

# From Quantum Wetware to Mental Illness: A Section Editor's First Interim Progress Report

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## Abstract

This paper summarizes the main points of target articles and commentary concerning quantum paradigms of psychopathology (QPP) appearing in the March 2010 issue of NeuroQuantology. Empirical findings, theoretical constructs, and problems raised at the subatomic, biomolecular, informational, molar neurophysiological, and social-ecological levels of analysis are reviewed. New questions for future researchers are posed.

**Key Words:** cell membrane, dissipative thermofield dynamics, implicate order, microtubule, mood disorder, nanowire, Orch OR, quantum phase transition, schizophrenia, tensor network theory, tuning.

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In the March 2010 issue of NeuroQuantology, theoreticians and scientific investigators contributed four target papers and five commentaries that introduce psychiatrists and allied thinkers to a new mode of discourse: quantum paradigms of psychopathology. The range of content covered by that material has created a diverse wealth of options for future consideration. However, this very diversity also generates a need to summarize and coordinate the authors' varied approaches, so that dialectical tensions and synergies among them may be highlighted and marshaled toward further progress. The present brief review attempts to provide such synoptic coordination.

The first target paper, authored by Gordon Globus (Globus, 2010), attempts to reformulate the broad outline of *DSM IV-R*, American psychiatry's currently ad hoc disease taxonomy, into a systematic nosology founded on dissipative thermofield dynamics. The point of departure for Globus is Clerambault's concept of *automatisme mentale*, which subsumes a set of clinical phenomena including thought insertion and auditory hallucinations. These manifestations of Bleulerian schizophrenia and its related conditions bracket a continuum of perceptual concreteness ranging from the fully abstract to the tangibly sensible. All gradations along with their bracketing states have in common an internally felt splitting of volitional agency into self and "other," coupled with a retained unity of phenomenal consciousness. Such experience does not resonate intuitively with non-schizophrenic subjects.

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Globus argues that pre-quantum approaches, for instance parallel distributive neural networks governed by classical non-linear dynamics, offer inadequate explanations of Bleulerian splitting, because their optimization principles exclude the possibility of superposed attractor basins which might support disjunctive agency in the context of preserved conscious integrity. Globus contrasts this non-quantum limitation with the advantages of systems possessing quantum degrees of freedom, allowing for superpositional interference among multiple probabilistic wavefunctions. He singles out for especially detailed consideration, among many existing quantum "languages," the potentially psychiatry-friendly lexicon of "dual modes," developed by Vitiello to address thermofield implications of consciousness and then adapted to the problem of decentered subjectivity by Globus's own work.

Globus demonstrates the elegant fit of *automatism mentale* into a dual-mode framework. His assertions are justified insofar as conjugate matches between two interfering wave functions, one connected with stimuli and the other with memories, may be "tuned" by a third wave function linked to the overall contextual agency of the brain. He is thus able to portray *automatism mentale* as a failure of the thermofield-dissipative brain to integrate its tuning of stimuli and memories. While conjugate matches do indeed still form to support a unified phenomenal consciousness in schizophrenia, the experience of functioning as a subjective agent becomes distorted by pathologically "dis-integrated" tuning and hence "splits" a la Bleuler.

The light thrown by this model on possible quantum-dissipative underpinnings of schizophrenia is constructively widened in scope by Globus to account etiologically for other symptom clusters categorized by DSM IV-R as mood and anxiety disorders. Here pathogenesis is seen in terms of integrated yet systematically biased thermofield "mal-attunements" by the brain's globally contextual agency. Globus enlists variations on this mal-attunement theme to explain DSM IV-R's adjustment disorders, ADHD, and characterological syndromes.

Commentary by Malik (Malik, 2010)

on the paper by Globus points out that, while the etiological explanatory power of the dissipative thermofield tuning model is considerable, its material specificity needs further fleshing out if all its possibilities are to be realized. In particular, Malik observes that contributions to mental disorders by genetics, medical comorbidities, and other biomolecular factors require concrete integration with the tuning approach, perhaps to the point of delineating underlying causes of constitutional vulnerabilities to abnormal attunements as a common pathway to their clinical expression.

Another commentary by Tonello and Cocchi (Tonello and Cocchi, 2010) addresses some aspects of Malik's challenge to Globus. These authors introduce the notion that the cell membrane may serve well as a physico-chemical bridge between a variety of foundational quantum processes and clinical expressions of psychopathology. The relevant components of the membrane are said to be the G-protein within its lipid raft microdomain and related fatty acids. The authors present evidence that different G-protein and lipid configurations affect cyclic AMP signaling in ways that can be correlated with depression and suicide; these correlations may be found in the cell membranes of platelets, whose assay in future clinical diagnostic technologies might prove more practically accessible than central neurons. Tonello and Cocchi list possible points of theoretical contact between depression-correlated membrane parameters and quantum neurodynamic models. The thermofield role of ordered water is described in conjunction with glial production of fatty acids; Bernroider's quantum account of voltage gating across Kv channels is recounted in terms of control by surrounding membrane proteins and lipids; tubulin as the main actor in the loop-gravitational Orch OR hypothesis of Penrose and Hameroff is related to G protein/lipid raft dynamics and via Hameroff's recent "conscious pilot" model to the opening and closing of gap junctions.

The target paper by Nancy Woolf, Travis Craddock, Douglas Friesen, and Jack Tuszynski (Woolf *et al.*, 2010) further addresses the challenge of identifying

molecular bases for quantum paradigms of psychopathology. The authors postulate that at least some mental disorders may arise from faulty quantum processing in dysfunctional microtubules associated with defective neuroplasticity. Woolf and her colleagues buttress this hypothesis with three categories of support.

First, Woolf and her co-workers cite empirically demonstrated connections between mental illnesses and abnormalities in genes coding for proteins regulating neuroplasticity through cytoskeletal influences. In particular, schizophrenia and mood and anxiety disorders, along with relevant animal models, have been linked to polygenetic anomalies such as single nucleotide polymorphisms, gene deletions, and transgenic modifications that alter proteins including DISC1, neuregulin-1, dysbindin, neurexin-1, and stathmin. These changes in turn may affect tubulin in concert with neurodevelopmental cell proliferation and migration, neurite outgrowth and synaptogenesis, myelination, axon terminal processes, postsynaptic density configuration, dendritic branching, and/or other manifestations of neuronal and synaptic plasticity. Adjunctive supportive data include the demonstrated dependence of basic cognitive functions, such as memory impaired by Alzheimer's disease and cytoskeletal toxins such as colchicine and aluminum, on cytoskeletal microtubules, actin filaments, and microtubule-associated proteins (MAPs) in brain structures including the hippocampus. Also mentioned are effects of environmental stresses like social isolation, aversive stimuli, and stress, which are known to exacerbate psychopathology, on cytoskeletal proteins of animal subjects.

Second, Woolf and her coauthors note that current mainstream drug treatments for depression and schizophrenia exert their therapeutic clinical effects with a latency of 2-6 weeks. This time lag is inconsistent with explanations solely invoking reversal of an underlying neurotransmitter "imbalance" but is consistent with the 2 week interval known to be required for neuronal cytoskeletal reorganization during learning. It is also pointed out that some antidepressants,

mood stabilizing drugs, and antipsychotic agents variously affect the organization of tubulin in microtubules, the character of MAPs, and the vigor of neurogenesis, and that neurotransmitter changes themselves exert effects on cytoskeletal dynamics.

Third, Woolf and her collaborators invoke the potentially greater depth and range offered by quantum paradigms compared to classical ideas in explaining how brain phenomena subservise not only normal but also abnormal mental processes. The problems of volitional agency, "theory of mind," and executive function, all impaired in schizophrenia, may move closer to clarification in a quantum framework, including explicitly quantum neurodynamical psychobiologies. The authors allow that the older quantum brain theories of Beck and Eccles regarding electron tunneling as a trigger for presynaptic exocytosis and of Stapp concerning single file calcium ion flow regulation by proteins through membrane channels are both physically implausible. However, Woolf and her coauthors next move to focus on the more robust thermofield approach of Vitiello and Globus and Orch OR hypothesis of Penrose and Hameroff, with a proviso that the still open question of rapid thermal decoherence germane to these models remains to be resolved. The double-well electron potential mechanism, postulated by Craddock and Tuszynski to operate inside the tubulin dimer, is mentioned as a related alternative. The nanowire network interpretation of microtubules and actin filaments by Woolf, Priel, and Tuszynski is outlined along with its promise of quantum-computationally integrating contributions to cognition from structures both spanning the whole brain and deep within each individual neuron.

With regard to thermofield, OrchOR, double well, and nanowire approaches, four possible patterns of progression in cellular automata instantiated as tubulin arrays with clocking mechanisms in the picosecond range are advanced by Woolf and her co-workers as a possible means of parsing links between atomic behaviors of fundamental proteins and macro-manifestations of mental illnesses; it is inferred that complex, sometimes durably localized types of

patterned structures may be deficient in depression but excessive in mania, anxiety, and thought disorders. Woolf and her collaborators speculate that the picosecond time scale at which such progressions are generated may relate interdependently to the millisecond time scale of classical neurophysiology, to the order of minutes across which periodic polymerization-depolymerization cycles occur, to 24 hour circadian rhythms, and to the seasonal fluctuations of large biosystems. The authors suggest that such considerations may apply to schizophrenic derangement of 2 to >40 Hz synchronization binding disparate brain loci and to observed disruption of circadian patterns in affective illnesses. It is conjectured that interdependence among time scales may reflect the Bohmian implicate order.

The target paper by Pylkkanen (Pylkkanen, 2010) analyzes and develops in detail the significance of Bohm's ontology for quantum paradigms of psychopathology. Bohm had endorsed the intrinsic importance of wholeness in the health of individuals and by extension of societies as well. This principle is utilized at the outset by Pylkkanen in his enlistment of quantum holism toward a definition of mental illness as the pseudo-fragmented streaming of consciousness which, rather than enfolding eddies of perceptions, feelings, intentions, and individual selves in a healthy way, falsely allows those "vortices" to project an autonomously atomistic character. Pylkkanen then refines his description of Bohm's quantum holism in terms of "active" information about an entire environment, intrinsically incorporated into the quantum potential which "informs" the wave-like behavior of a physical particle-wave within that same environment. The Bohmian concept of an implicate order as Pylkkanen portrays it builds upon the quantum potential's active information to construct a nested annealment of the causal gaps inherent in Cartesian dualism. What emerges is an essentially unlimited hierarchy of tiered meta-fields, each higher level influencing the physics of the level beneath by progressively subtler laws. Hence, increasingly subtle aspects of mind, including its normal semantics and pathological deviations, are able to impinge

upon the physical properties of the brain at least as efficaciously as models of brain function based on classical physics, e. g. neural network theory founded upon the statistical mechanics of Gibbs and Boltzmann, have been thought to direct mentation from "below."

This important point about "downward" causation is consistent with even more forceful views expressed by NeuroQuantology's Editor-In-Chief, Sultan Tarlaci, who posits that in the quantum world there exists "*no 'matter' without 'mind'*" (Tarlaci, 2010). Less explicitly ontological but still compatible support for downward subjective causality is expressed by Mender in a target paper (Mender, 2010) employing the language of quantum phase transitions and the quantum epistemology of Von Neumann, Wigner, and Stapp. Here, however, the number of tiered levels, rather than ramifying upward without limit a la Bohm, may reach a ceiling dictated by quantum gravitation and the Planck energy, in relation to whose "melting" of space-time distinctions among scales blur definitively.

To the extent that both Bohmian and Von Neumann metaphysics can justify the operation of subjective influences on "objective" brain processes, the "idealistic" stop-gap research program introduced by Bruza's commentary (Bruza, 2010) may prove useful. Bruza champions the practicality of a "quantum interactionist" approach, which tests predictions derived from high level abstractions of quantum principles against empirically observed macro-behaviors. No recourse to low level quantum physics "on the ground," i.e., involving actual tubulin dimers or membrane lipid rafts, is required for these purposes. Bruza mentions tensor network theory (TNT) as a possible means by which virtual quantum interactionist research regarding psychopathology might be accomplished.

Additional remarks in commentaries by Ghaemi (Ghaemi, 2010) and Germiné (2010) extend the possibilities for quantum paradigms of psychiatry to explorations of creative paradigmatic innovation itself and of the unconscious. Aside from these motifs, one might expect the following areas of potential future inquiry to prove

productive:

1) Does the viability of quantum psychiatry depend critically on solving the problem of rapid thermal decoherence, or can some "end run" around this issue keep quantum paradigms of psychopathology squarely within the universe of worthwhile scientific inquiry? Might the recent discovery of quantum processes mediating photosynthesis hint that the thorny question of biologically sustainable Bose Einstein condensation is about to be successfully resolved? If not, could the "quantum interactionist" techniques advocated by Bruza make useful contributions until resolution is at hand farther down the line?

2) Can the highly specific and yet relatively abstract attunement hypothesis of Globus, incorporating quantum field theory and dissipative thermodynamics but excluding consideration of gravity, be reconciled with OrchOR and its progeny, which take gravitation into account at the concrete "ground" levels of tubulin isoforms and the Planck energy? Where might these two theoretical domains optimally intersect?

3) Can the superficially differing quantum membrane biophysics of

Tonello/Cocchi and Bernroider be more fully and specifically coordinated with each other and with the work of Globus, Hameroff, and Woolf et al? Achieving this unifying goal, in accordance with the stated aims of Tonello and Cocchi, would significantly enhance quantum psychiatry's explanatory potency.

4) How might the nanowire perspective of Woolf and her colleagues be refined to reveal maximally specific and concrete mechanisms by which nuclear DNA, cytoskeletal proteins, membrane lipids, and the intercellular network all play roles in psychopathogenesis, perhaps via a final common pathway constituted by the abnormal tuning proposed by Globus?

5) Can the various "levels" of analysis germane to quantum paradigms of psychopathology, subsuming subatomic, biomolecular, membrane-organelle, cellular, tissue-wide, organismic, and social-ecological phenomena, be completely integrated in some formally rigorous yet post-emergent, perhaps enfolded or quantum-phase-theoretic way, eventually yielding innovative technologies that might help the mentally ill?

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