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Short Communication

Personality modulation of (un)conscious processing: Novelty Seeking and performance following supraliminal and subliminal reward cues

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ABSTRACT

This study provides evidence that personality traits associated with responsiveness to conscious reward cues also influence responsiveness to unconscious reward cues. Participants with low and high levels of Novelty Seeking (NS) performed updating tasks in which they could either gain 1 euro or 5 cents. Gains were presented either supraliminally or subliminally at the beginning of each trial. Results showed that low NS participants performed better in the high-reward than in the low-reward condition, whereas high NS participants' performance did not differ between reward conditions. Interestingly, we found that low NS participants performed significantly better when rewards were presented unconsciously, whereas high NS participants' performance did not differ whether reward cues were presented subliminally or supraliminally. Our findings highlight the necessity of taking personality into account in unconscious cognition research. They also suggest that individual differences might determine whether implicit and explicit motives have similar or complementary influences.

1. Introduction

Today, it is no longer denied that subliminal primes can influence people's emotion, cognition, and behavior below conscious awareness (Kouider & Dehaene, 2007). Unconscious stimuli have been shown to influence semantic processing (Dehaene et al., 1998), emotional processing (Morris, Öhman, & Dolan, 1998), choice (Verwijmeren, Karremans, Stroebe, & Wigboldus, 2011), and action planning/execution (Binsted, Brownell, Vorontsova, Heath, & Saucier, 2007). Even motivation can be influenced unconsciously. For example, recent studies have shown that incentives could influence resource mobilization below conscious awareness. In a physical effort task where participants were asked to squeeze a power grip to move the fluid level within a thermometer, Pessiglione et al. (2007) demonstrated that monetary reward cues presented subliminally could increase participants' investment in the task in a similar fashion to supraliminal reward cues. Likewise, Bijleveld, Custers, and Aarts (2009) found that participants solving an arithmetic task in which they could either gain 50 cents or 1 cent on each trial, showed higher pupil dilatation on subliminal high-rewards trials than on subliminal low-rewards trials.

But, are we all equally sensitive to subliminal reward cues? Despite the explosion of research extending the borders of unconscious motivation (see Custers & Aarts, 2010; Kouider & Dehaene, 2007 for reviews), it remains largely unknown whether individual differences associated with reward can modulate responses to unconscious reward cues. This study focuses on this specific question, and we believe it is important for two reasons. First, the effect sizes of unconscious primes are usually small (around $r = .06$; see Trappey, 1996 for review) and the robustness of these effects has been criticized (cf. Kouider & Dehaene, 2007). Part of the reason for the weak effect sizes might come from the fact that meta-analyses averaging

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across all primes include those that work and those that do not. However, it is also possible that a personality perspective could help to account for these "weak" results: some very unresponsive people might lessen the *average* effect of unconscious perceptions. For example, in Trappey's (1996) review on subliminal advertisement, most of the studies focus on products associated with addictive behaviors (e.g., chocolate, alcohol, or tobacco), which are well-known to be strongly related to personality traits such as impulsivity or Novelty Seeking (e.g., Mitchell, 2004). Second, exploring the relationship between personality and conscious vs. unconscious motivation might help to better understand the links between explicit and implicit cognition. Whereas some argue that unconscious/implicit functioning and conscious/explicit functioning are very similar and that the brain does not care whether something is primed subliminally or supraliminally (Dijksterhuis, Aarts, & Smith, 2005; for similar reasoning, see Bargh, 1989, 1992), others argue that implicit and explicit processing can result in different effects (e.g., Kiefer & Spitzer, 2000; Wilson, Lindsey, & Schooler, 2000). These two positions give rise to two competing hypotheses regarding the link between priming and personality. If implicit and explicit primes are processed similarly, then the mental representation of the word "danger" is likely to be associated with stronger reactions for neurotic individuals, irrespective of whether activation of the word was the result of subliminal or supraliminal perception—a proposition consistent with findings showing that subliminal priming tends only to affect behavior if the subliminal prime is relevant to their conscious goals and motivations (see e.g., Karremans, Stroebe, & Claus, 2006; Strahan, Spencer, & Zanna, 2005). On the other hand, if implicit and explicit primes are processed differently, then neurotic individuals may react differently when the word "danger" is primed below or above awareness. One might hypothesize that there are differences in reactivity to subliminal vs. supraliminal stimuli especially when it comes to temperament personality dimensions, which reflect differences in associative learning and involve automatic and preconceptual responses to perceptual stimuli, reflecting heritable biases in the unconscious memory system (Cloninger, 1987; Cloninger, Svrakic, & Przybeck, 1993). Consistent with this prediction, a study on unconscious emotional perception has shown that high trait behavioral inhibition was associated with more intense reaction to subliminal than supraliminal threat (Yoshino, Kimura, Yoshida, Takahashi, & Nomura, 2005).

The present research investigates whether and how personality influences responsiveness to subliminal and supraliminal reward stimuli in the particular domain of resource mobilization (e.g., Capa, Cleeremans, Bustin, & Hansenne, 2011). Recent research has shown that, on average, people tend to invest more effort in solving difficult arithmetic problems when rewards are high and less effort when rewards are low. This is irrespective of whether reward cues are presented consciously or unconsciously (Bijleveld, Custers, & Aarts, 2010; Capa, Bustin, Cleeremans, & Hansenne, 2011). However, not everyone might show such a "wise" selectivity in the way they pursue reward. Dopaminergic projections from the midbrain are important for learning to predict rewarding outcomes (Schultz, 2006), and dopamine levels have been strongly linked to personality traits such as Novelty Seeking (e.g., Bódi et al., 2009). Novelty Seeking (NS) can be defined as a trait involving activation or initiation of behaviors such as exploratory activity and approach to potential rewards (Cloninger et al., 1993). It is thought to reflect variation in the brain's behavioral activation system. High NS individuals are characterized as impulsive and excitable, while low NS persons are stoic and rigid. In addition to being hyper-responsive to reward cues, high NS people are also less likely to reflect on outcomes associated with their actions and to modify their response in accordance with shifts in environmental clues (see e.g., Cloninger, 1987; Finn, Mazas, Justus, & Steinmetz, 2002; Patterson & Newman, 1993). Such disinhibited individuals tend to allocate their cognitive resources less efficiently than their more cautious counterparts, decreasing their performance in a long-lasting monotonous task (Beauducel, Brocke, & Leue, 2006). Consistent with these results, Kemper et al. (2008) found that when a task varied in difficulty, extraverts showed less cardiovascular-related changes in effort mobilization compared to introverts, suggesting less "strategic" resource management.

Building on these findings, we hypothesize that participants with more careful dispositions (characterized by low scores in NS) would show more selective, reward-dependent investment in a difficult arithmetic updating task than their more impulsive counterparts (high NS). Exploring how personality interacts with conscious and unconscious motivation, we further examined how NS differentially modulated participants' performance when reward cues are presented supraliminally and subliminally, respectively. Because differences in NS reflect automatic biases in the unconscious memory system (Cloninger, 1987; Cloninger et al., 1993), we further predicted that low NS participants' sensitivity to reward cues would be even greater in the subliminal condition, in line with previous findings from unconscious emotional perception research (Yoshino et al., 2005).

2. Method

2.1. Participants and design

Forty-five undergraduates agreed to participate in our study on arithmetic operations in exchange for a performance-dependent monetary compensation (see below). Two groups of participants were created on the basis of their scores on the NS scale from the Temperament and Character Inventory-Revised (TCI-R; Cloninger, 1999; see Hansenne, Delhez, & Cloninger, 2005 for psychometric properties of the French version). Participants who scored above or equal to the median (score $\geqslant$101; M = 111.6, SD = 8.5) were defined as high in NS (12 women and 11 men aged between 18 and 26 years; M = 22 years, SD = 1.8), whereas participants scoring below the median (score <101, M = 92, SD = 6.9) were considered low in NS (10 women and 12 men aged between 18 and 26 years; M = 22 years, SD = 1.8). The experiment was approved by the local ethics