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Virtual personalities: Using computational modeling to understand within-person variability ☆

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ABSTRACT

How can the same underlying psychological/neurobiological system result in both stable between-individual differences and high levels of within-individual variability in personality *states* over time and situations? We argue that both types of variability result from a psychological system based on structured, chronic motivations, where behavior at a specific point in time is a joint function of the current availability of motive affordances in the situation, current motivationally relevant bodily or interoceptive states, and the result of the competition among alternative active motives. Here we present a biologically-based theoretical framework, embodied in two different computational models, that shows how individuals with stable personality characteristics, can nevertheless exhibit considerable within-person variability in *personality states* across time and situations.

1. Introduction

Personality *traits* are typically assumed to be relatively stable over time. However, recent research (e.g., Fleeson, 2001; Fleeson & Gallagher, 2009; Sherman, Rauthmann, Brown, Serfass, & Jones, 2015) has shown that the short-term variability in personality *states* is at least as large as the between subject variability in stable trends or dispositions (*traits*). How is it possible that the same underlying psychological/neurobiological systems can on the one hand result in stable between individual differences, while also resulting in high levels of within individual variability in personality *states* over time and situations?

Here we present a theoretical framework, embodied in two different computational models, that shows how individuals with stable personality characteristics, can nevertheless exhibit considerable variability across time and situations in personality-related behaviors. We argue that such variability is to be expected in a psychological system based on structured, chronic motivations, where behavior at a specific point in time is a joint function of the current availability of motive affordances in the situation, current motivationally relevant bodily or interoceptive states, and the result of competition among alternative active motives. As the result of variations in these factors over time and situations, personality *states* will also vary considerably.

These models extend our previous work (Read et al., 2010; Read & Miller, 2002, in press), which argues that both the structure of personality (e.g., the Big Five) and the dynamics of personality-related behavior arise from the behavior of structured motivational systems interacting with the motive affordances of the different situations that individuals encounter over time. This work has evolved from our earlier work on goal-based models of personality (e.g., Miller & Read, 1987; Read, Jones, & Miller, 1990; Read & Miller, 1989). In that work, we argued that personality traits can be viewed as configurations of goals and motives, plans, resources, and beliefs, and that goals and motives were central to traits. In more recent work on Virtual Personalities (e.g., Read et al., 2010; Read & Miller, 2002, in press) we have argued that a personality model based on structured motivational systems allows us to provide a unified account of both the structure and the dynamics of human personality. As a number of researchers have noted (e.g., Funder, 2001), research on the structure of personality (e.g., the Big Five (John, Naumann, & Soto, 2008), HEXACO (Ashton & Lee, 2007; Lee & Ashton, 2004)) and research on personality dynamics have tended to proceed independently. However, there is growing interest in developing an account of personality that integrates the two approaches. We have argued that our Virtual Personalities model provides such an account. The current paper extends the model presented in Read et al. (2010) in several different ways, as outlined below.

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2. The virtual personality model

Given the dynamic complexities of personality, it is not surprising that over the last decade there has been growing interest in using computational tools to model that complexity. For example, Shoda and Mischel's (Mischel & Shoda, 1995; Shoda & Mischel, 1998) CAPS model of personality is implemented as a general parallel constraint satisfaction neural network model, in which individual differences are represented in terms of the connections from a situational features layer to a highly bi-directionally connected set of nodes that represent the goals, strategies, and beliefs of an individual, and then to behavior. However, each individual is proposed to have their own unique network, which is relatively unstructured. This makes integration with work on the structure and dynamics of personality, and links to underlying biological systems, difficult.

Revelle and Condon (2015) have recently presented their CTA (Cues, Tendencies, Actions) computational model, which is based on Atkinson and Birch's Dynamics of Action (DOA) Model. In their model, Cues in the environment send activation to Tendencies and then Tendencies send activation to Actions. Actions have inhibitory links and compete with each other for activation. An enacted Action then sends inhibitory activation back to the Tendencies, representing consummatory forces. Although their model does provide the mechanisms for the different CTA systems to interact, this interaction is not organized in any particular way, such as the current model's organization into separate Approach and Avoidance systems. Moreover, there are no parameters to capture stable individual differences in the chronic importance of the corresponding Tendency.

In contrast to the CAPS and CTA models, the Virtual Personality model (Read et al., 2010) assumes that individuals' have structured motivational systems and that all individuals share the same basic structure. Individual differences arise in the parameters of components of the systems. At the broadest level, people's motivational systems are organized into two broad systems, an Approach and an Avoidance system (Carver, 2006; Carver & White, 1994). The Approach system governs sensitivity to rewards, whereas the Avoidance system governs sensitivity to punishment. Moreover, there are strong individual differences in the sensitivity of the Approach and Avoidance systems. This notion is the key foundation of Gray's Reinforcement Sensitivity Theory of personality (Gray, 1982; Gray & McNaughton, 2000). The basic distinction between Approach and Avoidance systems and tendencies has a considerable amount of support, including biological support for this distinction across species from reptiles to humans, and has been usefully applied in a wide variety of domains (Elliot, 2008).

Within each of these two broad systems are a number of more specific motives. Information about the nature of these different motives comes from a variety of areas, such as evolutionary analyses of the tasks that individuals must pursue in order to survive and reproduce (e.g., Bugental, 2000; Kenrick & Trost, 1997), and work on taxonomies of human motives (e.g., Boudreaux & Ozer, 2013; Chulef, Read, & Walsh, 2001; Talevich, Read, Walsh, Chopra, & Iyer, 2015). There are also important individual differences between individuals in the strength and importance of each of these major motives.

In addition, the VP model makes clear predictions about the nature of situations. Sherman et al. (2015) have argued that most models of the role of situations in personality-related behavior do not provide an explicit model of what is meant by a situation. However, in our work we have long provided an explicit account of what we mean by a situation (Miller & Read, 1991; Read & Miller, 1989). We have argued that situations can be conceptualized as motive or goal-based structures, where, consistent with Argyle, Furnham, and Graham (1981), situations can be viewed in terms of the motives afforded by the situation, the physical attributes of the situation, and the typical roles and scripts that can be enacted in the situation. In our earlier computational work (e.g., Read et al., 2010) and in the current work situations are operationalized in terms of features that directly activate relevant affordances.

These motive affordances are among the major factors that activate the motives in the model. For example, a situation that affords academic pursuits provides various affordances for achievement and will activate motives related to achievement, whereas a situation that affords romantic pursuits provides very different affordances. One implication of this conceptualization of situations is that it strongly implies that one major factor underlying variability in personality-related states over time and situation is variability in the motive affordances provided by different situations.

Sherman et al. (2015) have recently provided information that supports the idea that affordances will vary considerably over time. Using the DIAMONDS (Rauthmann et al., 2014) measure of situations in an ambulatory assessment study of personality characteristics, situations, and behaviors, they found that within-subject variability in the kinds of situations encountered was considerably higher than between-subject variability. We note that the DIAMONDS taxonomy and measure of types of situations seems to overlap with our focus on the role of motive affordances in conceptualizing situations. For example, major dimensions of the DIAMONDS measure include Sociality (social interactions required or desired), Adversity (external threats), and Mating (sexually or romantically charged situation), all of which seem to tap into important motive affordances.

Our model has been implemented as a neural network (Read et al., 2010; Read & Miller, in press). See Fig. 1 for a representation of that neural network model.

In the Read et al. (2010) neural network model situational features, indicated by individual nodes in the Situational Features layers, send activation to the Hidden Layer, which learns patterns of situational features that define different kinds of situations (e.g.,

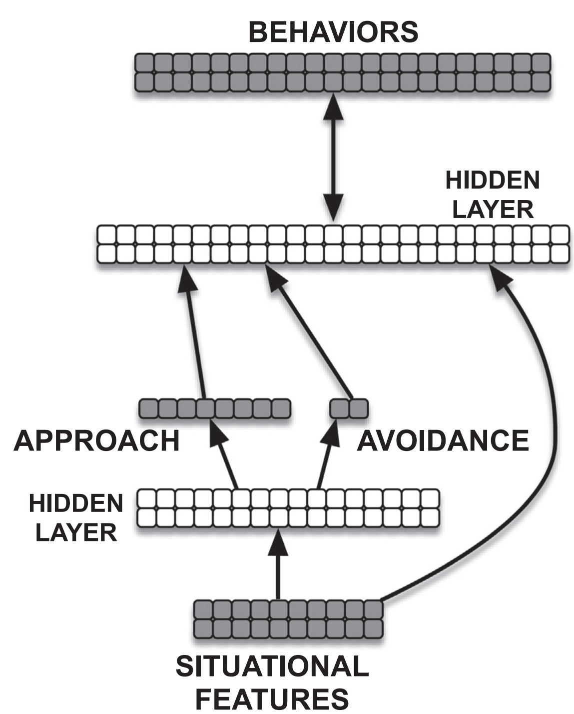

Fig. 1. Basic structure of the Read et al. (2010) Virtual Personalities model.