From Quantum Foundations to Clinical EEG: Rethinking the quest for Objective biomarkers.

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The history of quantum theory foundations can be seen as a long-standing tension between objectivity and subjectivity. Objective interpretations have sought to resolve Niels Bohr's assertion: *the outcomes of measurements are not objective properties of systems, but rather describe the interrelation between a system (S) and an observer (O)*. However, despite attempts to recover an objective reality—through Many-Worlds Interpretation (MWI), Bohmian Mechanics, or others—probability remains central to all these interpretations, and so does the role of subjective knowledge.

- In MWI, one must interpret probability as uncertainty about which branch one finds oneself in.
- In Bohmian Mechanics, predictions still rely on the agent's knowledge of hidden variables.
- Even in Relational Quantum Mechanics (RQM), system properties only exist relative to other systems, making the observer's perspective indispensable.

Thus, subjectivity is never truly eliminated; in fact, it may be fundamental. From this angle, quantum mechanics becomes a personalized decision-making guide (as in Qbism), helping agents structure beliefs and make consistent choices based on how the world responds to their actions.

This agent-centered view has striking parallels in clinical medicine, especially in diagnosis and treatment. A medical doctor begins forming beliefs from the first day of training—first through textbooks and lectures, later through practical experience with real patients. Over time, their subjective beliefs evolve, shaped by each new encounter. Clinical actions—whether diagnostic tests or treatments—are guided by these beliefs, constantly updated in light of outcomes.

Medical tests (like EEG, imaging, blood work) are often treated as additive sources of "objective" data. But in practice, each test is more like a projective lens through which the hidden clinical state is refracted—analogous to RQM's postulate that *new information can always be obtained from a system, updating our subjective beliefs*. However, since we lack the full reverse function to map these projections back to the underlying "objective" state, the pursuit of a perfectly objective biomarker is likely a mirage. What we *can* achieve, instead, are "good enough," coherent, subjective-choice-making biomarkers.

In this talk, we present a relational information framework for extracting such "informational physical analogs" biomarkers from EEG signals. Each EEG-derived relational information "physical"feature is viewed as a projection of the underlying clinical state. We demonstrate how this approach supports diagnosis of neuropsychiatric conditions and shows promising potential for guiding personalized treatment decisions. This perspective honors the complexity of clinical reasoning, embracing subjectivity not as a flaw, but as a principled foundation which emerges by the combined dynamic of subjective and hidden objective information which enables rational action.