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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.

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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 ≥ 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

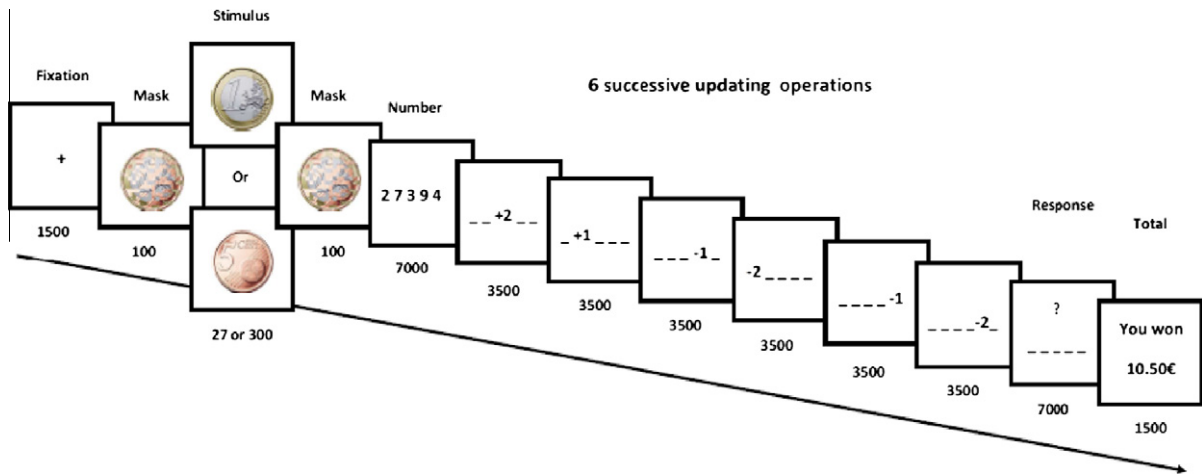


Fig. 1. Successive screens displayed in one trial with duration in milliseconds.

committee. All the participants gave written informed consent prior to taking part. A 2 (groups: high NS vs. low NS) \times 2 (rewards: high vs. low) \times 2 (presentation durations: supraliminal vs. subliminal) design was used.

2.2. Updating task

Participants performed a digit memory-updating task—based on the memory updating paradigm of Salthouse, Babcock, and Shaw (1991)—in which they could earn a coin (1 euro or 5 cents) presented on a computer screen by correctly updating and recalling a subsequent series of digits. They were told that the coin would sometimes be “difficult to perceive”. Following Pessiglione et al. (2007), half of the trials displayed the coin supraliminally (i.e., in a consciously perceivable manner) and the other half presented the coin subliminally (i.e., below conscious awareness). Participants were paid based on their performance.

As depicted in Fig. 1, each trial began with a fixation cross (1500 ms), followed by a premask (100 ms), reward cues (27 or 300 ms) and a postmask (100 ms). Participants were then asked to memorize five numbers associated with a set of frames and displayed simultaneously for 7000 ms. Six successive addition and subtraction operations (e.g. «+2», «+1», «−1», «−2») appeared in the frames. Numbers in the corresponding frame had to be updated according to the arithmetic operations. At the end of the trial, participants were asked to enter the updated sequence of numbers on a keyboard and received feedback about their performance (correct or incorrect) and their cumulative winnings. They were explained that they would only win the monetary reward presented at the beginning of the trial if all five numbers were correct. Participants were familiarized with the updating task with four practice trials. The actual task was composed of 60 trials (15 for each condition). Lastly, participants were asked to report how difficult they found the updating task on a 10–point scale, from extremely easy to extremely difficult.

2.3. Forced choice perception task

In order to ensure that supraliminal reward cues were consciously perceived and subliminal reward cues were not, participants were asked to perform a forced choice perception task after the updating task. The same first four screens (fixation cross, premask, reward stimulus, and postmask) were displayed and participants were asked to choose one of four responses: «I have seen 1 euro», «I have seen 5 cents», «I guess it was 1 euro», «I guess it was 5 cents». There was no limitation in the response time. The perception task included four practice trials followed by 60 experimental trials.

3. Results

3.1. Manipulation check

In order to make sure that supraliminal reward cues were consciously perceived, while subliminal reward cues were not, we analyzed the percentage of seen and guess responses in the perception task. Results showed that participants reported having seen the coins 98.1% of the time in the supraliminal condition and only 3.6% in the subliminal condition. The mean percentage of correct responses was 51.29%, which was not different from chance level (50%), $t(48) = 1.39$, $p = .17$. Moreover, we checked that the discriminability index (d') for each participant ($M = 0.02 \pm 0.31$) was not different from 0, $t(48) = .56$, $p = .58$.

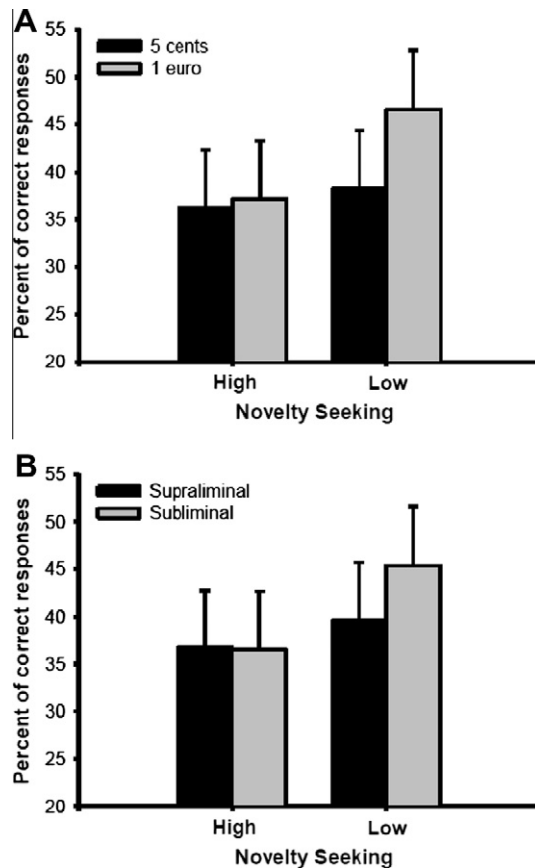


Fig. 2. Percentage of correct responses as a function of reward value for low and high novelty seeking participants (A) and percentage of correct responses as a function of reward presentation duration for low and high novelty seeking participants (B).

3.2. Reward cues, personality and performance

Student's *t* test did not reveal any difference in perceived difficulty between groups ($t = .03$). Performance on the updating task was examined using a mixed 2 (rewards: 1 euro vs. 5 cents) \times 2 (presentation durations: 17 ms vs. 300 ms) \times 2 (groups: low NS vs. high NS) analysis of variance (ANOVA) with repeated measures on the first two variables. Replicating findings from previous research, results showed a main effect of reward, $F(1,43) = 6.51$, $p = .01$, $\eta_p^2 = .13$, indicating that participants performed better in the high-reward than in the low-reward condition, both when reward cues were conscious and unconscious. Most relevant to the present study, we found a significant interaction between group and reward, $F(1,43) = 4.28$, $p < .05$, $\eta_p^2 = .09$ (see Fig. 2A). Post-hoc comparisons conducted by Duncan's test revealed that low NS participants performed better in the high-reward than in low-reward condition ($p < .002$), whereas high NS participants' performance did not differ between reward conditions ($p = .73$). Interestingly, we also found a significant interaction between group and presentation duration, $F(1,43) = 4.14$, $p < .05$, $\eta_p^2 = .09$ (see Fig. 2B). Duncan's test revealed that participants scoring low in NS obtained better performance in the subliminal than in the supraliminal condition ($p < .009$), whereas the performance of participants high in NS did not differ across presentation durations ($p = .89$). There was no significant triple interaction between group, reward, and presentation duration, $F(1,43) = 0.10$, $p = .75$. No other effect was significant.

4. Discussion

The present study provides the first evidence that Novelty Seeking, a personality trait strongly associated with responsiveness to conscious reward cues, also exerts an influence on responsiveness to unconscious reward cues. In both supraliminal and subliminal conditions, low NS participants performed better in the high-reward than in low-reward condition, whereas high NS participants' performance did not differ between reward conditions. Conceptually replicating previous studies suggesting that some individuals might be more efficient than others in managing their effort (e.g., introverts; Beauducel et al., 2006; Kemper et al., 2008), our research extends such personality findings to the realm of unconscious motivation.

Just like personal dispositions have been shown not only to moderate, but even sometimes eliminate or reverse classic psychological phenomena (e.g., *Cognitive dissonance*; Matz, Hofstede, & Wood, 2008; *Hedonic adaptation*, Diener, Lucas, & Scollon, 2006; *Impact bias*, Quoidbach & Dunn, 2010), these findings highlight the necessity of taking personality into account in subliminal and consciousness research. This individual differences approach might provide new valuable insight in understanding the limits as well as the possibilities of subliminal priming. For example, although it is often concluded that the effect of subliminal advertisement is relatively weak (Trappey, 1996), our results suggest that some people could actually be considerably more susceptible to subliminal persuasion. Support for this notion can be found in Weinberger Siegel, Siefert, and Drwal's (2011) recent study showing that subliminal primes can have opposite effects depending on the individuals. The authors found that subliminal exposure to a spider stimulus increased spider-fearful participants' tendency to approach a live tarantula but actually reduced it for participants not fearful of spiders. Thus, investigating the discrete individual differences most likely to modulate reactions to specific unconscious stimuli represents a fruitful avenue for future research.

Importantly, our results show that individual differences in NS interacted with the presentation duration of reward cues. Low NS participants performed significantly better when rewards were presented unconsciously than when they were presented consciously, whereas high NS participants' performance did not differ whether reward cues were presented subliminally or supraliminally. These results are consistent with previous findings showing that under certain circumstances, personal temperaments can influence the way individuals process unconscious emotional information, while bearing no consequences on the way they process conscious emotional information (Yoshino et al., 2005). This accords well with the idea that implicit and explicit motives have separate but complementary influences (Brunstein & Maier, 2005; McClelland, Weinberger, & Koestner, 1989; Wilson et al., 2000). Future studies are needed to better understand the underlying process behind these differential effects. For example, one can imagine that, unlike unconscious reward or threat cues, conscious cues might lead to more conflicting processes (e.g., strategic control vs. automatic processing) that cancel each other out. This idea is consistent with a growing body of literature that shows that consciously reflecting on reward can lead people to concentrating too much on the task, which paradoxically impairs performance (e.g., Baumeister, Masicampo, & Vohs, 2011), and that unconscious motivation can sometimes be more efficient (Bijleveld et al., 2010; Capa, Bustin, et al., 2011). However, another interpretation is that the amount of money at stake in the present study was not challenging for high NS participants. To address these two possibilities, further studies including very high rewards (e.g., 1 cent, 1 euro, and 10 euro) are required.

On another note, the finding showing that sensitivity to subliminal reward cues is related to NS opens the door to exciting new research in personality psychology. Designing personality measures based on responsiveness to different subliminal threats and motivators might constitute an interesting addition to traditional self-report measures. Such measures could be particularly useful in the context of job recruitment or detection of traits which individuals typically lie about, such as psychopathy and Machiavellian tendencies (MacNeil & Holden, 2006). Related to this proposition, research in the medical domain already shows that responsiveness to subliminal presentation can potentially serve as a functional test to help diagnose multiple sclerosis (Carrubba et al., 2010).

Aside from the personality question, the present research provides additional evidence supporting the notion that behaviors associated with high-order cognitive control functions—such as inhibitory control (Hugues, Velmans, & de Fockert, 2009; Van Gaal, Ridderinkhof, Fahrenfort, Scholte, & Lamme, 2008) and switching control (Lau & Passingham, 2007) processes—can be driven by subliminal stimuli.

Although this study breaks new ground in several ways, it leaves ample room for future research to probe and refine its findings. The present study focused exclusively on Novelty Seeking and performance in a specific updating task. Furthermore, in addition to behavioral measures such as performance, future research should also investigate the modulating effect of personality using physiological measures. For example, Bijleveld et al. (2009) found that subliminal high rewards cues increased physiological indicators of resource mobilization but not behavioral performance, suggesting that both types of measures might be required to fully understand the interaction between personality and unconscious perceptions.

Research on unconscious cognition is only at its infancy and in many ways, the present study generates more questions than it answers. There is little doubt that the systematic integration of personality differences into the field of (un)consciousness will aid understanding of the boundaries and possibilities of subliminal stimulation, engender fascinating new research questions, and kindle exciting ideas for potential applications.

References

- Bargh, J. A. (1989). Conditional automaticity: Varieties of automatic influence in social perception and cognition. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 3–51). New York: Guilford.
- Bargh, J. A. (1992). Being unaware of a stimulus versus unaware of its interpretation: Why subliminality per se does not matter to social psychology. In R. Bornstein & T. Pittman (Eds.), *Perception without awareness* (pp. 236–255). New York: Guilford.
- Baumeister, R. F., Masicampo, E. J., & Vohs, K. D. (2011). Do conscious thoughts cause behavior? *Annual Review of Psychology*, 62, 331–361.
- Beauducel, A., Brocke, B., & Leue, A. (2006). Energetical bases of extraversion: Effort, arousal, EEG, and performance. *International Journal of Psychophysiology*, 62, 212–223.
- Bijleveld, E., Custers, R., & Aarts, H. (2009). The unconscious eye-opener: Pupil size reveals strategic recruitment of resources upon presentation of subliminal reward cues. *Psychological Science*, 20, 1313–1315.
- Bijleveld, E., Custers, R., & Aarts, H. (2010). Unconscious reward cues increase invested effort, but do not change speed-accuracy tradeoffs. *Cognition*, 115, 330–335.
- Binsted, G., Brownell, K., Vorontsova, Z., Heath, M., & Sautier, D. (2007). Visuomotor system uses target features unavailable to conscious awareness. *Proceedings of the National Academy of Sciences*, 104, 12669–12672.

- Bódi, N., Kéri, S., Nagy, H., Moustafa, A., Myers, C. E., Daw, N., et al. (2009). Reward-learning and the novelty seeking personality: A between- and within-subjects study of the effects of dopamine agonists on young Parkinson's patients. *Brain*, *132*, 2385–2395.
- Brunstein, J. C., & Maier, G. (2005). Implicit and self-attributed motives to achieve: Two separate but interacting needs. *Journal of Personality and Social Psychology*, *89*, 205–222.
- Capa, R. L., Cleeremans, A., Bustin, G. M., & Hansenne, M. (2011). Long-lasting effect of subliminal processes on effort-related cardiovascular and performance. *International Journal of Psychophysiology*, *81*, 22–30.
- Capa, R. L., Bustin, G. M., Cleeremans, A., & Hansenne, M. (2011). Conscious and unconscious reward cues can affect a critical component of executive control: (Un)conscious updating? *Experimental Psychology*, *58*, 370–375.
- Carrubba, S., Minagar, A., Gonzales-Toledo, E., Chesson, A. L., Frilot, C., & Marino, A. A. (2010). Multiple sclerosis impairs ability to detect abrupt appearance of a subliminal stimulus. *Neurological Research*, *32*, 297–302.
- Cloninger, C. R. (1987). A systematic method for clinical description and classification of personality variants—A proposal. *Archives of General Psychiatry*, *44*, 573–588.
- Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. *Archives of General Psychiatry*, *50*(12), 975–990.
- Cloninger, C. R. (1999). *The temperament and character inventory-revised*. St. Louis, Missouri: Center for Psychobiology of Personality, Washington University.
- Custers, R., & Aarts, H. (2010). The unconscious will: How the pursuit of goals operates outside of conscious awareness. *Science*, *329*, 47–50.
- Dehaene, S., Naccache, L., Le Clec'h, G., Koehlin, E., Mueller, M., Dehaene-Lambertz, G., et al. (1998). Imaging unconscious semantic priming. *Nature*, *395*, 597–600.
- Diener, E., Lucas, R., & Scollon, C. N. (2006). Beyond the hedonic treadmill: Revising the adaptation theory of well-being. *American Psychologist*, *61*, 305–314.
- Dijksterhuis, A., Aarts, H., & Smith, P. K. (2005). The power of the subliminal: Subliminal perception and possible applications. In R. Hassin, J. Uleman, & J. A. Bargh (Eds.), *The new unconscious* (pp. 77–106). New York: Oxford University Press.
- Finn, P. R., Mazas, C. A., Justus, A. N., & Steinmetz, J. (2002). Early-onset alcoholism with conduct disorder: Go/No Go learning deficits, working memory capacity, and personality. *Alcoholism: Clinical and Experimental Research*, *26*, 186–206.
- Hansenne, M., Delhez, M., & Cloninger, C. R. (2005). Psychometric properties of the temperament and character inventory-revised (TCI-R) in a Belgian sample. *Journal of Personality Assessment*, *85*, 40–49.
- Hugues, G., Velmans, M., & de Fockert, J. (2009). Unconscious priming of a no-go response. *Psychophysiology*, *46*, 1258–1269.
- Karremans, J. C., Stroebe, W., & Claus, J. (2006). Beyond Vicary's fantasies: The impact of subliminal priming and brand choice. *Journal of Experimental Social Psychology*, *42*, 792–798.
- Kemper, C. J., Leue, A., Wacker, J., Chavanon, M. L., Hennighausen, E., & Stemmler, G. (2008). Agentic extraversion as a predictor of effort-related cardiovascular response. *Biological Psychology*, *78*, 191–199.
- Kiefer, M., & Spitzer, M. (2000). Time course of conscious and unconscious semantic brain activation. *Cognitive Neuroscience*, *11*(11), 2401–2407.
- Kouider, S., & Dehaene, S. (2007). Levels of processing during non-conscious perception: A critical review of visual masking. *Philosophical Transactions of the Royal Society B*, *362*, 857–875.
- Lau, H. C., & Passingham, R. E. (2007). Unconscious activation of the cognitive control system in the human prefrontal cortex. *The Journal of Neuroscience*, *23*, 5805–5811.
- MacNeil, B. M., & Holden, R. R. (2006). Psychopathy and the detection of faking on self-report inventories of personality. *Personality and Individual Differences*, *41*, 641–651.
- Matz, D. C., Hofstede, P. M., & Wood, W. (2008). Extraversion as a moderator of the cognitive dissonance associated with disagreement. *Personality and Individual Differences*, *45*, 401–405.
- McClelland, D. C., Weinberger, J., & Koestner, R. (1989). How do self-attributed and implicit motives differ? *Psychological Review*, *96*, 690–702.
- Mitchell, S. H. (2004). Measuring impulsivity and modeling its association with cigarette smoking. *Behavioral and Cognitive Neuroscience Reviews*, *3*, 261–275.
- Morris, J. S., Öhman, A., & Dolan, R. J. (1998). Conscious and unconscious emotional learning in the human amygdala. *Nature*, *393*, 467–470.
- 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.
- Pessiglione, M., Schmidt, L., Draganski, B., Kalisch, R., Lau, H., Dolan, R. J., et al. (2007). How the brain translates money into force: A neuroimaging study of subliminal motivation. *Science*, *316*, 904–906.
- Quoidbach, J., & Dunn, E. W. (2010). Personality neglect: The unforeseen impact of personal dispositions on emotional life. *Psychological Science*, *21*, 1783–1786.
- Salthouse, T. A., Babcock, R. L., & Shaw, R. J. (1991). Effects of adult age on structural and operational capacities in working memory. *Psychology and Aging*, *6*, 118–127.
- Schultz, W. (2006). Behavioural theories and the neurophysiology of reward. *Annual Review of Psychology*, *57*, 87–115.
- Strahan, E. J., Spencer, S. J., & Zanna, M. P. (2005). Subliminal priming and persuasion: How motivation affects the activation of goals and the persuasiveness of messages. In F. R. Kardes, P. M. Herr, & J. Nantel (Eds.), *Applying social cognition to consumer-focused strategy* (pp. 267–280). Mahwah, NJ: Erlbaum.
- Trappey, C. (1996). A meta-analysis of consumer choice and subliminal advertising. *Psychology and Marketing*, *13*, 517–530.
- Van Gaal, S., Ridderinkhof, R., Fahrenfort, J. J., Scholte, H. S., & Lamme, V. A. F. (2008). Frontal cortex mediates unconsciously triggered inhibitory control. *The Journal of Neuroscience*, *28*, 8053–8062.
- Verwijmeren, T., Karremans, J. C., Stroebe, W., & Wigboldus, D. (2011). The workings and limits of subliminal advertising: The role of habits. *Journal of Consumer Psychology*, *21*, 206–213.
- Weinberger, J., Siegel, P., Siefert, C., & Drwal, J. (2011). What you cannot see can help you: The effect of exposure to unreportable stimuli on approach behavior. *Consciousness and Cognition*, *20*, 173–180.
- Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological Review*, *107*, 101–126.
- Yoshino, A., Kimura, Y., Yoshida, T., Takahashi, Y., & Nomura, S. (2005). Relationship between temperament dimensions in personality and unconscious emotional responses. *Biological Psychiatry*, *57*(1), 1–6.