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Integrating the Context-Appropriate Balanced Attention Model and Reinforcement Sensitivity Theory: Towards a Domain-General Personality Process Model

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Over the last 40 years or more the personality literature has been dominated by trait models based on the Big Five (B5). Trait-based models describe personality at the between-person level but cannot explain the within-person mental mechanisms responsible for personality. Nor can they adequately account for variations in emotion and behavior experienced by individuals across different situations and over time. An alternative, yet understated, approach to personality architecture can be found in neurobiological theories of personality, most notably reinforcement sensitivity theory (RST). In contrast to static trait-based personality models like the B5, RST provides a more plausible basis for a personality process model, namely, one that explains how emotions and behavior arise from the dynamic interaction between contextual factors and within-person mental mechanisms. In this article, the authors review the evolution of a neurobiologically based personality process model based on RST, the response modulation model and the context-appropriate balanced attention model. They argue that by integrating this complex literature, and by incorporating evidence from personality neuroscience, one can meaningfully explain personality at both the within- and between-person levels. This approach achieves a domain-general architecture based on RST and self-regulation that can be used to align within-person mental mechanisms, neurobiological systems and between-person measurement models.

Keywords: personality processes, reinforcement sensitivity theory, response modulation model, self-regulation, personality neuroscience

What is personality? Many academics and practitioners in the field of psychology would describe personality as stable propensities, dispositional precursors, or latent potentials residing in the individual (e.g., Hoffman, Woehr, Maldagen-Youngjohn, & Lyons, 2011; Tett & Burnett, 2003). If asked to describe someone's personality, it's quite likely that most would draw on an established trait personality model, such as the Big Five (B5; Costa & McCrae, 1991; Goldberg, 1992). This would hardly be surprising, given that the majority of contemporary personality research is trait-oriented and a good proportion of this research uses the B5. Indeed, at the time of writing, 75% of the articles published in a major personality journal since 2014 made reference to the B5.[1] This figure increases to 90% when the term *trait* is added to the search criteria. Although the study of traits has advanced our understanding of individual differences in personality, we believe a near exclusive focus on trait personality has substantially limited our understanding of the antecedents of personality. Specifically, trait personality models do not explain the structures and processes, or mental mechanisms, that give rise to personality per se, nor do they adequately explain how personality accounts for individual differences in emotions and behavior. Importantly, trait personality models offer no plausible explanation for differences in the relationship between specific personality traits and related behaviors across situations and over time (Mischel & Shoda, 1995).

There is an important conceptual difference between within-person and between-person approaches to the study of personality that is often ignored by personality researchers. Within-person approaches explore the mental mechanisms operating within indi-

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[1] These statistics are based on the total number of articles published in the *Journal of Research in Personality*, similar percentages are also to be found in other leading personality journals.

viduals that underlie characteristic patterns of experience and behavior (i.e., individual-level constructs), whereas between-person approaches focus on dimensions of behavioral variation across people in populations (i.e., between-level constructs). The first approach explains what causes characteristic, adaptive, goal-directed behavior at the individual level, whereas the latter describes how people in the broader population differ in terms of their average, or typical behaviors (Borsboom, Mellenbergh, & van Heerden, 2003; Cervone, 2005; Dalal, Bhave, & Fiset, 2014). Many personality researchers mistakenly treat within-person and between-person constructs interchangeably, and incorrectly assume that between-person constructs (i.e., traits) are an appropriate starting point for investigating within-person mental mechanisms. In this article, we outline a number of problems with this assumption and argue that a realist approach is essential for understanding personality processes.

Our approach to personality architecture aligns with both entity and theory realism whereby within-person personality constructs correspond to entities in reality, that is, they "exist independent of measurement" in the same way as height or weight exists irrespective of a ruler or scales, respectively (Borsboom et al., 2003, p. 207). As realists, we are also concerned with the causal relationship between these theoretical constructs and observed behavior, namely, the construct applies to differences at the within-person level in the same way that it does at the between-person levels of analysis (Borsboom et al., 2003; Cervone, 2005). Reinforcement sensitivity theory (RST; Gray & McNaughton, 2000), for example, provides a theory-driven causal explanation of within-person variation in emotions and behavior across situations and over time. Importantly, a growing body of neuroscientific research highlights the neurobiological basis for personality (e.g., Depue & Collins, 1999; DeYoung & Gray, 2010; Fuentes-Claramonte et al., 2015). This evidence suggests that the motivational subsystems comprising RST (i.e., the behavioral approach system [BAS], the fight/flight/freeze system [FFFS], and the behavioral inhibition system [BIS]) are associated with various neurobiological systems and therefore exist independent from measurement.

In contrast, some trait personality models reflect theory realism *without* entity realism, that is, they reflect theory that refers to nonexistent entities, whereas other trait-based models are 'constructivist' such that they reflect theory referring to nonexistent entities, or "constructions of the human mind" (Borsboom et al., 2003, p. 207). We argue that the B5 represents a constructivist approach as it arose from data reduction as opposed to theory-driven techniques (i.e., a top down as opposed to bottom up approach). As such, the B5 describes between-person differences in personality but cannot explain how an individual's emotions and behaviors might vary across situations and over time. To do so, with varying degrees of success, has required additional interactionist theories of personality such as trait activation theory (TAT; Tett & Burnett, 2003). Although it is true that some B5 factors have been associated with the same neurobiological systems of RST (e.g., extraversion and neuroticism), evidence of additional associations with other B5 factors (e.g., openness/intellect and agreeableness) remains somewhat unclear and speculative (Corr, DeYoung, & McNaughton, 2013; DeYoung & Gray, 2010).

Our aim in this article is to provide a timely and lucid review of a complex literature that spans many of the central concerns of personality architecture (Cervone, 2005). In particular, we focus on the key issues underlying how within-person personality processes are fundamental to personality architecture and the key ways in which between-person models need to be constructed to be meaningful summaries of underlying personality processes. We suggest that the B5 can never fulfil this function despite arguments to the contrary (e.g., DeYoung, 2015; McCrae, 2005). Our review of the literature traces the theoretical development of RST and seeks to integrate a number of important yet underexplored connections with the response modulation model (RMM; Patterson & Newman, 1993) and the more recent context-appropriate balanced attention model (CABA; MacCoon, Wallace, & Newman, 2004). The outcome of this review is to propose a domain-general personality process model. Specifically, one that (a) incorporates RST and a self-regulatory construct associated with specific neuroanatomical networks and neurotransmitters; (b) explains how these within-person constructs correspond to equivalent between-person constructs; and (c) explicitly models the influence of contextual factors on emotions and behaviors at the individual level over time.

We begin by contrasting within- and between-person approaches to personality and demonstrate how within-person process models must be used to model meaningful between-person differences in personality. We then review RST and argue that this biologically derived model of personality provides the most suitable basis for a personality process model. Following this, we introduce the RMM and argue that it constitutes the only existing process model of RST. Next, we introduce the CABA model, which extends the original RMM by incorporating a self-regulatory construct based on a neurocognitive model of attentional resource allocation. The CABA model provides a novel way to integrate within-person approach—avoidance and self-regulatory constructs that are related to specific neurobiological systems. We then draw on the CABA model to explain how situational factors interact with neurobiologically based approach—avoidance systems to explain individual variation in emotions and behavior over time, which we then relate to between-person differences in emotions and behavior. We conclude by proposing a way to test this personality process model and suggest a number of areas for future research based on this model.

Personality Architecture and the Importance of Within- and Between-Person Constructs

Personality can be conceptualized at both the between-person and within-person levels of analysis (Borsboom et al., 2003; Cervone, 2005; DeYoung, 2015; Revelle & Condon, 2015). Between-person personality models describe interindividual variation in cognitions, emotions and behaviors in groups or the population at a point in time. Arguably the most recognized examples are trait descriptive personality models, such as the B5 (Digman, 1990; Goldberg, 1992; McCrae & Costa, 1987), which are concerned primarily with the organization, classification, or description of personality (see Cervone, 2005). In contrast, within-person models explain the organization and relationship between various intra-individual psychological constructs responsible for variation in an individual's cognitions, emotions, and behaviors over time and across situations. Biological models of personality, such as RST (Gray, 1972; Gray & McNaughton, 2000), and temperament theories based on human or evolutionary development can be conceptualized as within-person models in this regard (e.g., Henderson & Wachs, 2007). Some scholars argue that social–cognitive personality models, such as the cognitive–affective personality system (e.g., Mischel & Shoda, 1995), or the knowledge and appraisal personality architecture (Cervone, 2004), are also within-person personality models. However, we argue later that the authors of these and similar social–cognitive models have yet to clearly explain the relationship between the within- and between-person constructs in their models. Furthermore, few provide sufficient evidence that their within-person constructs exist independent of measurement (i.e., that they reflect entity realism).

Hence, between-person models classify or describe personality in terms of individual differences in traits, whereas within-person models explain the causal relationship between various personality constructs that exist within the individual. This important distinction, however, is frequently overlooked in personality and organizational psychology. Many scholars mistakenly view between-person and within-person personality constructs as the same (as noted by Beal, Weiss, Barros, & MacDermid, 2005; Borsboom et al., 2003; Cervone, 2005; Cervone, Shadel, Smith, & Fiori, 2006; Dalal et al., 2014). We believe that this oversight can result in conceptual ambiguity or misspecification that undermines the integrity of personality theories and models. Consistent with this, Borsboom et al. (2003) argued that "between-subject models do not imply, test, or support causal accounts that are valid at the individual level" (p. 214). Similarly, Dalal et al. (2014) warned that "the relationship between two constructs at the between-person level may differ from the relationship between the analogous constructs at the within-person level in sign, form, and/or size" (p. 1397). Finally, Corr et al. (2013) reminded us of the "need to separate within-level variance (related to dynamic processes) from between-individual variance (related to population-level traits)" (p. 170). They highlight this problem with the B5, contrasting the well-established negative relationship between conscientiousness and neuroticism at the between-person level, with the contradictory positive relationship between equivalent state-like constructs at the within-person level.

It should be noted that we do not suggest that classifying or organizing personality at the between-person level serves no purpose, rather that "theorizing at the within-person level will frequently provide a more scientific understanding of the *process* underlying the relationship"(Dalal et al., 2014, p. 1397, original italics). For example, it might be useful to compare individual differences in conscientiousness (i.e., a between-person level of analysis) if several candidates were applying for an air traffic controller job, which requires deliberation and self-discipline. However, it might also be helpful to understand the mental mechanism underlying conscientiousness in the general population, and specifically how this mechanism might influence cross-situational variability and consistency of emotions and behavior at the within-person level. This might help individuals develop self-awareness and useful strategies for managing their conscientious behavior across a range of situations. Finally, from a conceptual and empirical perspective could this same mental mechanism also be responsible for individual differences in conscientiousness at the between-person level at a given point in time? In other words, can individual differences in within-person mechanisms explain between-person differences in related emotions and behavior?

Although within-person and between-person models of personality differ in a number of fundamental ways, these different approaches can both inform and complement each other. Indeed, several personality scholars have attempted to integrate within- and between-person models. For example, Mischel and Shoda (1995) proposed a cognitive–affective system of personality where an "underlying stable personality system," comprising interactive cognitive–affective mediating units (e.g., goals, emotions, behavioral scripts), "produces the individual's characteristic average levels of behavior" (p. 246). Read et al. (2010), drawing on the approach–avoidance motivational system (Gray & McNaughton, 2000) and a general control or constraint system (Waller, Lilienfeld, Tellegen, & Lykken, 1991), described how these within-person systems can be observed at the between-person level and vice versa. More recently, DeYoung (2015) proposed a cybernetic B5 theory (CB5T) mapping the B5 to various steps of a 'cybernetic cycle,' namely, "goal activation, action (or strategy) selection, action, outcome interpretation, goal comparison" (p. 41).

These models provide new and interesting ways to conceptualize personality. However, we believe they do not sufficiently explain the connection between within-person constructs and between-person phenomena. For example, through what within-person mechanism does a specific goal, emotion, or behavioral script "produce" an individual's average level of behavior in Mischel and Shoda's (1995) model? Similarly, Read et al. (2010) offered no explanation of why approach–avoidance motivation and constraint can be "observed" at both the within- and between-person levels of analysis. Finally, DeYoung (2015) claimed that

> CB5T is designed to explain the major mechanisms in the intrapersonal causal structure of the evolved human cybernetic system, as well as the manner in which interpersonal variation in parameters of that system produces the traits in the Big Five hierarchy. (p. 50)

The CB5T appears promising at face value, however DeYoung (2015) described a number of problems with the model. For example, the cybernetic cycle (on which the model is based) "does not offer a well-elaborated theory of action selection or decision making" (p. 50). Furthermore, "the mechanisms underlying the Big Five and other traits are currently described by theories that need further testing" (p. 37). Finally,

> a one-to-one mapping of each of the Big Five to one step of the cybernetic cycle will not work because most of the mechanisms that carry out the cycle operate in parallel and influence multiple steps of the cycle. (p. 41)

All models have limitations, however, we believe that these specific problems arise from the constructivist nature of the CB5T. For example, DeYoung (2015) claimed that "Traits are directly caused by relatively stable parameters of psychobiological cybernetic mechanisms" (p. 37). As previously discussed, we agree that some traits have a basis in neurobiology as DeYoung (2015) suggested, however, we can find no explanation of how these cybernetic mechanisms directly cause the B5 traits in DeYoung's (2015) model. Also, the fact that these mechanisms operate in parallel and influence multiple steps of the cybernetic cycle suggest that this model may be too simplistic to explain B5 relationships at the within- and between-person levels of analysis. But fundamentally, we believe these issues highlight a number of conceptual problems with the B5 itself, as we discuss next.

Conceptual Problems With the B5

> "What grounds are there, then, for positing a conscientiousness operating in your head?" (Cervone et al., 2006, p. 344).

The B5 is a well-established trait personality framework describing individual differences in extraversion, neuroticism, conscientiousness, agreeableness, and openness/intellect (Digman, 1990; Goldberg, 1992; McCrae & Costa, 1987). This model provides a parsimonious framework for describing personality variability at the between-person level; however, the B5 does not explain the causal dynamics of personality at the within-person level (see also Block, 1995; Borsboom et al., 2003; H. J. Eysenck, 1992; Hampson, 2012; Poropat & Corr, 2015). Cervone (2005) aptly illustrated this point with the following example:

> Classificatory constructs do not explain the individual case; grass, for example, can be classified as a plant, but the classification does not explain the grass's functional capacities, such as photosynthesis. That requires explanatory constructs that make reference to structures and processes that occur within the grass. (p. 342)

Trait personality models like the B5 are a case in point. An individual might be classified as more or less conscientious in relation to others, according to the B5, but the conscientiousness construct itself does not explain the individual's functional capacities, or mental mechanism, that causes his or her conscientious behavior. This requires an explanatory construct that makes reference to this within-person mental mechanism. But the B5 provides no such explanatory construct and therefore no grounds to suggest that there is a conscientiousness operating in your head.

Furthermore, the descriptive taxonomy of the B5 exists at the between-person level, yet causal mechanisms are conceptualized at the within-person level. Although data reduction techniques can combine personality variables at the between-person level, this does not imply that the same variables represent mechanisms that combine at the within-person level (see Borsboom et al., 2003). However, McCrae (2005) claimed that personality variation at the between-person level, "through studies of groups", corresponds to "intrapsychic personality structure(s)" (p. 193). Yet the idea that these within-person structures (or mechanisms) are causally related to each between-person B5 factor is problematic for at least three reasons. First, Borsboom and colleagues (2003) cited empirical evidence indicating considerable discrepancy between within-person and between-person structures of the B5 to the extent that they "bear no obvious relation to each other . . . without heavy theoretical background assumptions that, in psychology, are simply not available" (p. 213).

Second, McCrae and Costa (1994) claimed that "individual differences in personality traits . . . are also essentially fixed by age 30" (p. 173). However, one of the essential conditions of causality is that cause (x) and effect (y) must covary (e.g., Kenny, 1979). Yet if an individual's standing on any given personality factor (y) is essentially fixed (i.e., constant), then it cannot covary with any intrapsychic personality structure (x) as McCrae (2005) claimed (see Cervone, 2005). Hence, an essential condition of causality (i.e., covariation) is violated by such assertions that personality traits are essentially fixed or stable.

Third, although the B5 describes between-person differences, it cannot account for the within-person mechanism by which behavior arises because it does not explain how individual scores are produced. Cervone (2005) argued that this within-person mechanism accounts for one's score on a given B5 factor. Accordingly, individuals with the same score should logically share the same causal mechanism, otherwise there can be no consistent explanation relating such causal mechanisms to B5 factor scores. Such explanations, known as "bridge principles" (Bennett & Hacker, 2003), provide a way to connect discrete mental mechanisms, which are homogenous across individuals, with corresponding B5 factors. Importantly, such bridge principles explain why there can be only one way to obtain a given score on a particular B5 factor. However, the B5 is explicitly multifaceted, which raises the issue of equifinality and implies that there can be no single explanation for an individual's score on a given B5 factor. This is because "different individuals may obtain the same aggregate factor score for different underlying reasons" (Cervone, 2005, p. 428).

Finally, an emerging interest in personality neuroscience has led some to suggest that the physical basis of the B5 can be located in specific neuroanatomical networks and neurotransmitters (e.g., Depue & Collins, 1999; DeYoung et al., 2010). For example, Depue and Collins (1999) provided evidence that extraversion, specifically the agency or positive incentive motivation component, is associated with the corticolimbic-striatal-thalamic network and the dopamine projection system. However, as we have argued, the B5 describes individual differences in personality at a between-person level and current neuroscientific evidence indicates that of the five factors only extraversion and neuroticism have been consistently mapped to specific neurobiological systems. Even then, only the agency component of extraversion has been reliably linked in this way (Depue & Collins, 1999). We are not denying that additional five factor traits might one day be associated with discrete neurobiological systems. However, there is insufficient evidence at this point in time to convincingly claim that the B5 in its entirety maps to specific neurobiological systems. Indeed, we believe this to be highly unlikely given the factor analytical heritage of this personality model, post hoc theorizing and emerging neurobiological evidence (Block, 1995; Cervone, 2005; Corr et al., 2013; Dalal et al., 2014; H. J. Eysenck, 1992; Hampson, 2012; Wood & Beckmann, 2006).

In summary, the distinction between within- and between-person constructs is central to personality architecture. A common mistake is to assume that these two constructs share the same theoretical status. As we have argued, this must be carefully demonstrated rather than automatically assumed. We believe that trait descriptive models of personality, such as the B5, are useful for classifying individual differences at the between-person level, however, such models are conceptually distinct from personality process models. Such models explain the mental mechanisms responsible for variations in cognitions, emotions, and behaviors by individuals over time and in different situations. Although personality neuroscience provides evidence of a neurobiological basis for extraversion and neuroticism, evidence for the remaining three factors is incomplete or unclear (see DeYoung & Gray, 2010, for an excellent review). Furthermore, personality researchers have yet to provide plausible bridge principals linking specific neurobiological networks to each of the five factors. However, we suggest that it makes little sense to do so as the B5 is fundamentally a statistically derived taxonomic between-person model of personality and is an inappropriate starting point for examining within-person mental mechanisms. We argue next that an alternative, yet underrepresented, personality theory based on approach and avoidance motivational systems provides an ideal foundation for a personality process model.

RST: A Foundation for a Domain-General Personality Process Model

Contemporary RST (or revised-reinforcement sensitivity theory, r-RST; Gray & McNaughton, 2000, referred to as RST here) comprises the following three motivational systems; BAS, FFFS, and BIS. These three motivational systems explain how changes in an individual's emotions and behaviors occur in response to different contextual factors (see Corr, 2004 for a brief review).

According to RST, the BAS regulates approach behavior and is activated by rewarding stimuli and the termination or omission of punishment. BAS activation leads to positive emotions such as optimism and reward-directed behavior. However, BAS activation can also lead to disinhibition after encountering a threatening stimuli and deficits in learning associated with such stimuli (Corr, 2004; Patterson & Newman, 1993). Anger and "offensive" aggression can also arise when the BAS is activated by nonrewarding stimuli and the omission or delay of anticipated rewards (Carver & Harmon-Jones, 2009; Carver & White, 1994; Harmon-Jones & Sigelman, 2001; Smillie, Pickering, & Jackson, 2006). The FFFS is activated by threatening stimuli in general, leading to fear and flight or freezing behavior in response to distal threats or punishment that can be avoided. However, it can also lead to fight or "defensive" aggression in response to proximal threats or punishment that cannot be avoided (Carver & Harmon-Jones, 2009; Corr, 2004; Gray & McNaughton, 2000). Finally, the BIS is activated during approach–avoidance conflicts, namely, where achieving a goal also requires approaching a source of punishment, threat or danger (Perkins, Kemp, & Corr, 2007). BIS activation leads to greater vigilance toward the source of conflict, heightened anxiety, and cautious approach or avoidance behavior (Smillie et al., 2006, p. 323).

RST was originally developed as a theory of motivation, emotion, and learning, evolving primarily from neurobiological (e.g., H. J. Eysenck, 1967; H. J. Eysenck & Eysenck, 1985; Gray, 1970, 1972) and experimental research (e.g., Newman, Schmitt, & Voss, 1997; Newman, Wallace, Schmitt, & Arnett, 1997; Patterson, Kosson, & Newman, 1987; Patterson & Newman, 1993). Although the theoretical processes underlying RST relate to individual level phenomena, the model has generally been applied to the study of between-person differences. For example, the BAS and BIS align with three contemporary personality models at the between-person level of analysis. Elliot and Thrash (2002, 2010) demonstrated this by factor analyzing data from measures of trait personality (H. J. Eysenck & Eysenck, 1985; McCrae & Costa, 1987), affective disposition (Watson, Clark, & Tellegen, 1988), and approach–avoidance motivation (Gray, 1970). The authors identified two latent constructs, accounting for shared variance among the central constructs, which they labelled *approach temperament* (comprising extraversion, positive emotionality and the behavioral approach system) and *avoidance temperament* (comprising neuroticism, negative emotionality, and the behavioral inhibition system).

Emerging evidence from personality neuroscience identifies neurobiological correlates for the BAS, BIS, and, to a lesser degree, the FFFS (e.g., Bari & Robbins, 2013; Fuentes-Claramonte et al., 2015; McNaughton, DeYoung, & Corr, 2016). For example, sensitivity to reward (BAS) has been associated with the amygdala, nucleus accumbens, striatum, and medial orbitofrontal cortex (Depue & Collins, 1999; Knutson & Cooper, 2005). Sensitivity to threat (BIS and FFS) has also been linked to activation of the amygdala as well as the anterior and midcingulate cortex, medial prefrontal cortex (PFC), insula, and hippocampus (Adelstein et al., 2011; Bennett & Hacker, 2005; DeYoung & Gray, 2010; Gray & McNaughton, 2000). Finally, increased serotonergic functioning is negatively associated with sensitivity to threat (DeYoung & Gray, 2010), while sensitivity to reward has been linked to increased dopaminergic activity (Depue & Collins, 1999).

Finally, there is considerable empirical evidence supporting the main tenets of RST (Berkman, Lieberman, & Gable, 2009; Kambouropoulos & Staiger, 2004; Leue & Beauducel, 2008). The behavioral predictions of RST have been examined across a broad range of areas over the last 40 or more years, including psychopathy (e.g., Gorenstein & Newman, 1980; Kosson & Newman, 1986; Newman, Schmitt, et al., 1997; Newman, Wallace, et al., 1997), criminal behavior (e.g., Arnett & Newman, 2000; Arnett, Smith, & Newman, 1997), substance abuse (e.g., Gullo, Jackson, & Dawe, 2010), university education (e.g., Avila & Torrubia, 2004), and organizational behavior (e.g., Hutchison, Burch, & Boxall, 2013; Izadikhah, Jackson, & Loxton, 2010; Jackson, 2008). As we discuss next, the study of disinhibition provides an invaluable yet underutilized perspective on personality architecture (see Smith & Lilienfeld, 2015). The RMM (Patterson & Newman, 1993), in particular, has a considerable advantage over contemporary trait-based models as it provides a conceptually and empirically sound within-person process model of personality.

The RMM

Patterson and Newman's (1993) RMM describes a process "involving temporary suspension of a dominant response set (i.e., approach motivation) and a brief concurrent shift of attention from the organization and implementation of goal-directed responding to its evaluation" (p. 717). The RMM describes the process of disinhibition where inadequate evaluation, or reflection, results in a response modulation 'deficit' and impulsive behavior. The RMM comprises four interdependent and temporally overlapping stages (see Figure 1).

Stage 1 of the RMM (dominant approach response set) involves an "effortful allocation of attention to goal-relevant environmental stimuli and an expectation that reward is likely" (Patterson & Newman, 1993, p. 720). Disinhibited individuals are highly sensitive to rewarding stimuli and readily form and maintain strong 'approach response sets'. A strong approach response set restricts information gathering, consideration of alternative response options and often results in an overly optimistic assessment of situations. Such overfocusing on rewards can result in discounting or ignoring threatening or punishing stimuli. Stage 1 of the RMM resembles functions attributed to the BAS. This dominant response set continues until the reward is obtained, removed (delay or

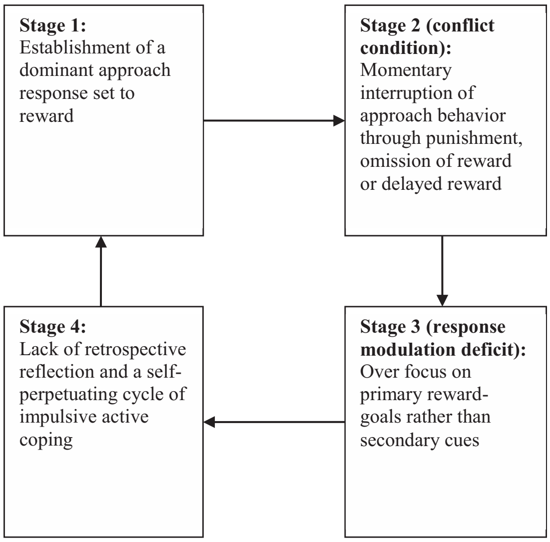

Figure 1. The response modulation model (Patterson & Newman, 1993).

omission), or an obstacle prevents reward attainment (punishment).

Disinhibition occurs because an aversive event disrupts this dominant approach set (Stage 2). This unexpected disruption elicits an automatic response to process the disruption as well as an immediate emotional reaction due to a mismatch between expectations and reality. The RMM predicts that individuals high in reward and threat sensitivity (high BAS and BIS) will display greater reactivity at Stage 2, particularly when approaching reward and facing novel, unexpected, or aversive stimuli (e.g., Robinson, Wilkowski, & Meier, 2008). Evidence also suggests that high sensitivity to threat (high BIS) amplifies the speed and/or force in individuals high in reward sensitivity (high BAS) when responding to an approach–avoidance conflict (Fowles, 1987; Wallace, Newman, & Bachorowski, 1991). Hence, for disinhibited individuals such reactivity when combined with high reward sensitivity (high BAS) contributes to impulsive behavior. Stage 2 comprises overlapping functions of the BIS and FFFS.

At Stage 3, nondisinhibited individuals are able to allocate central processing resources to shift from automatic to controlled processing, thereby adjusting their behavior or expectations. However, disinhibited individuals are unlikely to perform this switch, particularly if reward cues are still present. These disinhibited individuals fail to alter their response set even though the environment has changed—"they do not pause, process, and then go on" (Patterson & Newman, 1993, p. 720). This response modulation bias contributes to impulsive behavior in two ways. First, lack of information gathering, reflection and planning causes further aversive experiences in the changed environment (e.g., more errors or mistakes are made). Furthermore, such impulsive behavior is "colored by emotion, often anger or a similar affective response to the aversive event" (ibid., p. 722). Second, Stage 4 of the model suggests that disinhibited individuals exhibit poor judgment because they do not learn to anticipate stimuli and behaviors that warn of aversive outcomes. In particular, their actions in approach—avoidance conflict situations are more likely to be influenced by expectations of reward than by retrospective reflection and therefore result in a "self-perpetuating cycle of impulsive active coping" (ibid.).

In our view the RMM provides a conceptually and empirically sound foundation for a personality process model. This is because the RMM describes how an individual's emotions and behavior varies over time as a result of the interaction between within-person mental mechanisms (i.e., the BAS and BIS) and contextual factors (e.g., an approach–avoidance conflict). Three salient points support this claim. First, the RMM is explicitly a process model where causality can be tested empirically (Antonakis, Bendahan, Jacquart, & Lalive, 2010; Kenny, 1979). Second, the RMM is based on RST, most notably the BAS and BIS (based on original RST; Gray, 1987). As previously highlighted, evidence from personality neuroscience links the BAS, BIS, and disinhibition to neurobiological substrates residing within the individual (e.g., Avila, Parcet, & Barros-Loscertales, 2008; Bari & Robbins, 2013; Hewig, Hagemann, Seifert, Naumann, & Bartussek, 2006; McNaughton et al., 2016; Shankman, Klein, Tenke, & Bruder, 2007). Hence, there is evidence that the personality constructs described in the RMM are associated with physical phenomena that exist independent from psychometric measures of the BAS and BIS. Third, the RMM provides a coherent and plausible explanation of why emotions and behavior might vary at the individual level over time and across situations. Hence, the RMM provides the bridge principle, or explanatory link, between motivational systems at the neurobiological level (i.e., within-person) and individual differences in emotions and behavior at the observed level (i.e., between-person).

Although there is considerable theoretical and empirical support for approach and avoidance motivational systems, we also acknowledge that any complete model of personality requires a self-regulatory or inhibitory construct (Carver, 2005; Carver, Sutton, & Scheier, 2000; Elliot & Thrash, 2002; Read et al., 2010). For example, Henderson and Wachs (2007) proposed a general self-regulatory system in addition to an approach–avoidance motivational system (which they label te*mperamental reactivity*). Others have proposed similar self-regulatory constructs; for example, effortful control (Rothbart, Sheese, & Posner, 2007), attentional control (Derryberry & Reed, 2002), and social–cognitive constructs such as goals (Elliot & Thrash, 2002). Whereas a self-regulatory construct is not explicitly referred to in the RMM, Patterson and Newman (1993) mentioned "effortful allocation of attention" and "central processing resources" (pp. 720–721), which suggests the involvement of the attentional system (Posner & Petersen, 1990; Posner & Rothbart, 1998, 2009; Posner, Rothbart, Sheese, & Tang, 2007). A decade later, MacCoon et al. (2004), drawing on the idea of selective attention and cognitive control (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001), extended the original RMM to incorporate a self-regulatory function. We believe this improvement to the RMM provides a hitherto unexplored and novel way to relate specific neuroanatomical networks to RST and self-regulation at both the within-person and between-person levels. Before expanding this idea, we first explain how we conceptualize 'self-regulation.'

In the study of self-regulation Cervone et al. (2006) distinguished a mental mechanism from a self-regulatory function by proposing that a mental mechanism "contributes to people's capacity to execute one or more self-regulatory functions" (p. 338). Cervone et al. (2006) argued that a particular self-regulatory function might be executed via different mental mechanisms in different situations. Importantly, they warn that one cannot assume that a single construct can serve both as a mental mechanism and self-regulatory function. The terms *self-regulation* and *self-control* are often used interchangeably; however, Baumeister, Vohs, and Tice (2007) suggested that self-control can be conceptualized as a "deliberate, conscious, effortful subset of self-regulation" (p. 351). In a similar way, we hold the view that self-control, as a mental mechanism, is a deliberate and conscious act that contributes to self-regulation (i.e., as a self-regulatory function). Many social–cognitive constructs such as goals, expectations, or beliefs, for example, could be classified as mental mechanisms in this way. This idea can also be extended to the BIS, where approach behavior is inhibited or restrained in an approach–avoidance conflict situation. In addition, the freeze response of the FFFS acts to restrain behavior in situations where a proximal threat is imminent and cannot be avoided. In both examples, the BIS and FFFS can be conceptualized as mental mechanisms contributing to an individual's capacity to execute self-regulation, as opposed to being a self-regulatory function per se.

In the following section, we describe self-regulation as a top-down self-regulatory function and the RST systems as bottom-up mental mechanisms.[2] We argue that self-regulation results from the interaction between various mental mechanisms (i.e., the BIS, BAS, and FFFS) and contextual factors (Cervone et al., 2006). Finally, we conceptualize self-regulation and RST at the within-person level, via the CABA (MacCoon et al., 2004), and in subsequent sections relate these mental mechanisms to between-person differences in emotions and behavior. In so doing, we provide a broader process model of approach–avoidance motivation and self-regulation that supersedes the RMM.

The CABA

The CABA (MacCoon et al., 2004) describes how limited-capacity selective attention regulates the cognitions, emotions, and behaviors of individuals in response to various stimuli over time. Attention is viewed as a top-down mechanism capable of enhancing appropriate cognitions, emotions, or behaviors, and suppressing inappropriate cognitions, emotions, or behaviors (Baumeister, Gailliot, DeWall, & Oaten, 2006; Posner & Petersen, 1990; Posner & Rothbart, 1998). These cognitions, emotions, and behaviors are conceptualized as networks of co-activated neurons, activated automatically in a bottom-up manner in response to specific external or internal stimuli. In this model, "the most activated network of neurons represents the most dominant or prepotent cognition, emotion or behavior" (MacCoon et al., 2004, p. 423).

"The allocation of attention is central to self-regulation" in the CABA model (MacCoon et al., 2004, p. 423). This is reflected in a number of key modifications to the RMM, which include (a) replacing dominant response set with the most dominant networks activated at a given time; (b) extending the meaning of response to include cognitive and emotional responses in addition to behavioral responses; and (c) introducing dominant or nondominant cues to refer to specific stimuli that activate a dominant or nondominant network. The central tenet of the CABA model is that selective top-down attention is attracted to the most activated network at a given time and only activates nondominant networks when attentional capacity is available. Top-down attention is required to resolve network coactivation, which occurs when dominant and nondominant networks compete for attentional capacity. Failures in self-regulation, the equivalent of a response modulation deficit in the RMM, are predicted to occur when (a) too much attentional capacity is allocated to dominant versus nondominant cues and individuals fail to moderate their behavior; (b) attention is hijacked by a nondominant cue when capacity is available; or (c) individuals remain unaware of conflicting nondominant cues because they lack the necessary attentional capacity.

The selective attention mechanism of the CABA model is consistent with the concepts described in recent neural network models (e.g., Henderson & Wachs, 2007; Read et al., 2010) and is supported by evidence from cognitive neuroscience (Botvinick et al., 2001; Bush, Luu, & Posner, 2000; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Posner et al., 2007; Rothbart et al., 2007). For example, the PFC is associated with selective attention and measures of working memory and fluid intelligence (DeYoung, Peterson, & Higgins, 2005; Duncan et al., 2000; Gray & Thompson, 2004; Shamosh et al., 2008). In addition, the dorsolateral PFC is associated with reward and threat sensitivity and the attentional systems responsible for acquiring and maintaining the alert state, orienting to sensory stimuli, resolving conflict between these systems and regulating thoughts and feelings (Fan et al., 2005; Posner & Rothbart, 1998; Posner, Sheese, Odludas, & Tang, 2006). Finally, the dorsolateral PFC is connected to the anterior cingulate cortex (ACC), which has a conflict monitoring role by acting as a "source of feedback to mechanisms involved in recruiting attention, serving to indicate the need for increased 'top-down' control, and information processing" (Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999, p. 180). It is plausible that the ACC, as just described, is associated with the top-down attentional mechanism central to the CABA model. As a further example, activation of the ACC has been associated with the regulation of attention, error detection, working memory and modulation of emotional arousal via connections with bottom-up emotional networks, such as the hypothalamus, amygdala, hippocampus, and orbitofrontal PFC (Botvinick et al., 1999; Bush et al., 2000; Fan, Flombaum, McCandliss, Thomas, & Posner, 2003; Luu, Collins, & Tucker, 2000; Posner et al., 2007; Posner et al., 2006).

In summary, the self-regulatory function based on the CABA model explains how selective attention regulates cognitions, emotions, and behaviors at the individual level. Conceptualizing cognitions, emotions, and behaviors as activated neural networks provides a unique way to explain the automatic activation of the BAS, BIS, and FFFS in response to external or internal stimuli. In addition, the CABA model provides a novel way to integrate these bottom-up processes with a top-down neurocognitive self-regulatory function (see Figure 2). This top-down function, like that of the BAS, BIS, and to a lesser degree the FFFS, are associated with specific neuroanatomical regions (e.g., the ACC) and neurotransmitters (e.g., dopamine). We draw on these ideas in the following section to explain how specific contextual factors impact attentional resource capacity, self-regulation, and changes in an individual's cognitions, emotions, and behaviors over time.

[2] We use the terms *top down* and *bottom up* in this context to refer to neuroanatomical networks as opposed to two different approaches to personality architecture.

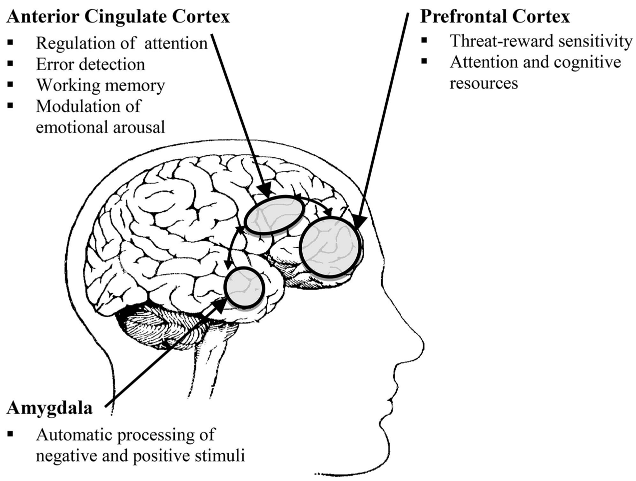

Figure 2. The neuroanatomy of a domain-general personality process model.

How Cognitions, Emotions, and Behavior Vary at the Within-Person Level

According to the CABA model, effective self-regulation relies on the efficient allocation and utilization of limited-capacity attentional resources. A sufficient quantity of attentional resources must therefore be available and allocated to dominant networks involved in the processing of cues associated with specific cognitions, emotions and behaviors. We propose that a dominant cue, such as a demanding or ambiguous task, will influence an individual's cognitions, emotions and behavior in the following way.

First, demanding or ambiguous tasks can place heavy demands on attentional and cognitive resources (Miller & Cohen, 2001; Shamosh et al., 2008; Shamosh & Gray, 2007). Over time, these attentional and cognitive resources are increasingly allocated to dominant networks involved in task processing. This leaves fewer resources available for nondominant networks, because attentional and cognitive resources are limited. Second, threat sensitive individuals (i.e., high BIS/FFFS) have a tendency to focus on processing threat-related cues such as negative cognitions and emotions as a priority, particularly anxiety (Derryberry & Reed, 2002; MacCoon et al., 2004). Further attentional resources from nondominant or dominant networks (e.g., resources involved in current task processing) are allocated in response to these negative cognitions and emotions. This leads to an escalation in intensity of negative emotions and depletes attentional resource capacity as further negative cognitions and emotions are processed. Finally, this reduction in attentional capacity impairs task performance, initiating more threat-related negative cognitions, further increasing the activation and allocation of attentional resources to these threat processing networks (Miller & Cohen, 2001; Shamosh et al., 2008). As a limited-capacity construct, the CABA model predicts that this ongoing process will result in diminishing levels of task-related attentional resources, increasing levels of negative emotion and a weakening or failure in self-regulation.

Hence, sufficient attentional resource capacity is required to maintain effective self-regulation, which reduces the adverse impact of negative emotions over the course of a demanding or ambiguous task. These negative emotions include BIS-mediated anxiety, BAS-mediated anger and FFFS-mediated fear. We next describe the emotional and behavioral outcomes of insufficient attentional resource capacity on each RST system.

First, BIS-mediated anxiety occurs when attentional resource capacity is insufficient to resolve the coactivation of dominant and nondominant networks. This occurs in approach–avoidance conflict situations where reward and threat networks compete for attentional resources. As previously discussed, threat cues increase activation of dominant threat networks and anxiety levels (e.g., Derryberry & Reed, 2002). This overwhelms limited attentional resource capacity leading to impaired self-regulation and cautious approach behavior.

Second, self-regulation impairment can also occur when attentional resource capacity is overallocated to dominant reward versus nondominant threat cues. In this situation attentional resources can be hijacked by nondominant threat cues if and when capacity becomes available. This might occur, for example, when a motorist is caught speeding on the way to a close friend's wedding (dominant reward) to avoid arriving late (nondominant threat). In this scenario self-regulation impairment might intensify the adverse effect of FFFS-mediated fear in the following three ways: (a) fight-mediated fear might lead to defensive aggression, for example, arguing with the police officer when stopped and further delayed; (b) flight-mediated fear might result in active avoidance behavior or even panic, for example, trying to avoid further delay by driving even faster and turning down a side-street; and (c) freeze-mediated fear might cause a delay, inaction, or even paralysis, for example, being unable to think straight or provide an explanation for speeding when stopped and questioned by the police officer.

Third, the effect of BAS-mediated anger is somewhat similar to that previously described for fight-mediated fear. In this case attentional resource capacity is also overallocated to dominant reward versus nondominant threat networks, and attentional resources are 'hijacked' by nondominant threat cues. This can occur when individuals with high reward sensitivity (i.e., high BAS) respond with BAS-mediated anger when prevented from attaining a desirable goal, for example, because an obstacle prevents goal attainment or a reward is withdrawn, which results in impulsive and aggressive behavior.

Finally, MacCoon et al. (2004) attribute self-regulation impairment specifically to negative not positive emotions. However, it is plausible that attentional resource capacity could be overallocated to dominant reward cues and associated networks leaving less attentional resources available for nondominant threat cues. For example, when a highly reward sensitive individual understates the risks and overstates the benefits of a highly speculative investment opportunity. In this scenario it is plausible that self-regulation is insufficient to restrain high reward sensitivity and optimism or excitement, leading to rash or impulsive decision-making (see Cyders & Smith, 2008; Cyders et al., 2007). This is a good example where prudent decision-making might result from activation of threat sensitive BIS or FFFS networks to counteract high reward sensitivity and restrain rash decision-making. This is clearly an example of effective self-regulation. However, the question remains as to whether this might occur automatically or as a deliberate act of self-control, or perhaps as we argue below, a combination of both.

The previous example represents an approach–avoidance conflict because there is both a financial gain and loss at stake, yet attention is overallocated to reward rather than threat networks. However, it is plausible that bottom-up threat sensitive networks can be automatically activated via the amygdala if a salient threat cue appears, for example, a memory of past financial loss (Bennett & Hacker, 2005; Irwin et al., 1996; LeDoux, 2000; Morris, Ohman, & Dolan, 1998). Conceptually, this automatic activation increases BIS-mediated anxiety to a level that activates more deliberate top-down processes such as self-control (Posner & Rothbart, 2009; van Noordt & Segalowitz, 2012). Could activation of top-down processes also occur in situations where attention is overallocated to threat networks, which inhibit or restrain approach behavior and give rise to anxiety or fear?

There is some evidence to suggest so (e.g., Derryberry & Reed, 2002), however, such activation requires greater attentional resource capacity and conscious effort or 'will power.' Baumeister, Bratslavsky, Finkenauer, and Vohs (2001) make a compelling case for the adverse impact of negative events over positive ones, best summarized as: "When equal measures of good and bad are present, however, the psychological effect of bad ones outweigh those of the good ones" (p. 323). To overcome one's fear of public speaking, for example, requires a conscious effort to "engage in goal-directed behavior to bring about long-term desirable outcomes" (Hagger, Wood, Stiff, & Chatzisarantis, 2010, p. 495). However, an alternative explanation might be that fear of public speaking is associated with greater activation of threat relative to reward networks rather than stronger self-control per se. For example, an electroencephalogram study by Shankman et al. (2007) indicates that early onset depression is associated with a deficit in the BAS-related left prefrontal regions of the brain, which suggests weaker activation of reward networks.

The preceding examples and interpretations are not intended to suggest that individuals respond to their environments in such predictable ways. Instead we have sought to illustrate the general utility of using the CABA model to explain how the motivational systems of RST might influence an individual's emotions and behavior in different situations. In doing so, we have explicitly conceptualized RST as a personality process model. This personality process model, based on the CABA model, differs from trait personality models in two important ways.

First, although RST was originally conceptualized as a biological model of personality (see Corr, 2004), it has been generally operationalized as a measurement model in much the same way as other trait personality models, including the B5 (i.e., between-person). The most notable exception being the RMM as discussed. We can think of no other RST-based model that is explicitly conceptualized as a within-person process model linked to neurobiological systems. In contrast, approach and avoidance temperament, conceptualized at the between-person level by Elliot and Thrash (2010), are "*constructs in and of themselves* and are only crudely captured by latent variables derived from other constructs" (p. 872, italics added). Furthermore, one important difference between RST and the B5 is that the former can be used to explain how physical within-person phenomena interact with contextual factors. The BAS, for example, is associated with a reward sensitive neurobiological system that explains how contextual factors influence an individual's emotions and behaviors over time. The same cannot be said of B5 extraversion, even though it is statistically related to the BAS at the between-person level of analysis.

Second, our conceptualization of self-regulation in the CABA model is 'domain-general,' in the same way that Elliot and Thrash (2010) conceptualize approach and avoidance temperament. This means that we have conceptualized personality at the broadest possible level based on approach–avoidance motivation and self-regulation. In so doing, we have identified a much broader role for the CABA model than originally envisaged by MacCoon et al. (2004). This is an important feature of our proposal as social encounters can often be ambiguous, novel or open to multiple interpretations, which suggests that different domain-specific stimuli activate different mental mechanisms (see Cervone, 2005). For example, we previously argued that activation of the BIS or FFFS restrains approach behavior in response to threatening stimuli. Furthermore, this automatic response is likely to activate more deliberate domain-specific mechanisms associated with threat avoidance such as goals, plans, resources, or beliefs. However, "before any of these domain-specific mechanisms can become active, the individual facing ambiguity must, in essence, figure out what domain they are in" (Cervone, 2005, p. 434). This figuring out requires domain-general, not domain-specific mental mechanisms. It may seem trivial that a threat avoidance goal is different to a reward attainment goal, yet the capacity to discern a threatening domain from a rewarding one is paramount to human survival.

A recent personality model that aligns somewhat with our thinking is the neural network model proposed by Read et al. (2010). The authors adopt the same objective of relating within- and between-person models by integrating a number of motivational systems and goal-based constructs at the broadest level of personality architecture. They also examine personality–situation interactions and present evidence from personality neuroscience to support their model. However, they do not explain how their personality mechanisms contribute to the dynamic relationships described in their model. For example, the authors claim that their "neural network model has a mechanism for inhibition that allows for the dynamic adjustment of degree of inhibition as a function of the level of activation layer" (Read et al., 2010, p. 84). Although they presented simulated evidence of a self-regulatory neural mechanism, they provide no explanation of how this mechanism operates. Similarly, they argued that "As different situations are encountered, different motives will be more or less highly activated, and the activated motives will 'compete' for the control of behavior" (Read et al., 2010, p. 87). Although this appears similar to the CABA model, the authors provide no explanation of how motives in their model compete for the control of behavior. Finally, their model makes no clear conceptual distinction between personality constructs that exist at different levels of analysis because they analyze B5 personality traits, approach—avoidance motivation and social–cognitive constructs concurrently. We address our solution to the issue of connecting within-person and between person constructs in the following section.

Connecting Within-Person and Between-Person Personality Constructs

The main reason for the failure of the within-subjects causal account seems to be that it rests on the misinterpretation of a measurement

> model as a process model, that is, as a mechanism that operates at the level of the individual. (Borsboom et al., 2003, p. 214)

Borsboom et al. (2003) remind us of a central axiom of personality research; measures test theory. Personality questionnaires and cognitive tests measure observable emotions, behaviors and actions that theoretically arise from some related yet latent construct. Individual differences in threat sensitivity, for example, can be measured using a BIS questionnaire from self or other observations of anxiety and cautious approach behavior. Accordingly, personality questionnaires reflect observable between-person behavior not unobservable within-person constructs. They are first and foremost associated with personality measurement not personality processes. This does not mean they cannot be used for within-person analysis, but the links between within-person and between-person constructs must be clearly explained. For example, Beal et al. (2005) argued that emotions are poorly conceptualized at the between-person level, that is,

> Happiness and anger, as examples, are not characteristics of people. They are experiential states that vary meaningfully within individuals over time. Even to say that someone is a happy or angry person is only to say that there is some tendency to experience these states. (p. 1054)

However, latent constructs such as emotions, for example, can provide sufficient explanation at both the within-person and between-person levels.

For example, Borsboom et al. (2003) propose that state-like constructs "such as mood, arousal, or anxiety, and perhaps some attitudes" can be conceptualized in this way (p. 214). Specifically, they argue that if the state construct on which an individual varies over time (within-person) is the same construct on which they differ from others at a given point in time (between-person), then the latent construct explaining within-person difference over time must be the same model as that explaining between-person difference at a point in time. For example, it is plausible that sensitivity to threat (BIS) consistently explains variation in state anxiety within the individual over time in the same way that it accounts for differences in the level of trait anxiety between people at a point in time. Individuals with high threat sensitivity are likely to experience rising levels of anxiety in response to a threatening cue over time, while individuals with similar high threat sensitivity are likely to rate themselves as experiencing high levels of anxiety in general. The same argument can be made for other emotions and other latent constructs such as attentional resource capacity and self-regulation. For example, the automatic allocation of attentional resources in response to a threatening cue might equally explain changes in one's level of state self-control over time in the same way that it explains individual differences in the level of trait self-control at the between-person level.

The preceding examples illustrate how various contextual factors (e.g., threatening cues) influence the within-person mechanisms described in RST and the CABA model. We made the point earlier that activation of domain-specific mechanisms requires recognition of domain-specific cues, which may be absent in novel or ambiguous situations (Cervone, 2005). The motivational systems in RST and the attentional allocation mechanism in the CABA model are activated by domain-general threat and reward cues. Hence, our conceptualization of personality allows not only the connecting of within- and between-person constructs as described, but also various personality models at the broadest to the narrowest conceptual level. We discuss how such models might be tested in the following section.

Testing a Domain-General Personality Process Model

It is not our intention in this section to review existing measures of RST or self-regulation (this has been done elsewhere, e.g., Corr, 2016) but rather to suggest a number of ways this domain-general personality process model might be tested. As previously argued, this model is explicitly causal and as a starting point any test must at a minimum demonstrate how (a) cause x precedes effect y temporally; (b) x correlates (beyond chance) with y; and (c) the relationship between x and y is not explained by other causes (Kenny, 1979). Hence, we do not recommend cross-sectional designs based solely on data collected from personality questionnaires at a single point in time, but experimental or longitudinal studies as these have proven to be the most successful in RST and RMM research (Leue & Beauducel, 2008; Smith & Lilienfeld, 2015). Furthermore, the emerging prevalence of neuroimaging studies beyond medical research (e.g., in the field of organizational cognitive neuroscience) suggests that techniques such as functional MRI might provide new and insightful ways to examine the neuroanatomical structure of personality (Becker, Cropanzano, & Sanfey, 2011; Cropanzano & Becker, 2013; Lee, Senior, & Butler, 2012). Although an examination of neuroimaging technology is also beyond the scope of our article, we believe that personality and cognitive neuroscience holds substantial potential to advance our knowledge of the neurobiological systems associated with intraindividual personality processes. However, for now we will limit our discussion to a number of suggestions that can be implemented using contemporary methods and measures.

A salient feature of our proposal is the way we have conceptualized the relationship between within-person and between-person constructs. Within-person constructs such as attentional resources, self-regulation, and emotions are state-like constructs in that they vary in intensity, frequency, and duration, whereas between-person constructs are trait-like constructs in the traditional sense (i.e., individual differences). Examples of trait-like constructs in our model include sensitivity to reward and threat (e.g., BAS and BIS), self-control, and emotions. Recall that emotions can be conceptualized as both states and traits, whereas self-control is a deliberate or conscious subset of self-regulation. Testing causal relationships between state and trait constructs poses a number of empirical challenges. For example, how does one design a study that can measure (a) a participant's sensitivity to threat and attentional resources, which are relatively stable constructs; (b) their level of state anxiety and self-regulation, which vary in intensity, frequency and duration; (c) their cautious approach behavior compared to others (i.e., between-person); when (d) they are experiencing an approach–avoidance conflict?

A recent study by Collins and Jackson (2015) provides one potential method. Drawing on the idea of a performance episode (Beal et al., 2005), the authors designed an experimental procedure based on the predictions of the CABA model. A performance episode is a relatively short, goal-directed task whereby, "*performance during an episode is a joint function of resource level and resource allocation*" (Beal et al., 2005, p. 1057, italics in original). Collins and Jackson (2015) used time-limited mathematical tests of varying difficulty to manipulate negative emotions and self-regulation in a sample of 161 organizational leaders. A novel feature of their study is the use of a performance-based state measure of self-regulation. This was based on the way participants favored speed over accuracy, or vice versa, when completing the mathematical test under time pressure (i.e., a trade-off decision). This study found that for difficult cognitive tasks, an individual's limited attentional resource capacity (trait) can become overwhelmed by high levels of negative emotions (state), resulting in self-regulation impairment (state), and impulsive and aggressive behavior (between-person). Consistent with the CABA model, the authors interpreted this as evidence for the automatic process by which negative emotions interfere with the allocation of attentional resources in the presence of threatening or punishing stimuli.

The study by Collins and Jackson (2015) highlights the importance of establishing a strong approach response set (or dominant network in CABA terminology) by reinforcing reward-directed behavior. The participants in this study were highly motivated to perform well in the mathematical test as this was part of an internal promotion process. Reinforcing reward-directed behavior, for example, is essential for testing the effect of nonreward on participants with strong reward sensitivity and for examining the process of disinhibition (Patterson & Newman, 1993). Establishing and maintaining a strong approach response set among participants in an experiment can be difficult and is cited as one of the main reasons for inconsistent or contradictory findings in the RST literature (see Leue & Beauducel, 2008; Smith & Lilienfeld, 2015). Keilp, Sackeim, and Mann (2005) found that once general demographic or ability factors are accounted for, specialized performance tasks requiring decision-making and response organization under time pressure provide the most effective means of assessing disinhibition. In particular, tasks that create uncertainty of response consequence in relation to the stimulus can serve the purpose of an approach–avoidance conflict condition (see Kagan, 1966; Leue & Beauducel, 2008). Many of the tasks used in neurocognitive research have been adopted for this purpose with measures like the go/no-go task, Stroop test, and Iowa Gambling Task being widely used to measure behavioral disinhibition (Endres, Rickert, Bogg, Lucas, & Finn, 2011; O'Connor & Jackson, 2008), impulsivity (Enticott, Ogloff, & Bradshaw, 2006; Keilp et al., 2005; Perales, Verdejo-Garcia, Moya, Lozano, & Perez-Garcia, 2009), risk-taking (Gardiner & Jackson, 2012), and decision-making (Davis, Patte, Tweed, & Curtis, 2007; Zermatten, Van der Linden, d'Acremont, Jermann, & Bechara, 2005). These and similar performance-based tasks could be used as state measures of self-regulation in a process model of personality.

It seems reasonable that any conceptually and empirically sound measure of RST (see Corr, 2016) and self-control (e.g., Derryberry & Reed, 2002) could be used to measure these constructs at the within-person and between-person levels. However, a clear conceptual argument must support the selection of each measure at the relevant level of analysis. A number of well validated measures of state emotions are also readily available (e.g., Watson et al., 1988). Somewhat more challenging, however, is how best to measure attentional resource capacity. This is arguably where neuroimaging research holds considerable promise. Our current understanding of attentional resources remains incomplete despite the general consensus that attention is associated with the dorsolateral PFC and the ACC (Bush et al., 2000; Fan et al., 2009; Rothbart et al., 2007). It is possible that other brain regions are more directly involved in the allocation of attention particularly during cognitively demanding performance tasks and when strong negative emotions are involved, for example, the ventromedial and orbitofrontal PFC (Del Missier, Mantyla, & De Bruin, 2012). In the previously cited study by Collins and Jackson (2015), a test of fluid intelligence was used to measure attentional resource capacity. However, the authors acknowledge that fluid intelligence may not be the best measure of attentional resource capacity and suggest that tests of working memory might also prove suitable (Ackerman, Beier, & Boyle, 2005; Hamilton, Hockey, & Rejman, 1977).

Finally, Elliot and Thrash (2010) reminded us of the limitations of relying on latent variables in empirical work and advocate using direct measures of approach and avoidance motivation. Importantly, they argued that direct measures would "afford a clear and efficient test of the predictive utility of the approach and avoidance temperament constructs" (p. 872). Others also argue that between-person measures of personality are not the only and best methods for measuring personality (Matthews & Gilliland, 1999; Poropat & Corr, 2015). We believe that experimental methods using performance-based measures and neuroimaging technologies will provide the most suitable tests of a personality process model. Such work is not without its challenges, as we discuss next.

Conclusions, Limitations and Future Directions

By drawing specifically from the neurobiological personality literature, we have arrived at a domain-general personality process model that explains how specific neuroanatomical networks, conceptualized as threat—reward sensitivity and self-regulation, cause emotions and behavior in response to various contextual factors. We have used the RST and CABA models as a way to associate within-person threat–reward sensitivity and self-regulation to between-person emotions and behaviors. This personality process model is domain-general in the sense that it includes both approach–avoidance motivation and self-regulatory functions and it differs substantially from existing between-person personality models in three important ways. First, the complete model is related conceptually and empirically to physical phenomena that exist independent of measurement (i.e., specific neurobiological systems). Second, the model is derived from an explicitly causal personality process model (the RMM) that has been subject to rigorous theoretical development (see Smith & Lilienfeld, 2015) and experiential validation. Finally, the influence of contextual factors are explicitly accommodated in this personality process model, rather than treated as a source of statistical error or confounding factors in trait personality research.

Conceptualizing personality in this way offers a number of distinct advantages over traditional trait personality models such as the B5. First, it provides a more plausible way to model the influence of contextual factors on the relationship between personality and behavior. Interactionist approaches, such as trait activation theory (Tett & Burnett, 2003), do not explain the within-person mental mechanisms associated with personality. In contrast, RST provides a well-established explanation of how the context impacts within-person motivational systems and causes variation in emotions and behavior over time. In addition, the CABA model provides theoretical clarity to the way personality and cognitive constructs, which have traditionally been viewed as separate entities (H. J. Eysenck, 1994), interact to cause emotions and behavior. Second, a process model of personality based on RST provides a bottom up approach to personality architecture that better aligns with emerging neuroscientific evidence and methods than traditional trait personality models such as the B5. The top down approach to trait personality serves to confuse and confound the relationship between various lower-order factors and discrete neurobiological systems. For example, trait anxiety and anger are both lower-order factors of B5 neuroticism, but as previously discussed, anxiety is associated with the BIS and anger with the BAS (and separate neurobiological systems). Hence, such relationships are conceptually clearer and more consistently identified in RST. Finally, our approach to personality architecture allows researchers to move beyond simple questions of correlation to those examining causation. It is one thing to know that anxiety is correlated with performance impairment at the between-person level, but it is more useful to understand how this effect arises and the conditions under which it hold (e.g., easy vs. simple tasks). Such knowledge affords more effective interventions (e.g., emotional self-regulation techniques).

Although our proposal provides a new way to integrate within- and between-person personality constructs, it also raises a number of unresolved questions. First, most of the neurobiological systems ascribed to the BAS and BIS are likewise associated with B5 extraversion and neuroticism, respectively (see DeYoung & Gray, 2010; McNaughton et al., 2016). Furthermore, there is evidence relating specific neurobiological systems to the remaining B5 factors. For example, broad regions of the PFC are associated with openness/intellect and conscientiousness (DeYoung et al., 2005). DeYoung and Gray (2010) posit a relationship between agreeableness and the medial PFC, superior temporal sulcus, temporal-parietal junction, and mirror neuron system. Hence, some might argue that the B5 readily maps to distinct neurobiological substrates as well and perhaps better than RST and CABA (e.g., DeYoung, 2015; DeYoung et al., 2010). We believe, however, that such a claim is difficult to substantiate at this point in time. Distinct neurobiological mappings are problematic for the B5. For example, the dopaminergic system is associated with both openness/intellect and extraversion (DeYoung et al., 2005), whereas agreeableness, conscientiousness, and neuroticism are all associated with the serotonergic system (DeYoung et al., 2010). Hence, although it is certainly possible to identify neurobiological systems for each B5 factor, some of these are shared between factors in ways that question the conceptual integrity of the five factor model.

Second, the RMM is based on Gray's original conception of RST (see review by Corr, 2004). It remains to be seen whether the predictions of the RMM will still hold using measures of revised RST (Corr, 2016). However, we doubt whether this will affect our proposal in a material way, as the CABA model is primarily concerned with dominant or nondominant cues and network activation. Hence, the specific nature of a threat or reward cue is to some degree less important than the allocation of attentional resources to dominant versus nondominant networks.

Finally, we did not specifically examine social–cognitive constructs, such as self-efficacy or goals, as we considered these to be more domain-specific than domain-general. However, we can see no reason why our proposal could not accommodate social–cognitive personality process models. One of the challenges, however, will be identifying relevant mental mechanisms that exist independent from measurement. Indeed, a potential avenue for future research could be the identification of specific neuroanatomical networks and neurotransmitters associated with various social–cognitive models. Personality neuroscience holds considerable promise in this regard, for example, in examining the neurobiological systems associated with organizational leadership (e.g., Boyatzis et al., 2012; Hannah, Balthazard, Waldman, Jennings, & Thatcher, 2013).

References

Ackerman, P. L., Beier, M. E., & Boyle, M. O. (2005). Working memory and intelligence: The same or different constructs? *Psychological Bulletin, 131,* 30–60. http://dx.doi.org/10.1037/0033-2909.131.1.30

Adelstein, J. S., Shehzad, Z., Mennes, M., Deyoung, C. G., Zuo, X. N., Kelly, C., . . . Milham, M. P. (2011). Personality is reflected in the brain's intrinsic functional architecture. *PLoS ONE, 6*(11), e27633. http://dx.doi.org/10.1371/journal.pone.0027633

Antonakis, J., Bendahan, S., Jacquart, P., & Lalive, R. (2010). On making causal claims: A review and recommendations. *The Leadership Quarterly, 21,* 1086–1120. http://dx.doi.org/10.1016/j.leaqua.2010.10.010

Arnett, P. A., & Newman, J. P. (2000). Gray's three-arousal model: An empirical investigation. *Personality and Individual Differences, 28,* 1171–1189. http://dx.doi.org/10.1016/S0191-8869(99)00169-5

Arnett, P. A., Smith, S. S., & Newman, J. P. (1997). Approach and avoidance motivation in psychopathic criminal offenders during passive avoidance. *Journal of Personality and Social Psychology, 72,* 1413–1428. http://dx.doi.org/10.1037/0022-3514.72.6.1413

Avila, C., Parcet, M. A., & Barrós-Loscertales, A. (2008). A cognitive neuroscience approach to individual differences in sensitivity to reward. *Neurotoxicity Research, 14*(2–3), 191–203. http://dx.doi.org/10.1007/BF03033810

Avila, C., & Torrubia, R. (2004). Personality, expectations, and response strategies in multiple-choice question examinations in university students: A test of Gray's hypotheses. *European Journal of Personality, 18,* 45–59. http://dx.doi.org/10.1002/per.506

Bari, A., & Robbins, T. W. (2013). Inhibition and impulsivity: Behavioral and neural basis of response control. *Progress in Neurobiology, 108,* 44–79. http://dx.doi.org/10.1016/j.pneurobio.2013.06.005

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. E. (2001). Bad is stronger than good. *Review of General Psychology, 5,* 323–370. http://dx.doi.org/10.1037/1089-2680.5.4.323

Baumeister, R. F., Gailliot, M., DeWall, C. N., & Oaten, M. (2006). Self-regulation and personality: How interventions increase regulatory success, and how depletion moderates the effects of traits on behavior. *Journal of Personality, 74,* 1773–1802. http://dx.doi.org/10.1111/j.1467-6494.2006.00428.x

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science, 16,* 351–355. http://dx.doi.org/10.1111/j.1467-8721.2007.00534.x

Beal, D. J., Weiss, H. M., Barros, E., & MacDermid, S. M. (2005). An episodic process model of affective influences on performance. *Journal of Applied Psychology, 90,* 1054–1068. http://dx.doi.org/10.1037/0021-9010.90.6.1054

Becker, W. J., Cropanzano, R., & Sanfey, A. G. (2011). Organizational neuroscience: Taking organizational theory inside the neural black box. *Journal of Management, 37,* 933–961. http://dx.doi.org/10.1177/0149206311398955

Bennett, M. R., & Hacker, P. M. S. (2003). *Philosophical foundations of neuroscience*. Malden, MA: Blackwell.

Bennett, M. R., & Hacker, P. M. S. (2005). Emotion and cortical-subcortical function: Conceptual developments. *Progress in Neurobiology, 75,* 29–52. http://dx.doi.org/10.1016/j.pneurobio.2004.11.002

Berkman, E. T., Lieberman, M. D., & Gable, S. L. (2009). BIS, BAS, and response conflict: Testing predictions of the revised reinforcement sensitivity theory. *Personality and Individual Differences, 46*(5–6), 586–591. http://dx.doi.org/10.1016/j.paid.2008.12.015

Block, J. (1995). A contrarian view of the five-factor approach to personality description. *Psychological Bulletin, 117,* 187–215. http://dx.doi.org/10.1037/0033-2909.117.2.187

Borsboom, D., Mellenbergh, G. J., & van Heerden, J. (2003). The theoretical status of latent variables. *Psychological Review, 110,* 203–219. http://dx.doi.org/10.1037/0033-295X.110.2.203

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108,* 624–652. http://dx.doi.org/10.1037/0033-295X.108.3.624

Botvinick, M., Nystrom, L. E., Fissell, K., Carter, C. S., & Cohen, J. D. (1999). Conflict monitoring versus selection-for-action in anterior cingulate cortex. *Nature, 402,* 179–181. http://dx.doi.org/10.1038/46035

Boyatzis, R. E., Passarelli, A. M., Koenig, K., Lowe, M., Mathew, B., Stoller, J. K., & Phillips, M. (2012). Examination of the neural substrates activated in memories of experiences with resonant and dissonant leaders. *The Leadership Quarterly, 23,* 259–272. http://dx.doi.org/10.1016/j.leaqua.2011.08.003

Bush, G., Luu, P., & Posner, M. I. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences, 4,* 215–222. http://dx.doi.org/10.1016/S1364-6613(00)01483-2

Carver, C. S. (2005). Impulse and constraint: Perspectives from personality psychology, convergence with theory in other areas, and potential for integration. *Personality and Social Psychology Review, 9,* 312–333. http://dx.doi.org/10.1207/s15327957pspr0904_2

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin, 135,* 183–204. http://dx.doi.org/10.1037/a0013965

Carver, C. S., Sutton, S. K., & Scheier, M. F. (2000). Action, emotion, and personality: Emerging conceptual integration. *Personality and Social Psychology Bulletin, 26,* 741–751. http://dx.doi.org/10.1177/0146167200268008

Carver, C. S., & White, T. L. (1994). Behavioral-inhibition, behavioral-activation, and affective responses to impending reward and punishment—the BIS and BAS scales. *Journal of Personality and Social Psychology, 67,* 319–333. http://dx.doi.org/10.1037/0022-3514.67.2.319

Cervone, D. (2004). The architecture of personality. *Psychological Review, 111,* 183–204. http://dx.doi.org/10.1037/0033-295X.111.1.183

Cervone, D. (2005). Personality architecture: Within-person structures and processes. *Annual Review of Psychology, 56,* 423–452. http://dx.doi.org/10.1146/annurev.psych.56.091103.070133

Cervone, D., Shadel, W. G., Smith, R. E., & Fiori, M. (2006). Self-regulation: Reminders and suggestions from personality science. *Applied Psychology: An International Review, 55,* 333–385. http://dx.doi.org/10.1111/j.1464-0597.2006.00261.x

Collins, M. D., & Jackson, C. J. (2015). A process model of self-regulation and leadership: How attentional resource capacity and negative emotions influence constructive and destructive leadership. *The Leadership Quarterly, 26,* 386–401. http://dx.doi.org/10.1016/j.leaqua.2015.02.005

Corr, P. J. (2004). Reinforcement sensitivity theory and personality. *Neuroscience and Biobehavioral Reviews, 28,* 317–332. http://dx.doi.org/10.1016/j.neubiorev.2004.01.005

Corr, P. J. (2016). Reinforcement sensitivity theory of personality questionnaires: Structural survey with recommendations. *Personality and Individual Differences, 89,* 60–64. http://dx.doi.org/10.1016/j.paid.2015.09.045

Corr, P. J., DeYoung, C. G., & McNaughton, N. (2013). Motivation and personality: A neuropsychological perspective. *Social and Personality Psychology Compass, 7,* 158–175. http://dx.doi.org/10.1111/spc3.12016

Costa, P. T., & McCrae, R. R. (1991). *Revised NEO Personality Inventory (Neo-PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual*. Odessa, FL: Psychological Assessment Resources.

Cropanzano, R., & Becker, W. J. (2013). The promise and peril of organizational neuroscience: Today and tomorrow. *Journal of Management Inquiry, 22,* 306–310. http://dx.doi.org/10.1177/1056492613478518

Cyders, M. A., & Smith, G. T. (2008). Emotion-based dispositions to rash action: Positive and negative urgency. *Psychological Bulletin, 134,* 807–828. http://dx.doi.org/10.1037/a0013341

Cyders, M. A., Smith, G. T., Spillane, N. S., Fischer, S., Annus, A. M., & Peterson, C. (2007). Integration of impulsivity and positive mood to predict risky behavior: Development and validation of a measure of positive urgency. *Psychological Assessment, 19,* 107–118. http://dx.doi.org/10.1037/1040-3590.19.1.107

Dalal, R. S., Bhave, D. P., & Fiset, J. (2014). Within-Person variability in job performance: A theoretical review and research agenda. *Journal of Management, 40,* 1396–1436. http://dx.doi.org/10.1177/0149206314532691

Davis, C., Patte, K., Tweed, S., & Curtis, C. (2007). Personality traits associated with decision-making deficits. *Personality and Individual Differences, 42,* 279–290. http://dx.doi.org/10.1016/j.paid.2006.07.006

Del Missier, F., Mantyla, T., & De Bruin, W. B. (2012). Decision-making competence, executive functioning, and general cognitive abilities. *Journal of Behavioral Decision Making, 25,* 331–351. http://dx.doi.org/10.1002/bdm.731

Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences, 22,* 491–517. http://dx.doi.org/10.1017/S0140525X99002046

Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology, 111,* 225–236. http://dx.doi.org/10.1037/0021-843X.111.2.225

DeYoung, C. G. (2015). Cybernetic Big Five theory. *Journal of Research in Personality, 56,* 33–58. http://dx.doi.org/10.1016/j.jrp.2014.07.004

DeYoung, C. G., & Gray, J. R. (2010). Personality neuroscience: Explaining individual differences in affect, behavior, and cognition. In P. J. Corr & G. Matthews, *Handbook of personality* (pp. 323–346). Cambridge, UK: New York: Cambridge University Press.

DeYoung, C. G., Hirsh, J. B., Shane, M. S., Papademetris, X., Rajeevan, N., & Gray, J. R. (2010). Testing predictions from personality neuroscience. Brain structure and the big five. *Psychological Science, 21,* 820–828. http://dx.doi.org/10.1177/0956797610370159

DeYoung, C. G., Peterson, J. B., & Higgins, D. M. (2005). Sources of openness/intellect: Cognitive and neuropsychological correlates of the fifth factor of personality. *Journal of Personality, 73,* 825–858. http://dx.doi.org/10.1111/j.1467-6494.2005.00330.x

Digman, J. M. (1990). Personality structure: Emergence of the five5-factor model. *Annual Review of Psychology, 41,* 417–440. http://dx.doi.org/10.1146/annurev.ps.41.020190.002221

Duncan, J., Seitz, R. J., Kolodny, J., Bor, D., Herzog, H., Ahmed, A., . . . Emslie, H. (2000). A neural basis for general intelligence. *Science, 289,* 457–460. http://dx.doi.org/10.1126/science.289.5478.457

Elliot, A. J., & Thrash, T. M. (2002). Approach-avoidance motivation in personality: Approach and avoidance temperaments and goals. *Journal of Personality and Social Psychology, 82,* 804–818. http://dx.doi.org/10.1037/0022-3514.82.5.804

Elliot, A. J., & Thrash, T. M. (2010). Approach and avoidance temperament as basic dimensions of personality. *Journal of Personality, 78,* 865–906. http://dx.doi.org/10.1111/j.1467-6494.2010.00636.x

Endres, M. J., Rickert, M. E., Bogg, T., Lucas, J., & Finn, P. R. (2011). Externalizing psychopathology and behavioral disinhibition: Working memory mediates signal discriminability and reinforcement moderates response bias in approach-avoidance learning. *Journal of Abnormal Psychology, 120,* 336–351. http://dx.doi.org/10.1037/a0022501

Enticott, P. G., Ogloff, J. R. P., & Bradshaw, J. L. (2006). Associations between laboratory measures of executive inhibitory control and self-reported impulsivity. *Personality and Individual Differences, 41,* 285–294. http://dx.doi.org/10.1016/j.paid.2006.01.011

Eysenck, H. J. (1967). *The biological basis of personality*. Springfield, IL: Thomas.

Eysenck, H. J. (1992). Four ways five factors are not basic. *Personality and Individual Differences, 13,* 667–673. http://dx.doi.org/10.1016/0191-8869(92)90237-J

Eysenck, H. J. (1994). Personality and intelligence: Psychometric and experimental approaches. In R. J. Sternberg & P. Ruzgis (Eds.), *Personality and intelligence* (pp. 3–31). New York, NY: Cambridge University Press.

Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach*. New York, NY: Plenum Press. http://dx.doi.org/10.1007/978-1-4613-2413-3

Fan, J., Flombaum, J. I., McCandliss, B. D., Thomas, K. M., & Posner, M. I. (2003). Cognitive and brain consequences of conflict. *NeuroImage, 18,* 42–57. http://dx.doi.org/10.1006/nimg.2002.1319

Fan, J., Gu, X., Guise, K. G., Liu, X., Fossella, J., Wang, H., & Posner, M. I. (2009). Testing the behavioral interaction and integration of attentional networks. *Brain and Cognition, 70,* 209–220. http://dx.doi.org/10.1016/j.bandc.2009.02.002

Fan, J., McCandliss, B. D., Fossella, J., Flombaum, J. I., & Posner, M. I. (2005). The activation of attentional networks. *NeuroImage, 26,* 471–479. http://dx.doi.org/10.1016/j.neuroimage.2005.02.004

Fowles, D. C. (1987). Application of a behavioral theory of motivation to the concepts of anxiety and impulsivity. *Journal of Research in Personality, 21,* 417–435. http://dx.doi.org/10.1016/0092-6566(87)90030-4

Fuentes-Claramonte, P., Ávila, C., Rodríguez-Pujadas, A., Ventura-Campos, N., Bustamante, J. C., Costumero, V., . . . Barrós-Loscertales, A. (2015). Reward sensitivity modulates brain activity in the prefrontal cortex, ACC and striatum during task switching. *PLoS ONE, 10*(4), e0123073. http://dx.doi.org/10.1371/journal.pone.0123073

Gardiner, E., & Jackson, C. J. (2012). Workplace mavericks: How personality and risk-taking propensity predicts maverickism. *British Journal of Psychology, 103,* 497–519. http://dx.doi.org/10.1111/j.2044-8295.2011.02090.x

Goldberg, L. R. (1992). The development of markers for the Big-Five factor structure. *Psychological Assessment, 4,* 26–42. http://dx.doi.org/10.1037/1040-3590.4.1.26

Gorenstein, E. E., & Newman, J. P. (1980). Disinhibitory psychopathology: A new perspective and a model for research. *Psychological Review, 87,* 301–315. http://dx.doi.org/10.1037/0033-295X.87.3.301

Gray, J. A. (1970). The psychophysiological basis of introversion-extraversion. *Behaviour Research and Therapy, 8,* 249–266. http://dx.doi.org/10.1016/0005-7967(70)90069-0

Gray, J. A. (1972). The structure of the emotions and the limbic system. In R. Porter & J. Knights (Eds.), *Physiology, emotion, and psychosomatic illness* (pp. 87–130). Amsterdam, the Netherlands: Associated Scientific. http://dx.doi.org/10.1002/9780470719916.ch6

Gray, J. A. (1987). *The psychology of fear and stress* (2nd ed.). Cambridge, UK: Cambridge University Press.

Gray, J. A., & McNaughton, N. (2000). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hipocampal system* (2nd ed.). Oxford, United Kingdom: Oxford University Press.

Gray, J. R., & Thompson, P. M. (2004). Neurobiology of intelligence: Science and ethics. *Nature Reviews Neuroscience, 5,* 471–482. http://dx.doi.org/10.1038/nrn1405

Gullo, M. J., Jackson, C. J., & Dawe, S. (2010). Impulsivity and reversal learning in hazardous alcohol use. *Personality and Individual Differences, 48,* 123–127. http://dx.doi.org/10.1016/j.paid.2009.09.006

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin, 136,* 495–525. http://dx.doi.org/10.1037/a0019486

Hamilton, P., Hockey, G. R. J., & Rejman, M. (1977). The place of the concept of activation in human information processing theory: An integrative approach. In S. Dornic (Ed.), *Attention and performance* (Vol. 6, pp. 463–486). Hillsdale, NJ: Erlbaum.

Hampson, S. E. (2012). Personality processes: Mechanisms by which personality traits "get outside the skin". *Annual Review of Psychology, 63,* 315–339. http://dx.doi.org/10.1146/annurev-psych-120710-100419

Hannah, S. T., Balthazard, P. A., Waldman, D. A., Jennings, P. L., & Thatcher, R. W. (2013). The psychological and neurological bases of leader self-complexity and effects on adaptive decision-making. *Journal of Applied Psychology, 98,* 393–411. http://dx.doi.org/10.1037/a0032257

Harmon-Jones, E., & Sigelman, J. (2001). State anger and prefrontal brain activity: Evidence that insult-related relative left-prefrontal activation is associated with experienced anger and aggression. *Journal of Personality and Social Psychology, 80,* 797–803. http://dx.doi.org/10.1037/0022-3514.80.5.797

Henderson, H. A., & Wachs, T. D. (2007). Temperament theory and the study of cognition-emotion interactions across development. *Developmental Review, 27,* 396–427. http://dx.doi.org/10.1016/j.dr.2007.06.004

Hewig, J., Hagemann, D., Seifert, J., Naumann, E., & Bartussek, D. (2006). The relation of cortical activity and BIS/BAS on the trait level. *Biological Psychology, 71,* 42–53. http://dx.doi.org/10.1016/j.biopsycho.2005.01.006

Hoffman, B. J., Woehr, D. J., Maldagen-Youngjohn, R., & Lyons, B. D. (2011). Great man or great myth? A quantitative review of the relationship between individual differences and leader effectiveness. *Journal of Occupational and Organizational Psychology, 84,* 347–381. http://dx.doi.org/10.1348/096317909X485207

Hutchison, A., Burch, G., & Boxall, P. (2013). Reinforcement sensitivity theory as a predictor of senior-executive performance. *Personality and Individual Differences, 55,* 931–935. http://dx.doi.org/10.1016/j.paid.2013.07.470

Irwin, W., Davidson, R. J., Lowe, M. J., Mock, B. J., Sorenson, J. A., & Turski, P. A. (1996). Human amygdala activation detected with echo-planar functional magnetic resonance imaging. *Neuroreport, 7,* 1765–1769. http://dx.doi.org/10.1097/00001756-199607290-00014

Izadikhah, Z., Jackson, C. J., & Loxton, N. (2010). An integrative approach to personality: Behavioural Approach System, mastery approach orientation and environmental cues in the prediction of work performance. *Personality and Individual Differences, 48,* 590–595. http://dx.doi.org/10.1016/j.paid.2009.12.012

Jackson, C. J. (2008). When avoidance leads to approach: How ear preference interacts with neuroticism to predict disinhibited approach. *Laterality: Asymmetries of Body, Brain, and Cognition, 13,* 333–373. http://dx.doi.org/10.1080/13576500802063053

Kagan, J. (1966). Reflection-impulsivity: The generality and dynamics of conceptual tempo. *Journal of Abnormal Psychology, 71,* 17–24. http://dx.doi.org/10.1037/h0022886

Kambouropoulos, N., & Staiger, P. K. (2004). Personality and responses to appetitive and aversive stimuli: The joint influence of behavioural approach and behavioural inhibition systems. *Personality and Individual Differences, 37,* 1153–1165. http://dx.doi.org/10.1016/j.paid.2003.11.019

Keilp, J. G., Sackeim, H. A., & Mann, J. J. (2005). Correlates of trait impulsiveness in performance measures and neuropsychological tests. *Psychiatry Research, 135,* 191–201. http://dx.doi.org/10.1016/j.psychres.2005.03.006

Kenny, D. A. (1979). *Correlation and causality*. New York, NY: Wiley-Interscience.

Knutson, B., & Cooper, J. C. (2005). Functional magnetic resonance imaging of reward prediction. *Current Opinion in Neurology, 18,* 411–417. http://dx.doi.org/10.1097/01.wco.0000173463.24758.f6

Kosson, D. S., & Newman, J. P. (1986). Psychopathy and the allocation of attentional capacity in a divided-attention situation. *Journal of Abnormal Psychology, 95,* 257–263. http://dx.doi.org/10.1037/0021-843X.95.3.257

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23,* 155–184. http://dx.doi.org/10.1146/annurev.neuro.23.1.155

Lee, N., Senior, C., & Butler, M. J. R. (2012). The Domain of Organizational Cognitive Neuroscience: Theoretical and Empirical Challenges. *Journal of Management, 38,* 921–931. http://dx.doi.org/10.1177/0149206312439471

Leue, A., & Beauducel, A. (2008). A meta-analysis of reinforcement sensitivity theory: On performance parameters in reinforcement tasks. *Personality and Social Psychology Review, 12,* 353–369. http://dx.doi.org/10.1177/1088868308316891

Luu, P., Collins, P., & Tucker, D. M. (2000). Mood, personality, and self-monitoring: Negative affect and emotionality in relation to frontal lobe mechanisms of error monitoring. *Journal of Experimental Psychology: General, 129,* 43–60. http://dx.doi.org/10.1037/0096-3445.129.1.43

MacCoon, D. G., Wallace, J. F., & Newman, J. P. (2004). Self-Regulation: The context-appropriate allocation of attentional capacity to dominant and nondominant cues. In R. F. Baumeister & K. D. Vohs (Eds.), *Handbook of Self-Regulation Research* (pp. 422–444). New York, NY: Guilford Press.

Matthews, G., & Gilliland, K. (1999). Personality, biology and cognitive science: A reply to Corr (2001). *Personality and Individual Differences, 30,* 353–362. http://dx.doi.org/10.1016/S0191-8869(00)00029-5

McCrae, R. R. (2005). Personality structure. In V. J. Derlega, B. A. Winstead, & W. H. Jones (Eds.), *Personality: Contemporary theory and research* (3rd ed., pp. 192–216). Belmont, CA: Wadsworth.

McCrae, R. R., & Costa, P. T., Jr. (1987). Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology, 52,* 81–90. http://dx.doi.org/10.1037/0022-3514.52.1.81

McCrae, R. R., & Costa, P. T., Jr. (1994). The stability of personality: Observations and evaluations. *Current Directions in Psychological Science, 3,* 173–175. http://dx.doi.org/10.1111/1467-8721.ep10770693

McNaughton, N., DeYoung, C. G., & Corr, P. J. (2016). Approach/avoidance A2. In J. R. Cloutier & J. Absher (Eds.), *Neuroimaging personality, social cognition, and character* (pp. 25–49). San Diego, CA: Academic Press.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24,* 167–202. http://dx.doi.org/10.1146/annurev.neuro.24.1.167

Mischel, W., & Shoda, Y. (1995). A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. *Psychological Review, 102,* 246–268. http://dx.doi.org/10.1037/0033-295X.102.2.246

Morris, J. S., Ohman, A., & Dolan, R. J. (1998). Conscious and unconscious emotional learning in the human amygdala. *Nature, 393,* 467–470. http://dx.doi.org/10.1038/30976

Newman, J. P., Schmitt, W. A., & Voss, W. D. (1997). The impact of motivationally neutral cues on psychopathic individuals: Assessing the generality of the response modulation hypothesis. *Journal of Abnormal Psychology, 106,* 563–575. http://dx.doi.org/10.1037/0021-843X.106.4.563

Newman, J. P., Wallace, J. F., Schmitt, W. A., & Arnett, P. A. (1997). Behavioral inhibition system functioning in anxious, impulsive and psychopathic individuals. *Personality and Individual Differences, 23,* 583–592. http://dx.doi.org/10.1016/S0191-8869(97)00078-0

O'Connor, P. J., & Jackson, C. (2008). Learning to be saints or sinners: The indirect pathway from Sensation Seeking to behavior through Mastery Orientation. *Journal of Personality, 76,* 733–752. http://dx.doi.org/10.1111/j.1467-6494.2008.00502.x

Patterson, C. M., Kosson, D. S., & Newman, J. P. (1987). Reaction to punishment, reflectivity, and passive avoidance learning in extraverts. *Journal of Personality and Social Psychology, 52,* 565–575. http://dx.doi.org/10.1037/0022-3514.52.3.565

Patterson, C. M., & Newman, J. P. (1993). Reflectivity and learning from aversive events: Toward a psychological mechanism for the syndromes of disinhibition. *Psychological Review, 100,* 716–736. http://dx.doi.org/10.1037/0033-295X.100.4.716

Perales, J. C., Verdejo-Garcia, A., Moya, M., Lozano, O., & Perez-Garcia, M. (2009). Bright and dark sides of impulsivity: Performance of women with high and low trait impulsivity on neuropsychological tasks. *Journal of Clinical and Experimental Neuropsychology, 31,* 927–944. http://dx.doi.org/10.1080/13803390902758793

Perkins, A. M., Kemp, S. E., & Corr, P. J. (2007). Fear and anxiety as separable emotions: An investigation of the revised reinforcement sensitivity theory of personality. *Emotion, 7,* 252–261. http://dx.doi.org/10.1037/1528-3542.7.2.252

Poropat, A. E., & Corr, P. J. (2015). Thinking bigger: The Cronbachian paradigm & personality theory integration. *Journal of Research in Personality, 56,* 59–69. http://dx.doi.org/10.1016/j.jrp.2014.10.006

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13,* 25–42. http://dx.doi.org/10.1146/annurev.ne.13.030190.000325

Posner, M. I., & Rothbart, M. K. (1998). Attention, self-regulation and consciousness. *Philosophical Transactions of the Royal Society of London Series B, Biological Sciences, 353,* 1915–1927. http://dx.doi.org/10.1098/rstb.1998.0344

Posner, M. I., & Rothbart, M. K. (2009). Toward a physical basis of attention and self regulation. *Physics of Life Reviews, 6,* 103–120. http://dx.doi.org/10.1016/j.plrev.2009.02.001

Posner, M. I., Rothbart, M. K., Sheese, B. E., & Tang, Y. (2007). The anterior cingulate gyrus and the mechanism of self-regulation. *Cognitive, Affective & Behavioral Neuroscience, 7,* 391–395. http://dx.doi.org/10.3758/CABN.7.4.391

Posner, M. I., Sheese, B. E., Odludaş, Y., & Tang, Y. (2006). Analyzing and shaping human attentional networks. *Neural Networks, 19,* 1422–1429. http://dx.doi.org/10.1016/j.neunet.2006.08.004

Read, S. J., Monroe, B. M., Brownstein, A. L., Yang, Y., Chopra, G., & Miller, L. C. (2010). A neural network model of the structure and dynamics of human personality. *Psychological Review, 117,* 61–92. http://dx.doi.org/10.1037/a0018131

Revelle, W., & Condon, D. M. (2015). A model for personality at three levels. *Journal of Research in Personality, 56,* 70–81. http://dx.doi.org/10.1016/j.jrp.2014.12.006

Robinson, M. D., Wilkowski, B. M., & Meier, B. P. (2008). Approach, avoidance, and self-regulatory conflict: An individual differences perspective. *Journal of Experimental Social Psychology, 44,* 65–79. http://dx.doi.org/10.1016/j.jesp.2007.02.008

Rothbart, M. K., Sheese, B. E., & Posner, M. I. (2007). Executive attention and effortful control: linking temperament, brain networks, and genes. *Child Development Perspectives, 1,* 2–7. http://dx.doi.org/10.1111/j.1750-8606.2007.00002.x

Shamosh, N. A., Deyoung, C. G., Green, A. E., Reis, D. L., Johnson, M. R., Conway, A. R. A., . . . Gray, J. R. (2008). Individual differences in delay discounting: Relation to intelligence, working memory, and anterior prefrontal cortex. *Psychological Science, 19,* 904–911. http://dx.doi.org/10.1111/j.1467-9280.2008.02175.x

Shamosh, N. A., & Gray, J. R. (2007). The relation between fluid intelligence and self-regulatory depletion. *Cognition and Emotion, 21,* 1833–1843. http://dx.doi.org/10.1080/02699930701273658

Shankman, S. A., Klein, D. N., Tenke, C. E., & Bruder, G. E. (2007). Reward sensitivity in depression: A biobehavioral study. *Journal of Abnormal Psychology, 116,* 95–104. http://dx.doi.org/10.1037/0021-843X.116.1.95

Smillie, L. D., Pickering, A. D., & Jackson, C. J. (2006). The new reinforcement sensitivity theory: Implications for personality measurement. *Personality and Social Psychology Review, 10,* 320–335. http://dx.doi.org/10.1207/s15327957pspr1004_3

Smith, S. F., & Lilienfeld, S. O. (2015). The response modulation hypothesis of psychopathy: A meta-analytic and narrative analysis. *Psychological Bulletin, 141,* 1145–1177. http://dx.doi.org/10.1037/bul0000024

Tett, R. P., & Burnett, D. D. (2003). A personality trait-based interactionist model of job performance. *Journal of Applied Psychology, 88,* 500–517. http://dx.doi.org/10.1037/0021-9010.88.3.500

van Noordt, S. J., & Segalowitz, S. J. (2012). Performance monitoring and the medial prefrontal cortex: A review of individual differences and context effects as a window on self-regulation. *Frontiers in Human Neuroscience, 6,* 197. http://dx.doi.org/10.3389/fnhum.2012.00197

Wallace, J. F., Newman, J. P., & Bachorowski, J. A. (1991). Failures of response modulation: Impulsive behavior in anxious and impulsive individuals. *Journal of Research in Personality, 25,* 23–44. http://dx.doi.org/10.1016/0092-6566(91)90003-9

Waller, N. G., Lilienfeld, S. O., Tellegen, A., & Lykken, D. T. (1991). The Tridimensional Personality Questionnaire: Structural validity and comparison with the Multidimensional Personality Questionnaire. *Multivariate Behavioral Research, 26,* 1–23. http://dx.doi.org/10.1207/s15327906mbr2601_1

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063–1070. http://dx.doi.org/10.1037/0022-3514.54.6.1063

Wood, R. E., & Beckmann, N. (2006). Personality architecture and the FFM in organisational psychology. *Applied Psychology: An International Review, 55,* 453–469. http://dx.doi.org/10.1111/j.1464-0597.2006.00263.x

Zermatten, A., Van der Linden, M., d'Acremont, M., Jermann, F., & Bechara, A. (2005). Impulsivity and decision making. *Journal of Nervous and Mental Disease, 193,* 647–650. http://dx.doi.org/10.1097/01.nmd.0000180777.41295.65

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