

5. Agents and Evolution.

Human beings play a singular role in Copenhagen quantum theory: within that scheme science is viewed as a human endeavor, performed by human beings for human beings. Still, most scientists believe that *something* was going on before Homo sapiens arrived on the scene, and many hold that the task of science will not be finished until we have a science-based idea of what that something was, and how our species emerged from it.

My intention here is to find the place of human beings in a broader non-anthropocentric setting, and I believe that this can be done by building upon the foundation laid by the creators of quantum theory, rather than by retreating to a mechanistic conception of man that ignores consciousness, or tries to replace it by something else, such as classically describable brain processes. Indeed, the approach of scientists and philosophers who base their thinking on the classical conceptualization of human brains depends on a promissory note that can never be redeemed.

That promise, or completely unsupported hope, is that *someday* we shall be able to understand how a conscious experience---a feeling or knowing---can either *be*, or *be a necessary consequence of*, a structure built exclusively out of the elements specified by classical mechanics. However, as already noted in Chapter 1, the classical concepts and laws entail all kinds of microscopic and macroscopic geometric, behavioral, and functional properties, but nothing in those concepts and principles can *ensure* or *dictate* that some changing arrangements of numbers assigned to space-time points, which is basically all that classical physics can ever provide, will *necessarily* be accompanied by, say, a “painful feeling”.

Thus feelings can be only gratuitous---not rationally entailed---add-ons to any structure built solely from entities possessing only the properties specified by the classical concepts. Such supernumeraries, being non-entailed either rationally, dynamically, or logically, can be stripped away without effecting the course of physical events prescribed by the theory, and hence are devoid of survival value. Nor can it be argued that feelings *must* emerge from such systems because we ourselves are the living proof. For we

ourselves are certainly not built out of elements that conform to the idealized unphysical concepts that are the basis of classical physics. We, insofar as contemporary science has correctly informed us, are built out a very different kind of stuff that is more like information and tendencies for experiences to occur, than like classical matter.

In short: in order to get something like consciousness out of a theory one must put something like consciousness in. Quantum theory already requires, in order to yield well defined predictions, the existence of Process I, which by its intrinsic nature is both a dynamically efficacious element of the theory and a link between the experiential and physical aspects of the theory. Thus quantum physics already provides, *as an essential feature of the dynamics*, what was formerly provided by metaphysics, namely a link between the physical attributes of an agent, which are described in mathematical terms, and the experiential aspects that are described in psychological terms?

So far I have restricted myself to the orthodox framework created by the founders of quantum theory, and developed by John von Neumann. The focus of those works was on *human* agents, and on intentional actions that created scientific experiments. I shall apply the same equations and ideas more generally.

So how does the evolutionary scenario work?

According to this theory, the universe initially evolves under the governance of Process II alone. All possibilities are mechanically generated by this evolving wavelike state. Given the nature of the laws implemented by these laws---which support, among other things, the possibility of the formation of organic molecules---the set of all possibilities will eventually lead to the formation of potential agents, which are simply mechanical subsystems that exist for a time in equilibrium with their environment, as (perhaps rudimentary) stimulus-response (input-output) system. These systems can be roughly conceived of as smeared out cloudlike *collections* of classical states that tend to endure for intervals of time in communication with their environments.

Each of these quasi-stable subsystems has, due to its wave-like (cloudlike) nature a tendency to degenerate into less cohesive states. However, nature has armed all potential agents with a counter-weapon: access to Process I, which is able by means of the Quantum Zeno Effect (to be described presently) to preserve over extended periods, in the face of all sorts of disruptive processes, the physical integrity of the agent.

We have as our building blocks the assumed existence of Processes I and II, and the known existence of feelings. This brings us to the critical questions: (1) What determines when a Process I event occurs? (2) What determines the specific form of that event? And (3) How is that event related to the “feeling” aspect of nature?

Due to the inherently wave-like quality of physical systems the quantum state of a potential agent will tend to evolve into a collection of states that represent alternative possible courses of action. Within that collection there may be a maximal state of high organization (low entropy) in which various modules---partially autonomous subsystems---within the agent act together in mutual support to form a state of quasi-stable equilibrium. This state will extend over a large region, and hence cannot be grasped or identified as a whole by the dynamically local Process II. But it can be specified by a projection operator P acting on some slowly changing degrees of freedom of the agent. The feel associated with Process I can be identified as the grasping of this state organization and separating it from the prior state S . This enduring state of quasi-stable equilibrium is the state PSP specified by Process I.

One might object that if the effect of this “feel” is precisely definable in terms of the mathematically defined projection operator P , then the “feels” could, just as in the classical case, be eliminated from the dynamics, rendering the feels superfluous and without causal efficacy. But the situation in this regard is very different from the classical one. In the classical case an ontology (i.e., reality) is specified that has no hint of the existence of anything like a “feeling.” And there is nothing physical for a feeling to do that is not already done by the classical physical process. But in quantum theory the physically described Process II, does not by itself lead to a well defined predictive theory, or to any understanding of the structure of our human experiences. Thus orthodox quantum theory introduces

Process I not to link consciousness to a theory that is already dynamically complete, but rather to complete the dynamics in a way that will bring the theory into concordance with our conscious experience. This process must involve “feelings,” if, following William James, we recognize all experiential happenings to be feelings of one kind or another.

This grasping event is represented in the mathematics by a von Neumann Process I event. Each such event separates the prior physical reality into two independent branches, ‘Yes’ and ‘No’. The ‘Yes’ branch, PSP, contains the organized state of equilibrium, which persists long enough for its physical traces to be etched into the physical structure of the agent, and for the action that it specifies to be initiated. The left-over ‘No’ branch (I-P)S(I-P) would not in general be associated with a quasi-stable state of equilibrium, and hence should not be directly connected to a (recollected) experience. However, subsequent Process I events can occur in either one of the two branches, and this would allow experiences to become associated eventually with either branch.

The theory assigns a statistical weight to each branch. The weights associated with the ‘Yes’ and ‘No’ branches are given by the formulas $\text{Tr PSP}/\text{Tr S}$ and $\text{Tr (I-P)S(I-P)}/\text{Tr S}$, respectively, where for any matrix M the expression Tr M represents the sum of all of the ‘diagonal elements’ $M(i,i)$ of M. (You need not understand these formulas, but should know that such probability formulas exist.)

Subjectively, these statistical weights determine the “probabilities” that the agent will experience the ‘Yes’ feeling or will not experience that feeling. They determine also the probability that another agent who is observing first agent will observe his actions to accord with the state PSP or (I-P)S(I-P).

The simplest explanation of these empirical facts is that “Nature chooses” either the state PSP or the state (I-P)S(I-P) in accordance with a “propensity” or “objective tendency” specified by the above formulas. However, this idea of a real objective eradication of one branch or the other leads to the conclusion that Process I events occurring in distant parts of the universe are linked together by “instantaneous” action-at-a-distance effects. Some physicists find this conclusion unacceptable, even though it generates no conflict with

experience, and prefer to believe that no real objective choice is made between the two states, but rather that *it only seems like that*. Von Neumann makes no commitment as to whether there is or is not a real objective eradication of branches, and I shall follow his lead of not becoming embroiled here in that controversy.

The really important fact is this: If the rapidity of nearly identical Process I events in a chain of 'Yes' choices is sufficiently great then, a straightforward application of the probability formulas given above shows that, the probability associated with this evolving 'Yes' state will not decrease as quickly as it otherwise would. Thus this state of organization can sustain itself by means of this "Quantum Zeno Effect" in the face of mechanical processes that tend to destroy it. This means that agents that have structures that tend produce suitable sequences of Process I events would enjoy a survival advantage over competitors that lack such structures. Our own large capacity to use Process I would then be an example of the adaptive tendency of living organisms to exploit the intricacies of the laws of nature.

It is important that the Quantum Zeno Effect of a rapid sequence of Process I events associated with a projection operator P would tend to keep the original state PSP confined to states of the form PXP , but that the factor X would evolve in a normal way. Thus a focus of attention associated with a projection operator P could be sustained in the face of strong mechanical disruptive tendencies while the mechanical processing *within* the subspace specified by that fixed focus of attention proceeds normally

This capacity of mental intention to keep attention focused in the face of natural distractions could produce large deviations in the behavior of a quantum agent from his classical zombie (i.e., nonconscious) counterpart. Mental effort can make a big difference in brain activity! And the dynamical equations that allow mental effort to make this big difference lie at the core of quantum theory.