

# **THE MENTAL DATABASE**

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## The Mental Database

### Abstract

This article uses database and bio-physics considerations to suggest how the mind stores and processes its data. Its principal innovations lie in:-

- The comparison between the capabilities of the mind to those of a modern relational database while conserving phenomenality. The strong structural similarity of the two systems leads to the conclusion that the mind may be profitably described as being a mental database. The need for bidirectional material-to-mental bridging and addressing indexes is discussed.
- The consideration of what neural correlates of consciousness (NCC) between sensorimotor data and instrumented observation one can hope to obtain using current physics. What emerges is that the various brain scanning methods reflect only the current activity transactions which update and interrogate the mind, but not the contents of the integrated mental database which constitutes the mind itself. This approach gives reasons why there is much neural activity in an area to which a function is ascribed (e.g. the anterior cingulate cortex is associated with pain), yet there is no visible activity that can be definitely identified as phenomenal. The conclusion arrived at is that no clear NCC at the molecular level can be identified using current physics. Figure 2 gives an overall view of the reasoning.

This concept of the mind is then situated in a Penrosian expanded physical environment requiring evolutionary continuity, modularity and phenomenality. The concept is then used to give further insights into the mind/brain, particularly its Darwinian advantages.

### Acknowledgement

I wish to thank Emeritus Professor Max Gauna for his counsel, criticism and collaboration.

## **1. Types of Data and Databases**

Two types of brain data are identified:-

The first is used to convey normal neurochemical data between the mind and the body. An example is the movement of pain data from the epidermis to the brain. This is well understood through the actions of calcium ions, readiness potentials and so on. This type corresponds to the computer's raw input data. It also corresponds to the brain's output data conveying instructions to the body, among other categories.

The second type is the structured mental data (both access and phenomenal, in Ned Block's well-known terms <sup>1</sup>), used by the mind in general and consciousness in particular. At this point the apparent consequence of Chalmer's<sup>2</sup> Hard Problem may be taken to mean that there is no visible form of mental data in the material world as it is currently defined by Science. This article attempts to show that this is in fact the case at this time, implying that the second type of data exists in a separate mental domain. It is maintained that, except for phenomenality, almost all of the mental domain's characteristics can already be identified by comparing them to those of a computer's database, which is conceived as a knowledge engine for use by the human mind. Hopefully, the mental domain will prove more accessible some time in the future using the methodology of Science.

The following operations are effected in transforming the data from type 1 to type 2:-

- The creation of connecting pointer indexes, relating the different data elements, whether it is in a brain or in a computer. Data is fundamentally useless without some form of interconnecting indexes. Obviously the axons and dendrites are materially necessary in this context.

- The bridging between the type 1 material form and the type 2 mental form.

All the data of the second type is in the mental form in which almost all memories and procedures are stored, accessed, executed and coordinated. The method by which this type of data yields consciousness is unknown. This constitutes the "Hard Problem". The data's indexes must be highly structured in order to answer queries since this requires the interrelating of many different data elements from many lists. In other words, the mind's data is held in a database form. Neurons are interconnected by dendrites, axons, neurotransmitters and so on, but the simple existence of point-to-point connections wouldn't furnish the brain with the necessary complex index structures corresponding to those in a computer's database, for which counterparts must exist in the brain. Thus, as in the IT world, one of the first things to happen to the incoming sensory data is its translation into an appropriate mental form, constructing pointers to relate the new data to existing data and supplying phenomenal capability where needed.

The positioning and structure of the bridge where the first type of data is transformed into the second is not known. It is known that the appropriate emotion isn't produced immediately the data enters the brain. Fear isn't excited unless the input data reaches the amygdala and pleasure isn't felt unless data reaches the putamen.

An example is the selection by touch of the warmer of two objects. Touching the first object permits the brain to memorize its warmth in the mental database, building the appropriate indexes. The detail concerning the touching of the second is as follows:-

- The sensory data (type 1) flows up from the finger to the brain.

- Bridging in the brain translates this data into the mental form (type 2). Simultaneously, the indexes necessary to relate the temperature of the new objects to those of the old are built and/or modified.

- The conscious mind executes the mental procedures which access the warmth data through its indexes.

- The two warmth data are consciously compared and the warmer is selected.

Expressed in IT terms, the sensory data must be uploaded into suitably structured mental databases in the brain, thus permitting mental processing such as conscious thinking to begin.

Following mental processing, the databases may output type 1 motor data which, for example, causes our limbs to move.

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The two types of data must present significant differences which would be visible to us if we knew what they were and possessed the technical means to perceive them.

At this point, two options are open to those who are physicalists:-

### A) The "Current Physics" Approach

It is assumed that the mental type of data can be better understood using the physical world as it is currently known – that is, as it is expressed through current physics and all other branches of accepted science, such as psychology and neurochemistry. Physics is the most important since all other branches, such as biochemistry, are dependent on it for explanations at the fundamental level.

### B) The "Expanded Physics" Approach

Because of the necessity of accommodating the phenomenal characteristics of the mind Penrose proposes an expansion of physics<sup>3</sup>, permitting the co-existence of phenomenal and physical worlds. Penrose does not believe that either a purely mathematical or a "current physics" approach can even simulate consciousness. As he is one of the world's foremost mathematicians and mathematical physicists, his opinion is not to be lightly disregarded<sup>4</sup>. He sees consciousness as uniting the mental ("qualian") and the physical worlds. Libet, for his part, refers to the expansion as a Conscious Mental Field<sup>5</sup>. These approaches mean that the mental type is available only to a physics as yet unknown to us, although it may be suspected that it will eventually appear from fundamental research now under way.

Other arguments supporting the choice "B" approach include Searle's Chinese Room<sup>6</sup> which indicates the phenomenal aspect of the mind's calculating. Penrose maintains a similar position.

As Searle points out, even a trivial conscious computation carries a mental (and therefore phenomenal) aspect, so our brains do not use only computationally oriented consciousness (Block's "access consciousness") while computing. Therefore in this article the Hard Problem is affronted from the start, declaring that the mental database must support computation as well as sentience.

Again following Penrose, functional consciousness is to be considered as computational because, as it can be simulated on a computer, it can be embedded in a computer controlling a robot<sup>7</sup>. In this view, 'Property Dualism' and 'Grand Illusion' viewpoints are considered as computational or eliminational.

So this paper is written using Approach "B". However, much of it remains applicable to Approach "A", since the brain must possess databases and the format distinction between database and non-database data must still apply.

## **2. Definitions and Vocabulary**

### **2.1. Physical, Material, Mind**

The terms "physicalism" and "materialism" are usually looked on as synonyms<sup>8</sup>, with the former being used perhaps in a more widely inclusive context. Sir Arthur Eddington, for example, distinguished between the two terms<sup>9</sup>. John Searle inveighs vigorously against dualism's separation of "physical" and "mental"<sup>10</sup>. To him the "mental" is part of the "physical", the latter being all-inclusive. This document takes the same monist approach, also used by almost all those quoted above. Put simply:-

Material + Mental = Brain, including mind

The term "material" is used to represent the term "current physical" (as defined above), except where it is necessary to emphasize the difference between "current physical" and the "expanded physical". Thus "material" corresponds to the ordinary day-to-day use of "physical" and applies to all that is currently available in established concepts of physics, including relativity and quantum theory. Versions of string theories, quantum gravity and other firmly identified extensions to physics are already seen as "physical". At some time in the future they will form a solid part of the "expanded physics", as will, hopefully, terms such as "qualia" and "unconsciousness".

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Further analysis of the contemporary view of the term "physical" has been given by Barbara Montero in the *Journal of Consciousness Studies*<sup>11</sup>.

Thus type 1 (non-database) activity is material as its operation can be explained using current physics. Type 2, (database) activity is mental and requires the expanded version of physics. In this document, physicalism is viewed as a completed materialism describing the whole of our universe to the extent that it can be incorporated into a unified physics including all forms of consciousness. The completion may implicate matters not normally perceived as being physical, as happened with Quantum Theory, Darwin's Evolution and Galileo's observations.

This differentiation between the terms "material" and "physical" is necessary for the purposes of this paper. It has the further advantage of avoiding unproductive discussion concerning personal beliefs, religious or other. Taking things to the extreme, there is nothing in principle preventing the incorporation of either a religious fundamentalist's or an atheist's view into this overall concept of the physical, as long as the view itself is consistent internally and with the world as we know it.

The view that the term "physical" has historically varied in meaning is not unconventional. Besides those cited above, the *Oxford Dictionary of Philosophy*<sup>12</sup> (Simon Blackburn, 1994) remarks on the impossibility of satisfactorily defining it. The concept of 'physical' has been expanding in scope since the time when the mind/body was first clearly expressed by Montaigne in the sixteenth century, several decades before Descartes<sup>13</sup>. A century ago, no respectable physicist would have entertained the weird consequences of quantum physics as suitable for a physical universe.

The term "mind" is equivalent to "mental". It includes both "procedures" and mental "memory". A procedure normally has more than one "process".

### **2.2. Brain, Mental, Information, Phenomenal, Format, Meaning**

In this document, the term "mental" applies to all the types of processing and memory associated with consciousness and unconsciousness. This includes access, phenomenal, procedural, declarative, episodic, intrinsic and other forms of consciousness. The mental is treated as being inherently semantic. It is a term taken to be valid and useful in expanded physics. The brain itself taken as possessing both material and mental components.

The term "phenomenal" may be said to correspond to the neologism "qualian", the standard example being the "redness" of a red object, impossible to generate in a computer. It implicitly evokes Chalmers' "Hard Problem" (HP).

By the definition used by this paper, computers deal in units of material information (as defined by Shannon et al.), whereas the mental deals in meaning. By this I mean that there is always a semantic aspect to what the mind performs, and that it is absent from computers, as argued famously by Searle<sup>14</sup> and Penrose<sup>15</sup>. The semantic itself is looked on as always possessing a phenomenal aspect. This means that access consciousness can coexist with phenomenal consciousness, a position which Block himself entertains.

The context in which these definitions have been determined is given below in the "concept outline" section of this paper. Fig. 2 offers an overall structural view in a visual context.

For the needs of this article, the basic IT concepts of procedure and data lend themselves to a simpler, more general and more accessible and meaningful categorization than do the same neuroscientific terms. The former are used unless otherwise specified. I have sometimes simplified the meanings of the terms using IT terminology.

For clarity, the term "mental database" is used in either the singular or the plural, depending on the context. It is to be understood that there is a set of flexible interconnected ("distributed" is the IT term) mental databases in the brain. The question of the likelihood of material (i.e. non-mental) databases is not broached in this document.

### **3. Brain/Database Functional Comparison**

#### **3.1. Justification for the Use of Database Terms**

##### Knowledge Engines and Procedures

The computer contains a data management system which is referred to as a database. Obviously one cannot directly compare a database's functions with those of a brain, but certain fundamental capabilities must be present in both, since they are both knowledge engines. Furthermore, given that the database's structure was built for the manipulation of data by the human mind, it isn't surprising that the structures of the two are so similar.

In computing terms, a procedure (or a process or a routine) is a suite of instructions which operates on data to produce a required result. In the case of a computerized robot an external action may ensue. The mind can also be considered as dealing in procedures/processes and data, though of a semantic, rather than a material nature. It is not meant that the brain is just a kind of stored program executor, as is a digital computer.

Neuroscience limits its use of the term "procedural memory" to that containing skills, such as bicycle riding. In this document the term "procedure" refers to all those procedures/ processes/ routines which are inherently held in some area of memory. For example, mental processing takes place when incoming visual data of a red object is transformed into the corresponding quale (see Fig. 2). This processing is referred to here as a procedure. The procedural steps of which a material procedure is composed are, typically, the successive generation and propagation of action potentials, ions and so on, as one neuron processes data and passes it on to the next.

##### Transactions

Transactions are the data changes which effect changes in the state of the database itself. A transaction may be described as a group of processes which operates on data, moving it from state  $S_0$  to state  $S_1$ . Thus, when, say, depolarization opens sodium ion channels in the neural membrane and  $\text{Na}^+$  ions are allowed to flow into the neuron, yielding its next state, one may say that this occurs through a succession of material processes, as happens when a row of dominos progressively collapses. In this case the transaction is constituted by the group of processes. The data on which it acts is constituted by the initial state  $S_0$  of the neuron.

##### Interesting Similarities between a Computer and a Brain

John Searle has remarked any material system can be described as a computer. Agreeing with Block, Searle quotes him as writing that "the irrelevance of hardware realization as to computational description"<sup>16</sup>. Even a window shutter, blown backwards and forwards is a computer computing wind speeds and turbulence, if one so chooses. Anything material is a digital computer, depending on how it is viewed. But not everything expresses qualia, so there is the mystery of a mind not present in a computer.

A digital computer can be looked on as an analog device or vice versa as one chooses. A computer can be in the von Neumann "step-by-step" form or in the "continuous analog" form, depending on the framing of the question being asked. Of course, almost all the useful questions asked by humans of a computer are framed digitally, but only because that is the best way for us to obtain comprehensible and accurate answers to pertinent questions. As mentioned above, I do not for a moment believe that the brain is *only* a digital computer. It is used because the computer's database metaphor is as an illuminating mode of expression, possessing so many of the same capabilities and features and sometimes even methods as are found in the brain, as shown in the table below.

This discontinuous "digitality" of neural operations is further illustrated by the "all-or-nothing" output from a firing axon. Either there is a resultant change in voltage (i.e. potential) or there isn't, as in a digital computer. One may even go further and say that, as the quantum world (of which the material world is constituted) is discrete, proceeding from one step to another, without spending any time at all in an intermediate state. Each successive realized quantum state may thus be looked upon as a procedural step. Mental procedures take place in the mental domain, which is seen as in some sense as existing within the material neuron.

### 3.2. Capability Correspondences

The perceived capability correspondences are as follows:-

TERM	COMPUTER	MIND/BRAIN
Database	The structure required to memorize, relate, retrieve and process data. It contains data, indexes and procedures	The mental database structure required to memorize, relate, retrieve and process mental data of all types.  There are probably also purely material databases, of less interest.
Unformatted Data	Raw input/output data (e.g. ASCII) not in a database	Material raw data, not in a database (e.g. incoming/outgoing sensorimotor data).
Data	e.g. Oracle data tables	Mental database data (e.g. stored qualia)
Suites of Instructions	Procedures  As they are held in memory, these are also considered as data.	Procedures in general, such as those associated with motor skills, thinking and feeling, which operate on data. Since they must be held somewhere in memory, they also constitute a form of data, whether material or mental.
Optimized Procedures	Compiled procedures	These are general procedures which have been optimized to effect a particular skill, such as riding a bike. Neuroscience usually reserves the term "procedures" for this type of case only.
Pointers indicating the locations of data related to that currently being processed	Data indexes, the structure of which gives the structure of the database itself (see Hebbian activity chapter 5.5).	Neural or mental pointers, linking different data elements.  The nerves connecting the neurons partially fulfill this role in the material domain and serve as a supporting and bridging platform for indexes in the mental domain (see Hebbian activity chapter 5.5).
Data Conversion Procedures	Interfaces	Bridging facilities, transporting data from one domain to the other, changing data and index formats from material to mental, or the reverse, as required.
Data Denormalisation: The multiple storage location/aggregation of the same data, improving access time.	Occurs frequently, especially in large "Data Warehouses"	Occurs frequently, especially between the conscious and unconscious.  For example, riding a bike is conscious during the apprenticeship, then unconscious but conscious control can be resumed when wished.

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Overall Coordination and Integration, which can be described as "Binding".	Operating Systems, controlling input/output, priorities and communication and other resource assignment. e.g. UNIX, Windows XP	Consciousness. A similar role as in a computer is adopted by the various types of consciousness, with the enormous that phenomenality is integrated.
"Housekeeping"	Database optimization, done while the computer is not busy on a user request or at night.	Sleep, which rids the brain of unneeded indexes and data while structurally re-optimizing those remaining.
Working Storage Holds intermediate data	Working Storage	Working Storage The fact that this is used also by computers supports the notion that the brain handles procedures in a way similar to that of computers

**Notes:**

a) To continue to exist when not used, procedures must be stored in memory and so constitute data in this sense. Phenomenal (i.e. mental) procedures require semantic storage space.

b) The phenomenal notion of "feeling" is included in the concept of procedure as it interprets sensory data.

**Denormalisation:-**

Denormalisation is defined as the holding of the same data in more than one area. Denormalisation is necessary where access time must be short. This is achieved by holding multiple copies of the data different formats and/or accumulations. An example of its use in the brain's databases is seen in "blindsight". The conscious region has been deprived of its normal access to certain data, but indirect conscious access still exists in another, unconscious, region where some of the same data is stored. Some of the same visual data has followed both ventral and dorsal paths.

Another example is shown in tennis through the ability of the brain's unconscious perceptual ability to beat the Libet delay of consciousness of about half a second<sup>17</sup> when executing a reaction tennis volley in response to a fast passing shot. All good volleyers watch the ball onto the racquet face, turning their heads to follow the ball. Given that the ball has moved several feet during the half second, the player cannot consciously see the ball onto the strings, but the "grooved" mental procedure executing the volley does receive the visual data where it is used unconsciously. If this were not so there would be no point in the player turning his head.

The fact that some denormalisation (i.e. data duplication) is found in the mind/brain in both consciousness and unconsciousness areas shows how earnest was evolution's search for mental processing speed and improved capabilities, as was so valuable to the evolving animal.

### **3.3. The Computer's Database Index**

Since the relational database is not necessarily an expertise of those concerned with neuroscience and the mind/body problem, a brief description of its basics is given below. Anyone at all familiar with database structures is invited to skip this section. The following paragraphs illustrate how such a database works and where the mind must employ similar capabilities, although, of course, not by the same means.

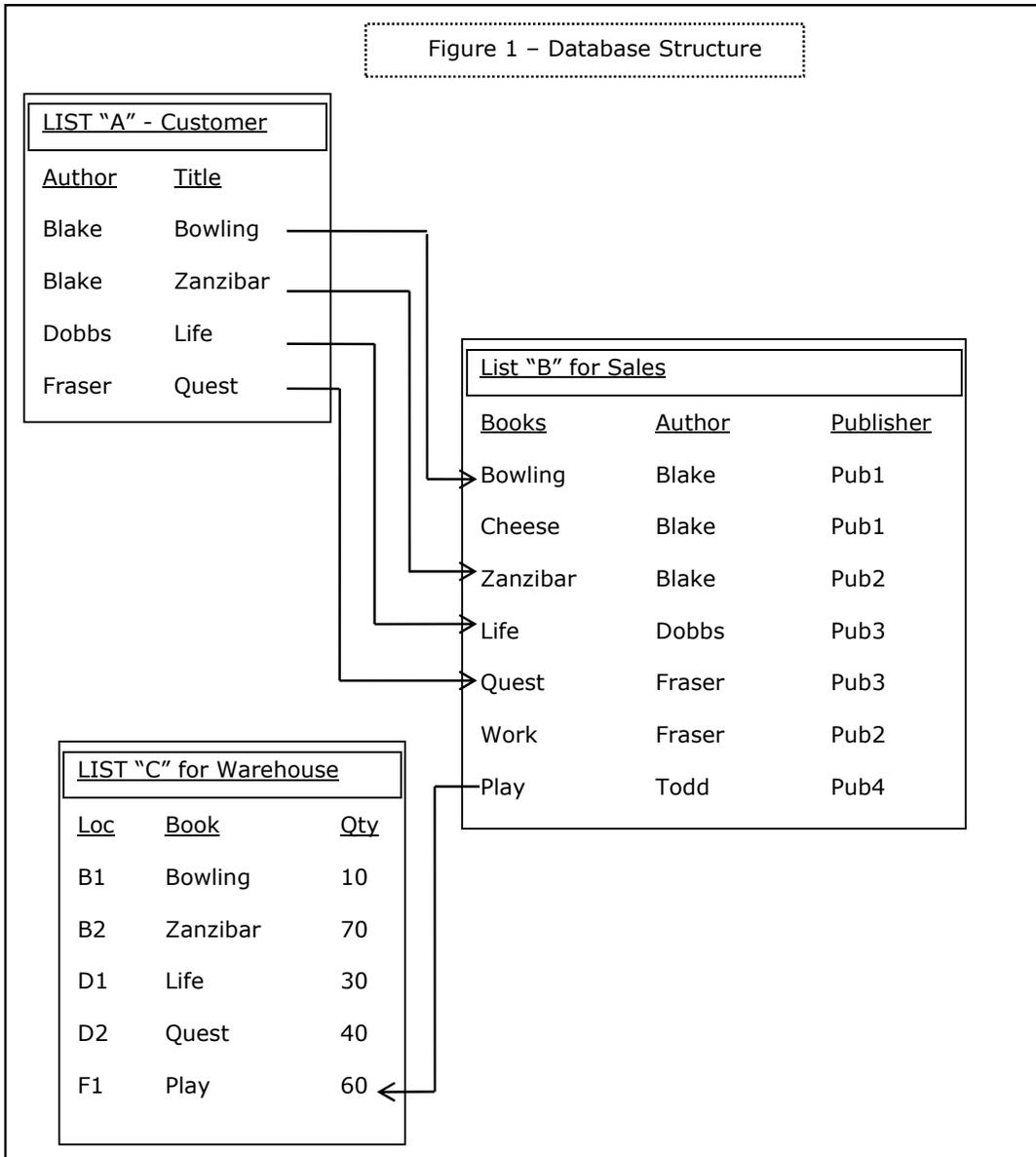
The *raison d'être* of an index is to enable the computing engine concerned to quickly locate and update the required data. It is basically a pointer from one element of data in one list to another element in the same or another list representing the same argument and its value. This pointer itself is, in fact, built from many structured levels of sub-pointers whose organization it is not necessary to describe in this document.

To proceed with an example, imagine that your online bookstore (such as Amazon) wishes you to buy more books of the three authors whose books you have previously purchased. Three lists exist in their computer. List "A" contains the names of your favorite authors and those of their

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books which you have already obtained from the bookstore. List "B" contains the titles of all their available books and the names of their authors. The necessary computer program must identify the books by your authors which you haven't yet bought. It then recommends these books to you the next time you visit to their site. List "C" is used by the bookstore's warehouse to control stock.

A data/index diagram of the example is given on the next page. The indexes (or pointers) are indicated by arrows. They effectively give the address of related data and take up considerable storage space and processing resources. The structure of the indexes (rather than the data) essentially represents that of the database itself. The example is, of course, only schematic. To make the figure easy to relate to the above system description, the lists are not normalized.



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The values of a short selection of data is shown in the list columns. The existence of the lowest List "A" pointer enables the computer program to deduce that Fraser's "Quest" book is not to be recommended because it is already possessed by the customer. The absence of a pointer on Fraser's book "Work" in List "B" enables the program to deduce that this book should be recommended because it is not possessed. The lowest arrow, pointing to List "C", illustrates one value of another index which will let the Sales Department know that there are 60 copies of the book "Play" in stock and that they are in warehouse location F1. Other values for indexes from List "B" to list "C" are not included in order to avoid overloading the diagram.

When the reader is sent the ordered books, the data and indexes of all three lists are updated. When a new book comes on the market it is added to the sales List "B", with its index. Since it must be stocked, its addition must generate an indexed entry in List "C". This means that the data and indexes on Lists "A" and "C" must be updated to reflect changes in the data.

The example shows that data is useless without indexes. As mentioned above, indexes occupy memory space to store the addresses of the desired data in its master list and in the other lists containing the data elements referred to. Although in the figure an index is represented by a single arrow, in reality there are many layers of index accompanied by much code in order for the indexes to function. In a large enquiry "database warehouse" the indexes will frequently take up more space than the data itself. Also, the greater part of the structure of a database is represented by the structure of the indexes, not that of the data itself.

There must be a mind/brain equivalent to the index which relates the mind's data lists, intrinsically representing its structure.

### **3.4. Distributed Databases**

In an IT environment, there may be several different databases of the same or different types working in parallel within a network of computers or even in a single computer. This is obviously the case for the brain. Presumably there is a database sub-type for each sense and mental type.

### **3.5. Necessity for a Mental Relational Database**

It is clear that the mind finds the relational methodology an illuminating efficient and way in which to model the external world – deprived of it we would be incapable of reasoning in our sense of the term. Perhaps there are other ways of visualizing and reasoning which we don't know but if true that just shows that these ways are not our ways and that such modeling is not innate to the brain. No computational evolutionary model of the mind has produced a relational database. This in itself suggests that computational models are subject to severe limitations in comparison with the mind.

## **4. The Mental Domain Hypothesis**

### **4.1. Concept Outline**

As mentioned above in the "Vocabulary" section, the term "mental" in this document always implies a content which is to be looked on as both "semantic" (and thus "meaningful") and "phenomenal". In his seminal paper on the subject<sup>18</sup>, Block himself suggests that the two types of consciousness may be active at the same time. For the purposes of this article there is always a phenomenal component associated with access consciousness. In effect, phenomenal consciousness may be phenomenal only, as when one is assaulted by an unexpected violent pain, whereas access consciousness requires a phenomenal component to provide the mental data in the format in which it operates.

"Access consciousness" pertains to thinking (as distinct from feeling) and is generally agreed to imply a semantic context. Most people will agree that there is something phenomenal in being in a state of access consciousness, as indicated by Searle's Chinese Room and Block's definition of the two terms.

"Phenomenal consciousness" is associated with the feeling of sensations. One may say that pain and pleasure are meaningful (i.e. semantic) as a consequence of being phenomenal.

Searle's Chinese Room illustrates clearly the difference between a state of access consciousness and a state which is robotic.

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To illustrate the existence of phenomenality, use is made of Jackson's famous Knowledge Argument (1982), whereby a scientist learns all there is to learn all of the known material scientific knowledge concerning color without ever seeing a red object and is then exposed to one for the first time. The question is "Does she learn anything from this new experience? The answer in most people's opinion is "Yes", thus confirming the existence and importance of phenomenal views.

Many persons go on to state that Mary knew all the physical facts concerning human color vision before her release, so what she learns on seeing red is a non-physical fact. Using the terminology of this paper a non-physical "red" does not appear, because the term "physical" comprises all science including that which is true even though as yet unknown. In the present terminology, seeing red is a non-material fact. This is of no concern to my thesis, because the material (current physics) is known to be incomplete and, in particular, doesn't explain qualia.

Many workers go on to say that this confirms that Mary didn't know all the *physical* facts about red. According to the definition used in this paper, this is a confusing use of the term "physical". The term "material" could be used instead, but the term "material" represents an incomplete physics, so the result whereby Mary learns something is unsurprising.

The implication for this paper is that the term "phenomenal" is used to identify both:-  
a) one type of consciousness (phenomenal)  
b) an aspect of the other type of consciousness (access)

but I can't find a better way to formulate my arguments using the current vocabulary.

As there is nothing semantic about the robotic material world, all semantic data must be stored in a mental domain. Thus relatively little data, as distinct from indexes, is stored in the mind's material domain. Destroying neurons will in all probability destroy all or much of the relevant mental domain. However, it is indicated below that the "unexpected stability" of memory, is adduced to suggest that mental data may be resistant to material trauma.

It is likely that intra-mental indexes also exist. Mental data isn't visible to current brain scanning methods such as fMRI. This poses no problem to the hypothesis of a mental domain since the neural unit itself contains material and mental domains which are seamlessly conjoined. In this context it is remarked that in computers the first and last operations on data transactions concern the data's indexes, not the data itself.

The following "Principle of Semantic Consistency" is now enunciated in support of the hypothesis:-

"Semantic data and semantic procedures require a semantic mental domain in which to operate".

It is worth noting that even if phenomenality could be explained in a material context (as suggested above in Option "A"), the semantic sub-domain would remain conceptually necessary; in this case its activity is, of course, visible on brain scans.

In writing of separate mental and material domains, I am making a distinction appropriate for human understanding, but of no importance to Nature itself. At the time of the appearance of consciousness, physics operated under the same laws as it does now. Humans perceive a difference because it is only recently that it has become significant to science as it always has been to philosophy.

I don't hazard an opinion on whether the unit of the mental domain relates to the sub-atomic, molecular, coalition, sub-Planck or any other level. For the purposes of this paper, the mental domain is simply where mental data and stored procedures (e.g. episodic, procedural) are held and where the various types of consciousness exercise their capabilities.

Taken together, the two hypotheses posit that functions are divided between the domains as follows:-

### **4.1.1. Material Domain**

- the interface relaying data to and from the mental domain.
- the relaying of sensorimotor data to and from the body, activating body systems as necessary.

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- the indexes pointing to the addresses of the required data/procedures stored in the semantic mental domain.
- support platform for the mental, supplying energy and other facilities.

### **4.1.2. Mental Domain**

- the complement to the material interface, relaying data from and to the material domain.
- the storing of memories: short term/long term, declarative, procedural, episodic, etc.
- running the procedures relating to emotions, decisions, consciousness and unconsciousness, etc.

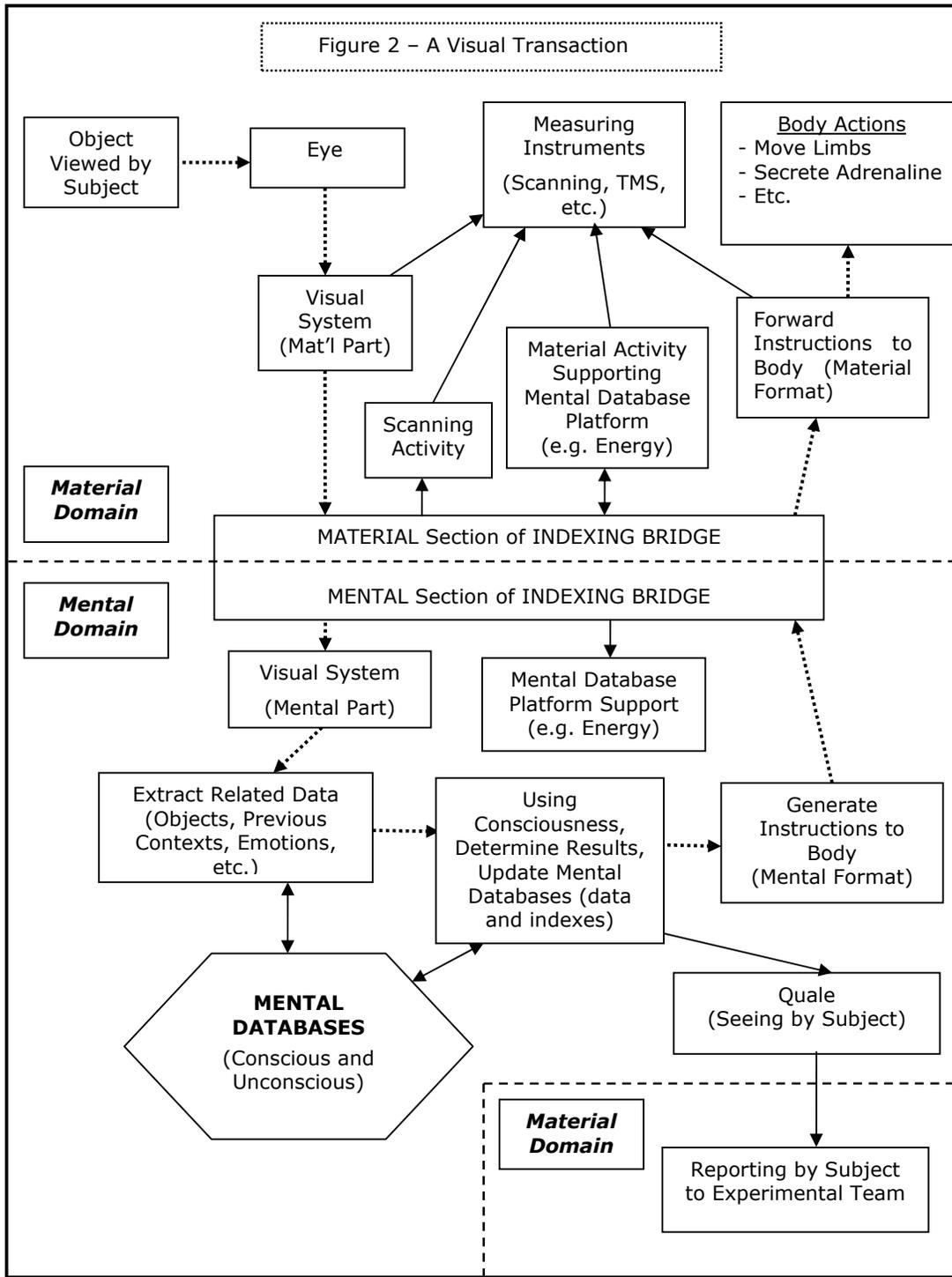
The originality of the hypotheses depend on the proposition that all of the semantic data is held and processed in a mental domain. This purports to explain why there are no clear signs in the material domain of either phenomenality or of comprehensible memory encoding and processing algorithms, nor any concrete prospect of finding them.

I surmise that the connections between neurons carry the indexes for both mental and material data (see section below on "Nerves Joining Neurons").

The diagram below shows the overall structure of the body/brain/mind/ and the flow of data and processing of a visual transaction. Visualisation is an appropriate example, since it is naturally "transactional" in nature, because about 25-30 separate sequential "photos" are taken by the eye every second. Each "photo" is considered as a transaction.

Note: In the figure below, dotted single arrow-headed lines indicate the procedural sequence as well as the flow of data; the solid arrows indicate the index and data connections; the rectangular boxes indicate the material/mental functions whose processing determines the updating of the mental database (i.e. the mind) and its output; the thicker horizontal dotted line separates the mental and material domains.

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Assuming it is correct, fig. 2 shows that we can never see direct neural correlates to consciousness using instruments which function by current physics. The experimental team and instruments receive only the following material data:-

- The material part of the indexes giving access to the mental data. This constitutes the greater part of the scanning activity visible on the measuring instruments. Indexing continues throughout the duration of the visual transaction (just as in a computer database).
- Visual input data.
- Database material needs (such as energy) while it is being updated by the visual transactions.
- Output material instructions to the body, resulting from conscious consideration of the visual input
- Reports concerning the experienced qualia, expressed by the subject himself.

According to the hypotheses, there is currently no way of directly comparing the mental and material formats. For example, there is no direct view of the mental emotional activity on our instruments. Of course we see the corresponding quale through the interpretation of images but we see nothing on the measuring instruments in the mental format, nor do we see anything of the mental processing that updates the mental databases (i.e. our mind including our memory). In IT terms, we see the database transaction but we don't see the database state itself. If the transaction adds \$500 to one's current mental bank account which contains \$2,000, only the material side of the \$500 transaction will be visible to the instruments. The instruments detect nothing of the \$2,000, nor of the resultant \$2,500, nor even of the mental part of the \$500 transaction, unless it is expressed in some material form by saying it out loud. Of course there will be some visible material index updating, but the amount itself which is indexed (i.e. the data) won't be visible or correlatable. Hopefully, the above statements will constitute some sort of testable of the hypotheses when scanning gains sufficiently detail. Either the \$2,000 will be visible or they won't.

Even if it is believed that Option "A" is the correct one (i.e. that the mental database is material; see paragraph 1), one still can't see clearly what is in the database using current instrumentation because we don't know the database coding, and the data must be in some form of database. On a computer, to obtain a simple data listing of a database field, one must use a piece of software adapted to the database format and structure in question. Using a low level machine language program would yield gibberish, intelligible only to the compiler/database writers, with perhaps now and again the odd chunk of data visibly part of the input.

Returning to Approach B (i.e. the database is mental), the correlation between the instruments measuring the "Material Indexing Bridge" activity and the "Reporting by Subject" is the most direct to which access can be obtained. The visible correlation with what is happening in the mental database itself will be low. There will be no one-to-one data item correspondence. Fig. 2 above illustrates the distance between these two correlated elements, showing how much goes on in between.

Let us take the case where a person whose right hand, on touching a warm surface, causes her brain to feel a mild discomfort and causes the withdrawal of the hand in consequence. There will be a certain neural coding/format train for the feeling of heat sent up to the brain and another neural coding/format for the train corresponding to the muscle movements effecting the removal of the hand concerned. For obvious reasons (one is sensory and the other motor), it cannot be expected that the two events will code the term "hand" in the same way. At least at this point in the development of neuroscience, we won't be able to compare the two codings/formats for "hand", although we may well see an increased activity and more spikes in the neural activities of the two sets of connected brain regions concerned; this may be said to constitute only a weak correlation. In a computerized robot the correlation would be perfect. In a human being the notion of "hand" exists only in the mental domain.

Even if it is believed that Option "A" is the correct one (i.e. that the mental database is material; see paragraph 1), one still can't see clearly what is in the database using current instrumentation because we don't know the database coding, and the data must be in some form of database. On a computer, to obtain a simple data listing one must use a piece of software

adapted to the database format and structure in question. A simple list using a low level machine language program yields gibberish with perhaps now and again the odd chunk of code visibly part of the input data.

## **4.2. Reasons for a Separate Mental Domain**

One may not agree with all the points made below, but if a clear majority of them are judged acceptable then the probability is that a non-material mental domain exists. Up till recently it was generally accepted that consciousness couldn't go very far down the evolutionary scale and was limited to the higher mammals at most. Now one sees it accepted in respectable contexts, though not everywhere. Christof Koch writes: "Perhaps they too (bees, squids, fruit flies and even roundworms) ... can experience pain, pleasure, and see"<sup>19</sup>. An article was written in early 2002 proposing that consciousness was almost certainly present in all mammals and in groups such as saurians and birds, and may well go back to the chordates (primitive creatures with the beginning of a backbone). The idea of such early consciousness was widely refused at the time. Perhaps the same will happen in the relatively near future with respect to the concept of a separate mental domain.

### **4.2.1. The Impossibility of Epiphenomenality**

Since epiphenomenalism invalidates my thesis, I will now attempt to rebut it.

The following argument was advanced by William James<sup>20</sup>: Put briefly, if consciousness were epiphenomenal there would be no reason why the emotion should match the action required by the situation. For example, hunger matches a need to eat, fear matches flight, anger matches attack. One does not feel mildly amused while struggling to free oneself from the constricting coils of a python. Also, if epiphenomenalism were operating then there would be much more genetic drift concerning emotion since it would have no survival value, but such drift isn't seen when examining the genome or animal behavior. The drift would occur in both new and existing species. It seems strange that the these unnecessarily appropriate feelings such as hunger and sexual desire should be passed on, attached to the appropriate action, essentially unchanged in the thousands of evolved animal species in which we see them.

Another reason for refusing the epiphenomenal option is that calling something an epiphenomenon doesn't absolve one from the obligation to explain it - it merely says that the something is not important in the current context. This is impermissible if the context is the explicating of the something itself - in this case, consciousness. Referring to Huxley's classical example, the train's whistle can be looked as an epiphenomenon with respect to the stationary train's acceleration away from the platform, but not if the subject of enquiry is train whistles.

The property dualism option seems to me to be unnecessarily nomological (i.e. arbitrarily lawlike), in effect maintaining that consciousness is a brute fact dependent on the material configuration of the brain and can't be explained further. If any reasonable explanatory proposition, even incomplete, is put forward, then the *deus ex machina* of property dualism (and substance dualism itself) may seem unnecessary.

If consciousness is not epiphenomenal, it must be useful to the animal that possesses it; otherwise Darwinian evolution would not have selected it and incorporated it into the species genome. This is tantamount to saying that it is causally efficacious. See below under "Evolutionary Advantages of Consciousness" for suggestions on this matter.

Genetic drift occurs spontaneously when there is no particular evolutionary need pushing genes one way or another. There are many useless "junk genes" in the genome. If consciousness were epiphenomenal, we would observe different sounds and sights diverging from a primeval standard. For example, hearing might become part of sight, as happens in subjects suffering from synesthesia. Where this mixture of senses becomes significant it is felt as a Darwinian disadvantage. The fact that it has not happened in the millions of years available means that there is no drift.

Personally, I find the above disproof of epiphenomenality, taken together with Searle's Chinese Room, Jackson's Knowledge Argument and Penrose's work to provide a firm base for a causal consciousness with its own domain.

#### **4.2.2. The Impossibility of a Complete Set of Material NCC**

The goal of many neuroscientists is to find the complete set of Neural Correlates of Consciousness (NCC) which match all mental activity to corresponding neural activity, visible on brain scans and elsewhere. However, the consequence of the above arguments is that we do not see anything that really merits the title of NCC. What we may see is the neural correlates between the different material inputs to, and material outputs from, the Material-Mental Indexing Bridge (see fig. 2), assuming that any exist.

According to the "Complete Set of NCC" viewpoint, all neural activity forms part of a closed material causal chain. Thus emotion is supposedly completely dependent on material events and is physically predetermined. This view leads inevitably to an epiphenomenal consciousness. Identity theories follow on. However, since consciousness has been shown not to be epiphenomenal, the complete set of NCC can't exist. Moreover, since the advent of Quantum Mechanics, physics does not support the notion of a predetermined universe because of the way in which the wave function is collapsed. Physics has been said for several decades through quantum theory to support the concept of a fundamentally random universe<sup>21</sup> but this statement is agreed to be open to modification by future discoveries.

It is perhaps worth mentioning in this context that we may already isolated a neuronal biochemical sequence which is actually an example of an NCC substrate, without having identified it as such, because the mental database part of the correlate is invisible. This would happen if the animal concerned can't or doesn't communicate a quale large enough to be visible when the substrate is activated. At the molecular level, minuscule qualia will not be visible and these are the types of result to be expected in experiments with only a few neurons, typical of those used to pinpoint neurochemical effects, although there accompanying indexing events may sometimes be visible.

#### **4.2.3. Likelihood of Expanded Physics and New Dimensions**

New fields, dimensions and forces are being discovered regularly. For instance the strong and weak nuclear forces were discovered within the last sixty years. String theories and their extensions are suggesting several more dimensions of space. These theories are not yet sufficiently developed for inclusion in the "current physical world". The fact that we feel a pain in a particular region of body space suggests that perhaps there exist at least three dimensions of phenomenal space. If the proposed advanced physics implies further fundamental spatial dimensions in our universe, it seems unlikely that they have no perceptible effect on us.

The whole concept of the "physical world" is evolving. No respectable Victorian physicist would have entertained the weird consequences of quantum physics, such as the multiverse hypothesis and "spooky action at a distance" as referring to a physical universe.

The "LMT physical dimension" problem:-

Note that the dimensions treated below don't represent the same concept as those mentioned above in proposing a multi-dimensional mental domain. These so-called "physical dimensions" give the dimensions of measurement intrinsically present in all equations referring to the material world.

##### "Physical Dimensions"

The term "Physical Dimensions" refers to a related but different concept to that used in talking of ordinary "dimensions". It is used in physics as follows:-

Typical physical dimensions are L (length), M (mass), T(time) and Q (electric charge). Nowhere in physics does one find a physical dimension which is even faintly semantic. All the equations in physics must have the same combination of physical dimensions on each side of the equation, e.g. velocity, measured in miles per hour has the dimensions of L divided by T, so  $v$  (velocity) =  $LT^{-1}$ . Volume has the physical dimensions of  $L^3$ .

However, as Penrose has remarked, special relativity has already enabled us to relate two apparently unconnected basic dimensions, using the well known equation  $E = mc^2$ . Thus mass can be expressed in terms of energy's dimensions of  $ML^2T^{-2}$ . It is suggested that, similarly, we may find a combination of known physical dimensions which proves to be suitable for consciousness.

Personally, phenomenality seems to me conceptually much further from the material than E is from M, both of which are material. I suggest that phenomenality is like, say, Q, which can't be reduced to any of M, L or T.

#### Emergence

Most people, including scientists, when asked how they expect the consciousness question to be resolved, reply that this will come about through "emergence". These persons expect that the current version of physics will suffice as a base. For them the advance will come through further in-depth examination of the high complexity of the brain. To give this statement some sort of base on which to judge, I suggest that emergence implies that the current physical dimensions will suffice. This, in turn, presumably means that consciousness is not "irreducible" and encourages the emergence proponents to make a suggestion in which dimensions will be involved.

Certainly new facts concerning consciousness will continue from the continuing advances in neuroscience. I believe it will be confined to indicators of which direction in which to aim subsequent research. Examples of such target indicators are the neural correlates of consciousness and the "observer/observed"<sup>22</sup> phenomenon, whereby the observer and the observed interact. This is impossible from a "common sense" point of view.

#### **4.2.4. The Absence of Phenomenality in Computers**

The ability of the human mind to experience phenomenality is fundamental to its nature, but no verifiable proposition for materially-based phenomenality has been produced, even as a reasonable thought experiment. Various computerized neural nets purporting to achieve the same material results have been advanced but none contain a phenomenal component. All computers, however massively parallel and interconnected, running software however sophisticated, are nevertheless subject to the restrictions applying to all Turing machines, which are void of any phenomenal or semantic content. No-one pretends to have cracked the brain's material-to-mental bridging code, nor that of phenomenal processing itself. This is understandable if the code depends on a domain not yet handled by physics. The useful work done on computers is limited to the material domain, where, for example, neural circuits round the eye or in the visual center correspond to different data shapes and colors, but not identified as objects in contexts.

There is as yet no case where the perceived neural activity can be mapped precisely to the mental event. It is therefore reasonable to suppose that it may take place elsewhere than in the material domain. In the case of the index we see only the material part.

#### **4.2.5. The Incompleteness of the Material World**

The current version of physics is agreed by mainstream physicists to be insufficient to describe our universe. It is therefore impossible to consider it as truly representing a causally closed universe, although a future version of physics may possibly do so.

#### **4.2.6. The Early Appearance of Consciousness**

The first brains came into being about 500 million years ago. Much the same base neurons and neurotransmitters existed at this time. The neurotransmitters serotonin and glutamates<sup>23</sup> existed before brains emerged. The serotonergic system, for example was in place in our evolutionary ancestors, the chordates, by then<sup>24</sup>). Gazzaniga remarks that many parts of the modern brain were in place long ago<sup>25</sup>. Glutamates were already present in the plant world. That part of the brain by which the phenomenal is represented and on which consciousness depends lies in a relatively primitive part of our brain near the brain stem, not in the later overlay of reasoning regions. It would appear that the functions and roles of those early components all that time ago haven't changed enormously, because much the same functional and biochemical mix persists today. Since primitive emotions, like sophisticated ones, expressed themselves through feeling (i.e. qualia), it is reasonable to entertain the possibility that phenomenal consciousness in some form existed at a time when the ancestral brain was much smaller and simpler than now, when it was driven more by phenomenal instinctive needs than by reasoning ones. To quote John Allman, an evolutionary neurologist: "*Remarkably similar results have been obtained in recordings from serotonergic neurons in invertebrates such as lobsters and sea slugs, findings which suggest a basic commonality of serotonergic function throughout the animal kingdom*"<sup>26</sup>.

Since evolution advances micro-step by micro-step through mutation, there exists a strong continuity between evolutionary steps<sup>27</sup>, as mentioned above. A phenomenal semantic database must have a very different molecular structure to that of a purely computational one, making continuity between the two difficult to envisage. Taken together, these two facts imply that consciousness can't have initially been a product of mere computational sophistication. Even in early times, consciousness was presumably dependent on that same extraordinary conconvocation of biomolecules, that same substrate as the present day to produce and support the mental domain. It is difficult to imagine a sudden huge discontinuous leap in the evolution of a brain organ such as the putamen (associated with the sensation of pleasure), which would imply that it went from a non-conscious state of a certain structure, function and utility to a conscious state, fulfilling much the same roles as before without an accompanying hugely discontinuous, and therefore forbidden, gap in evolution.

#### **4.2.7. Nature's Pre-existing Evolutionary Sense Nodes**

Attempts to simulate evolution through computational simulation evolving towards a living organism have not been successful. However, the mental domain possesses strong advantages in the form of several neatly separated nodes around which it can progress in a modular fashion. The nodes are constituted by the various types of qualia, such as sight, taste, audition and other senses. Such pre-existing, independent nodes don't easily interfere with one another and the very fact of their pre-existence means that only access to them has to be evolved, not the whole senses themselves. This means that less new code is needed to advance and that it is incorporated into a proven context.

#### **4.2.8. Richness of the Atomic Level**

For the computational approach, the atomic level is that of the basic bit stream, which in itself is devoid of interest or meaning. Binary code is trivial in content. For matter itself, the situation is the complete reverse. From the atomic level on down below the Planck limits, physics descends into the mysteries of quantum, superstring, twistor and other theories whose implications are as yet unknown and who leave plenty of room for consciousness.

#### **4.2.9. The Binding Question**

No single region has been found in the brain where all the senses are brought together, enabling their inter-relation. Thus touch may confirm the nature of an object which is being seen and smelt. No-one has had damage to a binding organ which would confirm its material existence. Personally I'm not sure it is needed. We can hit a tennis ball using both consciousness and unconsciousness simultaneously yet they differ in time by about half a second, during which the ball moves several yards without it being noticed by the player. But, if binding is needed, it is likely to take place in the mental domain where all qualia co-exist.

#### **4.2.10. The Non-Identification of a Material Feeling Region**

It is well-known that pain involves many brain sites including the thalamus. Pain impulses (action potentials) being conveyed from the area in which pain is felt (e.g. a toe) up to the brain may be said to be in the material non-conscious format as it is understood by current science and doesn't cause pain on its own. The pulse train continues to proceed through different areas in the brain, notably the thalamus and anterior cingulate cortex. Eventually pain is felt. But nowhere along the line can a particular pulse train, or other material situation, be said to be the substrate possessing the property P, directly causing pain. P may be expressed in pulse timing and length, voltage, ions, neurotransmitters or whatever. We know to some depth many of the possible regions in material terms. This would seem to indicate that when pain is caused by the necessary conconvocation of particular molecules in the required particular state, the causal influence is likely to be invisible to us on our current range of instruments and thus cannot be identified by us as being the essential substrate. If this continues to be true for all sensations as neuroscience continues its rapid progress, then the experiential percept and its cause become more and more likely to take place in another domain.

Patients with bilateral damage to the amygdala lose the ability to feel fear, so it may well be that its efferent nerves convey consciousness, since the neural input and output are apparently unharmed and the input doesn't convey fear. But as far as the author knows nothing pertinent to sensation itself has been seen in this or in any similar situation, yet the amygdala would seem to

be generating fear. It would seem not impossible that the conveying of fear is invisible to current means of observation.

#### **4.2.11. Conclusion**

The above points converge to indicate the existence of a semantic mental domain, whose nature will hopefully be more clearly visible to a future version of physics.

### **5. The Neural Index**

The concept of the material/mental index has been explained above. Further detail is to be found below.

It seems probable that non-material internal mental indexes exist as well, relating evanescent mental data to other evanescent mental data.

#### **5.1. The First Stage for Incoming Data**

As mentioned above, in computer systems in general, before becoming available for interrogation and sophisticated processing, incoming data must be uploaded into a database. In doing so, the data must be appropriately indexed. In the brain, as the incoming data is sensory, it is presumably material in nature. To become part of a semantic database, it follows that the first stage must be a material-to-mental bridging and indexing operation.

#### **5.2. The Evolutionary Role of Emotion**

The very fact that emotion was chosen by evolution to implement decisions demonstrates that in some respects it is more efficient than reasoning without emotion, otherwise natural selection would not have chosen it to do so. These advantages come partly from a short response time in making an appropriate and coordinated response, thanks to the parallel processing in the separate material and mental domains, facilitating the rapid coordination of several different decisions and actions.

Due to a brain injury or deficiency in a part of the brain used in emotional processing, certain patients suffer from an incompatibility between their prudent reasoned evaluation and their subsequent inappropriate, emotion-less actions. Damasio's well-known patient EVR<sup>28</sup> underwent an operation removing tissue from the ventromedial region of the frontal lobes, causing him to lose the normal harmonious match between emotion and reason. Although his IQ remained high and he could draw clear rational deductions as to what the likely consequences of an action, he invariably yielded to unprofitable temptation when confronted in a situation requiring a short-term decision. For example, when choosing a card from a deck, he would always choose the one which could give the most spectacular reward in the short term, while knowing that it was guaranteed to be unprofitable in the medium term. Considered with similar results from damage to other regions of emotion in other patients, this indicates that emotion is the most efficient means that evolution has found for responding to demanding situations in which reflexes are too limited and reasoning takes too long.

It seems that rational evaluation plus instinct plus learnt behavior contribute to the generation over time of an emotion appropriate to the situation. Emotion's value is that in complicated cases it reacts more quickly than reason. There is a solid experimental base for showing that fear is initiated and experienced before the subject is conscious of the reason for it. The amygdala is a brain region which is a base for fear processing. Naccache<sup>29</sup> of Salpêtrière Hospital in Paris has shown that if an emotionally loaded word such as "murderer" is fleetingly inserted into a neutral text, the amygdala reacts strongly as is seen via the electrodes implanted in the brain. A twinge of fear is felt, even though the brevity of the display of the loaded word prevents the word itself from being consciously seen, identified or remembered.

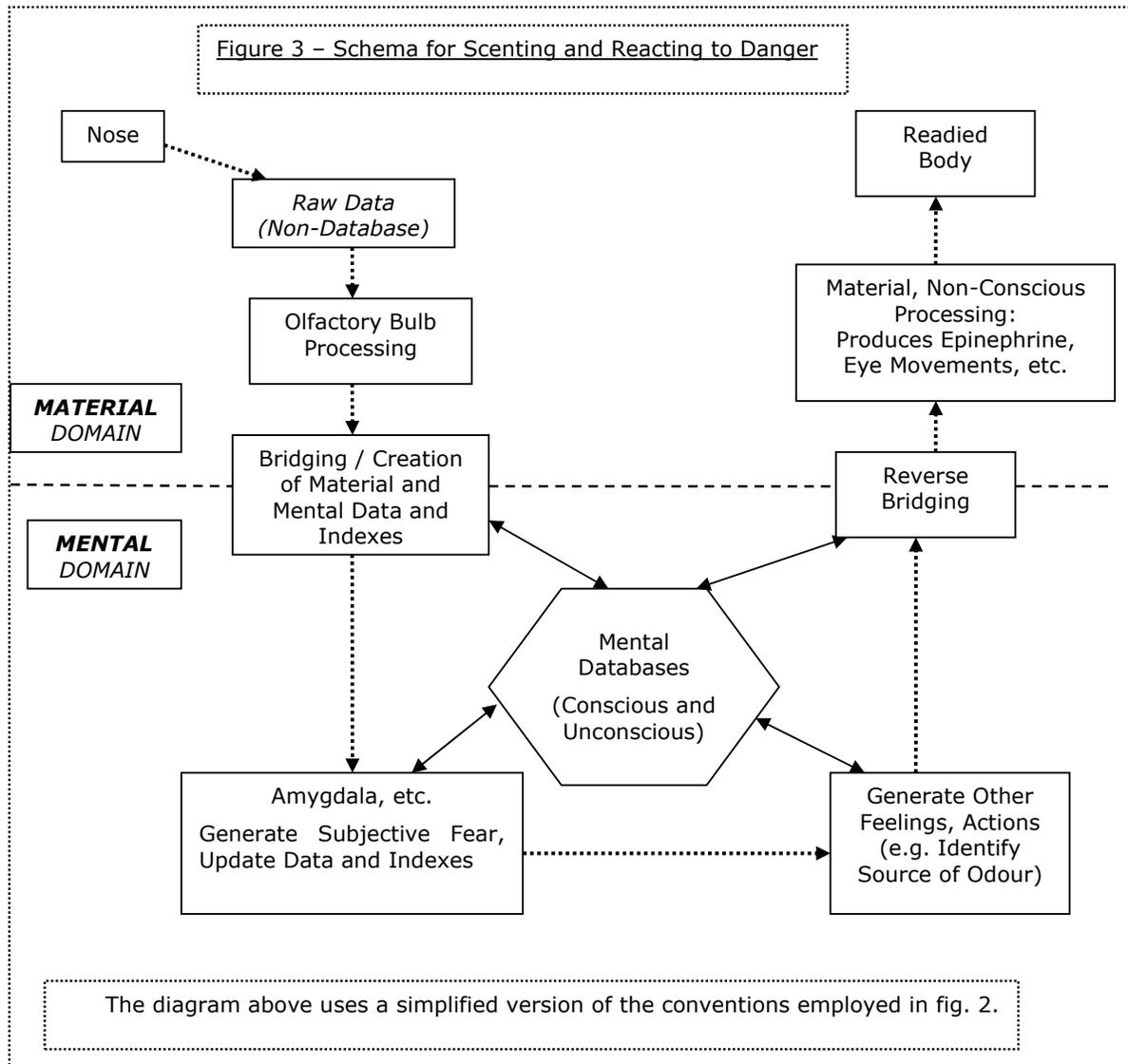
#### **5.3. Steps Associated with Olfactory Sensation**

The following example clarifies the concept of emotion in this context by describing the possible suite of events set off by the fear reaction to an odor associated with danger. It is, of course, simplified and will need revision. The most important unknowns concern the domain selected by the olfactory bulb outputs – which are mental and which remain material?

## The Mental Database

- The odor activates the nose's olfactory receptors.
  - Nerve impulses are passed to the brain's olfactory bulb
  - The olfactory bulb produces the:-
    - material substances such as epinephrine to prepare the body for attack.
    - mental data necessary to react appropriately (e.g. fight or flight), which will produce a further group of material substances.
  - Appropriate biochemical/electro-magnetic signals are relayed from the olfactory bulb to the amygdala. Whether or not they already possess a mental component is unknown.
  - The amygdala uses the bridging indexing capability to locate the appropriate "addresses" in the mental domain and passes data up to the appropriate mental regions.
  - Swift mental domain processing takes place, in the form of emotional activity which takes into account the known dangers associated with the odor and the manner to avoid them. The manner may be instinctual or have been consciously learnt and grooved, so becoming largely unconscious.
  - Interface signals are generated which pass back from the mental to the material domain through the reverse interface.
  - These signals activate appropriate neurotransmitters in the material domain.
- (The last four steps are perceived as a single step in the material world of brain scanning. It could be expressed as: "processing in the amygdala and associated areas causes the activation of appropriate neurotransmitters").
- Material domain neurotransmitters activate epinephrine (adrenalin) production, motor response and other immediately appropriate activities involving both mental and material processing.
  - The corresponding material brain areas are activated and the actions taken recorded in episodic memory, requiring activity in both domains and their databases.
  - The slower regions of the brain dealing with consciousness are by now well aware of the situation and have started the relevant material and mental processes, including those concerning access consciousness and procedural skills. A conscious decision on what to do next is made.

The Mental Database



## The Mental Database

If epinephrine (adrenaline) is directly injected into the bloodstream in the absence of a fear stimulus, the body will prepare the material and mental processing needed for a fight/flight reaction. In this case, obviously the olfactory data and fear of something specific will be missing.

The material database (if indeed it exists in a true database form) is simple. It acts as a kind of buffer where mentally generated decision instructions are held in the material domain prior to action, minimizing the reaction time required. For example when comfortable in a warm bed on a cold morning but aware of the necessity to get up in time, one suddenly finds one's self standing up without having been conscious of implementing the decision to do so – in fact it had been taken some time ago and the body has been readied to take the action at the moment of its choice. This faculty of early preparation would have been critical to survival on the savannah as it gains a vital fraction of a second with respect to the predator or prey (who may also possess it of course).

### **5.4. The Effect of an Antidepressant**

The following describes the expected effect of serotonin. This neurotransmitter occurs naturally in the brain and affects the biochemical processes taking place at synapses. In depressed persons there is apparently a deficiency of serotonin. Neurologists have expressed puzzlement that serotonin takes several days at least to produce any effect. This means that serotonin itself is not the "holder" of serenity. A frequent treatment for depression consists in supplying a daily supplement of serotonin, which helps about half of the patients. According to the Neural Index hypothesis, this has the effect of changing the state of the interfaces, progressively orienting new data towards areas associated with serenity in the mental domain through the progressive modification of the appropriate indexes. These areas color the perception of the depressed subject in general and progressively change her whole attitude towards her environment. Ensuing mental processing will be different from that which it was before. The globality, durability and integration of the overall change implies that many brain indexes have to be changed materially. The usual explanation for the mechanism of antidepressants has been that changes at the synapses mediate the mood, although it has been suggested recently that it is connected with the observation that certain neurons grow during the few weeks that it takes for the antidepressant to begin to have an effect. It is perhaps worth noting that the improvement due to a tranquilizer is transitory and diminishes certain faculties, so large scale neuronal changes are not needed, whereas an antidepressant must update the whole system in a harmonious manner and so takes longer.

### **5.5. Hebbian Activity**

Hebbian activity of neurons involves the following properties and results from their repeated stimulation:-

- the reinforcement of neuron firing
- the extended branching and thickening of its dendrites.

This is how one would expect dynamic indexes to behave. Repeated access to existing data and the incorporation of new data generate faster access through the improvement of existing paths to data and the creation of new ones.

The tree-like structure of database indexes is sometimes referred to as an "arborescence". The structure of the neuronal assemblies known as dendrites is also tree-like. However, there is nothing evident in the visible structure, obtained through the scanning of neural coalitions, indicating the presence of phenomenality.

When a small area of the brain is damaged, this normally degrades rather than eliminates the capability concerned. Again, this is what we would expect of indexes but not of data. The damage forces the brain to take a longer path, or to build a new one, to the data.

### **5.6. Multiple Object Referrals and Primary/Secondary Indexes**

Researchers have remarked that the same object may be referred to in neurons belonging to different brain regions. This is also what one would expect from relational indexes.

In most database systems there is a difference between primary and secondary indexes. The primary ones are usually stored with the data and determine its placement. In a more sophisticated version of the example above, the primary key for a book list would be the universal ISBN, identifying each individual book in a clear and unique manner, even if they have the same

title. An example of a secondary key would be the data element "author", since the system often needs to find out which books were written by a particular author. The primary key is the data element best identifying the list concerned. It possesses its own type of index. It usually constitutes the most efficient index for accessing the data. The point here is that the mind shows a similar behavior. Detectable neuronal activity seems to be at its most intense in the neurons associated primarily with the principal data element concerned, a lesser secondary activity being detected elsewhere. An example of this is found in the behavior of place cells.

### **5.7. Nerves Joining Neurons**

As was mentioned above, changes in the index of one list will frequently cause indexes in other lists to be updated. Since the primary indexes are partly material in nature, they participate materially in their mutual updating through the use of the nerves which join the relevant neurons. This is one of the types of activity seen on brain scans. The other main types are those interfacing with the material body and those acting as a support for mental domain activity.

Material neuronal stimulation is seen through scanning to occur early on in thought processing, even predating it, as maintained by Libet<sup>30</sup>. The fact that electromagnetic neural activity occurs before consciousness of the scene is consistent with the Neural Index hypothesis, because:-

- Mental activity occurs first and is invisible to current scanning.
- Indexes (material and/or mental) must be activated beforehand in order for the data itself to be retrieved, inserted or updated. Also, as mentioned elsewhere, optimally prepared rapid action requires preparation in the material domain which is closest to the body's muscles, endocrine systems and other material participants in the action.
- I suggest that Libet is not necessarily measuring only Reaction Times (RTs). He seems to be implicitly including the additional time it takes to be conscious of the fact that one is conscious of moving a wrist. This isn't a trivial remark since many mainstream neuroscientists say that animals other than ourselves are not conscious of being conscious (e.g. Joseph Le Doux<sup>31</sup>).
- I also suggest the possibility that we are conscious of an event within the first few ms, but that the memorizing capability comes into operation only after 500 ms, so we don't remember that we were aware of the event. This would have a Darwinian advantage in that consciousness could be used right away. This may be said to occur when one flings one's self into a ditch to escape an oncoming car and then, when questioned, says "I don't remember how I got here". If there had been a wall instead of a ditch one would have tried some other escape route, so more than instinct is in play.

### **5.8. Types of Visible Activity in Material Brain Regions**

Some parts of the brain seem to accomplish processing of data. They may well also need to store the intermediate working data. For example, the cerebellum is associated with the skill necessary to ride a bicycle. It presumably holds the working positional and balancing data which must be present somewhere in the brain, both mental and material. Another procedural area is the parietal lobe, responsible for the spatial reasoning which determines where things are and how their positions relate to each other. Again the need for closely associated working storage presents itself. The inferotemporal cortex has the complementary job of determining what things are. That these regions and others present activity associated with processing is clearly shown through the various material brain scanning methods. This activity can sometimes be seen as low frequency synchronized brainwaves of the type seen on EEGs. Brainwaves associated with attention are visible. It is therefore clear that data routing (i.e. indexing and bridging) is not the only activity of the material brain.

The hypothesis of this article cannot affirm that these procedural regions also store the raw data they process, although it seems likely that, for reasons of access rapidity, the data should be held as near as possible to the area where the procedural processing takes place. I do believe that these regions effectively contain mental procedures which in themselves constitute a form of data since they have to be stored and accessed for use (as in a computer). One could imagine the association of synchrony with the parallel activation of procedural regions which have been coordinated through consciousness. These regions may also interface with external body functions, thus causing material activity such as that necessary to stimulate the endocrine system. It may be further surmised that the mental domain needs the material domain as a supporting platform,

furnishing it with energy and supplying it with shape, for example. In this case, the material domain must be active for the relevant mental areas to function.

So, although most of the data and processing are handled in the mental domain, there is thus plenty of work to fully occupy the material domain, whether associated with procedures or data, which shows up as neurochemical changes, electromagnetic fluctuations, voltage potential movements, etc. on brain scans and other material investigations. Thus all, or almost all, invisible mental activity will be accompanied by visible material activity.

### **5.9. Considerations of Stability**

It is suggested that the instability of certain of the material brain taken with the apparent stability of many components of the phenomenal domain constitutes a further confirmation of the existence of a mental database and that the activity seen by modern instruments reflect transactions on the database (but not the database itself) and support activity.

#### **5.9.1. The Unexpected Instability of the Material Domain**

Recent discoveries concerning the instability of the brain's constituents (microtubules, synaptic connections, etc.) have been observed by John McCrone<sup>32</sup> to show that many of them have a lifetime measured in minutes or hours. This would seem to lead to so much data recopying and index regeneration that it is hard to understand how the mind can conserve its data integrity.

#### **5.9.2. The Unexpected Stability of Qualia Perception**

Qualia are oddly impermeable to aging. Vision declines materially with age, but the red we perceive when old is the same red as we perceived when young. In very few, if any, people does red decay to, say, pink or brown, although red objects can no longer be seen so clearly because of material effects such as astigmatism or an increasing opacity of the eye lens. The same is true of hearing. For clear material reasons it becomes less acute, but once the sound enters the mental state, it seems oddly stable in comparison to the years before. The same is true of the other senses – balancing on a gym bar still feels like balancing on a gym bar although one is less capable of maintaining a stable position.

The last two paragraphs, taken in conjunction, indicate that perhaps one of the reasons for the mental database to exist is that it contributes to the stability of memory.

#### **5.9.3. The Transaction Sub-Hypothesis**

I suggest that much of the fleeting activity to which John McCrone is referring is composed of the short-lived data transactions which update the longer-term integrated mental database which is the "master". A material transaction may contain only a few, or conversely a huge number of mental instructions coming from the material domain. The transaction might, for example, be to bend a finger. The detail activity of the transaction would be visible as action potential spikes, neurotransmitters acting at synaptic junctions and so on.

As the transaction progresses and the "master" database itself is updated. Activity data, such as the bending movement, is dropped/memorized after being made. The material unit that is replaced or freed up may vary from being an ion to being a coalition of neurons. The replacing/freeing up is necessary as the brain is finite in size and neural connections. Of course, much data is deliberately dropped from the mental database because of its obsolescence.

#### **5.9.4. An Implication for the NCC**

What follows attempts to show that that the correlation in the expression of "NCC" are weak and indirect.

It would be useful to possess a mental database scanning capability, assuming this is possible which, of course, is far from sure. Of this would yield far more interesting NCC since they would show the complete current "master state" (as opposed to "state of the latest transaction") of the data, which reflects the result of the application of all the transactions ever applied to it. Such NCC might be persuaded to show the data connections functioning in new ways and enable us to get nearer to the seats of consciousness and unconsciousness.

It is almost universally agreed that a certain substrate of biomolecules is necessary for the existence of consciousness. The mental, including consciousness, is currently invisible to us. The hope is that there will be a precise one-to-one, (or at worst, an n-to-n) relation between a precise mental event (appearing as a quale which can be described by its observer) and its precise neural complement which yields a neural decrypting tool. Among others, Libet partly did this partly by direct stimulation (through the placing of an electrode on a patient's brain from whom part of the skull had been removed) to produce a tingling feeling, but the results haven't given a clear correlation because, apart from any other consideration, to find it wasn't the object of the experiment. Trans-cranial methods have also been used. For the reasons given above and below, this article permits itself the deduction that, as no-one can point to a neuronal connection in a subject and say "this neuron is carrying conscious information at this instant and is manifested in this material event", consciousness traffic is as yet effectively unidentifiable using currently available instrumentation. This is so even if the corresponding bio-electric signals have passed in turn through all the organs such as the amygdala known to be associated with the type of consciousness which is currently being experienced by the subject if she is afraid. The observer is thus entitled to propose that the ongoing conscious data flow is taking place somewhere along a path which she can't see materially. The finer the detail perceptible in time and space to brain scanning, the more likely this observer's proposal (and the "mental domain" thesis) is to be correct.

An ideal correlate would give the corresponding biomolecular activity between the physical (i.e. mental plus material) states of the input transaction and the mental states of the database, before, during and after the application of the transaction. There wouldn't be many one-to-one correspondences even if we could probe the mental states down to their lowest levels.

It is also possible that conscious activity may use a certain neural path even when none of that path's neurons are firing. This might be the case in purely mental processing. Perhaps some neurons fire nevertheless to supply energy to the mental domain.

Once the composition of the necessary consciousness substrate is known it may be relatively easy to build a mental database probe, inputting material data and receiving mental output. Personally, I would say that this will not be easy. For a start, even if we had such a probe, how would we recognize its mental output? We could input perhaps "add 2 to 3" and receive an output of "5" without being further informed on how this is done mentally.

Scanning in principle can be used to build up a complete picture of how material processing in the brain works. As more and more detail is obtained without elucidation of the mental processing detail, the more probable becomes the notion of a mental domain.

### **5.10. Mirror Neurons and Place Cells**

The same mirror neurons are activated when one is performing an action<sup>33</sup> (or feeling an emotion), or imagining that some one else is performing the same action (or feeling the same emotion). This may be taken to indicate that the material part of the action can be observed in the material indexing neurons, but the index is pointing to a different, invisible mental area according to whether one is performing or imagining the performing (or emotion). The feeling itself takes place in the mental domain and isn't visible.

If a person is in a particular known place, his corresponding hippocampus place cells will fire. This might seem to suggest that the relevant data concerning that location is encoded in that particular area of the brain. However, more than one place is held in one cell. Also the cell may reflect the direction in which the subject intends to turn. Furthermore, references to memorized objects are held, not in one neuron in one part of the brain, but in several neurons in several parts of the brain. All this favors a distributed data structure, indexing interpretation.

## **6. The MD/NI Hypotheses**

I suggest that Mental Domain/Neural Index (MDNI) hypotheses encourage new interpretations of known facts. They further support the hypotheses. A few are given below:-

### **6.1. Plasticity and Tagging**

The surprising plasticity of the brain is an accepted fact. It is less surprising if there is a stable database, stable because it is in a different domain.

a) Christof Koch<sup>34</sup>, like many others, remarks "that the brain has amazing powers of recuperation". I suggest that this is because the damage to the brain has been to only those parts of the database indexes in the material domain, but not necessarily to the data itself, which can to a large degree be used to recreate the indexes. However, the reverse doesn't apply. Indexes can't don't suffice to recreate data.

b) Below is an extreme example of plasticity<sup>35</sup>:-

"Sur is a neuroscientist who managed to reroute the auditory data down the visual tract in ferrets to the auditory cortex. Surprisingly, the ferret learned to see anyway! Prominent features from the visual cortex appeared in the ferret's auditory cortex, and the ferret was actually able to visually distinguish between different stimuli. This seems to indicate that the cells in the visual and auditory cortex are not so specialized for their task ; rather they do some analysis of the input that is entirely independent of their location in the brain. If this is true, then any good model of V1 must explain what that principle is and how it is implemented in the brain."

If this has been confirmed to be true, it is difficult to see how the actual mental processing can take place in a set of neurons placed to process auditory data. In an IT context, "tags" are sometimes placed in data streams to give information on the nature of the data and its required processing. The tag may take the form of an "escape character", which when encountered causes processing to take a different processing path from the normal one. Applying this to the brain, an alternative view of the ferret's brain plasticity is that the visual data itself is tagged by the eye's neural complex as being "visual" in nature. Although fed to the auditory neurons, through use of the tag the data stream is oriented by indexes to the visual processing area in the mental domain. In any case, it would seem that the nature of the input data may influence its subsequent processing. To progress further on this problem it would help to know which faculties were impaired by the rerouting.

## **6.2. Four Levels of Reaction in a Situation of Urgency**

I suggest the following MD/NI interpretation of our successive reactions in an emergency.

When we react swiftly, it would seem that we do so in a sequence of four levels if we have the time to do so. They are:-

- Reflex (as in a knee-jerk): this type is simple and is driven by few neurons.
- Non-conscious procedural: readied well beforehand in the material mind. This was preceded by a conscious decision made perhaps a long time ago (e.g. to participate in Libet's finger-bending experiments). This is what Libet's scans show. It also readies the material brain in a way appropriate to the anticipated urgency. For example, it is advantageous to have epinephrine present in the bloodstream in advance of the bodily reaction to the danger.
- Emotional conscious: a fast, efficient, though complex reaction built up during previous related situations. It also includes instinctual procedures and data.
- Reasoning conscious: usually yields the most appropriate response, but is also the slowest.

If we don't have more than a fraction of a second available, no conscious decision can have the time to take place. We react according to a pre-established schema, built on emotions which are either instinctual or have been implanted through the consequences of reasoning and experience. As shown elsewhere in this document, a conscious emotional reaction can take place in less time than a reasoning access conscious event, but brain scanning may not show this clearly because it isn't taking place wholly in the material domain. Reasoned and emotional decisions take time and lag the production of the first neural action potentials to occur in response to a particular stimulus. The conflation of fast instinctual, conditioned and emotional reactions followed by slow conscious decisions may lead to the mistaken conclusion that the action potential must precede a decision if access consciousness is to be causal (see "Irrelevance of the Libet Delay"). There is a fundamental difference between a reaction (which is a fast event (both mentally and physically)) and a decision (which is a slow, mentally conscious event). By preparing events in the mental and then the material domains as far as is possible a valuable few tenths of a second may be gained – the slack is taken up in the right muscles as they are tautened, the eyes and balance are facing the right way, the endocrine system readied and so on. The wrist/finger bending Libet experiments were made maximizing the preparation. The related decisional events were the ones which took place when the subject agreed to participate in the experiment and then readied his mind/body

accordingly, thus setting up the material domain to which control is passed by the mental domain. Indexes were involved with both the material and mental events.

## **7. Common Conscious/Unconscious Database Structure**

This section is intended to show that the conscious and unconscious are so inextricably intertwined that they must be using the same "semantic database" structure and sometimes share the same data.

### **7.1. Evolutionary Continuity Principle**

Evolution progresses one small step at a time. This principle obliges a common origin for the conscious and the unconscious – it would be truly remarkable that, say, the unconscious evolved first and that the brain's subsequent evolution just happened to supply an appropriate data-sharing platform for the incorporation of consciousness.

### **7.2. The Simultaneous Use of Conscious and Unconscious Data**

A person who has successfully learnt the grammar of a language unconsciously, even as an adult, is frequently unable to consciously explain how it works when he uses it. Yet he must know unconsciously because he makes use of it when constructing grammatically correct sentences. I live in French-speaking Geneva, but my written French is not as good as it might be. When I have to decide on the spelling of a particular conjugation of a verb such as "marcher", I hesitate between "je suis allé *marché* près du lac" and "je suis allé *marcher* près du lac". They are both pronounced in the same manner. To find the correct spelling, I substitute the verb "vendre" for "marcher" as an unconscious yet meaningful reference, because its infinitive and its past participle are pronounced differently, unlike those of "marcher". "Je suis allé *vendre* près du lac" sounds correct but "je suis allé *vendu* près du lac" just sounds wrong. I don't consciously consult the grammar, I just rely on the unconscious feeling for spoken French which has been dinned into me over the years.

The grammatical structure held in my unconscious is available to my conscious if I perform some grammatical analysis, which is a further argument for a common database structure and common data in some databases.

Another example is that conscious learning has to be transformed into unconscious through frequent use to become optimally useful. For example, when one learns to read as a child, one first has to consciously learn which shapes correspond to which letter. Having finished this apprenticeship, one interprets the shapes unconsciously while reading. However, at any moment the unconscious can be called back to examine the same text. One may even unconsciously over time improve one's performance of a particular task involving logic, then one day realize consciously that one has done so and the reasoning behind it.

Further examples of the availability of knowledge acquired by one type of consciousness being used by the other can easily be found. It is theoretically possible that there are different structures for the conscious and unconscious types of the mental, with an interface converting one form to the other as required. But this would have the consequence that the shared data is held twice (once in each domain) and would have to be converted when needed by the other type. This "emulation" (to give it its IT name) has proven to be extremely inefficient on computers, consuming much memory space and processing time. There is no reason to believe that the same wouldn't be true in the brain.

The unconscious is no more material than is the conscious. Therefore the distinction is made between the unconscious (in the mental database) and the non-conscious (such as incoming material sensory data). The conscious and the unconscious must have completely compatible structures to be able to interact easily. They pass data from one to the other without problem and are procedurally compatible as well. The latter is shown by the way in which a skill such as riding a bicycle passes smoothly from the phase of intense conscious concentration to that of unconscious ease. The two are nevertheless so fundamentally different that evolution can't have produced one and then relied on chance mutations to produce the other. There must have been a strong compatibility pretty well from the start.

Access and phenomenal consciousness must have evolved at almost the same time because what use would it be to scent danger if one lacked the means to flee from it? A purely material

means of fleeing may well have existed before any consciousness arrived on the scene. Its initial decisive advantage was presumably a better integration with its phenomenal counterpart. The other advantages which would soon have permitted it to oust a mechanical activation have been mentioned above.

## **8. Rebuttals of Objections to the Mental Domain**

### **8.1. Irrelevance to a Causal Consciousness of the Libet Delay**

The Libet delay of about a third of a second (between the start of neural activity and consciousness of that activity) does not invalidate the notion of a causal consciousness, as is frequently claimed, though not by Libet himself. Since a causal consciousness is necessary to my concept, I give a rebuttal using the Neural Index hypothesis:-

The subject of the experiment had familiarized himself with finger/wrist movements in the normal course of her life. She had taken all the time-consuming relevant decisions consciously hours before initiating the tested action. All procedures and indexes in both the material and unconscious areas were therefore optimally readied in preparing to initiate the required movement soon afterwards. To be optimally fast, this movement had to be initiated by the unconscious and material parts of the brain. Thus the fact that consciousness is aware only after movement initiation does not constitute a problem, since the "decision/action/consciousness of the result of an action" chain is preserved. Mental domain activity isn't accessible to fMRI or other current brain scanning techniques, so wouldn't show up anyway. In any case, whether or not a non-material mental domain exists, there is no problem for a causal consciousness coming after the Libet delay.

Another possibility is that the subject was entirely conscious from the beginning of the wrist bending action but that the beginning wasn't memorized and so couldn't be recalled. It is possible that the memorizing process required too much of the brain's resources to be set in motion immediately the action was initiated.

When we were evolving on the savannah, the animal with the fastest reactions and reflexes, albeit by a tiny fraction of a second, had a huge advantage – watching a mongoose toy with a venomous snake demonstrates the point. So evolution has a strong interest in possessing a reaction method that functions faster than full consciousness during the action.

### **8.2. Rebuttal of the "Enlivening" Objection**

It has been proposed that there is no need for the notion of a mental domain. A phenomenal event could be memorized by a material operation using a particular algorithm/procedure which performs the appropriate encoding. Then, when the memory is to be called back up into the conscious, it is enlivened (i.e. recalled phenomenally) by the application of the reverse algorithm/procedure.

There are two observations to be made here:-

- If neither the storing/enlivening procedure nor the memory of the data itself possess phenomenality, then where does it come from? Unless one accepts that consciousness is nomological (i.e. a brute fact which is true but for which no explanation exists) and that there is a complete set of NCC (which was rejected above), this proposal won't work. The proposal's enlivening algorithmic procedure must be held somewhere in the material brain. This attempt to eliminate the phenomenal mental domain has simply displaced the problem from the data area to the procedural area.

- The very fact that material can be enlivened at all means that a mental domain exists at least fleetingly. And if it exists fleetingly, then why shouldn't it exist more permanently, if this is evolutionarily useful. That it is in fact useful is shown below in this document in the section on Darwinian advantages.

## **9. Evolutionary Advantages of Consciousness in a Mental Domain**

One frequently hears the argument that the functions of a phenomenal consciousness can be supplied by a purely computational brain. This may or may not be true but is, in any case, beside the question – Nature undeniably did furnish us with a phenomenal consciousness, as John Searle so conclusively demonstrates<sup>36</sup> – at least to my satisfaction and that of many others more

illustrious. However, there are very good reasons for Nature to have chosen the mental approach. A selection of them is listed below:-

### **9.1. Material Resources Economy**

Qualia are held in the mental domain, where capabilities take up no material weight or volume, apart from that required for their support, such as the furnishing of energy . This comports clear advantages to the animal concerned.

That the brain goes to great lengths to minimize the number of memories held is shown by the existence of "inattentional blindness" and "blindsight" type functions. We are surprised by the first but in practice the sort of situation in which it occurs would rarely be found on the savannah, where one knows all the members of one's own tribe and most of the neighboring ones.

### **9.2. Malleability and Modularity**

The fact that we intellectually relate so easily to the structure of the relational data base suggests that this is an important part of the way our minds work. The mental appears to be more malleable than computation in the hands of Nature. An important barrier to a computational brain is that step-by-step neuronal evolution is ill-equipped to produce so efficiently structured an engine as the mind/brain. Experience with artificial neural networks shows that after an initial spurt, they have difficulty in generating radically new structures. To possess a tree structure, computers have to have a database embedded by the persons building it. A database is fundamental for the human way of thinking. Despite the promise foreseen for them thirty years ago, AI systems are still limited largely to university labs and the tuning of the data of pre-existing systems. I don't personally know of one which spontaneously constructed an equivalent to the homeotic gene, for example (though I admit to having little knowledge of this area). Even for simply analyzing data on a computer, tree systems produced by humans are superior to evolved neural nets<sup>37</sup>, let alone for generating viable organisms. The reason we built databases is that we find it easy to think in its terms, such as entities, relations, etc. The very fact that neural nets don't seem to be capable of autonomously generating tree structures (let alone a structured database) argues that there is something important lacking in the computationally evolving approach, even in its own non-phenomenal terms. We couldn't think at all clearly if we lacked hierarchy and relational capabilities. Nature favored the establishment of a base system of laws and substances which made structured Darwinian evolution possible. One may imagine that an expanded physics contains new laws and substances for each sense, thus providing evolution with a modular capability right from the start.

Below I suggest certain advantages derived from the modularisation and variety perhaps available from Nature:-

In considering this matter we can use the analogy and terminology of IT. "Spaghetti Coding" is the undesirable complex program branching which occurs when "if ... then ..." and "go to ..." branching statements proliferate and the system ends up by becoming incomprehensible even to the programmer who wrote it. This is the result if the system isn't subdivided into functional modules. If the whole mind system consisted of one module, then the mind's equivalent of spaghetti coding would be generated, whereby any single mutation having a beneficial effect would frequently spark multiple harmful changes throughout the whole system. The ideal is to have many modules with separate functions and few interactions between the modules. This is favored by having the mind modularized through latching on to pre-existing separate and sub-divided mental and material domains. These modules are then further subdivided into different mental modules, databases, emotions and sub-domain senses derived from the structure of the universe, not from some single- domain material coding. For example, the body possesses several different endocrine sub-systems. One can see an exceptional occurrence of the spaghetti problem in the material body when a gene useful in fighting malaria gives rise to sickle cell anemia, presumably in response to the rapid outbreak of the first-mentioned illness. Although one can see that the gene structure of DNA is effectively modularized within the limits possible, the modular type of mind would be very difficult to develop harmoniously using only the material domain available to material evolution. As mentioned above, the problem is even more severe in computerized neural nets, where only one type of module medium (the material) exists, as in the single material domain approach proposed by Stephen Pinker<sup>38</sup>.

Change and inattentive blindness's seems to me to be only examples of the economy of resources which the brain is forced to respect. The examples given wouldn't occur on the savannah during evolution. For instance, a harmless gorilla walking around some distance away and separated from us by a barrier has no immediate priority for our attention, but at ground level in the Central African rain forest our reaction would be swift. There, if feeling in danger from approaching gorillas, one might be excused for not noticing a basket ball player among them.

It is now known that a particular region used in feeling, say, pain, will also be activated when empathizing with someone else feeling pain. Looked at from an IT point of view, this has the obvious advantage of enabling the brain to use modules which are common to different situations, thus economizing on the use of brain space. Obviously evolution pushes the brain to accommodate as much functionality as possible within the minimum volume, thus forcing it to produce functional modules. It is suggested that the existence of these so-called "mirror neurons" may be simply an example of the same modules being made available for use by several different mind functions. In the computer context this is referred to as "re-usable code" or "reentrant programs". One may therefore expect to find the use of mirror neurons in several contexts. Of course, optimization of modularization may not be the only justification but it is a powerful one.

### **9.3. Powerful "Presentation Language"**

In IT, the storage and retrieval of data is done by the database. The presentation of the retrieved data to the user on his screen is done by a language whose power optimizes the ease and efficiency with which this is done. The presentation of data through qualia is presumably favored by the power and flexibility of the phenomenal "language", whose functions have been "written" by evolution for that very purpose. Otherwise evolution would have used material means to do so.

However, if there is such a presentation language, then the computer models of qualia (e.g. fear) remain valuable for simulation and other purposes, but don't closely resemble the actual methods used by the brain to experience them.

### **9.4. Protection from Viruses**

As the mental is segregated from the material world, it is protected from the harmful parasites which inevitably try to attach themselves to any entity available, whether it be a computer or a brain cell. These parasites present a serious problem for both computers and the eukaryotic cells of which the material brain is made.

## **10. Further Comments**

### **10.1. The Efficiency of a Semantic Memory**

Words which are arbitrary labels, such as proper names, are the first to be forgotten through age or Alzheimer's disease. This may be so because they aren't so intrinsically semantic. Frequently we can remember an object or event or face although we can't remember the name it's attached to. Names are evolutionarily recent. We see advertisements for systems guaranteed to significantly improve our memories. They usually rely on associating arbitrary labels with a meaningful object, such as a number with a picture of a house. This is a further indication that our memory is fundamentally semantic.

### **10.2. Non-Evanescence of Memory**

The data in the mental domain can't be evanescent because that would imply that it would be lost during the night.

This, in turn, implies that the thought experiment whereby replacing a brain atom by atom with silicon chips produces a zombie is not possible. This is because the mental domain, being causal, is not derived from the material domain only.

### **10.3. Memory Retention Capability and Cascading Indexes**

The brain contains some ten billion neurons. As an IT person, my gut reaction is surprise that so much can be held in so few neurons. This is not due just to the volume of data, it is also the volume of indexes and the image processing capabilities involved. The latest computerized security

systems, which can't even reliably recognize a human face, take up an enormous amount of resources in failing to do so. These systems need several orders of magnitude more resources than that required to display a face represented by an index-less bitmapped photograph described by text.

It has been advanced recently that, in fact, we remember little of a given scene when asked to recall its details. I believe that this estimation takes into account only primary indexed memory (that which we access without using more than the original primary indexes). If we take the example of a friend's face, it is true that there are stringent limits to how much detail we can recall on paper through writing down a description. But this omits the huge amount of passive secondary data that springs to mind when we have the face of the familiar person in front of us, permitting us to easily distinguish between most identical twins, though having been incapable of describing their differences beforehand. This passive data must have been stored somewhere. A competent artist will apparently remember much more than an ordinary person. He is helped in doing this by first drawing an outline of the face's features, than using the information indexed by the outline to successively index and access more and more secondary detail, rather in the successive approximation method used by the police in building photofits. The brain can't afford to assign primary indexes to every detail any more than can the computer's database. A series of cascading indexes is necessary to both engines.

The brain isn't large enough to hold all possible indexes, linking every data element value with all its occurrences. This is illustrated in the way in which the brain has been obliged to economize when we try to recall an almost forgotten word. We find it much easier if we know with which letters, or syllable, the word begins. Knowing the letters in the middle or end of the word is less useful. This is a use of "partial indexes". The primary index consisting of the first part of the word gives access to all words beginning in this manner, from which the secondary indexes select the appropriate word. Again, the database and the brain act in the same manner.

## **11. Testables**

### **11.1. The Addiction Testable**

An important barrier to understanding animal behavior is that it is difficult to communicate with the animal concerned. It is suggested that addiction can be used as a way of obtaining feedback from the subject organism on the qualia it perceives.

The regular ingestion of cocaine by a human being soon results in dependence. This is observed as a fixation on the consumption of cocaine to the detriment of essential activities such as foraging and taking shelter from danger. Humans become cocaine addicts because it gives a "high". Other animals as disparate as elephants and dogs are well known to also be potential addicts to cocaine and alcohol. A high (or a low) is expressed as a quale, since it yields a phenomenal percept such as pleasure or pain. It would be interesting to see just how far down the evolutionary ladder we would see this addiction. For example, we could set out two small dishes of sugared water, one of which also contains cocaine. The subject, a moth, can choose either. If it spends an inordinate amount of time with the drug dish, to the detriment of normal activities such as flight and mating, we can justly entertain the notion that it is "hooked". If this is so, we can reasonably speculate that the moth has a brain which supports some kind of consciousness in some way resembling our own. To confirm this we can test the animals evolutionarily intermediate between ourselves and moths. We could then follow up other factors, such as the need for sleep, the continuity of neurotransmitters, which are present in early brains such as those of the chordates of hundreds of millions of years ago and of which we are descendants, as mentioned above.

It is important to identify the lowest point in evolution at which qualia exist as the simplicity of the brain involved will significantly help in identifying the minimum substrate needed for consciousness to exist.

### **11.2. Particle Accelerator Bombardment**

The mind and the material brain are constantly interacting in the ways given by Quantum Theory. Many physicist workers (Walter Stapp, Stuart Hameroff, Alwyn Scott<sup>39</sup>, etc.) in the field of consciousness, probably even the majority, believe that the explanation for consciousness will require the application of Quantum Theory, either in its current or in an extended form. This being

so, it is tentatively suggested that bombarding actively conscious neural tissue with the various types of sub-atomic particles and fields at the disposition of the different types of accelerator might show up something novel in terms of the particles themselves, their paths, their collisions, their energy interchanges, the effects on the behavior of the animal involved, etc. Ethical standards wouldn't be violated because of the potential medical applications.

## **12. A Parsimonious Approach**

Many of my neurochemist and computational colleagues find it difficult to accept that physics doesn't impose a mechanistic view of the universe. So, below, I further belabor the subject of the limits of current physics in an attempt to convince the reader that the non-material mental domain is not improbable. The reader informed in physics may wish to skip it.

### **12.1. Difficulties with Materialist Theories of Consciousness**

To summarize, important difficulties with current proposed materialist solutions for the question of consciousness include:-

- Their fundamental lack of phenomenality, which, after all, constitutes the Hard Problem itself. To add to the problem, phenomenality can be located in body-space. Through the connecting nerve, I feel a pain in my right big toe when I stub it. How is this achieved given that the pain sensation is presumably generated in the brain?
- The lack of a satisfying justification in Darwinian terms for the existence of consciousness.
- The bridging problem which faces all forms of dualism.
- The lack of explanation in nomological and eliminationist propositions which state that the consciousness problem is solved by stating that consciousness is either an irreducible natural consequence of the brain's make-up or that it simply doesn't exist. Both are in effect saying that there is nothing important in this context left to be discovered by science. This seems pessimistic given that physics and neurobiology have only begun to apply themselves seriously to the mind/body question.

### **12.2. Difficulties with the MDNI Hypothesis**

- The only important difficulty is the fact that current physics doesn't currently include the notion of a mental domain.

My answer is that there is also nothing in current physics to say that a mental domain can't exist in an expanded physics and a lot to say that it can. The incompleteness of current physics (see below) shows that there is plenty of room for new concepts. Once the notion of a mental domain is accepted, the neural index/interface becomes necessary.

Even in current physics, a mental domain and neural indexes must exist for the reasons given at the beginning of this paper.

### **12.3. Relative Importance of the Difficulties**

In my opinion, the difficulties with current theories concerning NCC are significantly greater than those with the MD/NI hypotheses.

Darwin was faced with what appeared to be an unanswerable objection to his theory concerning evolution. The rate of cooling of a thermally hot sun wouldn't support an age of the solar system greater than a few thousand years – much too short a time for natural selection to operate. Darwin himself was mystified, but took the right decision in saying there must be an as yet unknown mechanism for heating the sun. He was seen to be right when thermonuclear fusion was discovered. I suggest that we are now in a somewhat similar position with respect to the existence of the mental domain.

### **12.4. The Incompleteness of Physics**

The following list includes some of the huge physical questions which mainstream physicists agree that current physics hasn't answered:-

- Why something rather than nothing (Heidegger's question)?

## The Mental Database

- The universe started with the Big Bang. What came beforehand? What came before that? Obviously our notion of time itself is deficient.

- Almost all of the values of the important constants of physics can't be deduced. They have to be found experimentally and then plugged into the equations. An example is the masses of the different particles. Furthermore, current physics cannot deduce the number of dimensions our universe possesses, with the exception of string theories still in the process of formulation.

- Where and what is the dark matter that makes up most of the universe?

- The "Grand Unified Theory (GUT)", unifying General Relativity and Quantum Theory, has not yet been found.

- The "Theory of Everything (TOE)", combining all known phenomena in the terms of physics remains elusive.

It is often said that many of these questions are not for physics. The reply is that, physics cannot place limits on possible answers to a question if it won't entertain it. Secondly, any physicist who found the answer to any one of these questions would be top of the short list for the next Nobel physics prize, as, for example, did those who confirmed the Big Bang<sup>40</sup> and its indication of the beginning of time as we know it .

Many neuroscientists<sup>41</sup> believe that consciousness will prove to be *emergent* from the material (i.e. current physics), through a better understanding of the possibilities of increasing complexity. However, the best current physics (which, although dependent on randomness, is computational) can do is to explain in reducible terms a Turing machine. A bigger and better Turing machine is still a Turing machine, incapable of phenomenality, which is agreed to be produced by 1.3 kg of brain. John Searle's "Chinese Room" expresses vividly that even while calculating, let alone feeling an emotion, we are in some sense phenomenally conscious and not Turing machines. Neuroscientists have more faith in current physics than do physicists.

### **13. A Fanciful Implication of the MDNI Hypotheses**

If one deletes an entire Word document from the Recycle Bin of one's PC, the data disappears. However, materially it still exists on the hard disk. What has been deleted is only the layer of indexes giving access to the data and which can be recreated by a specialist (as several financial criminals have found to their cost). Perhaps re-creation of the mind's indexes, which are deducible from the data itself, recover the data for perusal in another universe. Or perhaps the indexes are maintained in parallel with our real-time. Perhaps when material neurons die the data remains in a permanent mental domain.

I don't for a moment believe any of the above to be true. However they do illustrate the creative possibilities of a database approach. In any case, as so many great minds have remarked so often, the universe is so weird a place that a concept can't be eliminated solely because it appears bizarre to us – many of the concepts now accepted by all respected mainstream physicists in the quantum physics context are no less strange and were initially refused on the grounds of their queerness. The "Many Worlds Hypothesis", which is now accepted by some mainstream physicists as being a possible means of elimination of the arbitrary collapse of the wave function and also the elimination of the need for a possibly conscious observer. However, this theory does possess what some find to be a disadvantage in that it creates a near infinity of universes every microsecond, each of which produce a near infinity of universes every microsecond<sup>42</sup> and so on.

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- <sup>1</sup> Block, Ned, (1994), *On a Confusion about a Function of Consciousness*
- <sup>2</sup> Chalmers, David (1996), *The Conscious Mind*, p.xii-xiii
- <sup>3</sup> Penrose, Roger (1995), '*Shadows of the Mind*', p. 39  
"we are trying to grasp [consciousness] in some way – a genuine scientifically describable phenomenon, playing an active ... role in the physical world".  
The thrust of Penrose's work on consciousness is in this direction.  
In *The Large, the Small and the Human Mind* (1997) p.102  
"Maybe future science will describe the nature of consciousness but present day science does not".
- <sup>4</sup> Penrose, Roger (1995), '*Shadows of the Mind*', pp. 12-17. The purely computational approach corresponds to Penrose's viewpoint **A**.
- <sup>5</sup> Libet, Bernard (2004), *Mind Time*, pp. 157-84
- <sup>6</sup> Searle, John R. (1980a), *The Rediscovery of the Mind* (1994), p. 45
- <sup>7</sup> Penrose, Roger (1995), '*Shadows of the Mind*', pp. 14-15
- <sup>8</sup> Blackburn Simon(1996), *Oxford Dictionary of Philosophy* pp. 233, 287
- <sup>9</sup> Eddington, Arthur, as quoted in *Quantum Questions*, p. 195, edited by Ken Wilbur(2001)
- <sup>10</sup> Searle, John R. (1994), *The Rediscovery of the Mind*, pp. 12-13
- <sup>11</sup> Montero, Barbara (2001), Post-Physicalism, *Journal of Consciousness Studies*, 8 (2), pp. 61-79
- <sup>12</sup> Blackburn, Simon (1994), *The Oxford Dictionary of Philosophy*, p. 287
- <sup>13</sup> Gauna, Max (2000), '*Montaigne and the Ethics of Compassion*', pp. 26-27 in *English*.  
The original French is: "*Mais comme une impression spirituelle face une telle faucée dans un massif et solide, et la nature de la liaison et couture de ces admirable resorts, jamais l'homme ne l'a sçue*". (II xii 520, A)
- <sup>14</sup> Searle, John R. (1992), *The Rediscovery of the Mind*, p. 45. "The Chinese Room" demonstrates the semantic, phenomenal aspects present in a mind performing a data comparison action involving consciousness.
- <sup>15</sup> Penrose, Roger, (1989), *The Emperor's New Mind*, pp. 23 – 29.  
Penrose comes down on the side of Searle in commenting on "The Chinese Room"
- <sup>16</sup> Searle John R, (1992), *The Rediscovery of the Mind*, pp. 206-8
- <sup>17</sup> Libet, Benjamin (2004), *Mind Time* (Harvard University Press) pp. 70-73
- <sup>18</sup> Block, Ned (1994), *On a Confusion about a Function of Consciousness*
- <sup>19</sup> Koch Cristof (2004), *The Quest for Consciousness*, p.13
- <sup>20</sup> James, William (1879; 1890), quoted from the *Stanford Encyclopedia of Philosophy*:-  
Epiphenomenalism ... offered an intriguing variant of the argument from natural selection. If pleasures and pains have no effects, there would seem to be no reason why we might not abhor the feelings that are caused by activities essential to life, or enjoy the feelings produced by what is detrimental. Thus, if epiphenomenalism (or, in James' own language, automaton-theory) were true, the felicitous alignment that generally holds between affective valuation of our feelings and the utility of the activities that generally produce them would require a special explanation. Yet on epiphenomenalist assumptions, this alignment could not receive a genuine explanation. The felicitous alignment could not be selected for, because if affective valuation had no behavioral effects, misalignment of affective valuation with utility of the causes of the evaluated feelings could not have any behavioral effects either. Epiphenomenalists would simply have to accept a brute and unscientific view of pre-established harmony of affective valuation of feelings and the utility of their causes.
- <sup>21</sup> Penrose, Roger (1997), *The Large, the Small and the Human Mind*, p. 59
- <sup>22</sup> Mills, Robert (1994), *Space, Time and Quanta*. See Chapter 15 on "The Observer", pp. 359-375
- <sup>23</sup> Chiu J., De Salle R., Lam H.-M., Maisel L., Coruzzi G. (1999). Molecular evolution of glutamate receptors: A primitive signaling mechanism that existed before plants and animals diverged. *Mol. Biol. Evolution* 16 : 826-838
- <sup>24</sup> Allman, John (1999), *Evolving Brains*, Scientific American Library, 1040-3213; no. 68, p. 20-21, 68-71
- <sup>25</sup> Gazzaniga, Michael, Richard B. Every, George R. Mangun (2002), *Cognitive Neuroscience* (New York and London: W.W. Norton), p 578 'The human brain is a unique amalgamation of evolutionary old areas and new areas that have been modified in predictable ways through expansion or reduction of existing parts, formation of new connections and adaptations ...', *Cognitive Neuroscience* p. 578

<sup>26</sup> Allman, John (1999), *Evolving Brains*, Scientific American Library, 1040-3213; no. 68, p. 23

<sup>27</sup> Gould, S. J. , Eldredge, N. (1977), Punctuated Equilibria, *Paleobiology*, **3**: pp. 115-51.

This theory doesn't mean less steps per useful mutation; it only indicates that most of the steps are taken within short bursts, so continuity is conserved.

<sup>28</sup> Churchland, Patricia (2002), *Brain-wise*, pp. 224-229 is the most easily accessible reference.

<sup>29</sup> Naccache, Lionel et al (2005), *Proceedings of the National Academy of Sciences vol. 102, p. 7713*  
Cited in the New Scientist of 21 May 2005, p.20

<sup>30</sup> Libet, Bernard (2004), *Mind Time*, pp. 72-73

<sup>31</sup> Gazzaniga, Michael, Richard B. Every, George R. Mangun (2002), *Cognitive Neuroscience*, p. 543

<sup>32</sup> McCrone, John (2004) *Science and Consciousness Review*, who cites:-  
Star EN, Kwiatkowski DJ and Murthy VN. Rapid turnover of actin in dendritic spines and its regulation by activity, *Nature Neuroscience* 5:239-246 (2002)

Ehlers MD.(2003), Activity-dependent regulation of postsynaptic composition and signaling by the ubiquitin-proteasome system. *Nature Neuroscience* 6:231-242  
Shimizu E, Tang YP, Rampon C and Tsien JZ. NMDA (2000) receptor dependent synaptic reinforcement as a crucial process for memory consolidation. *Science* 290:1170-1174

Lisman JE and Fallon JR. What maintains memories? *Science* 283:339-340 (1999)

Wittenberg GM, Sullivan MR and Tsien JZ (2002),. Synaptic Reentry Reinforcement Based Network Model for Long-Term Memory Consolidation *Hippocampus* 12:637-647

<sup>33</sup> Becchio C., Bertone, C, (2005), Beyond Cartesian Subjectivism, *Journal of Consciousness Studies*, 12 (7), pp. 20-24.

<sup>34</sup> Koch Cristof (2004), *The Quest for Consciousness*, p. 34.

<sup>35</sup> [www.cs.rochester.edu/users/grads/jshaw/neural/node4.html](http://www.cs.rochester.edu/users/grads/jshaw/neural/node4.html), *Views from Artificial Intelligence*

<sup>36</sup> Searle, John (1997), *The Mystery of Consciousness*, p.45, containing his famous *Chinese Room* thought experiment, (1980a)

<sup>37</sup> Two studies came to the conclusion that the "decision tree (symbolic) approach yields more accurate results than the neural network (subsymbolic) method." They were by:-

- Saedler and G. Theißen ([www.inb.mu-luebeck.de/publications/publikationen-d.html](http://www.inb.mu-luebeck.de/publications/publikationen-d.html))

- Werner Dubitzky, Martin Granzow, Daniel Berrar  
([www.infi.ulst.ac.uk/~cbbq23/papers/camda00\\_02.pdf](http://www.infi.ulst.ac.uk/~cbbq23/papers/camda00_02.pdf))

<sup>38</sup> Pinker Stephen, (2002), *The Blank Slate*, (Viking Adult)

<sup>39</sup> Scott, Alwyn (1995), *Stairway to the Mind*, p.16

<sup>40</sup> Penzias and Wilson (1978), *while working as electrical engineers for Bell Labs.*

<sup>41</sup> Koch, Christof (2004), for example "*The Quest for Consciousness*", p. 3

<sup>42</sup> Hugh Everett III (1957). The phrase "Many-Worlds" was first used by Bryce DeWitt