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Two qubits for C.G. Jung's theory of personality

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Abstract

We propose a formalization of C.G. Jung's theory of personality using a four-dimensional Hilbert-space for the representation of two qubits. The first qubit relates to Jung's four psychological functions: **T**hinking, **F**eeling, **S**ensing and i**N**tuition, which are represented by two groups of projection operators, {**T**, **F**} and {**S**, **N**}. The operators in each group are commuting but operators of different groups are not. The second qubit represents Jung's two perspectives of extraversion and introversion. It is shown that this system gives a natural explanation of the 16 psychological types that are defined in the Jungian tradition. Further, the system accounts for the restriction posed by Jung concerning the possible combination of psychological functions and perspectives. The empirical consequences of the present theory are discussed, and the results of a pilot study are reported with the aim to check some basic predictions of the theory. In addition, it is shown why the present praxis of personality diagnostics based on classical statistics is insufficient.

Keywords: Personality theory; Quantum cognition; Qubit; Entanglement; Type indicator; Big five

1. Introduction

Modern personality psychology recognizes persons as complex, multifaceted entities whose understanding requires a whole collection of methods. The field today possesses rich theories and an impressive collection of research methods. Besides the psychodynamic tradition starting with Freud (2000) and continuing with Jung (1921), Adler (1927), Sullivan (1953), and many others, there are influential developments whose inspirations came largely from the general tenets of behaviorism (Cattel, 1943; Eysenck, 1947, 1967; Goldberg, 1993; McCrae & Costa, 1997). We further find socioanalytical theories (e.g. Hogan, 1982), various theories of self-regulation (e.g. Block, 1981; Carver & Scheier, 1981), Tomkins' (1978) script theory, and the life story model of identity (McAdams, 1985; McAdams, 2001).

In this paper, the psychodynamic tradition founded by C.G. Jung is followed. We restrict ourselves to this tradition for two reasons. First, this tradition is still the predominant one in many domains of application, including individual and couples counseling, human resource development, conflict management, interpersonal relationships, negotiating organizational development and team building, and coaching and career planning. The second reason is a methodological one. It concerns the difference between the Jungian tradition and the behaviorist tradition. We have the structural substance of Jungian depth psychology on the one hand, which contrasts with the assumption of a general empiric procedure for detecting the crucial dimensions of human personalities on the other hand. Besides this difference, there is a crucial contrast between the technical prerequisites of the two conceptions. The behaviorist tradition generally assumes Bayesian probabilistics, which is required in order to justify the application of standard statistical methods such as factor analysis and component analysis. In this Bayesian framework, an underlying Bool-

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ean algebraic structure is assumed for modeling events, propositions and (complex) properties. A careful analysis of the original Jungian ideas shows that this assumption is questionable if it comes to consider the needs of an appropriate formalization. Though it is tempting to press the Jungian framework in the Procrustean bed of Bayesian probability theory (Myers-Briggs & Myers, 1980), this is methodologically unsound, and it is important to understand why this is not an adequate way of formalizing the spirit of Jung' personality theory. The body of this paper is devoted to explaining this issue.

For a preliminary illustration of our methodological point, it is useful to consider the question of concepts. According to the classical, set-theoretic picture of concepts, each concept is defined as a set of its instances (Margolis & Laurence, 1999). The system of concepts then can be seen as forming a Boolean algebra. This arises from the fact that basic set-theoretic operations such as complementation, intersection and union are used for constructing new concepts. Hence, if A denotes a concept, then the complement $\neg A$ constitutes another concept. And if A and B denote concepts, then the union $A \cup B$ and the intersection $A \cap B$ both form new concepts. Further, Bayesian probability theory can be developed founded on a Boolean algebra. It is based on a simple axiomatic fact: the additivity of a measure function (probability function) μ: if A and B do not overlap (i.e. $A \cap B \neq \emptyset$), then $\mu(A \cup B) = \mu(A) + \mu(B)$ (Kolmogorov, 1933).

Unfortunately, most *natural* concepts cannot be adequately represented by Boolean algebras, and the idea of Bayesian probabilities is likewise questionable in the context of natural concepts. The reason has to do with the idea of prototypes, as used in cognitive psychology (Margolis & Laurence, 1999). Concepts are formed by the typical exemplars of a set (prototypes). What exemplar does or does not belong to a certain concept depends on the *similarity* between the exemplar and the prototypes that constitute the concept. Mathematically, this idea is described by a Euclidian vector space where the instances are described as vectors and the similarity relation is expressed in terms of the inner product (=scalar product). As a consequence, the set of instances that constitutes a prototype concept can be seen as a *convex* set.[1] Obviously, the domain of convex sets does not form a Boolean algebra: though the intersection of two convex sets is still convex, neither the union of two convex sets nor the complement is convex. Hence, when we see natural concepts as conforming to convex sets, the idea of representing conceptual systems by Boolean algebras breaks down. Likewise, it has been argued that classical probability theory cannot be used for modeling typicality or probability judgments (Aerts & Gabora, 2005; Blutner, 2009; Khrennikov, 2003).

Is there an algebraic structure that describes prototype concepts? Recently, some authors have suggested that the algebraic structure that best fits the idea of prototype concepts is an ortho-algebra (Widdows, 2004a, 2004b; Widdows and Peters, 2003). Interestingly, this kind of structure is underlying quantum logic – a logical foundation of the structure of propositions as formulated in modern quantum physics (Birkhoff & von Neumann, 1936; Dalla Chiara, Giuntini, & Greechie, 2004; Kalmbach, 1983; Piron, 1976). A measure function can also be formulated on an orthoalgebraic basis, but with properties quite different from those of Bayesian probabilities. Some of these properties are investigated in quantum information science (Vedral, 2006).

Taking this and related motivations into account, it is not surprising that an increasing number of authors argue that the basic framework of quantum theory can find useful applications in the cognitive domain (Aerts, Czachor, & D'Hooghe, 2005; Atmanspacher, Römer, & Walach, 2002; Blutner, 2009; Busemeyer, Wang, & Townsend, 2006; Franco, 2007; Khrennikov, 2003; Pothos & Busemeyer, 2009). Recently, Gabora, Rosch, and Aerts (2008) have demonstrated how this framework can account for the creative, context-sensitive manner in which concepts are used, and they have discussed empirical data supporting their view.

The present application of the mathematical framework of quantum theory to personality diagnostics is new. We propose a simple formalization of the crucial traits of C.G. Jung's theory of personality by using the formulation of quantum theory as currently used in the context of quantum information science (Vedral, 2006). Our claim is not only that the structure underlying the diagnostic questions typically asked in personality diagnostics can be characterized by an ortho-algebra. We also aim to demonstrate that concepts like superposition, entanglement, and quantum probabilities are useful instruments for modeling psychodynamic personality theories.

In Section 2 we will present the basic traits of C.G. Jung's theory in some detail. Further, we will refer to three inventories claiming to assess his typology: (a) the Myers-Briggs type indicator, (b) the framework of socionics, and (c) the Singer–Loomis inventory of personality. The discussion will show why the original Jungian framework cannot be pressed in the Procrustean bed of Bayesian probability theory. Further, it demonstrates the potential of the origin Jungian ideas in the context of modern personality theories.

Section 3 introduces some basic concepts of quantum theory including the notion of a qubit and the Pauli spin operators. Section 4 introduces our formal model that addresses the structural ideas of Jungian depth psychology. We also give detailed argumentation as to why we chose this particular approach. Though we have to admit that our model is presently open to several speculations, we give

[1] In Euclidean space, an object is convex if for every pair of points within the object, every point on the straight line segment that joins them is also within the object. For example, a solid globe is convex, but anything that is hollow or has a dent in it is not convex. For better understanding the importance of the notion of convex sets in cognitive science, the reader is referred to Gärdenfors (2000).