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Applying a dual process model of self-regulation: The association between executive working memory capacity, negative urgency, and negative mood induction on pre-potent response inhibition

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ABSTRACT

This study tested a dual-process model of self-control where the combination of high impulsivity (negative urgency – NU), weak reflective/control processes (low executive working memory capacity – E-WMC), and a cognitive load is associated with increased failures to inhibit pre-potent responses on a cued go/no-go task. Using a within-subjects design, a cognitive load with and without negative emotional load was implemented to consider situational factors. Results suggested that: (1) high NU was associated with low E-WMC; (2) low E-WMC significantly predicted more inhibitory control failures across tasks; and (3) there was a significant interaction of E-WMC and NU, revealing those with low E-WMC and high NU had the highest rates of inhibitory control failures on all conditions of the task. In conclusion, results suggest that while E-WMC is a strong independent predictor of inhibitory control, NU provides additional information for vulnerability to problems associated with self-regulation.

1. Introduction

Those with high levels of trait impulsivity do not always show behavioral evidence of poor self-control (Wiers, Ames, Hofman, Krank, & Stacey, 2010). Dual-process models of self-regulation explain this phenomenon by positing that self-controlled behavior is the result of the interaction between impulsive and reflective processes (Smith & DeCoster, 2000). While trait impulsivity reflects general approach tendencies, reflective processes reflect those executive cognitive processes, such as executive working memory, that serve to check and modulate the approach tendencies. For instance, some evidence suggests that high working memory capacity may reduce the likelihood that someone with strong alcohol-related impulsive tendencies will actually drink excessively and develop alcohol problems (Thrush et al., 2008). Relevant for the current study of negative urgency (NU), these models also posit a role for situational factors, such as mood, that may weaken or enhance either process (Hofmann, Friese, & Strack, 2009). Using a dual-process model perspective, we investigated the association between NU (impulsive processes associated with negative mood), executive working memory capacity (E-WMC), negative mood, and a specific behavioral measure of inhibitory control, pre-potent response inhibition (Friedman & Miyake, 2004). We hypothesize that NU will be associated with poor pre-potent response inhibition only for those with low E-WMC and that a negative mood induction will enhance this association.

Negative urgency (NU) is a facet of impulsivity that reflects a tendency to act rashly when experiencing negative affect (NA) (Whiteside & Lynam, 2001). In other words, negative mood is thought to enhance impulsive processes for those with high NU. There is some evidence that trait impulsivity is associated with low E-WMC (Gunn & Finn, 2013; Khurana et al., 2012), but this is not well studied and there are no reports of the association between NU and E-WMC. Likewise, there are not very many studies of self-report trait impulsivity and inhibitory motor control and the studies that do exist present mixed results. In some studies, NU is associated with poor pre-potent response inhibition on go/no go measures (Cyders & Coskunpinar, 2011; Gay, Rochat, Billieux, d'Acremont, & Van der Linden, 2008), but not in others (Cyders & Coskunpinar, 2012). Another study reported an association between trait impulsivity and poor oculomotor inhibition and to some degree poor behavioral inhibition on a Stop Task for those with ADHD (Roberts, Fillmore, & Milich, 2011). Enticott, Ogloff, and Bradshaw (2006) report that measures of trait impulsivity are consistently associated with increased interference on the Stroop task, but less consistently associated with measures of poor inhibitory control on other behavioral measures. None of these

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studies examined the possible interaction between trait impulsivity and reflective/cognitive control processes, or in the case of NU, the interaction between NU, negative mood, and reflective processes. We hypothesize a more consistent and stronger association between NU and poor pre-potent response inhibition for those with lower E-WMC, especially after a negative mood induction.

We are particularly interested in E-WMC, as a reflective process, because it is consistently associated with decision making (Bechara & Martin, 2004; Endres, Donkin, & Finn, 2014; Finn, Gunn, & Gerst, 2014; Shamosh et al., 2008) and it is considered a key reflective – control process critical for adaptive self-regulation and decision-making (Barkley, 2001; Barrett, Tugade, & Engle, 2004). Reduced E-WMC also has been associated with poor inhibitory control on a range of tasks (Kane, Bleckley, Conway, & Engle, 2001; Kane & Engle, 2003; Redick & Engle, 2006), including incentive learning go/no-go tasks (Endres et al., 2014; Redick, Calvo, Gay, & Engle, 2011), but not the cued go/no-go task specifically.

The current study brings together these related concepts by testing the association between NU, E-WMC, and pre-potent response inhibition on the cued go/no-go task (Fillmore, Marczinski, & Bowman, 2005). Pre-potent response inhibition reflects the ability to suppress an automatic, primed response and is a specific domain of inhibitory control that is separable from the broader, more general construct of inhibitory control (Friedman & Miyake, 2004). In addition, we are interested in investigating the role of NU in these associations because it has not been studied with E-WMC and because it measures an impulsive disposition related to NA specifically.

To fully apply the dual-process model, we also consider situational factors that may enhance NU via a negative mood induction or compromise control processes via a cognitive load. Although NU posits poor self-control when experiencing negative affect, to our knowledge there have been no studies of the association between NU and measures of self-control after a mood induction. We also use a cognitive load because studies indicate that cognitive loads increase impulsive, disinhibited decision making on a range of tasks such as delay discounting tasks (Finn et al., 2014; Hinson, Jameson, & Whitney, 2003), incentivized go/no-go learning tasks (Endres et al., 2014), and the Iowa Gambling Task (Fridberg, Gerst, & Finn, 2013; Hinson, Jameson, & Whitney, 2002).

1.1. Specific hypotheses

The primary hypothesis tested in this study is that NU will be associated with poor pre-potent response inhibition only for those with low E-WMC. We also hypothesized that the association between NU and response inhibition for those with low E-WMC will be enhanced by the cognitive load and negative mood induction.

2. Method

2.1. Participants

2.1.1. Sample characteristics

The sample consisted of 86 young adults (*M* age = 21.5, SD = 4.3; 50 females). The sample was 72.1% European American, 12.8% African American, 3.5% Hispanic or Latino, and 11.6% Asian, Indian, or Middle Eastern. Eighty-five percent ($n = 73$) of the total sample were current undergraduate students at a large Midwestern university.

2.1.2. Recruitment

The sample was recruited from a larger study, where participants gave consent to be contacted for future studies conducted in the same laboratory. Participants were contacted by phone to determine study inclusion criteria including being between the ages of 18 and 30, able to read and speak English, having at least a 6th grade education, not currently taking any medications that seriously affect behavior (e.g., tranquilizers or epilepsy drugs), and no history of psychosis or head trauma.

2.2. Materials

2.2.1. Negative urgency (NU)

Self-reported NU was assessed with the UPPS Impulsive Behavior Scale (UPPS-P; Lynam, Smith, Cyders, Fischer, & Whiteside, 2007). The UPPS-P is a 59-item self-report inventory that measures five impulsive personality traits, including NU. Items are assessed on a Likert scale from 1 (agree strongly) to 5 (disagree strongly). Higher scores denote higher levels of NU. This measure has revealed clear discriminant and convergent reliability. In addition, a multitrait, multimethod matrix analysis revealed good interrater reliability among the constructs (see Smith et al., 2007).

2.2.2. Executive working memory capacity (E-WMC)

Individual E-WMC was measured at the time of initial participation in the laboratory (before the being recruited for the present study) using the Operation Word Span test (OWS; Conway & Engle, 1994), a complex span task which has been found reliable in numerous studies (Conway et al., 2005). Although E-WMC was measured at a separate time point, measures of E-WMC have been shown to be stable over time (Conway et al., 2005; Friedman & Miyake, 2004; Klein & Fiss, 1999). This task requires the simultaneous use of attentional and maintenance resources. It requires confirming the accuracy of a mathematical operation while remembering a word (5 + 4 − 1 = 9 *CAT*). After a sequence of these operation word pairs (3 sets of each 2, 3, 4, & 5 word spans paired with mathematical operations) the participant is asked to recall, in order, the words as they were presented. Performance on this task is measured by the number of words recalled correctly.

2.2.3. Mood ratings

The SAM MANIKIN valence scale (Bradley & Lang, 1994) was used to rate mood on a single dimensional Likert-scale. This scale uses a five-point measure to indicate current mood ranging from images of a smiling and happy face to a sad and frowning face (higher ratings indicating more negative mood) and displays good internal reliability in adults (Backs, da Silva, & Han, 2005; Lang, Bradley, & Cuthbert, 1999). Additionally, the negative scale (16 items) of the PANAS-State self-report measure was used to measure current NA, which has been found to have high internal reliability and to be stable across time (Crawford & Henry, 2004; Watson, Clark, & Tellegen, 1988). Participants rate "*the extent to which you are currently feeling this way*" (*very slightly or not at all* to *extremely*) on a five-point Likert scale in response to a range of negative emotion words. An average score is calculated, higher scores indicating greater negative affect.

2.2.4. Mood induction and cognitive load

At the beginning of the combined load condition, an autobiographical recall of a negative life event was elicited. In this procedure, participants were asked to "*. . .recall a negative event in your life and reflect on it. . .*". They were instructed to write down as many details as possible and to "*. . .really try to place yourself in the context of the event. . .*" for 10 min. This method has been shown to effectively induce negative mood in individual procedures (Bless, Schwarz, & Wieland, 1996; Krauth-Gruber & Ric, 2000) as well as in comparison procedures and meta-analyses (Jallais & Gilet, 2010; Westermann, Spies, Stahl, & Hesse, 1996).