Commentaries on Articles

Idealistic Quantum Psychopathology: A Way Forward?

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Abstract

Quantum psychopathology holds the so called "quantum mind" hypothesis, which is controversial. In addition, this hypothesis focuses attention onto quantum processes in the brain, and how this may relate to psychopathological issues. This is very "low level". As a consequence, it is challenging to form bridges to "higher level" problems related to psychopathology. By adopting the stance used in the quantum interaction community or researchers, this reply puts forward the idea that an idealistic approach may circumvent the controversy and opens the way for addressing challenges at higher levels of psychopathology.

Key words: psychopathology, quantum theory, idealism, quantum interaction.

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I write these comments from the perspective of "quantum interaction", a label referring to a growing community of researchers who are applying quantum theory outside of physics to problems in fields such as artificial intelligence, cognition, information retrieval, organizational decision making.

One of the big challenges faced by the quantum interaction community is how to provide a convincing demonstration that a quantum or quantum-like approach actually does show an advance over "classical" approaches. This challenge is shared by the quantum neurodynamics community and in my opinion entails two aspects.

The first aspect involves demonstrating how a classical explanation can be ruled out, or where the boundary between classical and quantum can be clearly defined. This is very difficult to do, though some important steps have been taken in this direction, e.g., (Aerts and Aerts, 2008). In practice, however, the quantum interaction community often motivates the use of quantum models as innovative abstractions of existing problems. These abstractions have the character of idealizations in the sense there is no claim as to the validity of the idealization "on the ground". For example, work on quantum-like models on the human mental lexicon involves modelling words in human memory as entangled "particles", e.g., (Bruza *et al.*, 2009; Aerts *et al.*, 2000). This work makes no claim as to whether there is associated physical entanglement going on somewhere in the brain. This may seem like a cop out, but is not that different to idealizations employed in other areas of science. For example, in models of population dynamics, infinite populations are idealized, even though this idealization is patently false on the ground.

The second aspect revolves around how "advance" is defined. The work on quantum cognition is perhaps strongest in this area. For example, models based on quantum theory are shown to better fit the

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empirical data with respect to a range of human decision theoretic tasks (Pothos and Busemeyer, 2009).

The articles presented in this special issue "Quantum Paradigms of Psychopathology" are informative and thought provoking. They embrace the quantum mind hypothesis, e.g., via thermofield brain dynamics (Globus, 2010). this issue). The quantum mind hypothesis is controversial. In addition, the question is raised as how to bridge the significant gap between quantum neurodynamic models, which seem very "low level" and "higher" social and psychological levels of psychiatric phenomenology, as pointed out by Mender (this issue).

A way forward could be to idealize the use of quantum models in psychopathology as is done in quantum models of cognition in the quantum interaction community. This would allow one to remain agnostic towards the quantum mind hypothesis, and thereby side-step the associated controversy.

One way to do this would be via a re-appraisal of artificial neural networks (ANNs), which Mender (this issue) cites in the context of schizophrenia, and provides detailed motivations why ANNs are unsatisfactory. Might not tensor network theory (TNT) be an area worthy of investigation? TNT has its roots in neuroscience but has been recently adopted by quantum computing community for simulations of quantum systems on classical computers. The TNT framework may provide sufficient expressivity to model some of the "higher level" aspects mentioned above, as well as providing a computational basis for simulations, which can be used to provide evidence of an "advance". Furthermore, TNT theory is being developed to deal with very large amounts of data in extremely high dimensions and would at first sight seem appropriate to the scale of modelling required in quantum neurodynamics. (Acar *et al.*, 2009). It is significant that Charles van Loan is one of the major players behind TNT. He was co-author of the seminal work "Matrix Computations" with Gene Golub.

Another direction worthy of note is provided by Paul Thagard and his colleagues who have recently developed an ANN model of emotional consciousness based on many interacting brain areas coordinated in working memory (Thagard and Aubie, 2008). Whilst this work does not cross into the field of psychiatry, it does demonstrate an interesting attempt to go beyond toy neural models. Whilst this model would probably fall within the ambit of Mender's criticisms mentioned above, there may be ways to make such models more quantum-like despite Thagard *et al.*,'s view stating mental phenomena and the brain are unlikely to require quantum theory (Litt *et al.*, 2006).

For example, the convolutions used to model interactions can be investigated to see whether non-separable interactions are possible.

Without the development of serious models, which are being empirically validated, and their quantum-like nature being validated, the quantum neurodynamics community runs the risk of advancing interesting and thought provoking ideas, which will remain just that.

References

Acar E, Alter O, Bader B. *et al.*, (eds) Future directions in tensor-based computation and modelling. Accessed Date, Feb 28, 2010 www.cs.cornell.edu/cv/TenWork/FinalReport.pdf

Aerts D, Aerts S, Broekaert J and Gabora L. The Violation of Bell Inequalities in the Macroworld. Foundations of Physics 2009; 30: 1378-1414.

Aerts S and Aerts D. When is a set of data best described by a quantum (like) theory? Proceedings of the Second Quantum Interaction Symposium (QI-2008). College Publications, 2008; pp. 27-34.

Bruza PD, Kitto K, Nelson D and McEvoy CL. Is there something quantum-like about the human mental lexicon? Journal of Mathematical Psychology 2009; 53: 362-377.

Globus G. Toward a quantum psychiatry: hallucination, thought insertion and DSM. NeuroQuantology 2010; 8(1): 1-12.

Litt A, Eliasmith C, Kroon F, Weinstein S and Thagard P. Is the brain a quantum computer? Cognitive Science 2006; 30: 593-603.

Pothos EM and Busemyer J. Quantum Probability Explanation for Violations of 'Rational' Decision Theory. Proceedings of the Royal Society B 2009; 276 (1165): 2171-2178.

Thagard P and Aubie B. Emotional consciousness: A neural model of how cognitive appraisal and somatic perception interact to produce qualitative experience. Consciousness and Cognition 2008; 17: 811-834.