

Your Quantum Brain

Certain conscious experiences are “causally influential” for reasons that related to their survival in the evolution of a species. I refer to these as *anchor experiences*. They include pain, fear, pleasure, desire, and in general, the feelings or emotions that *cause us to behave* in some way. The question is, “How does this influence express itself physiologically?”

As stated in Chapter 2, a conscious state can only exist as a pulse of states that have a width reflecting the ability of the brain to resolve conscious experiences. It is proposed that the influence of consciousness takes the form of *altering the content and migration* of these pulses prior to their being stochastically chosen in a quantum mechanical interaction. A suggestion is offered as to how this might be carried out on the molecular level throughout the body.

Consciousness and the Call-up Code

It is important to realize that consciousness would not have survived biological evolution if it did not have a causal influence. Without any physical influence on biology, there would have been no survival-based reason for the introduction of consciousness into a species or its persistence and increased sophistication over time. More specifically, I claim in Chapter 1 that anchor experiences like pain and fear *repress* behavior, and other anchor experiences like pleasure and desire *enhance* behavior. How evolution sorts this out (deciding which behaviors will be repressed and which will be enhanced) is discussed in Chapter 1. The mechanics of these decisions explain why it is that *consciousness parallels behavior* in the life of the evolved individual.

In this chapter, I introduce the notion of a “call-up code.” If one experiences a bad smell, an irritable itch, or a toothache, then there must be a coded physiological

event, or call-up code, that summons that experience into being. That code must have an enormous representative capacity if it is to distinguish between a bad smell, an itch, a toothache, and all the other disagreeable (or agreeable) experiences that it might possibly call into existence. It must have the representative capacity of a barcode.

We assume that there is a separate call-up code for every imaginable conscious experience; however, I will only be concerned in this chapter with the call-ups of anchor experiences. The call-up codes of non-anchor experiences, like sight or sound, have no direct causal influence and are dealt with separately in Chapter 5.

It is further assumed that anchor call-ups are associated with particular locations in the body, such as the terminal end of a nociceptive neuron. This does not mean that neurons generate the code, but rather, that they terminate on and stimulate the code generators. I suggest, for instance, that the code is embodied in the structure of specific molecules. The model I propose imagines that a neuronal action potential stimulates a voltage-gated ion channel into a neocortical chamber that contains the molecule or molecules of a particular conscious experience. Ions entering the chamber will temporarily bind with the molecule(s) to create the call-up code for the experience. They are then evacuated to restore the chamber in preparation for another action potential and another such experience. I accept this as a working model for the creation of specific bits of conscious awareness, and I assume that a chamber of this kind exists in the neocortex for each conscious experience of a conscious creature. Why molecules should perform such a function is of course a great mystery, but every code I am aware of is an equally great mystery.

Call-up codes and their physiological influence are speculative. Binding codes that connect spatially separated neurological events have been experimentally confirmed [Engel 1999], but there is no experimental evidence supporting the existence of call-up codes. However, they must surely exist *in some form* if events in the brain are the underlying cause of conscious experience, and they are certain to be a mystery for the foreseeable future, in whatever form they take.

Quantum Applications

Suppose that a quantum mechanical system S is in a conscious state given by C_0 . An interaction gives rise to two other conscious states C_1 and C_2 with some probability per unit time, so as C_0 diminishes, the amplitudes of states C_1 and C_2 increase in the q-rule equation

$$S(t \geq t_0) = C_0(t) + \underline{C}_1(t) + \underline{C}_2(t) \quad (3.1)$$

where t_0 is the initial time and both underlined components receive probability current from the initial donor state C_0 . The underline of a component means that it is not empirically real during the time $t \geq t_0$ as described in Chapter 2. It hasn't yet been stochastically chosen. We called it a *ready* component. Only the initial component C_0 is empirically real in this equation, and it is called a *realized* component. The relationship between realized and ready components is also discussed in Chapter 2 and is treated more generally in Chapters 9–12.

According to the Born interpretation, all three of these components have an equal status in reality, differing only in the probabilities given by their magnitudes. But as I say in Chapter 2, the magnitude of a component has no physical meaning; the notion of probability comes into the picture only through probability current as we defined it. If conscious states are to be introduced into quantum mechanics in an objective and unambiguous way, I claim that the interpretation in Chapter 2 (or something like it) must supersede the Born interpretation.

Now imagine that \underline{C}_1 is more painful than C_0 in Equation 3.1 and \underline{C}_2 is less painful than C_0 . According to the proposed influence, the more painful component \underline{C}_1 will be repressed, and the more pleasurable component \underline{C}_2 will be enhanced. This means that the interaction will deliver less current from C_0 to \underline{C}_1 , and it will deliver more current from C_0 to \underline{C}_2 . In both cases, I propose that this redistribution of probability current is caused by the *presence of consciousness* in the realized component C_0 in Equation 3.1; for technically, consciousness only appears in this component at this time. A suggestion as to how this might work at the molecular level is discussed in later sections of this chapter.

This influence is holistic. The effect of pleasure or pain consciousness is not contiguous as in classical physics, or even non-local as in quantum physics. It is an influence that suppresses or enhances *entire components* like \underline{C}_1 and \underline{C}_2 independent of pre-established correlations or entanglements. It also involves a relationship between existing components and as yet non-existing components, thereby spanning the interaction between the present and the future (i.e., spanning a relationship between components that are empirically real and those that are not yet empirically real). If the evolutionary requirements of Chapter 1 are to be fulfilled, it appears that the theory of consciousness must employ a different kind of causal dynamic than any that contemporary physics recognizes.

The Classical Limit

A biological organism is a collection of discontinuous quantum jumps acting together with many continuous processes. At the macroscopic level, the quantum processes are ignorable or averaged out, so the organism can be regarded as a classical system. However, if the above influence is allowed, then a number of quantum processes like that in Equation 3.1 might alter the macroscopic evolution. If the initial macroscopic state is causally related to more or less painful macroscopic states, and if there are a number of quantum jumps between the initial state and each of these accessible states, then the evolution of the system will be diverted away from the more painful states by virtue of the microscopic quantum jumps. A specific mechanism for this influence is proposed later in this chapter. Assume for the moment that this kind of influence is possible.

Let an initial macroscopic state *not* be influenced by surrounding conscious states, so the system follows the Schrödinger path shown in Figure 3.1a. This state will evolve according to the laws of physics as presently understood. Now imagine that this initial state is the conscious state C_0 and is surrounded by conscious states with varying degrees of pain, where those above C_0 in the figure are more painful, and those below C_0 are less painful. The evolution of the system would then be diverted downward as shown in Figure 3.1b.

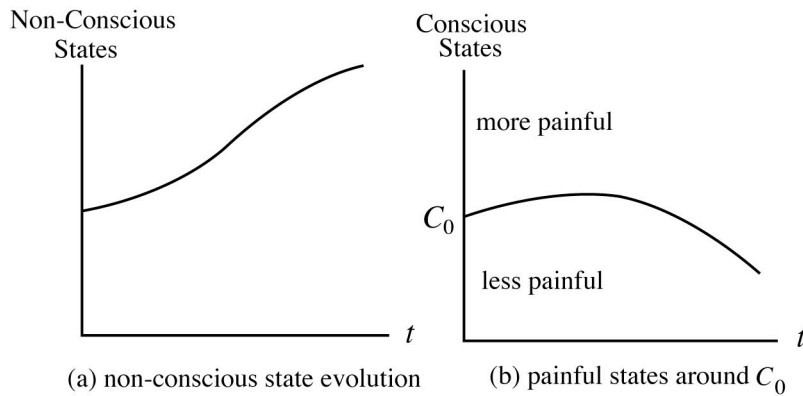


Figure 3.1: Conscious vs. non-conscious state evolution

The curve in Figure 3.1a can be said to represent the ordinary behavior of a macroscopic system, and consciousness can be said to influence that behavior in Figure 3.1b.

Pulse Widths

I explain in Chapter 2 that conscious states can only exist with pulse widths that fall within the ability of the brain to resolve conscious experiences. These pulses are superpositions that cluster around an average state C_0 and are represented by the symbol $\{C_0\}$, called an *endogenous superposition*. The pulse is not a mixture of components because there is no opportunity for decoherence between them. Equation 3.1 therefore becomes

$$S(t \geq t_0) = \{C_0\}(t) + \{\underline{C}_1\}(t) + \{\underline{C}_2\}(t) \quad (3.2)$$

Any future reference to a physiological state will be assumed to be a pulse. The sharply defined lines in Figure 3.1 should be broadened to reflect the state's pulse width. It is then apparent that consciousness can influence the content and migration of a conscious pulse.

It is not clear if the ready pulses in Equation 3.2 are intended to lie within a single pulse, or whether they are the centers of two different pulses. We will assume in the following that each of the ready choices that follow an initially given realized pulse will be a separate pulse.

In summary to this point, the presence of consciousness in the first pulse of Equation 3.2 represses or enhances the probability current flow into the ready pulses in such a way as to repress painful states and enhance pleasurable states. More generally, consciousness in any realized pulse will preferentially *alter the current flow into its ready pulses*, favoring the more pleasurable among them.

There is one other point to notice about pulse widths. Evolution has fashioned the nervous system so that components within a conscious pulse are sufficiently close together as not to be confusing. Blurred subjective or conscious motor states are thereby minimized. However, there is no such limitation on ready pulses like $\{\underline{C}_i\}(t)$ in Equation 3.2. Pulse widths of empirically unreal ready components may be much wider than are allowed for realized components because they are *unconscious* during the time considered; hence, they are not confusing to the observer if they are spread out more extensively. So the influence of consciousness may take the form of *broadening* the search for ready components. Not only does consciousness select a more desirable ready component (i.e., the one with the least pain and the most pleasure), but it pursues this goal by broadening the range of possible ready pulses while moving them in a desirable direction. Consciousness may *alter the content* of its ready pulses as well as *choose preferentially among* them.

The Mechanism of Choice

We have yet to consider the mechanism at the molecular level that carries out the influence of consciousness. It is concerned with how the body's atomic particles rearrange themselves to divert probability current in the direction of more favorable ready components. There is no mechanism in the ordinary contiguous or non-local sense that will perform this function, so we have to imagine another kind of influence that is felt at the molecular level. It must be a holistic influence, in the sense that it manifests itself throughout the affected parts of the body. Let me suggest a possibility.

The body is replete with ligands and their receptors. Ligands are molecules that attach to receptors that activate neurons. The primary example is that of a neurotransmitter that travels across a synaptic junction in the brain to attach to a receptor on the dendrite of a target neuron. There are also a number of ligands that are found throughout the body that attach to opium and other kinds of receptors. Most important if behavior is to be affected, motor neurons release the ligand acetylcholine that attaches to a receptor on muscle fibers. These initiate an action potential that travels along the muscle, causing it to contract.

Before attaching to receptors, ligands are unattached quantum mechanical molecules whose wave function occupies a volume that may or may not make contact with the receptor. They connect with a receptor with a quantum mechanical probability that depends on their distribution in the gap between their points of release and the receptor. The probability of an attachment is normally determined by the dynamic principle driving the system (e.g., the Schrödinger equation), but the molecular mechanism proposed here carries out the influence of consciousness in a different way. It is proposed that *consciousness has the power to alter these spatial probability distributions*. It can increase or decrease the probability that an unattached ligand will make contact with a given receptor. This means that the pulse of a realized component like $\{C_0\}(t)$ in Equation 3.2 can be made to migrate in a way that favors a more pleasurable or less painful receptor. The pulse can also expand beyond its initially given receptors, increasing the choice to more pleasurable possibilities or to less painful ones.

It is left to a more complete theory to say how consciousness accomplishes this push or pull of a ligand toward its receptor, how it expands over its receptor, and how it knows whether to push, pull, or expand in a given case. In this chapter I only suggest a possible form of the influence that I believe might exist, but I do not have the theoretical means to be more specific.

The body is also replete with ions that may or may not pass through voltage-gated chambers that have been opened up for them. These unattached ions have probability distributions in space that may be altered by consciousness to cause the system as a whole to drift toward more pleasurable states and away from more

painful states. In particular, the molecular call-up model, suggested above, uses voltage-gated ions to complete the molecular code, and consciousness might influence these ions in one direction or another. In addition, a critical number of unattached ions play a role in triggering the action potentials of neurons, so a borderline firing can possibly be swayed one way or another by conscious moderation of ionic distributions.

Through these devices, the normal constraints of the dynamic principle are supposedly modified in a way that favors survival in the evolutionary struggle; however, it is required that any one of the states within a ready pulse must be a thoroughly consistent quantum mechanical system. Inflicting these changes on ligand or ion distributions is like adding potentials to the dynamic principle at all the places where they are required. This does not threaten the internal consistency of the system, and in fact, it would seem to insure that normalization in Equation 3.2 is preserved. The proposal therefore affirms that realized conscious pulses are *reshaped in a way that can be simulated by adding potentials that increase or decrease ligand-receptor interactions or ion densities*. Here again, many questions go unanswered because we lack the theoretical means to treat holistic processes of this kind.

What We Need and What We Have

The program presented here is far from a complete theory of consciousness. What we need is a convincing way of bringing such incommensurables as consciousness and matter into a more harmonious relationship. A satisfactory theory of consciousness must show how a holistic influence like consciousness can rank with presently known physical influences, sufficient to exist in equilibrium with them. The theory must also find the logic that allows a holistic influence to carry out its mandate throughout the volume of a physical system – knowing where to repress and where to enhance. The above reference to “potentials” is only a way of visualizing how that might be done consistent with the Schrödinger process. If

this account seems unsatisfactory, it is because we simply do not yet have the ability to deal adequately with this problem.

The universe has somehow solved this problem. It has joined these incommensurables in a lawful way, while we struggle endlessly with the apparent absurdity of it. We are all dualists living in a monistic universe. We simply do not yet have the theoretical muscle to bridge the gap. Nonetheless, there are several essential features of the above line of thinking that I find entirely believable. The first is the evolutionary introduction of the causal influence of consciousness established in Chapter 1. Without that influence, consciousness would have atrophied long ago, and it certainly would not have evolved in parallel with behavior. Second, certain anchor experiences are identified that carry out this causal influence. Third, it is important that each conscious experience has a unique physiological call-up code. These call-ups are necessary to the causal loop that brings consciousness into a physical system. Fourth, a conscious state can only exist in groups of states in superposition with one another, forming an endogenous pulse that is sufficiently narrow as to not be confusing. And finally, the quantum mechanical formalism must be specified into which these considerations fit. I believe that the only way that consciousness can be compatible with quantum mechanics without paradox is to deny the relevance of the Born interpretation, and to adopt the one developed in Chapter 2.

These five things are central: (1) The causal influence of consciousness, (2) anchor experiences that carry out this cause, (3) call-up codes in some form, (4) conscious pulses, and (5) a non-paradoxical interpretation of quantum mechanics. The rest is speculation that draws these parts together and fills out the package. Many of the features of that package may or may not be included in an eventual theory of consciousness, but I think the basic five are necessary and entirely defensible at this time.