Abstract: Faced with probabilistic relationships between causes and effects, quantum theory assumes deterministic causes do not exist, and that only incomplete probabilistic expressions of knowledge are possible. As in its application to physics, this fundamental epistemological stance severely limits the ability of quantum theory to provide insight and understanding in human cognition.

Main Text

Some physicists have serious objections to quantum theory. Their dissent does not relate to ontology---there is broad acceptance that quantum theory has led to surprising and accurate predictions about the physical world, with useful applied results---but, rather, to epistemology. Since the target article is clear that it is not making ontological claims about the brain being quantum, but arguing for the epistemological promise of the quantum approach offering psychological understanding of “the fundamental why and how questions of cognitive process,” the criticisms from physics are directly relevant.

The physicists’ argument against the quantum approach to modeling is clearly explained by Jaynes (2003, pp. 327-328). If there is some effect E that does not occur unless some condition C is present, it seems natural to infer that the condition is a necessary causative agent for the effect. If, however, the
condition does not always lead to the effect, it seems natural to infer that there must be some other causative factor F, which has not yet been understood. This is the approach taken by classic probability. Asking the Gore question C causes an opinion E to be produced. If the opinion is different when the Clinton question F is asked first, then the conditional probability $p(E|C)$ must be extended to $p(E|C,F)$ to take account of the relevant additional information in factor or context F. Quantum theory, as advocated by the target article, takes a fundamentally different approach. Faced with probabilistic relationships between causes and effects, quantum theory assumes deterministic causes do not exist, and that only incomplete probabilistic expressions of knowledge are possible. Rather than trying to understand the exact nature of the influence of the relevant factor F, quantum theory simply assumes this level of understanding is beyond its scope.

We think it is reasonable to have reservations, when dealing with something as complicated as human cognition, about whether it is practically feasible to isolate all the relevant factors and fully understand their interactions. But that is not the issue here. In sharp contrast to classical probability, adopting the quantum approach makes it nonsensical even to aim for this understanding. As Jaynes (2003, p. 328) puts it: “The mathematical formalism of present quantum theory, like Orwellian newspeak, does not even provide a vocabulary with which one could ask such a question.” It is the difference between, in practice, not having the understanding of physics needed to control deterministically the outcome of a coin flip, versus assuming, in principle, that such a level of understanding can never be reached (i.e., that even with sophisticated instruments for applying forces and measuring initial conditions, the outcome of a physical coin flip is inherently probabilistic). The deterministic effects of order, context and the other factors highlighted in the target article on human cognition might be hard to understand, but adopting the quantum approach requires us to stop trying.

The target article seems to acknowledge this hamstringing, when it argues that the basic quantum property of superposition is “an intuitive way to characterize the fuzziness (the conflict, ambiguity, and ambivalence) of everyday thought.” But should characterizing indefiniteness be the objective when building models of cognition? Surely the goal of modeling cognition is to sharpen our understanding, and remove the fuzziness, rather than to replicate it in the modeling machinery. The fact that people cannot unpack the relevant contexts or other factors that mediate their cognitive processes does not mean our models must be similarly unable to do so. The same basic issue plays out in discussion of entanglement, which makes it impossible to construct a complete joint distribution between two variables, and thus impossible to model how they interact with each other. Instead, the quantum approach implants indefiniteness about how cognition works directly into the modeling framework, and there is neither the possibility nor need to work hard to build better models that remove the confusion.

The target article argues the acid test is “whether there are situations in which the distinctive features of QP theory provide a more accurate and elegant explanation for empirical data.” Viewing quantum theory as newspeak implies that it cannot, in principle, lead to complete explanations. We think the worked examples in the target article bear this out. There are striking disconnects between the descriptions of the formal workings of the models, and their psychological interpretations. The former seem devoid of psychological content and the latter seem vague and verbal. For example, the projection of lines onto subspaces that models the conjunction fallacy, with its mathematical precision,
is ‘explained’ as “a kind of abstraction process, so that the projection onto the feminist subspace loses some of the details about Linda.”

Sloman’s review of the Busemeyer and Bruza (2012) book on quantum models of cognition and decision says “Mathematical models of cognition so often seem like mere formal exercises. Quantum theory is a rare exception. Without sacrificing formal rigor, it captures deep insights about the workings of the mind with elegant simplicity.” We think that is exactly the wrong way around. Quantum models of cognition offer formal exercises that might produce impressive fits to data but, by their founding assumptions, cannot offer some of the most basic insights into the causes, effects and relevant factors that underlie the workings of human cognition.

Jaynes (1993, p. 269) puts the physicists’ epistemological dissent bluntly, saying “I am convinced, as were Einstein and Schrödinger, that the major obstacle that has prevented any real progress in our understanding of Nature since 1927, is the Copenhagen Interpretation of Quantum Theory. This theory is now 65 years old, it has long since ceased to be productive, and it is time for its retirement.” It would be unfortunate if a theory ready for retirement in its professional field of physics were to enjoy a second hobbyist career in psychology.

Reference List:

