6 The Physical Effectiveness of Conscious Will and the Quantum Zeno Effect

A crucial question now arises: How does this dynamical psycho-neurological connection via process 1, *which can merely pose a question*, but not answer it, allow a person's effort to influence his or her physical actions?

Take an example. Suppose you are in a situation that calls for you to raise your arm. Associations via stored memories should elicit a brain activity having a component that when active on former occasions resulted in your experiencing your arm rise, and in which the template for arm-raising is active. According to the theory, this component of brain activity will, if sufficiently strong, cause an associated process 1 action to occur. This process 1 action will partition the quantum state of your brain in such a way that one component, labeled 'Yes', will be this component in which the arm-raising template is active. If the 'Yes' option is selected by nature then you will experience yourself causing your arm to rise, and the state of your brain will be such that the arm-raising template is active.

But the only dynamical freedom offered by the quantum formalism in this situation is the freedom to perform at a selected time some process 1 action. Whether or not the 'Yes' component is actualized is determined by 'nature' on the basis of a statistical law. So the effectiveness of the 'free choice' of this process 1 in achieving the desired end would generally be quite limited. The net effect of this 'free choice' would tend to be nullified by the randomness in nature's choice between 'Yes' and its negation 'No'.

A well-known non-classical feature of quantum theory provides, however, a way to overcome this problem, and convert the available 'free choices' into effective mental causation.

6.1 The Quantum Zeno Effect

A well studied feature of the dynamical rules of quantum theory is this: Suppose a process 1 query that leads to a 'Yes' outcome is followed

by a rapid sequence of very similar process 1 queries. That is, suppose a sequence of identical or very similar process 1 actions is performed, that the first outcome is 'Yes', and that the actions in this sequence occur in very rapid succession on the time scale of the evolution of the original 'Yes' state. Then the dynamical rules of quantum theory entail that the sequence of outcomes will, with high probability, all be 'Yes': the original 'Yes' state will, with high probability, be held approximately in place by the rapid succession of process 1 actions, even in the face of very strong physical forces that would, in the absence of this rapid sequence of actions, quickly cause the state to evolve into some very different state (Stapp 2004a, Sect. 12.7.3).

The *timings* of the process 1 actions are, within the orthodox formulations, controlled by the 'free choices' on the part of the agent. Mental effort applied to a conscious intent increases the intensity of the experience. Thus it is consistent and reasonable to suppose that the rapidity of a succession of essentially identical process 1 actions can be increased by mental effort. But then we obtain, as a mathematical consequence of the basic dynamical laws of quantum mechanics described by von Neumann, a potentially powerful effect of mental effort on the brain of the agent! Applying mental effort increases the rapidity of the sequence of essentially identical intentional acts, which then causes the template for action to be held in place, which then produces the brain activity that tends to produce the intended feedback.

This 'holding-in-place' effect is called the quantum Zeno effect, an appellation that was picked by the physicists E.C.G. Sudarshan and R. Misra (1977) to highlight a similarity of this effect to the 'arrow' paradox discussed by the fifth century B.C. Greek philosopher, Zeno the Eleatic. Another name for this effect is 'the watched-pot effect'.

The quantum Zeno effect can, in principle, hold an intention and its template in place in the face of strong mechanical forces that would tend to disturb it. This means that agents whose mental efforts can sufficiently increase the rapidity of process 1 actions would enjoy a survival advantage over competitors that lack such features. They could sustain beneficial templates for action in place longer than competitors who lack this capacity. Thus the dynamical rules of quantum mechanics *allow* conscious effort to be endowed with the causal efficacy needed to permit its deployment and evolution via natural selection.