The Parallel Principle

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Abstract

Von Neumann’s psycho-physical parallelism requires the existence of an interaction between subjective experiences and material systems. A hypothesis is proposed that amends physics in a way that connects subjective states with physical states, and a general model of the interaction is provided. A specific example shows how the theory applies to pain consciousness. The implications concerning quantum mechanical state creation and reduction are discussed, and some mechanisms are suggested to seed the process. An experiment that tests the hypothesis is described elsewhere.

Introduction

I assume that there is a rough correspondence, or at least a working relationship, between the subjective life of any creature and the objective world in which it is a part. John von Neumann calls this a psycho-physical parallelism, according to which the images of the creature’s psychic experience mirror the objects in its physical environment [1]. Presumably, creature learning begins in infancy by creating a parallelism of this kind that is practical and useful for the adult. For this to happen, a conscious species must develop a rudimentary psycho-physical parallelism at an early stage of evolution.

By consciousness I mean all that which is contained in the subjective or psychic life of an individual. Consciousness is different from the physiological state that gives rise to it, for although it is a by-product of the physical processes, it is not itself a physical entity. It is the psycho part of the psycho-physical parallelism.

Consciousness is widely believed to be epiphenomenal, which means that it is created and choreographed by a physical body but cannot, conversely,
influence the behavior of that body. If that were the case in any species including our own, then there would be no point to a psycho-physical parallelism. It would not then matter if a creature’s psychic life mirrored or failed to mirror its physical environment, for having no influence, its psychic life would not matter to anything at all.

The two fundamental disciplines of modern physics, quantum mechanics and general relativity, are mechanically autonomous. They provide no mechanism that would allow consciousness to influence the behavior of a physical body; and accordingly, consciousness can only appear scientifically as an epiphenomenon. Therefore, barring the acceptance of the miraculous principle of Pre-Established Harmony proclaimed by Leibnitz, there is no reason to believe that the subjective life of a conscious being would in any way reflect the physical world in which it lives. There is not even reason to believe that the subjective life of a conscious being would be rational; and certainly, the appearance of rational thinking that parallels the objective world would be enormously improbable. So given the present scientific understanding, a psycho-physical parallelism would exist only if there were an amazing and inexplicable harmony in nature of the kind suggested by Leibnitz.

I do not accept ‘pre-established harmony’. I believe that subjectivity arises naturally within the objective world in a way that results in a psycho-physical parallelism, and that we can, at least partially, document the reasons for that development. To do so, we will have to amend to physics.

The Parallel Principle

The following statement of the parallel principle asserts how subjectivity is generally related to physiology in humans, and presumably in all conscious species.

The subjective images and ideas of a conscious species are related to its physiology in such a way as to allow the development of a working psycho-physical parallelism at every stage of evolution.

For this parallelism to work, there must be some degree of mutual monitoring between the psychological and physiological worlds to keep them together on parallel tracks. This means that subjectivity must feed information back to the underlying physiological system, correcting it on the evolutionary stage when it does not create appropriate (i.e., parallel) images and ideas. Physiology must respond to this instruction.
The idea that mind and body must have evolved interactively was discussed by William James, who believed that the evolution of “appropriate” subjective feelings would be incomprehensible if feelings were biologically redundant [2].

On this model, our effort should initially focus on how this parallelism develops in primitive species. Our strategy will be to consider amendments to physics that will satisfy the parallel principle in early organisms. Attention goes first to the ways in which a creature that is fully automated might begin to experience consciousness.

An automaton operates on the basis of a simple stimulus/response sequence, where the success of a sequence is awarded to the survivor of the evolutionary struggle. Suppose, as a result of mutation, an amended sequence appears in the form stimulus/consciousness/response. The conscious experience in this sequence does not have to be the sole determinant of the response, but we will allow that it is influential; that is, that it will increase or decrease the likelihood of one response or another. If the response favored by the newly introduced consciousness is wrong (i.e., if it encourages an unfortunate response), then the species will not survive; but if the favored response is right, then the species will survive. In the end, a successful species will have a specific conscious experience that is associated with a successful stimulus/response sequence, and this is the signature of a psycho-physical parallelism. A more accurate formulation of the parallel principle might be:

2nd Formulation: If an element of consciousness becomes associated with a stimulus/response sequence in a species, and if it contributes to the long-term survival of the species by enhancing or repressing a response, then the species will have acquired a rudimentary psycho-physical parallelism.

Again, this is because a subjective state that enhances or represses a response will enable the creature to learn (through evolution) to couple that ‘psychological’ state with a successful ‘physiological’ response. It is my belief that the psycho-physical parallelism that we identify with humans began in this way.

It must be emphasized that the conscious element in the above statement is not just a circuitous way of talking about another (equivalent) physiological configuration that is itself a response to the stimulation and a determinant of the response. That would defeat our purpose by reestablishing an epiphenomenal interpretation; for again, the content of the conscious element would then be irrelevant to any behavior. We say, rather, that it is the conscious element itself that is associated with an enhanced or repressed response. That is not to say that consciousness has an existence independent of physiology; for indeed, we
assume that it arises out of physiology. But we claim that the qualitative properties of the experience are directly related to the enhancement or repression of a response, and that that correspondence cannot be explained by contemporary physics. One way of providing the required feedback is described in the final sections on physics.

The General Model & Hypothesis

A model is shown graphically in fig. 1 in which a stimulus gives rise to two possible responses $R$ and $R'$, together with a possible subjective experience $E$. This appears in two possible sequences, one being either $R(E)$ or $R'(nE)$, and another being either $R(nE)$ or $R'(E)$, where $nE$ indicates no associated experience.

\[
\begin{align*}
\text{Stimulus} & \quad \xleftarrow{R(E)} \rightarrow \quad R(E) \quad \rightarrow \quad \text{survive} \\
& \quad \xleftarrow{R'(nE)} \rightarrow \quad \text{repressed} \\
\text{Stimulus} & \quad \xleftarrow{R(nE)} \rightarrow \quad \text{repressed} \\
& \quad \xleftarrow{R'(E)} \rightarrow \quad R'(E) \quad \rightarrow \quad \text{extinct}
\end{align*}
\]

Figure 1

We now add a hypothesis concerning the experience $E$ that, we will say in this example, enhances a response. To put this hypothesis into play, it will be necessary to amend the underlying physics in a way that will be explained in a later section.

The General Hypothesis applied to an enhancing experience:

\textit{When the experience $E$ appears in association with a response, it will “enhance” the response by increasing its probability relative to other responses.} Since the bracketed term $nE$ means that there is no associated experience, it produces no special effect.

The claimed influence of $E$ increases the probability of the response $R(E)$ in the first sequence in fig. 1, and $R'(E)$ in the second sequence. Because of normalization, this effectively represses the responses $R'(nE)$ and $R(nE)$. We make the further assumption that the response $R$ is favored in the evolutionary struggle, and $R'$ is not. Therefore, the only species that survives is one in which the experience $E$ is associated with a life affirming response $R$. 
It should be noted that the experiential mutation introducing $E$ is capable of advancing the evolution of the species in this example, and it does so without the help of a mechanical mutation of the kind that advances an automaton. That is, the sequence in fig. 1 might proceed as indicated without a mechanical mutation also taking place. This does not mean that the evolutionary process is thereafter dominated by experiential mutations in preference to mechanical ones. However, it is possible that these two processes (mechanical and experiential) operate independent of one another; and if that is so, they might also operate in tandem. If that were historically so, then whatever the relative frequency of the two processes, the species would evolve faster than it would with either one of these processes working by itself. We would then be able to say that if consciousness is introduced in a way that gives rise to a psycho-physical parallelism, it will always benefit evolution by increasing the speed with which a species adapts to its environment.

A fanciful Example

An example that I use in previous papers is more specific [3,4]. It involves the experience of “pain” that is assumed to decrease the probability of any response to which it is associated. In the interest of concreteness, a fictitious encounter is imagined between an ancient fish that is initially assumed to be an automaton, and an electric probe that somehow exists in primordial waters. The probe provides the stimulus that gives rise to two possible responses of the fish (1) W-withdraw, or (2) C-continued contact.

A mutation is assumed to introduce the conscious experience of pain associated with one or the other of these responses. The sequence W(no pain) or C(pain) therefore presents itself as a possibility together with the sequence W(pain) or C(no pain). In the first case, C(pain) is repressed inasmuch as we require that pain always represses the response with which it occurs. This leaves a painless withdrawal W(no pain) that will survive the evolutionary struggle inasmuch as it is a healthy response for the fish. In the second sequence, W(pain) is repressed, leaving the fish in painless contact C(no pain) with the probe; and this leads to the fish’s demise inasmuch as that response is unhealthy. The result is the emergence of a species of fish that instinctively withdraws from a probe, and at the same time, experiences a release from pain. We therefore see the beginnings of a psycho-physical parallelism in which pain is coupled with a dangerous behavior.

When I speak of “pain” in this example I do not necessarily refer to the
painful experience known to humans. Different creatures might experience pain differently. What is important about pain is the way that it is associated with the repression of unhealthy responses.

I have been alluding to the causal efficacy of consciousness by referring to its ability to ‘enhance’ or ‘repress’ responses. I will continue to do so in the interest of simplifying and unifying the discussion. However, strictly speaking, one should only talk about possible “correspondences” or “associations” between conscious experiences and physiological responses (or our models of physiological responses). That’s because we can only hope to discover empirical relationships at this point. We have no general theory that can explain the psycho-physical interaction proposed here, and we may never have such a theory. It is even possible that there is a third unknown (and unknowable) cause that is common to these relationships [5]. I will nonetheless continue to speak of consciousness as a ‘causal’ influence because that is the most heuristically effective way of presenting this model.

The Physics

A stimulus that acts on a biological organism will generally create a quantum mechanical superposition of body states over a wide range of possible responses[6, 7]. I call a superposition of this kind of an endogenous superposition. It will consist of many competing physiological configurations, each supporting a distinctive conscious state, and each with a specific quantum mechanical probability of being realized. The external stimulus therefore gives rise to an endogenous superposition of states that are capable of supporting different degrees and qualities of consciousness. The probability that one of these states is realized is normally determined by quantum mechanics alone. However, I add a special hypothesis concerning pain consciousness.

The Psycho-Physical Hypothesis applied to pain:

When pain consciousness is associated with a component of an endogenous

\footnote{It is frequently said that macroscopic states cannot be in quantum mechanical superpositions because they behave like classical mixtures (i.e., like classical statistical ensembles). However, quantum mechanical interference terms do exist between these states when they are taken together with correlated elements in their environment. The states in this entanglement appear to be a classical mixture when the environmental variables are integrated out; but Joss and Zeh call it an “improper mixture” because, globally considered, it is a bona fide quantum mechanical superposition with distinct probability amplitudes. See refs. 6 and 7. It might equally be called an “improper superposition”.}
superposition, it will repress that component relative to other ‘painless’ components.

If more than one component contains pain consciousness, than the degree of repression of each component will be a function of the intensity of the pain in each. This hypothesis is entirely qualitative inasmuch as no data is available to give us a measure of the degree of repression. It is further limited to one kind of experience - pain consciousness. Presumably, pleasurable experiences are associated with enhanced behaviors; and more sophisticated experience/behavior interactions are dealt with at later stages of evolution.

Again, the hypothesis is intended to be an amendment to the fundamental mechanics. It provides feedback from conscious states to physiological states that is essential if we believe that there is a naturally occurring psycho-physical parallelism. The feedback cannot be thought of a euphemism for a physiological activity that is ‘really’ the underlying cause of the influence; for barring a Leibnizian miracle, a genuine psycho-physical interaction is necessary for there to be a parallelism.

State Reduction

There is still no general agreement concerning how, why, or exactly when a quantum mechanical wave function collapses upon measurement. The why of it will not concern us here, but for the parallel principle to work we must choose a reduction process that satisfies one important condition: namely, that state reduction (or state collapse) cannot happen too quickly. A developing endogenous state must have enough time to grow to macroscopic proportions; and it must have enough time to mature sufficiently to support consciousness.

This condition is automatically satisfied if we adopt the state reduction ideas of John von Neumann. Accordingly, (1) state reduction will not occur unless a conscious observer is present and aware of the system. This means that an endogenous macroscopic state will not collapse until it has matured sufficiently to support a conscious observer; that is, until an internal self-observation is possible. This idea is sometimes said to imply that consciousness causes the collapse of a quantum mechanical state function. As previously stated, I use terminology like this myself; but one should be reminded that we are talking about empirical relationships in which consciousness is only found to be associated with state reduction in a certain way. With this qualification, I accept the von Neumann account of state reduction. Without it, a psycho-physical parallelism would not
be possible.

Seed Particles

There remains the question of how an endogenous quantum mechanical superposition can be formed in the first place. Henry Stapp proposed that the calcium ions that are needed to release neurotransmitters across a synaptic junction are possible seed particles for the creation of such a superposition. Because of the Heisenberg uncertainty principle, one of these small ions will grow to many times its “classical” size during the time it takes for it to diffuse to the vesicles containing neurotransmitters. The resulting uncertainty as to which transmitters are released is passed on to the neurological level, and this results in the macroscopic uncertainty implicit in an endogenous superposition.

Other seed mechanisms are possible. There are many migratory transmitters that travel significant distances from their point of origin to receptors in other parts of the body, and these can acquire Heisenberg uncertainties in position. They are the steroids and peptides that move throughout the body, carried along by blood or intercellular fluids. Many of these are small enough and travel for a long enough time to be significantly affected by Heisenberg uncertainty. This means that the time of a molecule/receptor attachment is governed by a quantum mechanical probability distribution. This in turn leads to an uncertain receptor response. To this extent, migratory transmitters guarantee the existence of a superposition of receptors in different stages of stimulation. When the resulting uncertainties in all of the body’s receptors are taken together, the result will be a wide-ranging endogenous superposition of possible body states.

The Case of Pain

The endorphins produced by the body are migratory molecules that mediate pain by seeking out and attaching to opiate receptors in the brain and other

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A migratory molecule spreads out spatially as it moves about, due to its Heisenberg uncertainty of momentum. Its components interact strongly with the fluids in which it is immersed, so they are also dispersed by such classical mechanisms as diffusion, turbulence and laminar flow. Either way, the probability with which a given molecule attaches to a given receptor is governed by quantum mechanical uncertainty. The resulting ensemble of receptor states is an entanglement of seed molecules and the liquid environment in which they are immersed. But when that environment is integrated out, thereby eliminating it as part of the local (macroscopic) system, the resulting receptor states are found to lack the ability to interfere with one another (see ref. 6, 7).
parts of the body. These molecules are peptides that are small enough and gener-
ally travel far enough to seed endogenous quantum mechanical superpositions
that include a broad range of states with different degrees of pain conscious-
ness. Endorphins can therefore function as the pain suppressers in the fanciful
example of the fish, and this gives them a possible evolutionary role of some
importance. Opiate receptors have been found in very ancient species, going
back to the early vertebrates \(^{[9]}\). Since they serve no other purpose than to
stimulate analgesic and euphoric effects, and since they have such a pervasive
presence in all vertebrates, it is easy to believe that opiate receptors served a
compelling evolutionary purpose associated with the most elementary of con-
scious experiences\(^{3,4}\)\(^{[10]}\).

Because of its (Heisenberg) uncertainty of position, a migrating endorphin
molecule has a less-than-one probability of attaching itself to an opiate receptor
at any given moment. So the total number of receptors that are turned on at
that moment is quantum mechanically uncertain. This number is a variable
of a quantum mechanical superposition, each component of which potentially
supports different degrees of pain consciousness. Our psycho-physical hypothesis
tells us that those components with a greater degree of pain will be repressed
relative to those with a lesser degree of pain; and as a result, the distribution
of states in the superposition will shift in the direction of states with lesser pain.
The probability that the subject will experience less pain is thereby increased,
thus establishing a connection between subjective experience and physiology as
required by the psycho-physical parallelism.

It is difficult to imagine how this theory can be tested if the only seed par-
ticles available are the calcium ions within neuron synapses. But small migrating
molecules are a different story. Exogenous opiates, such as codeine, morphine,
heroin also alleviate pain and/or give pleasure by attaching to opiate recep-
tors \(^{[11]}\). These molecules are small enough and they travel far enough to be
seed particles, and they are easier to manipulate experimentally. It is therefore
possible to test the above theory by injecting pharmacological doses of these
opiates into subjects, determining the extent to which they attach to receptors
in conscious subjects; and comparing this with their attachment in subjects

\(^{3}\)In advanced species, receptors perform these functions as well as modify more sophisti-
cated moods in the direction of analgesia and euphoria. See ref. 10.

\(^{4}\)The existence of ancient opiate receptors does not in itself prove the existence of con-
sciousness, inasmuch as an automaton might very well use these devices to modify a response
to certain kinds of stimuli. However, I believe that consciousness was introduced through
these devices. The extent to which they existed before that event, or came into existence as
party to that event, is not a question that I address here.
who receive subpharmacological doses. The author has proposed an experiment along these lines that injects synthetic opiates into humans using positron emission tomography (PET), or into rats using autoradiography.

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