Microvita and the Quantum Zeno Effect - Part II

by Dr. Hans-Joachim Rudolph (MD), Microvita Research e.V.

The Quantum Zeno Effect got its name from the Greek philosopher Zeno of Elea, and was brought into prominence by an analysis of Baidyanath Misra and George Sudarshan dealing with an unstable quantum system whose decay could be inhibited by repeatedly measuring its initial state (1). The notion points to the fact that such systems can be "freezed" by continuous observation (see Fig. 1).

NeuroQuantology | September 2012 | Volume 10 | Issue 3 | Page 374-388
Georgiev D., Mind efforts, quantum Zeno effect and decoherence

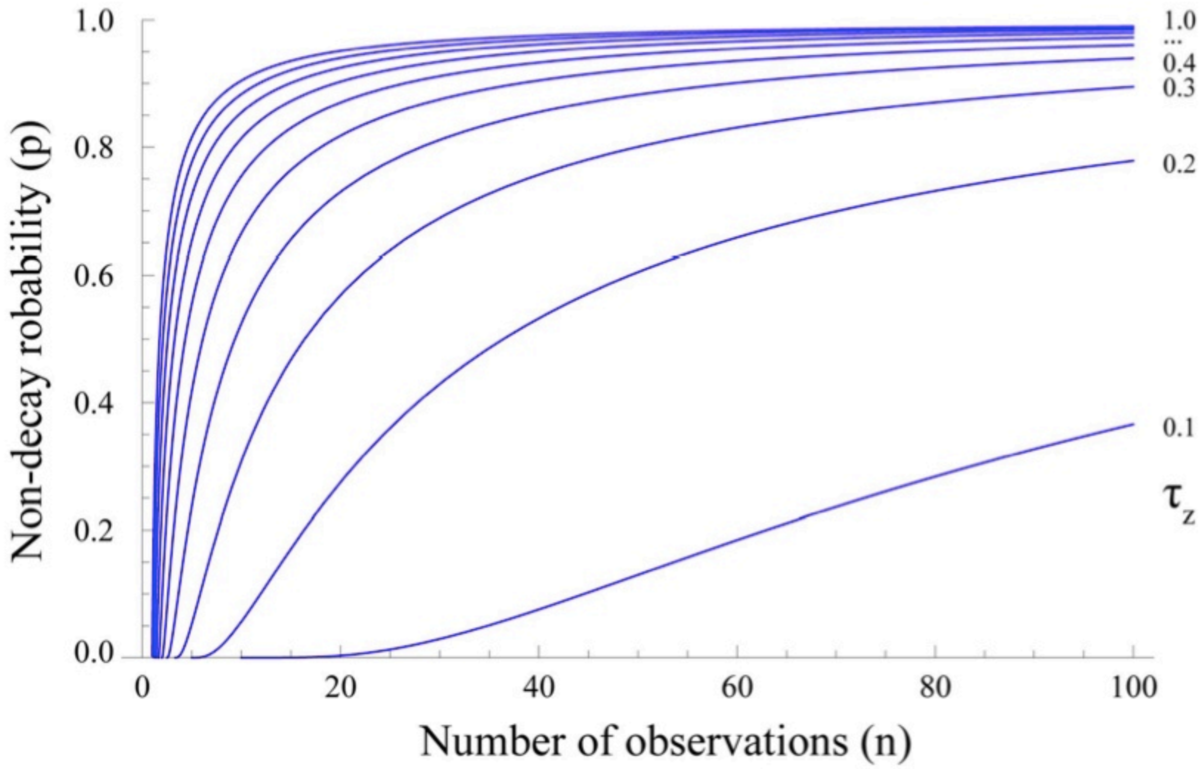

Figure 1. QZE efficiency measured by the non-decay probability *p* for different values of the Zeno time τ_z (from 0.1 to 1.0) of the system as a function of the number of observations *n* performed by an external agent for a unit time interval *T*. The non-decay probability *p* for a given number of observations *n* is higher if the Zeno time τ_z of the system is longer.

In the given context, the crucial question is what it means to observe or measure a quantum system – keeping in mind that the quantum measurement problem remains unresolved since decades:

In contrast to the Copenhagen interpretation of quantum mechanics, London and Bauer advised as early as 1939 that it is not a macroscopic device, but human consciousness which completes a quantum measurement (2).

In 1955, von Neumann discussed the conceptual distinction between the observed and the observing system. Thereby, he considered the general situation of a measured object system (I), a measuring instrument (II), and the brain of a human observer (III). His conclusion was that it makes no difference for the result of measurements on (I) whether the boundary between the observed and the observing system is posited between (I) and (II & III) or between (I & II) and (III). As a consequence, it is inessential whether a detector or the human brain is ultimately referred to as the "observer" (3).

In 1958, Heisenberg introduced a distinction between the potential and the actual, implementing a decisive step beyond the operational Copenhagen interpretation of quantum mechanics. Heisenberg's notion of the actual is related to a measured event in the sense of the Copenhagen interpretation. His notion of the potential, however, relates to the situation before measurement, which expresses the idea of a reality independent of measurements (4).

On this background, Henry P. Stapp used the freedom to place the interface between the observed and the observing system and located it in the observer's brain. Consequently, he advanced that the mind is 1. able to hold the brain in a superposition of states, using the Quantum Zeno Effect, and that this phenomenon is 2. the principal method by which the conscious can effect change (5). As to the quantum aspect of a template for action, Stapp argued that the attention devoted to intentional acts can protract the lifetime of neuronal assemblies representing such templates (6).

Danko Georgiev criticized Stapp’s model in two aspects:

1. In this model, the mind acts upon the brain using projection operators without having an own wavefunction or density matrix, which would be mandatory in standard quantum mechanics.
2. Stapp’s claim that the Quantum Zeno Effect is robust against environmental decoherence directly contradicts a basic theorem in quantum information theory according to which the von Neumann entropy production by mental

efforts is always non-negative, provided that the mind is able to act only locally at the brain (7).

1. B. Misra and G. Sudarshan, The Zeno's paradox in quantum theory. Journal of Mathematical Physics, Volume 18, Issue 4, p. 756 (1977)
2. F. London and E. Bauer, La théorie de l'observation en mécanique quantique. Trans. in Wheeler and Zurek (eds.), Quantum Theory and Measurement, Princeton University Press, p. 251 (1983)
3. J. von Neumann, Mathematical Foundations of Quantum Mechanics. Princeton University Press, p. 366 (1955)
4. W. Heisenberg, Physics and Philosophy. Harper & Row, New York (1958)
5. H.P. Stapp, Mindful Universe: Quantum Mechanics and the Participating Observer. Springer-Verlag, Berlin, Heidelberg (2007)
6. H. Atmanspacher, Quantum Approaches to Consciousness. In Zalta (ed.), Stanford Encyclopedia of Philosophy (summer 2011)
7. D. Georgiev, Mind Efforts, Quantum Zeno Effect and Environmental Decoherence. NeuroQuantology, Volume 10, Issue 3, p. 374 (2012)