviour.

Now, what are the main characteristics of complex-system behaviour?: The behaviour of a complex system is determined by a behaviour development law which can be expressed in mathematical terms if all variables and their interactions are known, which, however, is normally not the case. If the development law is known, the behaviour of the system can be predicted and displayed in a graphic plot spanned by the variables involved, i.e. by a three-dimensional plot for three variables, and by an x-dimensional plot for x variables, known as an attractor space (for a reason to be explained in a moment). In this kind of plot the instantaneous behaviour is a point, and the behaviour over time is a line. This line forms an endless succession of non-identical loops apparently centred on an imaginary core space within the plot, which seems to act as an attractor (hence the name attractor space for the plot). A peculiarity is that the looping line never again passes through the same point, implying that the same instantaneous behaviour is never returned to. The attractor space represents a particular type of behaviour within which the looping line represents the actual behaviour over time. This makes the behaviour appear chaotic, although (due to the development law) it is, in fact, deterministic.

Two more characteristics of a complex system are (1) the so-called butterfly-effect characteristic, and (2) the change-of-attractor-space characteristic. The former means that a small change of one variable can give rise to a greatly disproportionate change of behaviour within a given attractor space, and the latter means that the development law can take the behaviour to a common border point with a second, adjacent, different attractor space, when the behaviour can cross over into this second attractor space, where it can stay for a while (as determined by the development law). The behaviour in the second attractor space is, obviously, also chaotic, though still deterministic.

Human-mind manifestations of the butterfly-effect characteristic are often observed in the form of unexpected changes of mood, temper, or emotion. Manifestations of the change-of-attractor-space characteristic are seen in the behaviour of psychopaths, amuckers, and suicidal murderers, but also in the behaviour of groups of people when changing from a civil-behaviour type of attractor space of civilian life to the enemy-destroying attractor space of war, or to the Tutsi-neighbour-exterminating attractor space of the 1994 genocide in Ruanda.

A particular point I wish to make is that sudden aberrations of behaviour as seen in psychopaths, amuckers, and suicidal murderers are not pathological. Rather, the mind modules triggering or sustaining these aberrant behaviours must have been in place sufficiently long for the slow construction of the underlying physical modules to be completed. Hence, the precondition for a sudden aberrational behaviour is that an appropriate knowledge module must have pre-existed and held at the ready for eventual use [18], whence the occasional activation of this knowledge module is anything but pathological.

And, another important point, also the observation of large groups of people simultaneously changing over from a civil-behaviour type of attractor space to a non-civil-behaviour type of attractor space, and vice versa (civilians to soldiers and to Holocaust killers, and back) is indicative of a pre-existence of the relevant mind modules in all adults. In other words, these mind modules must have been inherited or laid on early in life.

A final point I wish to make is that aberrant individual behaviour is not acceptable in-group, and, hence, is not favoured by the evolutionary process. Therefore, the Model must identify possible means which may have subdued in-group the more extreme manifestations of complex-system behaviour. I am proposing that this purpose may be served by private paradigm modules. This proposition and other aspects of the complex system behaviour of mind is elaborated in a long-version text.

The function of consciousness and the seat and sense of self

The most heretical key element of the Modular Mental Structure Model is my vision about the function of consciousness and the nature and the seat of the self.

[18] Psychopathic behaviour is defined by the American Psychiatric Society (APS) as "pervasive pattern of disregard for, and violation of, the rights of others", and is, according to psychologist Kevin Dutton (*The Wisdom of Psychopaths*, William Heinemann, 2012), estimated to be prevalent in one to two percent of the population. Psychopathic behaviour is latent and emerges only occasionally, from which one can conclude that the appropriate knowledge modules are laid on, but are dormant between activations.

I regard this vision as heretical because it departs so drastically from the widely-held existing vision that I may be running the risk of "being burned at the stakes". The widely-held existing vision, certainly non-standardised and rather underspecified, can be summarised as one in which consciousness not only creates an awareness of self, but also manages a person's reasoning and behaviour. The latter aspect, if not spelt out straight, becomes apparent in often-used expressions such as 'conscious effort'. Regrettably, I adhered to this vision myself until not so long ago.

In my 2010 essay, I claimed a vetoing function for consciousness in an attempt to reconcile my mistaken view of consciousness with the results of the now famous Libet experiments of the early nineteen eighties, when physiologist Benjamin Libet found that the motor response to a sensory stimulus is not triggered by a conscious decision, but is triggered subconsciously, well ahead of a person's sensation to have taken a conscious decision for such motor action. I know better now! My current vision is one of a completely subconsciously operating human brain, not subject to instructions from a phenomenon called consciousness.

This is a most-difficult-to-believe aspect of the Modular Mental Structure Model, particularly if one hears of reports of new types of artificial limbs which are operated by "conscious" willing of the handicapped. This is not a scientifically sound counterargument, though, as shall be elaborated in the long-version text.

The subject of the how and why of consciousness is a mine field, and few psychologists are prepared to stick out their necks for as clear an opinion on the matter as psychologist Daniel Kahneman in his best-selling book *Thinking, Fast and Slow* (Allen Lane, 2011), where he equates slow thinking to consciousness-directed thinking.

My rethinking re. the function of consciousness and the nature of the sense of self set in when I could not allocate a place for Kahneman's vision of slow consciousness-directed thinking in my model. To be specific, I cannot think of an agency, in form of a mental module and its physical basis, which could and would persistently and consciously interfere with the subconscious processing of information between challenge and response as assumed in the Model. In fact, I envisage the mental modules to be fully capable of subconscious processing of any input, and to subconsciously decide on an appropriate response to any challenge, just as can other animals much farther down the evolutionary lineage to man.

If there were an agency, its interference with the self management of mind would have to act within the drastic constraints imposed on the mind by its

physical basis, and such interference would make sense only if the agency had information superior to that available in the subconsciously acting mind. Where would such information come from, if not from the same mind? Hence, my model negates any mind-managing function whatsoever for the phenomenon of consciousness.

What then is the function of consciousness if not that of managing human reasoning and behaviour? In the Modular Mental Structure Model the function of consciousness is that which I envisage it to be in all animals, viz. a purely informative function, in that consciousness informs the mind about the role played by its owner in any event about which the mind receives sensory information. In other words, consciousness has the function of providing a "that-was-me" tag to that part of the sensory information which pertains to the self. This tag facilitates the routing of the that-was-me information to an appropriate information module, and ultimately to a knowledge module dedicated to the self. And the sense of self derives essentially from the memory of self held in this knowledge module. These heretical views about consciousness and the seat and sense of self are further elaborated in a long-version text.

The foregoing hypothesis about the function of consciousness and the seat and sense of self once again raises the question of signal routing in the brain.

Signal routing by tagging

When discussing above the routing of signals in the brain, I suggested that the network of its default-mode activity may have an architecture being the biological equivalent of that of the Transport Protocol Standards in IT networks. Because the physical modules for processing of sensory information are generated by learning, and modified by re-learning throughout life, one may have to invoke a further means of allowing a piece of information to find its way to the appropriate processing module (in IT networks the 'host'). I envisage this to be achievable by address-tagging the information transmitted through the default-mode-activity network. Such signal tagging is common practice in IT networks, where it is referred to as 'routing information'.

Routing of tagged information to the appropriate processing module (for instance, the knowledge module of the self) in an often re-configured network is not quite as difficult as it may sounds, because such re-configuration does not necessarily imply also a change of the spatial position of the module in the brain. In fact, findings of neuroscience indicate that sets of related modules involved in, for instance, speech are located in equivalent positions in different brains. This is an indication of a genetic predisposition for generating certain sets of modules at certain pre-selected areas within the brain. This predisposition

would have to include the information supply lines from the sensory organs. Even then, an address tagging would make sense.

Over and above the address tagging, I also posit that the address-tagged information may also be tagged with one or more codes indicative of associated information of importance, such as about the emotions involved.

The groupthink phenomenon

The phenomenon to be discussed now is, strictly speaking, part of the Modular Mental Structure Model only in the sense that it is based on the least effort principle. It manifests itself as an important "engineering property" of mind and is not part of the Ansatz for the Model. But it has grave consequences for the advancement, or rather lack of advancement, of physical science.

Earlier, I have pointed out that the least effort principle causes the conditions for a fast-track development of mind to be optimal in families and in groups of people. I also pointed out that it is natural for such groups to develop a leader/followers structure. This leader/followers structure is not always clearly visible, as, for instance, in groups of physicists. While the least effort principle applies - obviously - also here (in form of a top-down university education), the question arises as to whether the claim that a university education generates post-university independent minds of high objectivity and rationality can be upheld. This claim is implausible for reason that the fast-track development of a scientific mind follows the same pattern as in other leader/followers groups, here in groups referred to as Schools within the various branches of physical science.

One must distinguish between two types of Schools, viz. one in the process of formation around an innovative leader, where one re-finds the simple leader/followers pattern from above. And another type, focused on the published teachings of an absent, often long-dead, highly reputed, often mystified, authority (Einstein, Bohr, Heisenberg, and the like), where the followers are shepherded by one or more self-appointed spokespersons of the chosen authority's view. The latter type of School, which is the more common one, perpetuates the chosen authority's view by authority-bonded teaching and examinations. It is in this type of School in particular where researches on the phenomenon of groupthink are of relevance.

The concept of groupthink was developed in an effort to identify advantages or otherwise which may result from decisions arrived at by consensus of group rather than by individuals. The focus here was on groups of "equals", like in an expert team, rather than on groups with a definitive leader/followers structure. But the group structure of an authority-focussed School is sufficiently similar to an "expert" team for the findings on groupthink to pertain also to such Schools.

According to Wikipedia, psychologist Irving Janis defined groupthink (in 1972) as "mode of thinking that persons engage in when concurrence-seeking becomes so dominant in a cohesive in-group that it tends to override realistic appraisal of alternative causes of action". According to Janis, groupthink is characterised by four symptoms of in-group pressure for preserving in-group uniformity, viz. by censorship of deviating ideas, illusion of unanimity when staying silent is viewed as agreement, direct pressure on "disloyal" members to conform, and self-appointed "mind guards" who shield the group from dissenting information. Four other symptoms are equally divided between a self-overestimation of the group and the closed-mindedness of its members.

From long experience, I posit that the Janis symptoms are found, in all grades of stringency, in all groups who practice (my definition) "any convergent thinking, whether involuntary or voluntary [19], whether pertaining to all aspects of life or to one aspect only", i.e. also in Schools of the type discussed above. It is an illusion therefore to expect physicists who graduated from these Schools to be automatically blessed with an objective and rational post-university mind.

In physical science it is in the branches of quantum theory and cosmology where groupthink has taken hold, and that in particular in fields which are least accessible by experiment, but highly inviting for theoreticians. This is pointed out in extensive detail by physicist Alexander Unzicker and science writer Sheilla Jones in their book *Bankrupting Physics* (Palgrave Macmillan, 2013).

Summary of key elements

Main aspects:

- A physical-science type of understanding of mind can be derived from a reductionist vision of the brain's development, in combination with a levels-of-logic analysis, a modular-mental-structure-model Ansatz, a complex-system vision of the model, the principles of least effort and of least mental stress, and the private-paradigms concept.
- My Ansatz posits the mental contents of a module to be encoded in the network configuration of a physical module.

[19] My reference to a 'voluntary' act of man must not be misunderstood as meaning the act to have been the result of a consciousness-directed free choice. It simply means that a person has become aware of his/her mind's convergence to groupthink, because groupthink elements have been added to the contents of the knowledge module about the self. The sense of voluntariness derives from consensus between these new elements and pre-existing knowledge.

- My Ansatz posits sensory information transport to information-collecting modules in a first stage, and an assembly of information in knowledge modules in a second stage.
- No sensory information is going to waste.
- The principles of least effort and of least mental stress govern the conversion of information to knowledge.
- In-brain communication is governed by the least-effort principle, and is facilitated by the default-mode-activity network discovered by Raichle.
- Consciousness has no managing function in reasoning and behaviour.
- Consciousness has a purely informative function, viz. that of providing an "I" tag to that part of the sensory information which pertains to the self, thus facilitating the most direct routing of the tagged information to a knowledge-of-self module.
- The sense of self is generated by the knowledge-of-self module.

Additional aspects:

- The definition of mind deriving from the Model is "Totality of the mental contents of (1) learning-generated modules and (2) inherited needs modules as described by the Modular Mental Structure Model. Consciousness plays no role whatsoever in the management of a person's reasoning and behaviour by this mind."
- Mental modules are of essentially physical nature. Of these, the knowledge modules are continuously being configured and re-configured (more in pre-adult times then thereafter), continuously demanding a large share of a persons resources of material and energy.
- Configuration and re-configuration are governed by the least effort principle (for saving material and energy) as well as by the least mental stress principle (for optimal processing of challenges).
- The least mental stress principle ensures optimal processing of challenges by optimising both intra-module self-consistency and inter-module compatibility (for optimal signal transmission).
- Persistent incompatibility of knowledge modules is resolved by organising modules into parallel-operating, contents-related clusters, which exhibit an optimal degree of in-cluster compatibility.
- The minimising-of-incompatibilities process may require a bending of the "truth" both in the information-to-knowledge conversion and in the compatibility-optimisation process.
- Every cluster of knowledge modules is "crowned" by a cluster-dominating private paradigm.
- Needs, private paradigms, and complex-system properties are key factors in determining reasoning and behaviour.

- The Model readily allows the mind to develop new knowledge clusters in parallel to others, but not the destructive "overwriting" of one module by another.
- The least effort principle allows whatever it takes (including murder and warfare) to prevent any outside attempt at a disassembly of an existing well-functioning structure of mind.

Memory aspects:

- Both information modules and knowledge modules serve as sources of conscious memory.
- Only a fraction of the contents of these two types of mental modules is 'recallable' into awareness.

SOME FURTHER CONTEMPLATIONS

Reductionism. Bottom-up Ansatz vs. top-down Ansatz. Post-humanism aspects of the Modular Mental Structure Model. Significance of the Model for physical science and beyond. Concrete cause identification.

The foregoing is the first brief, and, I hope, reader-friendly, description of a physicist's model of mind in which the author's visions about a re-philosofying of physical science, as expressed in Essay 2 of December 2014 (http://hdl.handle.net/2263/43388), were applied.

I have no illusions about the mixed reaction by many of those on whose territories I had to intrude to fill my 'philosopher's toolbox' for the identification of the "starting assumptions and propositions" for an Ansatz for my Modular Mental Structure Model. Some of these reactions will be critical of my selection of findings and/or of the manner in which these findings were used. Their criticism is very welcome and essential for an improvement of the model.

As was pointed out (by reference to an atomic model of steel), the physicist's point of view requires a reductionist view with some stringent boundary conditions, referred to as levels-of-logic rules, specified in Essay 2 of December 2014. The mere fact that I am using a reductionist view requires some further discussion of the often misunderstood claims attributed to reductionists.

Reductionism

The main argument against reductionism is that the "one mathematical formula which will explain everything" - which some physicists are indeed searching for at the fundamental-particle level - will contribute but little or nothing to the

understanding of human reality. This argument is convincing when used against those superstring theoreticians who offer their mathematical model of eleven space dimensions and one time dimension as the ultimate unifying theory of the universe (Brian Greene, *The Elegant Universe*, Vintage, 2000).

The anti-reductionism argument is not so convincing, though, when it comes in the form voiced by biologist Rupert Sheldrake (*The Science Delusion*, Coronet, 2012), when he points out, for instance, that physiologists do not require subatomic particles to explain blood pressure. This is like pointing out that materials physicists do not require subatomic particles to explain the behaviour of steel. True! But the *ultimate* explanation doesn't end there, because the atomic structure of steel requires a knowledge of the atom itself for an explanation of the atomic structure, and an understanding of the atom, in turn, requires a knowledge of the constituents of the atom, and so on, down to the most fundamental constituents of matter.

In other word, an ultimate explanation of blood pressure is necessarily based on the reductionist view of a hierarchy of many levels of association of fundamental particles into ever more complex entities (e.g. subatomic particles, atoms, molecules, bio-molecules, organs, organisms), inclusive of the realisation that totally new entity-specific properties emerge with every such more complex entity; properties which cannot be explained, however, in terms of those of fundamental particles. These emergent properties certainly blur one's reductionist view.

Furthermore, the reductionist view is blurred not only by emergent properties, but also by the unpredictable, though deterministic, behaviour exhibited by higher-complexity dynamic systems which operate far from equilibrium, also referred to as chaotic systems. In other words, there is more, much more, to a reductionist view of the universe then is suggested by its superficial dismissal by Sheldrake.

One of the most important scientific benefits deriving from a proper understanding of reductionism is that the view of a 'hierarchy of many levels of association of fundamental particles into ever more complex entities' (separated by new emergent properties) necessitates the associated vision of a parallel hierarchy of levels of logic which is required for reasoning in a scientifically sound manner, as set out in detail in Essay 2 of December 2014.

Returning now to the belief of super-string theoreticians of being on the way to an ultimate theory of the universe, one can only admire such theoreticians for their inventiveness, but not for their belief in the gullibility of everybody else. Their current contribution to a reductionist view of the universe is not helpful by any means.

To summarise, reductionism is indispensable for establishing the above-named hierarchy of levels of complexity, both for the purpose of establishing an associated hierarchy of levels of logic and for proper application of the level-of-logic rules specified in Essay 2 of December 2014.

Reductionism also makes everyone aware of the fact that the models of physical science generally follow, in fact have to follow, a bottom-up Ansatz in order to comply with its currently reigning key paradigm, according to which all phenomena in our universe have natural causes and any claim of supernatural interference is to be rejected.

Bottom-up Ansatz vs. top-down Ansatz

The currently reigning key paradigm of physical science implies that every Ansatz for a model in physical science should be a bottom-up Ansatz and not a top-down Ansatz. For instance, an incipient postulation of an Almighty is a top-down Ansatz, whereas an incipient postulation of evolution, retraceable by reductionism, is a bottom-up Ansatz. This is the type of Ansatz chosen for the Modular Mental Structure Model.

Not every scientific Ansatz is clearly distinguishable as a bottom-up Ansatz, whence one must beware of not mistaking the one for the other. For instance, one may interpret the notion of swarm intelligence as a higher form of intelligence, which determines the behaviour of the swarm members (a top-down view). In reality, studies show that swarm behaviour can be explained by a set of plausible, usually simple, rules inherited or learned by every swarm member (a bottom-up view).

An attempt at replacing the general bottom-up-Ansatz rule of physical science by a top-down-Ansatz rule is made by biologist Rupert Sheldrake (*The Science Delusion*, Coronet, 2012) in an effort to replace the materialistic basis of physical science (which he is highly critical of) by his theory of "morphogenetic fields", which he postulates to have developed during evolution of the universe, and which (fields) he postulates to continuously interfere with the subsequent development of everything within the universe, including man.

Sheldrake's theory reminds me of the mistaken argument about swarm intelligence. His top-down Ansatz relies on a belief in the existence of morphogenetic fields without querying the cause or causes of such fields. This approach is unscientific to physicists.

Post-humanism aspects of the Modular Mental Structure Model

The Modular Mental Structure Model is post-humanistic in the sense that it is physical-science-based, and in that it does not feature a single fundamental characteristic which would exclude man from the natural process of evolutionary development in the lineage to man, i.e. a feature which would justify the humanistic denial of man being part of the natural world (philosophers Paddy McQueen and Hilary McQueen, *Key Concepts in Philosophy*, Palgrave Macmillan, 2010). On the other hand, the Model does not exclude the possibility that one day man may succeed in constructing an advanced, learning-eager, intelligent, self-reproduction-capable humanoid entity featuring the mind characteristics described in the Model.

This contemplation leaves me at a loss of how to short-label a post-humanism organism with a mind as described by the Model? If I call the organism a human, then I am equating my model of mind to the real mind of a human. This would be unscientific. The distinction between model and reality must be maintained. But I certainly cannot use the label 'robot' for the organism.

One label which comes to mind for a post-humanism organism with a mind as described by the Model is that of 'environment-programmed biological system'. Why 'programmed'? Because the interaction with the environment is quasi-indelibly recorded in the brain. And why 'environment-programmed' if part of the human mind is inherited? Simply because also the inherited part originated from the interaction between man's precursors (down to the first cell) and the environment, whence all of human mind can be retraced to such interaction. I shall leave the question of a suitable label for a post-humanism organism with a mind as described by the Model for a more extensive discussion in a long-text version.

My post-humanistic model of mind is certain not to be to the liking of humanists, nor to the liking of those who believe in the mind-managing function of consciousness. To them, the Model is an invitation for developing an alternative model more to their liking, preferably also in agreement with the currently reigning key paradigm of physical science. To others, the Model can meanwhile serve as a starting point for critical re-evaluation of long-held humanism-shaped convictions about human nature and about human reasoning and behaviour. The Model will certainly have implications for the administration of law [20], but also for the current rules of ethics as well as for an

[20] As a note of warning: It would be wrong to fall for the widely heard simplistic argument that deterministic human reasoning and behaviour implies that man is not responsible for his/her actions. There is far more to it!

untold number of other issues, in particular when complex-system behaviour is involved. I plan to discuss some of these issues in a long-text version.

One of the issues is briefly referred to here and now, viz. the implication of the post-humanistic vision of man for the possible further development of man. Based on the Model's view of the brain as a totally subconsciously operating information-processing organ, requiring consciousness only for making the mind aware of an individual's bodily and mental presence, I foresee the next stage of human development to be that of an Internet-interfaced biological system. To be specific, I envisage that the present access to the Internet, which is facilitated by motor-action demand (touch and voice) and via sensory-organ reception (seeing and hearing), will in the not too distant future be via a wearable gadget which bypasses the cumbersome demand-and-reception procedure by routing a subconscious demand to the Internet for urgently required information that is not available in the mind. This same gadget will convert the received-back information into brain-readable signals representing the requested information. In other words, any knowledge accessible via the Internet becomes directly available to the human mind, without mediation by the sensory organs.

Significance of the Modular Mental Structure Model for physical science and beyond

Finally, I have to return to my introductory sentence re. my "conviction that advances in physical science are hampered to an ever-increasing degree by the enormous lack of physicists' knowledge about the working of the human mind". Does the Modular Mental Structure Model indeed have the potential for promoting physical science in a significant way? There is clear evidence that it has.

To be specific, a first significant advance arose from clarifying the meaning of 'understanding' in physical science. A second significant advance arose from introducing the levels-of-logic analysis into scientific reasoning. And a third significant advance arose from the exclusion of consciousness from entanglement arguments in quantum theory [21]. All of these were explained in some detail in Essay 2 of December 2014 (http://hdl.handle.net/2263/43388).

Both in quantum theory and in cosmology, the dangers of groupthink have been pointed out by Unzicker and Jones (U&J), and the phenomenon of groupthink,

[21] Affected are (1) the alleged quantum entanglement of the experimentalist with his/her experiment (Copenhagen Interpretation), and (2) the argument of Penrose and Hameroff, which invokes an entanglement between the experiment and an alleged consciousness-generating component of the neuron.

in turn, has been shown by the Model to be retraceable to the least effort principle. Typical of groupthink in these fields is that the most outlandish idea of a theoretician of name is not openly questioned, but is rather extrapolated to an even more outlandish idea. An example quoted by U&J is the multiverse idea of physicist Hugh Everett: This came about in reaction to the idea of "superposition" of quantum states, which allows a quantum objects, e.g. a particle, to exist in several different quantum states at the same time (or to "live several lives at the same time", thus U&J). The next idea (the idea of entanglement) is, that if someone tries to measure the particle "it jumps into one of the possible states" (U&J). Along came Everett with the further idea of the "many worlds" interpretation of quantum physics (U&J), suggesting that the different quantum states are not superposed in a single world, but separately in as many different worlds (hidden from one another) as there are quantum states.

Everett's idea of multiple universes (multiverse for short) had the further advantage of neutralising the Anthropic Principle, i.e. the discovery that life on earth would not have developed if physical conditions in our universe would have differed by the slightest from what it is measured today. If one excludes a teleological explanation (a outcome-directed evolution), then the multiverse idea, in an infinite-number-of-parallel-worlds version, is the cheapest way out. Humans happen to live in the one world which meets all the requirements. The difficult and ignored way out would be the one of admitting that the current cosmological model is seriously flawed.

Now where does the Modular Mental Structure Model come in? It comes in at the entanglement idea. The Model posits that if someone tries to measure a quantum object, it *does not* jump into one of the possible quantum states, at least not on account of the presence of the experimentalist. In other words, the Model negates any quantum entanglement between the quantum object and the experimentalist.

The Model comes in also at another idea of cosmology, viz. the abovementioned idea that superstring-theoreticians will be able to develop an ultimate unifying theory of the universe. This idea does stand up neither to the demands of the levels-of-logic rules, nor to the complex-system character of the universe and that of its uncountable constituents.

Also outside of physical science, the Model is showing its worth. For instance, when the levels-of-logic rules are called for, as in the mirror-neuron hype which arose after the discovery of this type of neuron. Neuroscientist Gregory Hickok (*The Myth of Mirror Neurons*, W. W. Norton, 2014) is highly critical of the wide-spread vision of the importance of mirror neurons for the development of mind characteristics such as theory of mind, empathy, social awareness, appreciation of music and the arts, autism, and even speech. These claims are in

obvious violation of the level-of-logic rules, whence, on this count alone, the properties attributed to mirror neurons shall have to be looked at again.

Other advances of significance (in and out of physical science) are certain to flow from the least effort principle, the least mental stress principle, the new visions of consciousness and of the self, as well as from the complex-system vision of the brain. One of these advances will involve the hitherto ill-understood concept of human motivation, which is of significance in psychology, psychiatry, the philosophy of law, and the philosophy of ethics.

Concrete cause identification

The phenomenon which I am calling 'concrete cause identification' is not actually part of the Modular Mental Structure Model, but is a manifestation of mind of general significance. The name refers to the ever-active striving of the human mind for the identification of causes of observed actions, and that to an extent which makes the cause clearly identifiable in any future scenario; a 'concrete identification' for short. This striving for concrete identification can be retraced to survival-relevant needs for definitive identifications of threats and challenges over all stages of biological evolution.

Examples for such concrete identification are dangerous animals and enemies, thieves and competitors, but also angry ancestors, mischievous spirits, and malevolent witches in the African bush (but not only there). Not so long ago it were also satanic witches in Europe and North America who were the cause of ill-fortune. Another such concrete identification is the Almighty who metes out blessings and punishments in appropriate measure. Other causes in antiquity were the Greek, Roman, and Nordic gods. Physical science has replaced some of these causes of ill-fortune and fortune by natural explanations, which are at the root of man's technological progress. But quantum physics and cosmology have landed man again in uncertainty about the nature and origin of man's universe.

But the mind doesn't like uncertainties. The least mental stress principle makes the mind strive for concrete cause identification, even from the scantiest of facts. Explanations must be generated, if ever so weird. Hypotheses such as the Big Bang emergence of the universe, the Universe Inflation model, and the Multiverse model are the result.

The mind's striving for explanations is so critical that neuroscientist Michael S. Gazzaniga (*Who's in Charge?*, HarperCollins, 2011) has identified a brain module, the Interpreter, which he posits to specialise in generating explanations of causes. And if the available facts are too few after all, then it is not unusual for a mind to develop false memories which provide the missing explanation for a cause (thus psychologist Max Steller, *Nichts als die Wahrheit?*, Wilhelm

Heyne, 2015). Or, in the case of quantum theory or that of cosmology, the mind makes up any ever so outlandish explanation for ill-understood observations.

By the way, the striving of my mind for a concrete identification of itself has triggered the invention of the Modular Mental Structure Model.

****