

Conscious Pulse II: The rules of engagement

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28 October 2002

This is the final paper in a series that considers the rules of engagement between conscious states and physiological states. In this paper, we imagine that an endogenous quantum mechanical superposition is created by a classical stimulus, and that this leads to a ‘physiological pulse’ of states that are in superposition with one another. This pulse is correlated with a ‘conscious pulse’ of the kind discussed in a previous paper (Conscious Pulse I). We then add a rule (5) to the four rules previously given. This rule addresses the effect of ‘pain’ consciousness on both of these pulses, and in doing so, it validates the “Parallel Principle” applied to pain.

Introduction

In previous papers, I consider a quantum mechanical superposition of apparatus states in the laboratory system, where an external observer is present during the time it is being produced [1], [2], [3]. This results in a superposition of observer brain states that are correlated with the apparatus. The laboratory superposition of macroscopic apparatus states therefore become entangled with an *endogenous superposition* of macroscopic brain states. Locally, the components of both the laboratory and the endogenous superpositions are incoherent in a sense that is explained below and in ref. 1. It is the effect of environmental decoherence [4], [5].

Four *rules of engagement* are proposed in refs. 1–3 that describe how brain states arise from and are related to apparatus states. In order to formalize this relationship, it is

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necessary to distinguish between a conscious brain state and a *ready* brain state. The latter is physiologically capable of consciousness but is not conscious; and furthermore, it cannot become conscious until it is chosen by the stochastic process peculiar to quantum mechanics. In ref. 3, it is found that a conscious state will quickly become a pulse of closely grouped neighborhood states in the endogenous superposition. This is called a *conscious pulse*. A ready brain state may also appear as a *ready pulse*. The pulse of a conscious brain state \underline{B} is written $\{\underline{B}\}$, where the underline means that it is conscious. The pulse of a ready brain state B is written $\{B\}$.

In the present paper, there is no laboratory superposition that serves as an external stimulus to the observer. Instead, we suppose that the observer is ‘classically’ stimulated, but that that is sufficient to initiate an endogenous quantum mechanical superposition. This is possible if there are *seed particles* (molecules or atoms) within the body that, by virtue of their size and Heisenberg uncertainty, become miniature superpositions that mushroom into larger ones. In order to see how this works, we will focus on one particular kind of external stimulus and one kind of consciousness. The problem is otherwise too difficult. I therefore limit consideration to the case of “pain” consciousness. The reason for this choice will be explained in a later section.

Seed Particles

There are several possible seeds. Henry Stapp proposed that the calcium ions that initiate the release of neurotransmitters might serve this purpose [6]. But since the stimulus that I will be discussing produces pain consciousness, I focus on seeds that are related more directly to pain and the alleviation of pain. These are the endorphin molecules and other peptides that move through the blood stream and cerebrospinal fluids seeking opiate receptors to which they can become attached. When these molecules attach to a receptor they induce euphoria and/or analgesia in the subject. These are suitable seed molecules because they are small enough that their Heisenberg uncertainty

of position grows significantly in the time that it takes for them to move from their point of origin to their final destination [7].

The extent to which a given receptor is stimulated by a single migratory seed molecule is therefore uncertain. We assign a quantum number u to the number of receptors that are stimulated by all the seed molecules in the system. Due to a receptor's strong interaction with its environment, incoherence is locally assured between components of the resulting superposition. These receptors are part of a much wider superposition that includes the seed molecule and their fluid environment; but when all the non-receptor variables are integrated out of cross terms, the variable u will identify receptor components that lack the possibility of mutual interference (see Appendix).

The Initial Distribution and Pulse Formation

Let the observer be subjected to a classical pain stimulus S_p . An exact physiological response R cannot be classically determined from S_p because of the quantum mechanical uncertainty in the number of opiate receptors that are occupied by seed molecules at that moment. This means that the pain stimulus represented by S_p is correlated with a distribution of responses represented by R_u , where u is the quantum number of occupied receptors. This includes all of the receptor combinations that sum to that number. Each u is correlated with a ready brain state that is called into being by the interaction. We will say that R_u includes the entire "low level" physiology of the observer that leads into the "high level" ready brain state B_u . Immediately following the interaction, the state of the system is therefore

$$\Phi(t = t_0) = S_p\{X\} + S'_p\sum_u R_u\{B_u\} \quad (1)$$

where $\{X\}$ is the unknown state of the observer prior to his interaction with the classical stimulus, and where the primed component in eq. 1 is equal to zero at t_0 . In order to simplify matters, we will initially assume that $\{X\}$ is not conscious. Instead, we will say

that the observer is unconscious and is aroused by the painful stimulant that links him to a single (i.e., non-pulse) ready brain state B_u . The more general case of an unknown conscious pulse $\{X\}$ is discussed at the end of this section.

Equation 1 is then

$$\Phi(t = t_0) = S_p X + S'_p \sum_u R_u B_u$$

where again, the primed component is equal to zero at t_0 . The sum $\sum_u R_u B_u$ is the endogenous superposition that has been produced by the seed molecules².

According to the rules in ref. 1, the system is certain to experience a stochastic hit on one of the ready brain states at a time t_{sc} , and this reduces all other states to zero.

$$\Phi(t = t_{sc} > t_0) = S'_p R_{sc} \underline{B}_{sc} \quad (2)$$

Then according to rule (3a) in ref. 3, this single state will dissolve into a conscious pulse, giving

$$\Phi(t > t_{sc}) = S'_p R_{sc} \{ \underline{B}_{sc} \} \quad (3)$$

The details of brain state dissolution are discussed in ref. 3. It is assumed that when the entanglement $R_{sc} \underline{B}_{sc}$ in eq. 2 dissolves into $R_{sc} \{ \underline{B}_{sc} \}$ in eq. 3, the physiological state R_{sc} will split into a superposition in which each component is connected to a component of the higher brain pulse $\{ \underline{B}_{sc} \}$, while joining with the single classical state S'_p at the other end. I will not bracket R_{sc} as I do brain pulses. So as in ref. 3, it will be understood that the physiological connection to a brain pulse is itself pulse-like.

The probability that the state \underline{B}_{sc} in eq. 2 will be chosen is found by integrating Jdt over the time of the interaction, making use of the requirement in ref. 3 that $\int d\mathbf{a} \underline{B}_r * \underline{B}_s = \delta(r - s)$. For a stochastic choice that ranges over non-continuous brain states such as the receptor number u , this expression is

$$\int d\mathbf{a} \underline{B}_r * \underline{B}_s = \delta_{rs} \quad \text{or} \quad \int d\mathbf{a} \underline{B}_{sc} * \underline{B}_{sc} = 1$$

² This expression does not preclude the possibility that there may be other endogenous superpositions embedded in each R_n . One is enough to make the point of this paper.

In addition, the square modulus $s = \int d\mathbf{a} (S_p X)^*(S_p X) = S_p^* S_p$ inasmuch as ref. 3 requires that $\int d\mathbf{a} X^* X = 1$, so we have

$$\text{Prob}^{(\text{sc})} = (1/s) S_p^* S_p R_{\text{sc}}^* R_{\text{sc}} \int d\mathbf{a} \underline{B}_{\text{sc}}^* \underline{B}_{\text{sc}} = R_{\text{sc}}^* R_{\text{sc}}$$

The total probability is then found by summing over all possible stochastic choices

$$\text{Prob}^{(\text{total})} = \sum_{\text{sc}} \text{Prob}^{(\text{sc})} = \sum_{\text{sc}} R_{\text{sc}}^* R_{\text{sc}} = \sum_u R_u^* R_u$$

The complete process is shown in fig. 1. Stage 1 shows the distribution $R_u^* R_u$ as a function of the number of receptors u that are occupied at the time of the interaction, where u_0 locates the central number, and u_{sc} is the stochastic choice that is made during the rise time of the distribution (i.e., during the rise time of S'_p). The large number of u -states is represented as a continuum in fig. 1.

Stage 2 shows the reduction of the distribution to just R_{sc} at time t_{sc} as given in eq. 2. The single conscious state in eq. 2 then dissolves into the conscious pulse given in eq. 3, and this causes the connected physiological state to fan-out into a connecting *physiological pulse* as shown in stage 3 of fig. 1. Normalization is not preserved in this reduction.

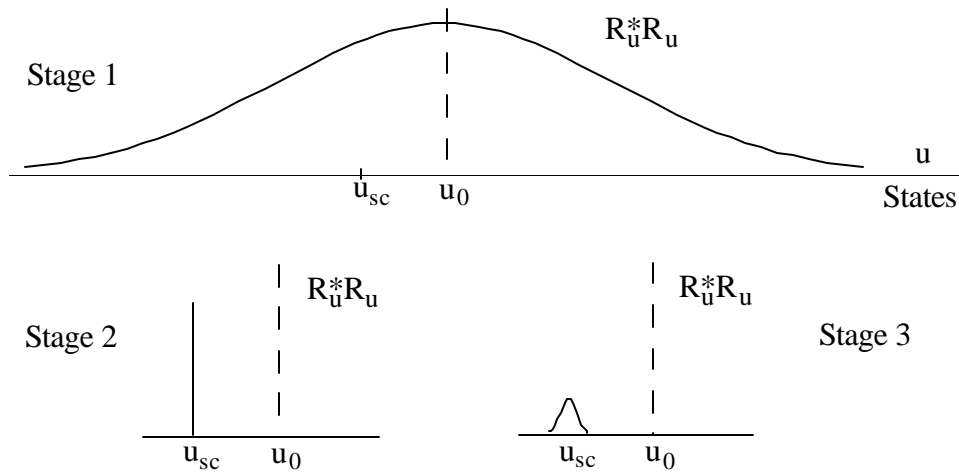


Figure 1

If the unknown pre-interaction state in eq. 1 is a conscious observer $\{X\}$, then the interaction prior to t_{sc} will be

$$\Phi(t = t_0) = S_p\{X\} + S'_p \sum_u R_u \{B_u\}$$

where the prime component is again zero at t_0 . Substituting the expression for $\{B_u\}$ in eq. 2 of ref. 3 gives

$$\Phi(t = t_0) = S_p\{X\} + S'_p \sum_u R_u \int du' F_n(u') B_{u'}$$

or

$$\Phi(t = t_0) = S_p\{X\} + S'_p \int du' P_{u'} B_{u'}$$

where $P_{u'} = \sum_u R_u F_u(u')$. A stochastic hit on a value of u' at time t_{sc} will then yield

$$\Phi(t = t_{sc} > t_0) = S'_p P_{sc} B_{sc} \tag{4}$$

The difference between eq. 2 and eq. 4 is that the term R_{sc} in eq. 2 is replaced by a more a general physiological expression given by $P_{sc} = \sum_u R_u F_u(sc)$. This uses values of R that are associated with the conscious distribution, and these may be different from the R s associated with the unconscious distribution. Despite these differences, stage 2 will always appear as a single state at the stochastically selected site u_{sc} of a physiological distribution $P_{u'} * P_{u'}$ similar to the one shown in fig. 1; and the final physiological reduction pulse will always appear like the one shown in stage 3. The final state will generally take the form

$$\Phi(t = t_{sc}) = S'_p P_{sc} \{B_{sc}\} \tag{5}$$

where the entanglement $P_{sc} \{B_{sc}\}$ connects every component of the brain pulse with the physiological pulse associated with P_{sc} .

The probability that the pulse $\{B_{sc}\}$ in eq. 5 will be chosen is found by integrating Jdt over the time of the interaction. In this case, (sc) is assumed to be a continuous variable. The total probability is then

$$\text{Prob}^{(\text{total})} = (1/s) S_p * S_p \int d(sc) P_{sc} * P_{sc} \int d\mathbf{a} \{B_{sc}\} * \{B_{sc}\} = \int d(sc) P_{sc} * P_{sc}$$

where we use $\int d\mathbf{a} \{B_{sc}\} * \{B_{sc}\} = 1$ from ref. 3.

In general for an endogenous superposition, we conclude that the stochastic choice of a ready brain state and its dissolution into a conscious pulse as per rules (3) and (3a) will result in a physiological pulse (in eq. 5) that is correlated with the chosen conscious brain pulse.

The Parallel Principle and Pain Consciousness

The reason I have chosen to focus on pain consciousness is related to my belief in the validity of the *parallel principle*, and the fact that pain provides an excellent example of how that principle might work.

It is generally accepted that the subjective world of our personal experience corresponds in critical ways with the objective world that exists outside of ourselves. It is assumed that formal relationships can be found in the subjective world that parallel formal relationships that exist in the objective world - and this is the basis of epistemology in physics. Von Neumann calls it the *psycho-physical parallelism*. Why a psycho-physical parallelism should exist at all is an open question, inasmuch as these two separate realms of reality have such different natures. There is no obvious reason why one of these worlds should pay attention to the fortunes or machinations of the other. Responding to this point, Leibniz claimed that one is compelled to believe in a Pre-established Harmony between the two worlds that is arranged by God.

Opposed to this, the parallel principle says that the psycho-physical parallelism is the consequence of natural evolutionary processes. It is claimed here that the conscious evolution of a species develops in parallel with the physiological evolution of the species; and for this to happen, there must be an *interaction* between consciousness and physiology. The general mechanism for this interaction is described in a previous paper [8].

The rules that have been considered so far allow one to believe that consciousness is only epiphenomenal; that is, that it may be regarded as an insubstantial by-product of a

rule (3) reduction that has no influence of its own. But for the parallel principle to work, consciousness must be influential. It must do something. Its presence must give an evolutionary preference to one kind of physiology over another, and to achieve this we adopt rule (5).

Rule (5): *If two states within a conscious pulse represent different degrees of pain, then the square modulus of the state with lesser pain will increase at the expense of the state with greater pain.*

Let the pulse on the left in fig. 2 be the conscious brain pulse in eq. 5. When this pulse is formed soon after t_{sc} , it is centered over u'_{sc} . But the effect of rule (5) is to subsequently move the pulse to the right as indicated by the arrow in that figure.

Recall that u (now u') represents an increasing numbers of opiate receptors that are occupied by seed molecules. Therefore, states on the right-hand edge of the conscious pulse have a greater population of occupied receptors than the states on the left-hand edge. This means that the right edge states are less painful than the left edge states. Rule (5) then requires that right edge states grow in magnitude at the expense of left edge states, so current flows from left to right. The net effect is to shift the pulse to the right as shown.

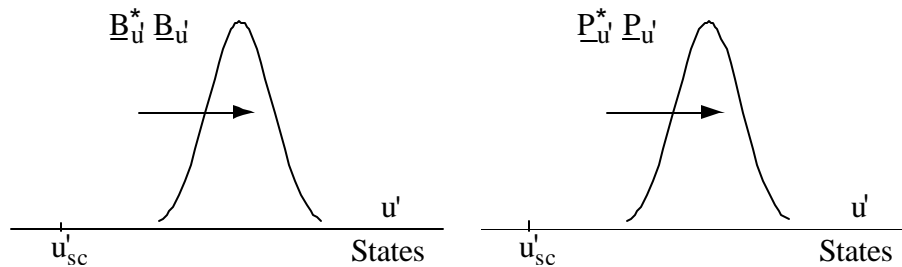


Figure 2

The brain pulse $\{B\}$ in eq. 5 is correlated with the physiological pulse appearing in that equation, so when the former moves, the latter moves with it. This is shown in the pulse on the right in fig. 2. It is also centered over u'_{sc} at t_{sc} , and it also moves to the right because of its connection with the conscious brain pulse.

I claim that the mechanisms of evolution will work together with rule (5) to promote the creation of a psycho-physical parallelism applied to pain. The rightward drift of the physiological pulse in fig. 2 will have behavioral consequences that may or may not benefit the species. Remember that each physiological state P_u includes a response to K_u of the entire organism leading up to the high level brain state B_u . The conscious pulse drift dictated by rule (5) therefore results in a behavioral drift. The resulting behavioral change might be trivial or it might be significant; and nothing has been said that would give us a clue as to what that change might be. But we can say that if the induced behavior is harmful, then the species will become extinct. If it is beneficial, then the species will survive with an instinctive physiological response to K_u that is associated with a psychological avoidance of pain. Rule (5) therefore provides a platform from which a psycho-physical parallelism can be launched. It establishes a mechanism that makes the parallel principle possible. Further details are found in ref. 8.

Causal Influence and Equilibrium

The physiological pulse is a superposition whose leading edge components grow at the expense of its trailing edge components; so as it moves to the right, more and more receptors will be occupied by seed molecules. This physiological movement is not caused by physiological terms that are present in the Hamiltonian, except those that keep the connection between the physiological states P and the upper brain states B . The causal 'push' behind this movement comes from the extra-physical influence of consciousness itself, enforced by rule (5). It is important to note that consciousness cannot be thought of as something that is equivalent to just "another" physiological

package. It is not a euphemism for an extended physiological mechanism that renders it epiphenomenal after all. If that were so, then there would be no reason why consciousness should be shaped by evolution. If the substance of consciousness makes no difference to the objective world, then it will make no difference if it does or does not mirror the objective world. Therefore, rule (5) must refer directly to the properties of consciousness (in this case the 'pain' in pain consciousness) in order for the parallel principle to work.

While consciousness is said to override the Hamiltonian as described in rule (5), it is only a partial influence, competing with the more familiar physiological influences. So the pulses in fig. 2 will not continue indefinitely to the right. I assume that these two pulses will always remain correlated, but that opposing tendencies inherent in the Hamiltonian will eventually bring them to a halt. For instance, increasing values of u means that there are greater numbers of occupied opiate receptors. But the initial distribution in stage I of fig. 1 shows that there are a limited number of seed particles that are available for that purpose. So the pulse cannot move too far to the right. There will be a final equilibrium between the influence introduced by rule (5) and all the other physiological influences contained in the Hamiltonian.

Because rule (5) establishes a causal influence of pain consciousness on physiology, it should be possible in principle to test that rule experimentally. I have previously suggested two experiments that purport to test the existence of the above 'pulse drift' among pain states [9]. The experiments use either a PET scan with human subjects experiencing pain, or autoradiography with rats experiencing pain. If one of these tests proves to be positive, I believe that will confirm the account given in this paper as to how a primitive a psycho-physical parallelism is established. That will also support my claim that all five of the rules given in these papers are correct "rules of engagement" between conscious brain states and physiology.

A Previous Experiment Is Explained

In 1999, the author performed an experiment in which a β -source was used to create a two-component superposition, one of which gave the author a painful electric shock, and the other of which gave no shock (see ref. 7). The idea was to see if the pain consciousness induced by one component of this externally created superposition would be instrumental in suppressing that component. At the time, it seemed possible that the effect of pain consciousness on an external superposition might be directly observable in this way, but the result of the experiment was negative. This suggested that that effect of pain is felt at a deeper level, although it was not clear at the time why that should be so. The present model shows why that is so.

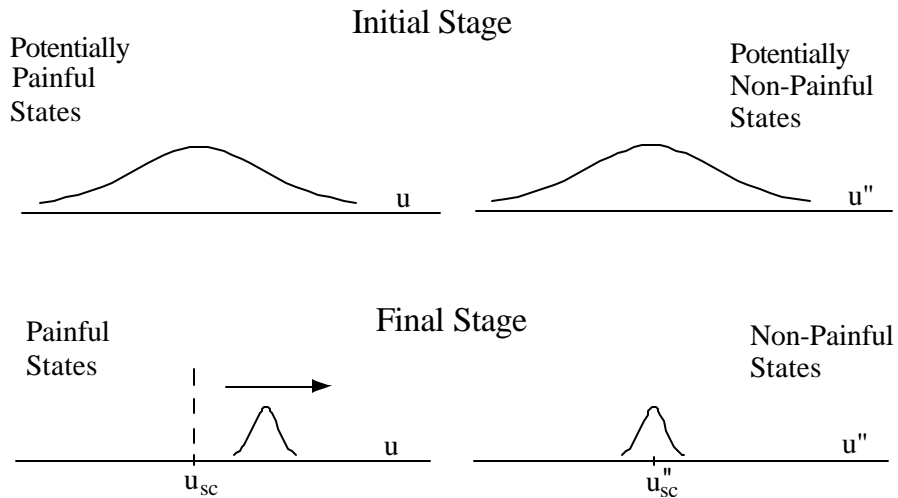


Figure 3

Painful states are designated by the variable u (left side of fig. 3), and the non-painful states are designated by u'' (right side of fig. 3). If the β -source chooses the painful stimulus with a frequency that is equal to the non-painful stimulus, then according to my results, the probability that a painfully conscious pulse will arise on the left in fig. 3 will be equal to the probability that a non-painfully conscious pulse will arise on

the right³. It is only *after* the stochastic decision has taken place that the differential influence of pain consciousness can cause a physiological effect. If a conscious pulse arises among the painful states on the left side of fig. 3, it will drift to the right. If the pulse develops on the right side of the figure among the non-painful states, it will not drift in either direction because those states are assumed to be neutral on a pleasure/pain scale.

Apparently the differential influence of pleasure or pain consciousness can only occur after the stochastic choice has located the initial position of the conscious pulse. The deeper level is then to be found within the post-stochastic conscious pulse. This result is consistent with my 1999 experiment; although of course, this experiment did not allow the drift to be observed.

Appendix

We will say that the classical volume V_0 of a molecule is the smallest volume that it can have, consistent with its intrinsic structure. If left by itself, its wave function will expand *via* Schrödinger because of its momentum uncertainty, reaching a volume V in time T . The molecule's position within the volume V will be entirely uncertain, *and* the wave function covering the volume will be *spatially coherent*. That is, any spatially identifiable part of the wave is related to any other spatially identifiable part by a well-defined phase relationship.

If the molecule is immersed in a stationary liquid, its expansion will be severely limited by the environmental forces that constrain its motion, thereby limiting the volume that it can reach in time T . However, if the liquid is undergoing turbulent or laminar flow, then the molecule's volume might very well reach a volume V in time T , except that

³ The variable n'' is not physically interpreted, so its distribution in fig. 3 need not look like that of n . It does not even have to be a quantum superposition. It is important only that non-painful states are equally probable with painful states.

it will be broken up and widely distributed. As before, the position of the molecule will be entirely uncertain within that volume; but in this case, the wave function will be spatially *incoherent*. That is, when the environment variables are integrated out of the cross terms between different (spatial) parts of this single molecule, the result will be zero – indicating incoherence between these parts⁴. This means that the wave function will be a *locally incoherent superposition* in the sense that the molecule will not display interference between the molecule's spatially separated parts (beyond its intrinsic size), even if those parts are adjacent to one another. The reason for this break-up of the molecule's wave function is the thermal pounding given to it by its liquid environment. This incessant interaction between the liquid and the molecule therefore leads to an environmental decoherence that disassociates different parts of the wave function from one another.

The seed molecules we are considering have a maximum atomic mass of 10,000 u and a classical width of at most 10 nm. Therefore, their minimal quantum mechanical uncertainty in velocity in one direction will be $\Delta v = 0.6$ mm/sec, assuming that we begin with a molecule of classical size. These molecules are carried along by blood and/or cerebrospinal fluid in turbulent or laminar flow, so their displacement L along that line of flow is likely to be as much as $\Delta v \Delta t = 60$ μ m in just 0.1 s. Therefore, the wave function of this molecule will be an incoherent quantum mechanical superposition of classically sized molecules that are spread out over this macroscopic distance. The particle's position will be uncertain to that extent.

Since a single seed molecule can spread itself out over a large number of opiate receptors in this way, it is able to produce an uncertainty of stimulation in a widely disbursed group of receptors. This means that a single molecule can give rise to an

⁴ This is generally expressed by saying (ref. 4) that when the environmental variables are traced out of the density matrix of the total system, the remaining density matrix of the molecular subsystem is an 'improper' mixture.

endogenous superposition of receptors like the one in fig. 1, and that that superposition will be locally incoherent when its environmental influences (including the seed molecules) have been integrated out of any cross terms.

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