Quantum Consciousness

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Abstract

In a previous paper, the author proposed a quantum mechanical interaction that would insure that the evolution of subjective states would parallel the evolution of biological states, as required by von Neumanns theory of measurement. The particular model for this interaction suggested an experiment that the author has now performed with negative results. A modified model is outlined in this paper that preserves the desirable features of the original model, and is consistent with the experimental results. This model will be more difficult to verify. However, some strategies are suggested.

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1 Introduction

For conscious states and brain states to mirror one another in any species, thereby establishing what von Neumann calls a psycho-physical parallelism, these intrinsically different states must evolve together and interact with one other during their time of evolution. Standard physics makes no provision for an interaction of this kind, but a quantum mechanical opening for an objective/subjective interaction is shown to exist, and is described in previous papers.[1] [2]

Our theory of subjective evolution calls for the existence of a Central Mechanism (CM) within an evolving organism, which contains presently unknown components of the nervous system. The function of a CM is to reduce quantum

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mechanical superpositions within the nervous system, and to simultaneously
give rise to a conscious experience of the eigenvalues of the reduction. This
accords with von Neumann’s requirement that a quantum mechanical state re-
duction is accompanied by an observer’s conscious experience of the measured
variables. At the present time, no one knows what there is about a conscious
organism that gives rise to either consciousness or state reduction. We simply
combined these two mysteries inside the CM, thereby placing our ignorance in a
black-box so we can ask another question, namely: how do physical and mental
states evolve interactively to insure the psycho-physical parallelism?

The model in references 2 and 3 requires that a conscious organism sponta-
neously creates a profusion of macroscopic quantum mechanical superpositions
consisting of different neurological configurations. A mechanism for this gen-
eration is proposed by H. Stapp.[3] The result is a superposition of different
neurological states, each of which may be accompanied by a different subjective
experience. A reduction to a single eigenstate is not assumed to be triggered
microscopically along the lines of Ghirardi-Rimini-Weber[4]; but rather, it is
assumed to occur in response to a macroscopic event. It occurs the moment an
emerging subjective state becomes actively conscious in one of the macroscopic
neurological components of a Stapp superposition. The consciousness that is
associated with such a reduction is assumed to fade the moment reduction is
complete, and the resulting subjective pulse is supposedly followed by similar
pulses in rapid succession. This can make the subject aware of an apparent
continuum of consciousness.

Presumably, any reduction of this kind is accompanied by a reduction of
all other parts of the organism as well as all those parts of the external world
that are correlated with it. This means that a second observer, coming on
the heels of the first, will make an observation in agreement with the first.
More formally, a measurement interaction establishes correlations between the
eigenstates \( |a_i\rangle \) of some apparatus (with discrete variables \( a_i \)), eigenstates of a
first observer \( |\Phi_i\rangle \), and eigenstates of a second observer \( |\Theta_i\rangle \), such that the total
state prior to reduction is given by

\[
|\Psi\rangle = \sum_i C_i |a_i\rangle |\Phi_i\rangle |\Theta_i\rangle
\]

The coefficient \( C_i \) is the probability amplitude that the apparatus is in state \( |a_i\rangle \). Let the first
observer become consciously aware of the apparatus variable \( a_k \). The resulting
reduction is a projection in Hilbert space that is found by applying the projection
operator of that observer \( |\Phi_k\rangle \langle \Phi_k| \) to the total state.

\[
|\Phi_k\rangle \langle \Phi_k| |\Psi\rangle = C_k |a_k\rangle |\Phi_k\rangle |\Theta_k\rangle
\]  \hspace{1cm} (1st reduction)

Let the second observer then become consciously aware of the apparatus variable
The subsequent reduction is found by applying the projection operator of that observer \( |\Phi_m\rangle \langle \Phi_m| \) to the first reduction.

\[
|\Theta_m\rangle \langle \Theta_m| C_k |a_k\rangle |\Phi_k\rangle |\Theta_k\rangle = \delta_{km} C_k |a_k\rangle |\Phi_k\rangle |\Theta_m\rangle \quad \text{ (2nd reduction)}
\]

Only if \( m = k \) is the probability non-zero that the second observer will make a measurement. The second observer therefore confirms the results of the first observer that the apparatus has been left in the eigenstate \( |a_k\rangle \).

Again, many of the particulars of a reduction (such as its nonlinearity) are ignored in this paper so we can concentrate on the influence of subjective states on physiological states. To this end we require that \textit{when the emerging subjective states of a neurological superposition are different from one another, they will generally exert an influence on their relative probability amplitudes that is a function of that difference.} In particular, we imagine that when a painful subjective state emerges in superposition with a pleasurable subjective state, the probability amplitude of the painful state will be decreased relative to the probability amplitude of the pleasurable state.

No currently known observation contradicts this conjecture, for no previously reported experiment deals specifically with the creation of different observers experiencing different degrees of pain, arising on different components of a quantum mechanical superposition.

Let \( N \) in fig. 1 represent the nervous system of the first primitive organism that makes a successful use of the subjective experience of pain. In a previous paper we imagine this creature to be a fish. It is supposed that the fish makes contact with an electric probe, at which time its nervous system splits into a superposition (\textit{via} the Stapp mechanism) consisting of a withdrawal behavior \( W \) that is accompanied by [no pain], and a continued contact behavior \( C \) that is accompanied by [pain]. The probability of survival of each component in this highly artificial model is initially assumed to be 0.5. However, because of the hypothetical influence of subjective pain on probability amplitudes, only the withdrawal state is assumed to survive the reduction in this idealized example. State reduction in fig. 1 is represented by the horizontal arrow. If \( W \) is furthermore a good survival strategy from the point of view of evolution, then the association \( W\) [no pain] and \( C\) [pain] will serve the species well, whereas a wrong association \( W\) [pain] and \( C\) [no pain] will lead to its demise.

It does not matter to the above argument if the variables are pleasure/pain or some other range of subjective experiences. If a subjective experience like ‘A’ increases the probability amplitude of an escape behavior, and if a subjective experience like ‘B’ diminishes the probability amplitude of that behavior, and if
the escape is one that moves the creature away from something that is dangerous to its health, then a distant descendent will experience ‘A’ associated with life supporting escapes, and ‘B’ associated with life threatening failures-to-escape. It is apparent that the quality of the experience does not matter. We require only that the subjective experience in question has a predictable plus or minus effect on the probability amplitudes within a superposition, and the survival mechanisms of evolution will do the rest. They will insure that the eventual subjective life of a surviving species mirrors its experiences in a definite and predictable way thereby establishing a reliable psycho-physical parallelism.

\[
\begin{align*}
N & \xleftarrow{W \text{[no pain]}} (0.5) \xrightarrow{C \text{[pain]}} (0.5) \xrightarrow{W \text{[no pain]}} (1.0) \\
& \hspace{1cm} (0.5) \hspace{1cm} (0.0)
\end{align*}
\]

Figure 1

We assume that ordinary perception do not have this effect. They do not give rise to the hypothetical feedback. In fig. 2 we imagine the existence of an externally imposed two component superposition consisting of environments \(e_1\) and \(e_2\), which is produced by using, say, a \(\beta\) source. The two environments are assumed to have equal probability, and are allowed to interact with the subjects nervous system given by \(N_0\). Before a reduction can occur, two conscious states emerge from the interaction represented by the superposition of \((eN)_1[x_1]\) and \((eN)_2[x_2]\), where the conscious part shown in brackets is the observed eigenvalue \(x\) associated with components 1 and 2. Since we require that an observer of the perceived variable \(x\) cannot affect the probability of \(x\), the pure state reduces to a mixture having the same probability as the initial superposition (horizontal arrows in fig. 2). State \(e_i\) represents the relevant laboratory apparatus together with the wider environment with which it is entangled. The phase angles \(\phi\) and \(\phi'\) are definite, but they are not localized to manageable parts of the apparatus.\(^6\) We call them “arbitrary” in this paper to indicate that their values are not practically calculable, and to emphasize the lack of coherence between these “macroscopic” components.

On the other hand, if pain were the variable in fig. 2 rather than the
externally perceived variable \( x \), it is suggested by our hypothesis that the resulting mixture might no longer be a 50 - 50 split. This possibility is represented in fig. 3, where the final mixture probabilities are left unspecified because they must be discovered by observation. The author has now performed an experiment of this kind with the result reported below.

2 The Experiment

Two scalers L and R recording local background radiation are placed side-by-side in fig. 4. Their outputs are fed to a selector box that chooses channels L or R, depending on which is the first to record a single count after the selector has been turned on. A 20 V signal is then emitted from the output of the chosen channel. The output on the R-channel is unused, but the L-output closes a relay that puts 80 volts across two metal bars. Two seconds after the selection, an L or R-light goes on indicating which channel was selected. A finger placed across the metal bars will receive a painful 80V shock when the L-channel is selected.

This apparatus allows us to carry out the experiments diagramed in figs. 2 and 3. If the selector is initiated in the absence of an observer, we say that the system will become a macroscopic superposition given by \( \langle e^{i\phi} e^1 e_1 + e^2 e_2 \rangle \), where \( e_1 \) is the entire apparatus following an L-channel activation, and \( e_2 \) is the entire apparatus following an R-channel activation. The incoherence of the two components (represented by the arbitrary angle \( \phi \)) is generally understood to mean that the system is indistinguishable from a classical mixture, since interference between these macroscopic components is not possible. However, for reasons given in previous papers, we claim that the final state is really an incoherent quantum mechanical superposition rather than a classical mixture.\(^1\)

The uncertainty associated with a classical mixture state represents an outsider’s ignorance, whereas a pure quantum mechanical state superposition represents an uncertainty that is intrinsic to the system (see ref. 1, pp. 1622, 1624; and ref. 2, bottom of p. 1703). Following von Neumann, we assume that the initial intrinsic uncertainty (concerning which of the scalers fires first) will remain an intrinsic uncertainty until it is reduced by “observation”. Hence, the apparatus will remain a macroscopic pure state quantum mechanical superposition until an observation occurs.
of interference between the components has no bearing on our result because the hypothetical effect described in this paper relates to, and directly affects, probability amplitudes only. The effect we are looking for should be observable with or without coherence between L and R.

If an observer is present and exposed only to the L-light or the R-light, then a reduction will occur like the one in fig. 2, where eigenvalues $x_1$ and $x_2$ represent a conscious experience of one or the other of those lights. If the observer is exposed only to a conscious experience of “pain or no pain” through his finger across the metal bars, then a reduction like the one in fig. 3 will occur. This experiment may not appear to be quantum mechanical, but it is quantum mechanical by virtue of the particular hypothesis that is being tested in fig. 3.

The equipment in fig. 4 was used for a total of 2500 trials, each consisting of two parts. The author’s finger was first placed across the metal bars, the selector was turned on, and a shock or no shock was recorded before the lights were observed. In the second part of each trial the finger was replaced by an equivalent resistance, the selector was again initiated, and the appearance of the L or R channel light was recorded.

Total number of trials $N = 2500$

Number of shocks received in the first part $N_S = 1244$

Number of times the L-light went on in the second part $N_L = 1261$

There are three possible outcomes of a single trial. Either the difference $N_L - N_S$ increases, or it decreases, or it remains the same. The three possibilities are represented by the variables $u$ (increase) occurring with a probability $p$, and
d (decrease) with a probability $q$, and $e$ (remain the same) with a probability $r$. It was found in the experiment that $u = 632$ and $d = 615$ after 2500 trials.

If we approximate $p_0 = N_L/N$ to be the probability that the left channel fires in the second part of each trial (absent the finger), and $q_0 = 1 - p_0$ to be the probability that the right channel fires in the second part of each trial, then

$$p_0 = \frac{1261}{2500} = 0.5044 \quad q_0 = 0.4956$$

Assuming as a null hypothesis that there is no statistical difference between the displacement of a finger across the metal bars and an equivalent resistor, we have $p = p_0q_0$, $q = q_0p_0$, and $r = p_0^2 + q_0^2$, giving

$$p = 0.2500 \quad q = 0.2500 \quad r = 0.5000$$

The variances of $(u + d)$ and $(u - d)$ are

$$\sigma^2(u + d) = <(u + d)^2> - <u + d>^2 = \sigma^2(u) + \sigma^2(d) + X$$
$$\sigma^2(u - d) = <(u - d)^2> - <u - d>^2 = \sigma^2(u) + \sigma^2(d) - X$$

therefore

$$\sigma^2(u - d) = 2\sigma^2(u) + 2\sigma^2(d) - \sigma^2(u + d)$$
$$= 2p(q + r)N + 2q(p + r)N - r(p + q)N$$

or

$$\sigma(u - d) = \sqrt{[4pq + r(p + q)]N} = \sqrt{[N/2]} = 35.4$$

Our alternative hypothesis is that $u - d$ is significantly different from 0. But from the data, $u - d = N_L - N_S = 17$ after 2500 trials, and this is well within the above the standard deviation around 0. The separate variables $u$ and $d$ are also within the standard deviation $\sigma(u) = \sigma(d) = \sqrt{p(q + r)N} = 21.7$ of their expected value of 625.

One can always argue that the statistics are inadequate to reveal a significant difference between $u$ and $d$. However, they are sufficient to convince the author that the presence of pain on one component of this externally imposed superposition has no significant effect on the outcome. We therefore conclude that the reduction in fig. 3 is not affected by the subjective content of the square brackets in that figure.

Further details about this experiment can be found in the document "QC Experiment" on the authors home page. [6]
3 Model Modification

This result forces us to make a distinction between externally imposed superpositions and the superpositions created internally by a CM.

In fig. 5 we let a CM interact with an environmental superposition, where the latter includes all that is not contained in the CM (including other possible CMs within the organism). The first pair of diverging arrows in that figure carries the initial product into components ($eCM_1$) and ($eCM_2$). This reaction goes according to Schrödinger. The subsequent pairs of diverging arrows shown in fig. 5 denote the appearance of new superpositions that are produced by the (Schrödinger) process proposed by Stapp. It is at this point that we engage the (non-Schrödinger) hypothesis of sect. 1 that allows the emerging ‘subjective’ states on different components of these CM-superpositions to vary their own probability amplitudes. However, we add the further stipulation that any such variation can only occur relative to the other components of the originating CM-superposition. This restricts the range of states over which the relative amplitude variation can take place.

\[
\begin{align*}
\{ e_1 & \quad (0.5) \\
\{ e_2 & \quad (0.5) \} \ CM \quad(0.5) \ (e CM)_1 \quad(0.5) \ (e CM)_2 \\
\end{align*}
\]

Figure 5

It is thereby required that any variation (due to the hypothetical subjective influence) that takes place within ($eCM_1$) in fig 5 has no effect on a variation within ($eCM_2$), and vice versa. More generally, the probability amplitude of any CM as a whole is not affected by a variation that takes place outside of itself, so the normalization of each component ($eCM_i$) of the superposition is preserved.

This modification is consistent with the results of the experiment in sect. 2. The superposition in our experiment is represented by the first pair of diverging arrows. Since it is external and not created by the CM, it cannot, according to the above stipulation, be affected by the subjective content of components 1 and 2. On the other hand, the second pairs of diverging arrows represent superpositions that are created by the CMs 1 and 2, so they are subject to our hypothesis of sect. 1. On this modified model, subjective evolution does not rely in any way on externally created superpositions, thereby insuring that the observer of (external) quantum mechanical systems will always record eigenvalues with the probability predicted by standard theory. At the same time, our
hypothetical subjective influence can still be realized within either one of the $CM$-superpositions in the figure.

With this modification, the hypothesis becomes much more difficult to demonstrate experimentally. Although verification remains possible in principle, it will require a more detailed understanding of the workings of the nervous system and/or other parts of the body.

4 Bio-Active Peptides

Neurological communication depends on the diffusion of chemical neurotransmitters across the synaptic junction between neurons. There is another communication system within the body that makes use of chemicals that are produced at one site and received at another; but in this case, the distances between a production and receiver sites are macroscopic. About 95% of these chemical communicators are peptides, which are mini-proteins consisting of up to 100 amino acids having a maximum atomic mass of 10,000 u. Their classical dimensions are $\Delta x = 10$ nm at most, which we assume approximates their size close to the production site.\footnote{8} Therefore, Heisenberg tells us that the minimum quantum mechanical uncertainty in the velocity of one of these free peptides is $\Delta v = 0.63$ mm/s. Peptides are carried through intercellular space by blood and cerebrospinal fluid. They do not move very far in a tenth of a second, but in that time the Heisenberg uncertainty in position of a peptide will be at least $\Delta s = \Delta v \Delta t = 63$ mm. This is an enormous uncertainty of position relative to one of the peptide receptor sites which has a size similar to that of the peptide, and which is often separated from its neighbors by comparable distances. Therefore, quantum mechanical uncertainty is an important factor in determining the probability that a given peptide is captured by a given receptor.

Stapps mechanism for introducing quantum mechanical superpositions into the brain relies on the uncertainty in the position of calcium ions in neuron synapses. We suggest that peptides represent another possible source of superpositions that may be just as widespread. And because peptides play an important role in the chemistry of the body, they too may have a significant quantum mechanical influence on behavior.

As with the Stapp mechanism, one might object that the uncertainty associated with the peptides classical diffusion during its migration will overwhelm the quantum mechanical uncertainty, or that a large number of migrating molecules will obscure all quantum mechanical effects. However, the classical uncertainty associated with many-particle ensembles has only to do with our ignorance
of initial conditions. In reality, the only uncertainties a receptor will see are
those associated with an incoherent quantum mechanical superposition of pure
peptide states. This superposition will have as many components as there are
peptide molecules involved. And since our hypothetical influence acts through
the amplitude of these components, the presence of a large number of indepen-
dent particles will only increase the hypothetical influence.

5 Drugs

There are many drugs that can be introduced into the body that will compete
with endogenous peptides to occupy the body's receptor sites, and some of these
drug molecules are small enough to have a very large quantum mechanical
uncertainty of position. For this reason, peptide/drug superpositions are more
promising for the purpose of experimental manipulation than calcium ion super-
positions.

For example, endorphins are peptides that unite with special receptors to
eliminate pain and/or produce euphoria. They and their receptors can be found
everywhere in the body, but they are most intensely located in the limbic system
of the brain. There is a drug called naloxone that is a strong competitor
with the endorphins to occupy the same receptors, and it has the property
that it reverses the analgesic/pleasurable effects of the endorphins. If
endorphin molecules and externally administered naloxone molecules are in
quantum mechanical superposition with one another as their sizes and likely
time together suggests, and if they both compete with one another for successful
attachment to the same receptor site, then the ratio of endorphin attachments
to naloxone attachments would (according to our hypothesis) be a function
of the competing subjective states. Since the difference in subjective effects
between these two molecules is considerable along the pleasure/pain spectrum,
an experimental design involving endorphin/naloxone superpositions appears to
offer an opportunity to test the modified model proposed in sect. 3. The author
is not able to propose a specific experiment at this time, but an approach along
these lines seems promising.

6 Evolutionary Advantage

It was pointed out in a previous paper that our evolutionary mechanism of
objective-subjective interaction (represented by fig. 1) does not insure that a
creature evolving under its influence will evolve more quickly or be more successful than a creature evolving strictly as an automaton. That will be true as well of the modified model in sects. 3-5. However, it is not unreasonable to suppose that both conscious evolution and autonomic evolution might work separately and in tandem with one another. The kinds of neurological changes that are necessary for autonomic evolution might very well be independent of the kinds of neurological changes that are necessary for quantum/consciousness evolution. If that is so, and if these two processes work in tandem, then the evolution of the organism will be faster than either the autonomic route by itself, or the conscious route by itself. One would then be able to say that the introduction of consciousness as proposed in this paper will always work to the advantage of the organism.

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