New Theory

Psychiagenia

A Gauge Theory for the Mind-Brain Problem

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Abstract

Science explores the brain, but fails to explain how our subjective experience of the world is linked to it. This is the 'mind-brain problem'. Many theories have tried to solve the issue: some are based on dualism, most are based on materialism. A third current suggests that the mind and brain may have a common root (this is often called 'double-aspect monism'). In this paper, this common root is called 'psychiagenia' and the impossibility of directly assessing it is placed at the core of the mind-brain problem. In order to explain why psychiagenia is not directly assessable, a theoretical model of physics known as the 'superstring theory' is used as an analogy. This model offers a very unusual description of nature that has proved to be useful when confronted with the inconsistencies in a unified description of the world. The logic of the superstring theory (a 'gauge theory' for quantum physics) is here applied to the description of psychiagenia. New perspectives for the understanding of the mind-brain problem are then raised and discussed.

Key Words: psychiagenia, mind-brain, gauge theory, quantum physics

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"I have noticed when I was younger, that lots of old men in the field couldn't understand new ideas very well, and resisted them with one method or another, and that they were very foolish in saying these ideas were wrong – such as Einstein not being able to take quantum mechanics. I'm an old man now, and these are new ideas, and they look crazy to me, and they look like they're on the wrong track. Now I know that other old men have been very foolish in saying things like this, and, therefore, I would be very foolish to say this is nonsense. I am going to be very foolish, because I do feel strongly that this is nonsense! I can't help it, even though I know the danger in such a point of view. So perhaps I could entertain future historians by saying I think all this superstring stuff is crazy and is in the wrong direction."

Richard P. Feynman (1918-1988), Nobel Prize for Physics

INTRODUCTION

At the crossroads of many sciences, the mind-brain problem remains a key unsolved question. Although originally a purely philosophical, not to say a religious matter, it has now become the central dilemma of neuroscience, as well as a training ground for artificial intelligence and medical imagery. If cognitive psychology satisfactorily studies the mind, and if medical imagery now brilliantly captures the mechanics of the brain, the main problem remains unexplained – that is: what is the relationship between the objective neural structure of the brain and the subjective manifestations of consciousness?

Over the centuries, many theories have attempted to answer that question. These can be found elsewhere (Hobson, 1999; Cacioppo *et al.*, 2000; Godfroid, 2002c), but let us assume that they can be divided into three categories: 1) dualistic theories, 2) materialistic theories, and 3) non-dualistic-non-materialistic theories. Among the representatives of this last group, Dutch philosopher Spinoza's point of view has been the most stimulating alternative to dualism and pure materialism. According to Spinoza, the mind and brain are only two manifestations of a third entity (Spinoza, 2000). The correlations between subjective phenomenon and brain processes are thus the manifestations of their shared root (Della Roca, 1996). This theory of the common root has later been developed by the German philosopher Hartmann, who hypothesised that the common root was by essence 'not psychical nor physical' (Hartmann, 1975); this is called 'neutral monism'. The mind-brain problem would then lie in the impossibility of directly assessing the shared root of those two entities. Indeed, the very nature and localisation of this common root being unknown, the question simply seems to be shifted.

This paper presents an original analysis of the problem of consciousness based on a development of the common root theory. 'Psychiagenia' is the term that will be used here to describe that common origin (Godfroid, 1998; Godfroid, 2002b). After a brief summary of some important notions of physics, the theory of psychiagenia will be presented as a possible solution for the mind-brain problem. A theoretical model known as the 'superstring theory' (Green, 1985; Davies and Brown, 1988) will be used in order to explain why the common root of mind and brain is not directly assessable. I will use it *as an analogy*, in order to show that a possible answer to the 'hard problem' of neuroscience might come out of the logic of a theory that has solved another difficult problem of science, the relation between gravity and quantum mechanics.

AN OVERVIEW OF THE RELEVANT NOTIONS OF PHYSICS

Four forces rule nature: gravity, electromagnetism, strong nuclear force and weak force. Each one is associated to a messenger particle: the graviton for gravity, the photon for electromagnetism, the gluons for the strong force and three particles known as W+, W- and Z for the weak force. The behaviour of all these subatomic particles is governed by the quantum theory. According to this theory, a messenger particle is a discrete packet of a force, or quantum. For example, the photon is the quantum of the electromagnetic field. Subatomic objects can thus be regarded as particles or appear as waves – although not at the same time (in fact, an individual system always appears as a particle; the wave aspect is inferred statistically). This wave-particle duality is crucial to the quantum theory, as one can never simultaneously determine both the momentum (wave) and the position (particle) of a quantum object. This imprecision is irreducible, and is known as Heisenberg's uncertainty principle.

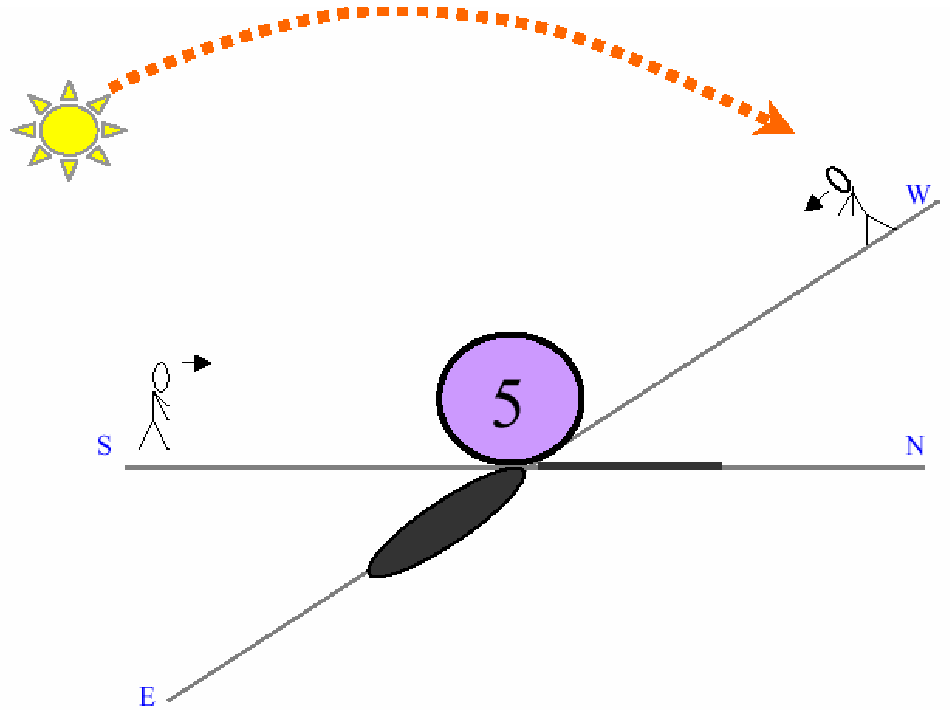

Figure 1. Mind and brain: analogy with two shadows of a coin

Any system in nature is a quantum system; even if under certain conditions some could approximately be described using classical laws of physics. Nonetheless a major problem remains when attempting to unify the forces in a unique theoretical frame: the inconsistency between the gravity theory and quantum mechanics (Green, 1986). Gravity is elegantly described by a non-quantum theory: the general theory of relativity, but its reformulation according to the rules of quantum mechanics leads to mathematical inconsistencies (Davies and Brown, 1988). Indeed, the quantum theory of gravity creates infinities and anomalies (i.e., symmetry breakdown – a notion to be explained below). The main problem here lies in the non-linear nature of gravity, contrasting with all the other forces. Gravity is said to be non-linear because gravitons (that is, the messenger particles of gravity), unlike the other particles, can interact with each other. Gravitons cannot simply superimpose on each other like photons, instead they create mutual disturbance.

However, the search for a unified theory of all the forces is still acceptable using another framework: the superstring theory, or M-theory (Kaku and Lynn, 1998; Greene, 1999; Gribbin, 1999). Quantum physics usually considers messenger particles to be point-like. In the string theory, the messenger particle is no longer a point but a little vibrating string of 10^{-33} centimetres across (Green, 1986) – or 10^{-18} centimetres, as was recently proposed (Antoniadis *et al*, 1998). By way of comparison, an atom might be 10^{-8} centimetres across. Moreover this superstring can vibrate at different frequencies (or harmonics), and the different harmonics of the string correspond to the different elementary particles. Thus the graviton, the photon, the gluon and W+, W- and Z are different frequencies of vibration of an elementary small string. Viewed as strings instead of point-like particles, subatomic entities, as well as forces, can be integrated in a common description of nature: a theory of everything (TOE). The search for a TOE has subtended the evolution of physics within the last century, and there are strong arguments for considering the superstring theory as a possible TOE (Davies and Brown, 1988; Greene, 1999).

The 'super' prefix in superstring refers to the notion of supersymmetry – an abstract mathematical concept (Gribbin, 1999; Kane and Witten, 2000). Supersymmetry is a powerful theoretical idea providing a geometrical framework within which bosons and fermions (two major classes of subatomic particles) receive a common description, becoming in a way two different "images" of a single underlying entity. The unifying of particles in a common theory needs the concept of supersymmetry: a symmetry of physical laws. Electromagnetism, strong and weak force are theories within which the notion of symmetry is used to describe the property of the force fields – they are called 'gauge' theories (Davies and Brown, 1988). The description of this gauge symmetry needs strong mathematical concepts known as 'group theory'. The superstring theory is thus a complex gauge theory allowing the unification of the general theory of gravity with quantum mechanics.

An important point is the fact that in the theory, strings vibrate not only in space but in time too (Green, 1985). Replaced in the Einsteinian four-dimensional world (three spacial dimensions plus time), this leads to mathematical inconsistencies. In fact, the superstring theory only works if space has nine dimensions, and thus spacetime ten dimensions – which is its more striking conceptual consequence (Green, 1986). Anyway we are unable to discern these six extra dimensions because they are so efficiently curled up that they cannot be observed (see Randall (2002) for a recent review on the possibility that extra dimensions can even be macoscopic).

Finally, the concept of 'decoherentization' is another physics notion that will be used here as an analogy. According to Gell-Mann, decoherentization can be described as a way of allowing very small scale phenomenon to be studied in our scale, using *amplification* and *nullification* (Gell-Mann, 1995). This can only be understood if one accepts the idea that any system in nature is a quantum system – that is, at a scale level too small for direct observation. If one could observe planet Mars at a quantum level, one would only see a diffuse ensemble of particles interacting with photons coming from the sun. To see Mars at our human level, we need to nullify the interaction of Mars with the other planets, and to amplify the quantum reality of this planet in order to allow our eyes to identify it as an independent physical reality. Of course we can *imagine* the quantum reality of Mars, but we cannot visualize it – and in a way a parallel can here be made with Heisenberg's uncertainty principle: the more you explore the structure of nature, the less you have a genuine image of it.

APPLICATION TO THE MIND-BRAIN PROBLEM

I will now expose the theory of psychiagenia and discuss how the string theory might be relevant. First of all, I will assume that any system in nature is a quantum system, and thus the mind/brain system, being part of nature, is also a quantum system (Stapp, 1996; Globus, 1998). More precisely, and in other words, assuming that the string theory is a TOE, this theory is relevant to the mind-brain problem (Godfroid, 2002b).

Cerebral imagery demonstrates that the brain has 4 dimensions (3 spatial and time). This is represented by φ_4. I postulate that the mind is inseparable from brain function but is not reducible to it because it has a different number of dimensions (n), represented by: ψ_n (with $|n|>4$). I call psychiagenia (P) the mind and brain relationship, as:

$P=\psi_n \varphi_4$

Psychiagenia thus designates a unique and indivisible entity of which the brain is a 4 dimensional representation and the mind an *n* dimensional representation. Psychiagenia is not reducible to these representations.

The theory can be illustrated by the following analogy (figure 1). Let us imagine a coin, posed on its edge in a North-South axis. This coin is not directly visible to two observers (one to the South, the other to the West), but its shadow is. When the sun shines behind the southern observer, his image of the coin will be a simple line of shadow – let us assume here that this is a one-dimensional representation of the coin. On the other hand, the western observer will perceive an oval shadow when the sun is behind him – that is, a two-dimensional representation of the coin. These two observers will thus have both a correct description of the object, but divergent ideas regarding its real shape. Moreover, they will both be unable to give a precise description of the three-dimensional structure of the coin: their method of observation has led to the loss of one or two dimensions.

Psychiagenia can also be viewed as a 'third entity': a common root to our perception of the brain and of consciousness. The analogy with communicating vessels gives another illustration to the model. Indeed, in the theory of psychiagenia, the mind and the brain can be viewed as two communicating vessels: the alteration of a vessel leads to a modification of the level of the other one. From another point of view, there is a continuum composed by the two vessels and their common part. The 'mind' vessel and the 'brain' vessel are thus intimately linked. Let us imagine that you cannot observe both of them at the same time: you will hardly see any logic in the variation of level measurements. Observations could only be interpreted as an estimation of an inaccessible entity – in others words, a gauge.

DISCUSSION

When I first read about the superstring theory I was somewhat confused because the description of our world that was subtended is far from the common-sense picture. The elementary entity of nature is a string vibrating through space and time in a ten-dimensional world ruled by quantum physics. Understanding that the world could be correctly described far from common logic was nonetheless very helpful when I tried to assess consciousness with new arguments.

Dualism and materialism are the most frequent answers to the mind-brain problem (Godfroid, 2002a). For dualism, the mind and the brain are different in essence (Eccles, 1986). Materialism – a dominant theory in neuroscience nowadays – postulates on the contrary that each mind state results from a brain state, and cerebral mapping is its principle research route (Andreasen, 1997; Kandel, *et al.*, 2000). Neither of these trends is particularly satisfactory when we come to appreciating the complexity of the human mind (for a complete discussion, see Godfroid, 2002c). There are two reasons for this: firstly it is not easy, without taking a simplistic view, to encompass such diverse elements as consciousness, free will, subjectivity, memory, or the unconscious in one theory alone, and to associate these phenomena with a cerebral substratum of which the complex biological nature is becoming increasingly better known (Varela, 1996; Austin, 2000). The other reason is that the approach to the mind-brain problem is all too rarely multidisciplinary, which explains why no model entirely satisfies the laws of biology, physics and psychology all at the same time. The theory of psychiagenia is an attempt to reconcile and unite these views.

Strengths and implications

The theory of psychiagenia is an alternative to dualism and materialism. It is a post-spinozian model, that is: mind and brain are two manifestation of a *common root*, called 'psychiagenia'. If we consider the possibility of a common root for the mind and brain, then a lot of inconsistencies now make sense. The impossibility of medical imagery assessing subjectivity becomes trivial: imagery is examining the brain, not the mind. Both of them are nonetheless linked, and a mind activity (e.g., thought, emotion, memory) produces an objective modification of the brain (that is, glucose and oxygen consumption, blood circulation reorganisation). An alteration of the brain (e.g., head injury, stroke, psychosurgery) produces a modification of the mind (amnesia, depression, behavioural disturbances) as well. This apparent paradox can be explained using the analogy with a 'gauge': mind and brain are simply linked like communicating vessels. Moreover, classical observations reporting the preservation of thought (subjective phenomenon by essence) in the absence of language (Alajouanine and Lhermitte, 1964; Weiskrantz, 1988; Laplane, 1997), as occurs after the destruction of the Broca area of the cortex by a stoke – a state known as 'aphasia' – may be interpreted as evidence in favour of the existence of a common root for the mind and brain. Indeed, psychiagenia seems unaffected when the existence of thought remains without its 'usual vehicle' (see Carruthers (2002) for a discussion of contrary views).

After Spinoza and Hartmann, the problem then appears to lie in the impossibility of directly assessing the common root. This difficulty is certainly raised again by the theory of psychiagenia, which can be described as a form of monism where all properties of 'matter' (that is, the common root matter) are not directly assessable. Medical imagery can nonetheless reveal the cerebral areas participating in some subjective experience (Sergent, 1994) – e.g., alteration of the metabolism of certain cortical regions during memory tasks or emotions (Reiman *et al.*, 1997). This inconsistency may be avoided within the superstring framework. My theory postulates that the mind and the brain are two different perceptions of a single underlying entity. In other words, I propose a common description for consciousness and the cerebral areas implicating the existence of a certain kind of *symmetry* between them. A possible explanation might come from the breaking of this symmetry (the unity of mind and brain), due to the application of the exploratory device itself. Thus, if a cerebral correlate of a subjective phenomenon is observable, it is only by way of 'a kind of decoherentization'. Medical imagery might be responsible for the decoherentization of psychiagenia, making an objective measurement realisable, but *breaking* the unity of mind and brain. Any assessment of psychiagenia is thus truncated, but the decoherentization is the only way to obtain a comprehensible image of it. It is possibly the mere nature of psychiagenia (like its number of dimensions) that makes its direct assessment unrealisable: medical imagery reduces it to a four dimensional brain map – and cognitive psychology to, let us say, an n-dimensional summary.

Another main strength of the theory of psychiagenia lies in its capacity to offer a new intellectual framework for the mind and brain problem, and to generate fertile analogies from a theoretical point of view. My objective here is to stress that the 'physical reality' of psychiagenia may lie at a quantum scale, and that the string construction can help to place it beside every other phenomena of nature. Indeed the possibility of describing our world in a ten-dimensional model could prove fruitful for further understanding of the structure of a common root.

Limitations

A first limitation of the theory of psychiagenia is linked to the concept of superstring itself. Several authors reject the string model (see a discussion in Davies and Brown, 1988; Laughlin and Pines, 2000), and without it, psychiagenia might simply be seen as another property dualism.

Another limitation is related to the purely theoretical nature of my purpose, but several valuable precedents can be mentioned. Eccles (1986) and Penrose (1994) are frequently quoted as pioneers in their attempts to reconcile physics and biology, respectively in a dualistic and a materialistic framework. They were reproached for building their theories largely on speculation, and for relying too much on the advancement of science to confirm and define their hypothesis (Godfroid, 2002c). This surely is a major weakness of the psychiagenia theory as well, whether the superstring theory is a TOE, or not.

Finally, the principle of combining physics and physiology in the field of neuroscience may by itself lead to several misunderstandings. First of all, there is a famous precedent where the American physicist Sokal submitted a paper to a peer-reviewed journal (Sokal, 1996) which he later revealed to be a deliberate hoax, a parody of the misuse of science by academic philosophers (Sokal and Bricmont, 1998). This controversy certainly discredits any further attempt of the kind – like this particular work. I must also stress the fact that the theory of psychiagenia is an integrative model, not a purely physical one. For example, the equation [P = $\psi_n \quad \varphi_4$] must only be understood as an intellectual support, and has no relevance in physics. Neither do I think that psychiagenia could be viewed as a physical force, with a messenger particle being itself a mode of vibration of an elementary string. Even if the existence of a 'fifth force' has indeed already been evoked, and revealed acceptable within the superstring framework (Davies and Brown, 1988), identifying psychiagenia as this fifth force, along with gravity, electromagnetism, strong and weak nuclear forces, is evidently excessive. Again, only the *analogy* with the logic of the superstring theory must be considered, as far as the notion of a 'gauge theory' is regarded.

Future research needs

Recent developments in artificial intelligence offer a very pragmatic and significant summary of the mind-brain problem. Researchers in this field have now reached a border they cannot cross: consciousness. As Brooks states, the problem is no longer a technical limitation preventing man building a robot as complex as the brain is, but the absence of a coherent description of the mind-brain relationship (Brooks, 2001). In the absence of a new kind of interpretation of the mind-brain problem, technical advances will obviously remain sterile. An integrative model is needed. The theory of psychiagenia was built for this purpose, but has to be developed, both at the theoretical and the practical level. Further developments will have to focus on the nature of the common root (the main problem remaining its direct assessment), and its links with *intentionality* (i.e., free will, volition) and subjective experience.

Advances in string physics allow us to envisage that validation by experimentation is possible. Indeed, the LHC (Large Hadron Collider) that will be operational in 2005 at the European Laboratory for Particle Physics (CERN) in Geneva will experimentally study ordinary aspects of string physics (Antoniadis *et al.*, 1998; Randall, 2002). The validity *of the superstring theory* will then be tested for the first time. This could remove a first limitation on the theory of psychiagenia, but this will not validate it. However this first stage is likely to provide a better idea of the structure of our world. As the concept of psychiagenia is intimately linked to it, we will then know if it has any relevance to the mind-brain problem, or if it only offers a new intellectual framework.

CONCLUSION

Dualism and materialism both lead to inconsistencies in the mind-brain problem that are well illustrated by the state-of-the-art of artificial intelligence: as consciousness is not understood, its mechanism cannot be properly imitated. An alternative theoretical framework is needed, and the purpose of this paper is to propose one, even though it is incomplete.

As an evolution of Spinoza's third entity theory, psychiagenia is described as the common root of the mind and brain. Since psychiagenia is not directly assessable, only a truncated image of it is obtainable (brain mapping or subjective description). Quantum physics, and more precisely string physics, is likely to govern this common root. A better understanding of this root is thus directly linked to an improved representation of the nature of our world, subtended by the superstring theory. After all, if this is a theory of everything, consciousness must be involved.

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