Inhibitory Spillover : Increased Urination Urgency Facilitates Impulse Control in Unrelated Domains

Mirjam A. Tuk, Debra Trampe and Luk Warlop

Psychological Science 2011 22: 627 originally published online 5 April 2011
DOI: 10.1177/0956797611404901

Research Article

Psychological Science
22(5) 627–633

DOI: 10.1177/0956797611404901
http://pss.sagepub.com

Inhibitory Spillover: Increased Urination Urgency Facilitates Impulse Control in Unrelated Domains

Mirjam A. Tuk[1], Debra Trampe[2], and Luk Warlop[3,4]

[1]Department of Marketing Communication and Consumer Psychology, University of Twente; [2]Department of Marketing, Faculty of Economics and Business, University of Groningen; [3]Department of Marketing, Faculty of Economics, Katholieke Universiteit Leuven; and [4]Department of Marketing, Norwegian School of Management

Abstract

Visceral states are known to reduce the ability to exert self-control. In the current research, we investigated how self-control is affected by a visceral factor associated with inhibition rather than with approach: bladder control. We designed four studies to test the hypothesis that inhibitory signals are not domain-specific but can spill over to unrelated domains, resulting in increased impulse control in the behavioral domain. In Study 1, participants' urination urgency correlated with performance on color-naming but not word-meaning trials of a Stroop task. In Studies 2 and 3, we found that higher levels of bladder pressure resulted in an increased ability to resist impulsive choices in monetary decision making. We found that inhibitory spillover effects are moderated by sensitivity of the Behavioral Inhibition System (Study 3) and can be induced by exogenous cues (Study 4). Implications for inhibition and impulse-control theories are discussed.

Keywords

impulse control, inhibition, BIS, bladder control, intertemporal choice, Stroop task

Received 9/10/10; Revision accepted 11/14/10

People are often confronted with choices that involve trade-offs: Obtaining the benefits of one option implies that the benefits associated with the rejected option cannot be obtained. For example, people regularly choose between spending money on short-term pleasures such as going out for dinner and saving money for a later, more important purchase. This type of choice dilemma has been characterized as a self-control conflict, in which the impulsive urge (instigated by the immediate temptation) has to be overridden by a deliberative and effortful process (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Vohs, 2006). Previous research has extensively examined how people deal with self-control conflicts (Hagger, Wood, Stiff, & Chatzisarantis, 2010; Vohs & Heatherton, 2000). Recently, scholars have demonstrated that visceral states (such as hunger and sexual desire) can affect how people respond to self-control conflicts, even in unrelated domains (Briers, Pandelaere, Dewitte, & Warlop, 2006). However, the bulk of prior research in this area has investigated visceral factors associated with approach, and it remains unclear whether and how visceral factors associated with inhibition (e.g., controlling a filling bladder) affect people's responses to temptations. Do visceral factors associated with inhibition deteriorate impulse control? Or might bladder pressure provide a condition under which people's ability to control impulses, and hence their ability to act in their own long-term best interest, improves?

Self-control refers to the capacity to alter one's responses in order to bring them in line with social and personal standards and to support the pursuit of long-term goals (Baumeister, Vohs, & Tice, 2007). It enables a person to restrain or override one response, thereby making a different response possible. Research has shown that the ability of people to control their immediate impulses is not stable, but varies. One condition known to make self-control more difficult is the prior arousal of visceral factors (Loewenstein, 1996). The effects of these visceral factors have been shown not to be restricted to the visceral domain. For example, Briers et al. (2006) showed that hunger increases the desire for money and vice versa; in their

Corresponding Author:
Mirjam A. Tuk, Department of Marketing Communication and Consumer Psychology, University of Twente, Cubicus C2-04, P.O. Box 217, 7500AE Enschede, The Netherlands
E-mail: m.a.tuk@utwente.nl

research, hunger lessened the self-control of participants not only in the food domain, but also in domains unrelated to food (e.g., monetary decision making). Van den Bergh, Dewitte, and Warlop (2008) showed that exposing men to sex cues increases their desire for smaller, sooner rewards over larger, later rewards. On the basis of neurological evidence (Camerer, Loewenstein, & Prelec, 2005), Van den Bergh et al. argued for the existence of a general reward system, in which the same dopaminergic reward circuitry of the brain is activated for a wide variety of different reinforcers. The degree to which various reinforcers result in generalized reward-seeking behavior appears to be moderated by the sensitivity of the Behavioral Approach System (BAS; Gray, 1990; Torrubia, Avila, Molto, & Caseras, 2001; see also Li, 2008, and Wadhwa, Shiv, & Nowlis, 2008). Thus, prior research suggests the existence of a neurologically based general reward system that can be triggered by reward-related cues, a process that results in an increased preference for reward-providing cues in general, regardless of the nature of the triggering cue.

Although these findings highlight important visceral influences on the inclination to follow one's impulses, they provide no evidence regarding conditions that result in improved impulse control. In the current research, we investigated whether visceral factors that call for inhibitory responses (i.e., a filling bladder) result in inhibitory responses not only within the target domain but also in unrelated domains. We examined whether inhibitory spillover occurs independently of the reward system, rather than reflecting a deactivation of it. Preliminary evidence for this claim stems from recent neuroscientific research by Berkman, Burklund, and Lieberman (2009) on the existence of an inhibitory network in the brain. Berkman et al. proposed that inhibition of motor, cognitive, and affective responses originates in the same neurological areas. A by-product of this inhibitory network is that inhibitory signals intentionally directed toward one response unintentionally spill over to unrelated domains, increasing inhibitory signals in these domains as well. Berkman et al. showed that motor inhibition (on a go/no-go task) resulted in the unintentional inhibition of neurological responses related to emotion regulation in trials that aroused negative affect. Furthermore, they showed that trials that required motor inhibition and trials that required affect inhibition activated the same neurological areas. On the basis of these findings, they concluded that inhibitory signals for motor, cognitive, and affective responses originate from the same neural regions, which are vulnerable to inhibitory spillover. In the current research, we examined the occurrence of inhibitory spillover effects in the behavioral domain.

An important and daily physiological sensation that relies on inhibitory responses is controlling one's bladder as it fills with urine (Griffiths & Tadic, 2008). As their bladders fill, people increasingly have to inhibit their motor impulse to void. The inhibition of this motor response is present while people engage in other behaviors, so that these simultaneous behaviors would be susceptible to inhibitory spillover effects. Griffiths and Tadic (2008; see also Griffiths, 2007) identified the anterior cingulate cortex (ACC) as important for bladder control; the same region was identified by Berkman et al. (2009) as part of the inhibitory network. This suggests that inhibitory signals due to increasing levels of urination urgency might induce unintentional inhibitory spillover effects. We thus expected that as bladder pressure increased and stronger inhibitory signals were required, people would show improved performance on other tasks that rely on inhibition. In the current research, we examined this hypothesis by investigating the impact of urination urgency on Stroop (1935) task performance (Study 1) and intertemporal patience (Studies 2, 3, and 4).

Study 1

Method

Participants. One hundred ninety-three university students (104 men, 89 women; mean age = 20.64 years) participated in exchange for course credit.

Procedure. After two practice rounds of 10 trials, participants completed a Stroop task that consisted of four blocks of 25 trials each. In two of the blocks (Blocks 2 and 4), participants were instructed to indicate the meaning of the word on each trial. This is the dominant (impulsive) response and does not require response inhibition. We therefore did not expect any effect of urination urgency in these blocks. In the other two blocks (Blocks 1 and 3), participants were instructed to indicate the color of the word on each trial. This task requires inhibition of the dominant response (reading). We expected stronger urination urgency to facilitate inhibition of this dominant response, resulting in faster response times in these blocks. After completing the Stroop task, participants indicated how urgently they felt the need to urinate, using a 7-point scale (from 1, *not urgently at all*, to 7, *very urgently*).

Results and discussion

Incorrect responses and response times more than 2.5 standard deviations below or above the average were excluded from the analysis. Participants who responded incorrectly on more than 10% of the trials were removed, which left a final sample of 176 participants. Number of errors did not correlate significantly with reported urination urgency. A general linear model with block number and block type (color or word naming) as within-subjects variables and urination urgency as a between-subjects variable showed only the expected significant two-way interaction between block type and urination urgency, $F(1, 174) = 4.68$, $p = .03$. In line with our expectations, response times in the color-naming blocks decreased with increasing urination urgency, $t(174) = -2.13$, $p = .034$, $b = -0.015$, whereas reported urination urgency had no effect on response times in the word-meaning blocks, $t(174) = -0.86$, $p = .39$.

Study 1 provides correlational evidence for unintentional inhibitory spillover effects from the visceral domain (increased bladder pressure) to another domain (as shown by speeded performance on the color-naming trials of the Stroop task).

Study 2

In Study 2, we manipulated bladder pressure to rule out alternative explanations for our correlational results in Study 1. We also aimed to show that the inhibitory spillover effect generalizes to another domain known to require inhibition of impulsive responses, namely, intertemporal decision making (Li, 2008; Van den Bergh et al., 2008). Finding evidence for inhibitory spillover on an intertemporal choice task would indicate not only that our findings for the Stroop task generalize to another task, but also that acts of impulse control that are more deliberative than those required in color naming can benefit from unintentional inhibitory spillover effects.

Method

Participants. One hundred two university students (67 men, 35 women; mean age = 21.49 years) were recruited on campus and received €10 for their participation.

Procedure. Bladder pressure was manipulated by means of a water taste test. Half of the participants were instructed to drink the entire volume of five cups of water (approximately 700 ml; high-bladder-pressure condition); the other half were instructed to taste the water by sipping from the cups (drinking approximately 50 ml; low-bladder-pressure condition).[1] After a filler task that lasted approximately 45 min, participants were asked to make eight intertemporal choices (similar to choices used by Li, 2008). Participants had to choose between a smaller reward that they would receive the next day (hereafter referred to as the SS option) or a larger reward that they would receive later in time (the LL option). For example, participants chose between receiving €16 the next day or €30 in 35 days. In a manipulation check that followed, we asked participants to indicate how urgently they felt the need to urinate, using a 7-point scale (from 1, *not urgently at all*, to 7, *very urgently*). After participants had completed the study, the experimenter collected the cups from the water taste test and checked to verify that each participant had followed the drinking instructions, which they all had.

Results and discussion

Participants in the high-bladder-pressure condition reported a greater urination urgency ($M = 4.48$, $SD = 1.92$) at the end of the experiment than did participants in the low-bladder-pressure condition ($M = 2.75$; $SD = 1.79$), $t(100) = 4.71$, $p < .001$.

A t test on the summed preference for the LL option over the SS option showed that increased bladder pressure resulted in preferences reflecting increased impulse control, $t(100) = 2.20$, $p = .03$, $p_{rep} = .98$. People in the high-bladder-pressure condition chose the LL reward more often ($M = 4.50$, $SD = 1.59$) than did people in the low-bladder-pressure condition ($M = 3.83$, $SD = 1.49$). These findings indicate that inhibitory signals stemming from increased bladder pressure spill over to the domain of intertemporal choice; this spillover is reflected in an increased ability to inhibit the urge to choose more immediate but smaller rewards and to opt more often for rewards that are more beneficial in the long term.

Study 3

The aim of Study 3 was to replicate the findings of Study 2 and to provide more evidence for a generalized inhibition system by examining whether inhibitory spillover effects are moderated by sensitivity of the Behavioral Inhibition System (BIS; Carver & White, 1994; Gray, 1990). As we discussed earlier, the BAS has been found to play a crucial role in the general reward system (e.g., Van den Bergh et al., 2008); in contrast, the BIS is sensitive to signals of punishment and is involved in the inhibition of ongoing behavior in the face of a threat. The BIS has been shown to be involved in conflict monitoring and self-regulation (Carver & White, 1994; Shackman, McMenamin, Maxwell, Greischar, & Davidson, 2009). An examination of the neurocognitive components of the BIS and BAS indicated that the BIS is associated with ACC activation (Amodio, Master, Yee, & Taylor, 2008; see also Shackman et al., 2009). Following the reasoning that inhibitory signals in different domains originate from the same neurological areas, which are vulnerable to unintentional inhibitory spillover (Berkman et al., 2009), we expected people with a more sensitive BIS to be more prone to inhibitory spillover effects. Hence, we expected to find that effects of increased bladder control on intertemporal patience would be stronger for people with a more sensitive BIS.

Method

Participants. One hundred five university students (76 men, 29 women; mean age = 21.08 years) were recruited on campus and received €10 for their participation.

Procedure. The procedure for this study was similar to that of Study 2, except that participants completed the BIS/BAS scales (Carver & White, 1994) and measures of thirst and mood at the end of the experiment. Following Van den Bergh et al. (2008), we limited our measure to the BIS scale and the BAS Reward Responsiveness subscale. Participants rated their current level of thirst on a 7-point scale (from 1, *not at all thirsty*, to 7, *very thirsty*) and their current mood on a 7-point scale (from 1, *very negative*, to 7, *very positive*). After participants completed this task, the experimenter collected the cups from the water taste test and checked whether the participants had followed the drinking instructions.

Results and discussion

Eight participants did not follow the drinking instructions (they left more than 100 ml in the high-bladder-pressure condition or less than 500 ml in the low-bladder-pressure condition); excluding these participants left a final sample of 97. A *t* test confirmed that our manipulation of bladder pressure had a significant effect on urination urgency, $t(95) = 9.70$, $p < .001$ (high bladder pressure: $M = 4.93$, $SD = 1.51$; low bladder pressure: $M = 2.02$, $SD = 1.39$). Participants' mood was not affected by this manipulation.

A *t* test revealed a significant effect of the bladder-pressure manipulation on intertemporal patience, $t(95) = 2.11$, $p < .05$, $p_{rep} = .98$. People in the high-bladder-pressure condition opted more often for the LL reward ($M = 4.80$, $SD = 1.91$) compared with people in the low-bladder-pressure condition ($M = 4.02$, $SD = 1.63$). To test for the expected moderation of this effect by BIS sensitivity, we conducted a regression analysis with condition (contrast-coded), BIS score (mean-centered), and their interaction as predictors. This regression model showed a significant interactive effect of condition and BIS score, $t(93) = 2.58$, $p = .01$. A spotlight analysis (following Fitzsimons, 2008) at 1 standard deviation below the BIS mean did not show a significant effect of bladder pressure. However, a spotlight analysis at 1 standard deviation above the BIS mean revealed a significant difference between the high-bladder-pressure condition and the low-bladder-pressure condition, $F(1, 93) = 10.42$, $p < .01$, $b = 1.64$: Participants in the high-bladder-pressure condition chose the LL reward more often than did participants in the low-bladder-pressure condition, a pattern indicating that bladder pressure increased impulse control (see Fig. 1). Including BAS score, level of thirst, and their interactions with condition did not reveal any significant effects of these factors, nor did it change the significance of the BIS × Condition interaction effect. These results indicate that inhibitory spillover effects occur independently of the reward system, rather than reflecting a deactivation of the reward system.

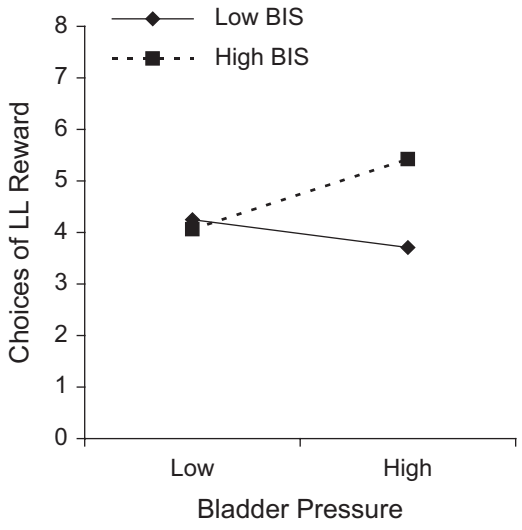

Fig. 1. Preference for the later, larger (LL) reward as a function of Behavioral Inhibition System (BIS) sensitivity and bladder-pressure condition in Study 3.

Study 3 again showed that increased levels of urination urgency and consequent bladder control result in an increased ability to forgo more immediate rewards in favor of rewards that are more beneficial in the long run, indicating that bladder pressure increases impulse inhibition and that inhibitory signals are not domain-specific but can spill over to other domains. Furthermore, results from this study indicate that inhibitory spillover effects are stronger for people with a more sensitive BIS, which is in line with the idea that various inhibitory signals originate from a general inhibitory network (Berkman et al., 2009).

Study 4

In Study 4, we examined whether exogenous cues can also induce increased bladder control and thereby instigate inhibitory responses in unrelated domains. This would be in line with the general notion of a bidirectional link between perception and behavior (Dijksterhuis & van Knippenberg, 1998). Both Li (2008) and Van den Bergh et al. (2008) induced desire by exposing participants to exogenous cues: In their studies, they used pictures of appetitive stimuli (either desirable food or sexually appealing women) in order to induce participants' craving for rewards. Finding that thinking about urination can trigger increased bladder sensations and accompanying inhibitory signals would suggest that inhibitory spillover effects are not necessarily limited to physiological cues (i.e., a full bladder), but can be triggered by environmental cues as well.

Method

Participants. One hundred thirty-one university students (65 men, 66 women; mean age = 20.1 years) participated in exchange for partial course credit.

Procedure. Participants were randomly assigned to one of two priming conditions (urination or control prime). The experiment was presented as two unrelated studies. The first task was a word-search paradigm. Participants saw a list of nine words and were instructed to identify these words in a 10 × 9 letter matrix (see Lammers, Galinsky, Gordijn, & Otten, 2008, for a similar procedure). Participants in the urination-prime condition had to search for urination-related words (e.g., "urination," "toilet," "bladder"). Participants in the control condition searched for words unrelated to urination (e.g., "table," "watching," "hammer"). After finishing this task, participants completed the same intertemporal choice task used in Studies 2 and 3 and indicated how urgently they felt the need to urinate, using a 7-point scale (from 1, *not urgently at all*, to 7, *very urgently*). After answering this question, participants were thanked and debriefed.

Results and discussion

We expected the urination prime to increase participants' feelings of bladder sensations, which would trigger inhibitory responses and generalize to the domain of intertemporal patience. Therefore, we tested for mediation, following the recommendations of Shrout and Bolger (2002) and Preacher and Hayes (2004; see also Zhao, Lynch, & Chen, 2010). We first tested the effect of the independent variable (prime) on the mediator (reported urination urgency), which was significant, $t(129) = 2.27$, $p < .05$. Participants who had searched for urination-related words reported greater urination urgency ($M = 2.43$, $SD = 1.54$) than did participants who had searched for control words ($M = 1.84$, $SD = 1.39$).We next tested the impact of the mediator on the dependent variable (intertemporal patience) while holding the independent variable constant. A regression analysis revealed that this effect was also significant, $t(128) = 2.71$, $p < .01$, $b = 0.34$, indicating that participants who reported higher levels of urination urgency made choices that reflected more temporal patience. Finally, in order to test whether the mediation was significant, we performed a bootstrapping procedure (following Preacher & Hayes, 2004) with 5,000 resamples. This procedure showed that the mediation effect was significant (95% confidence interval: [0.006, 0.49]); thus, the urination prime had a significant effect on intertemporal patience, via increased sensations of urination urgency.

Study 4 showed that exogenous cues associated with urination cause increased feelings of urination urgency and accompanying bladder control. These increased inhibitory responses spill over to the domain of intertemporal choice and result in increased intertemporal patience.

General Discussion

Visceral drives have an enormous impact on people's daily life (Loewenstein, 1996). People buy more (unhealthy) food when their stomach is empty than when they are satiated. People experiencing sexual arousal are prone to engage in unsafe sex (Ariely & Loewenstein, 2006), even when they are aware of the potential consequences. Moreover, in hindsight, people have a hard time fully realizing the impact of these visceral states on their behaviors (Nordgren, van der Pligt, & van Harreveld, 2006). These visceral drives are recognized as important determinants of impulsive and reward-seeking behavior. The impact of visceral drives generalizes beyond the visceral domain, resulting in a general increase in impulsive behavior (Van den Bergh et al., 2008). However, whereas previous research focused on the approach-related visceral states, we investigated the impact of an important and thus-far-overlooked inhibitory visceral factor—urination urgency—on impulsive behavior.

In four studies, we found that inhibitory signals stemming from increasing levels of bladder pressure can spill over to other domains, resulting in increased impulse control in unrelated domains. In Study 1, increased levels of bladder pressure correlated with speeded performance on color-naming trials of a Stroop task, but not with performance on word-meaning trials. Thus, bladder control facilitated impulse inhibition on this task. In Studies 2 and 3, we manipulated bladder pressure and showed that it facilitates intertemporal patience in the monetary domain, as reflected by an increased tendency to resist immediately rewarding options in favor of long-term beneficial options. Furthermore, we provided additional support for the idea of a general origin of inhibitory responses by showing that sensitivity of the BIS moderated the effect of bladder pressure on intertemporal patience. In Study 4, we showed that even exogenous cues can trigger a sense of urination urgency, which subsequently leads to increased intertemporal patience.

To the best of our knowledge, these studies are the first to examine the impact of inhibitory visceral factors on self-control conflicts and to provide evidence for inhibitory spillover effects in the behavioral domain. Whereas Berkman et al. (2009) provided evidence for spillover effects of inhibitory signals at the level of brain activation, we have shown that inhibitory signals from one domain can increase impulse control in unrelated domains. We showed this effect both with a Stroop task (which requires inhibition of an automatic but incorrect response) and with a task relying on more deliberative acts of control (intertemporal choice). Together with neurological evidence from earlier studies, our findings seem to suggest that people possess a general inhibition system. The inhibition of various behaviors (motor and cognitive) seems to have its origin in the same neural areas. Inhibitory signals are not bound to focal tasks requiring inhibition, but spill over to other domains.

Our findings seem to contradict a large body of research in the domain of self-control and ego depletion (Baumeister, 2002; Baumeister et al., 1998). A common finding in this area is that the execution of self-control in one domain causes subsequent self-control impairment in a second domain. Two important differences between the conditions of our studies and those of typical ego-depletion studies must be acknowledged. The first difference concerns the nature of the first tasks requiring control. Tasks known to result in a state of ego depletion rely on deliberative and conscious efforts to exert self-control (see Hagger et al., 2010, for a meta-analysis). Bladder control, in contrast, is a largely automatized, highly learned, and nonconscious form of control (this type of control has also been referred to as self-regulation; Baumeister et al., 2007). The degree of effort required to exert control on a first task might be an important determinant of whether impulse control on a subsequent task will improve (inhibitory spillover effect) or deteriorate (depletion effect).

The second difference concerns the timing of the tasks. A decline in performance has always been demonstrated on sequential tasks requiring self-control. But as Berkman et al. (2009) showed, inhibitory spillover effects occur when the inhibitory signals originating from one task are present during the execution of an unrelated task. This was the case in the current studies: Our participants were inhibiting their impulse

to void while they participated in the Stroop or intertemporal choice task. This line of reasoning suggests that inhibitory spillover effects are likely to occur during simultaneous control tasks.

Recently, Dewitte, Bruyneel, and Geyskens (2009) demonstrated that exercising self-control can increase the ability to exert self-control in later tasks involving similar response conflicts. Furthermore, Hung and Labroo (in press) have argued that the tensed muscles (e.g., clenched fists) that are a common result of people's attempts to recruit willpower can also steel willpower, resulting in increased self-control. Future research is needed to determine which conditions tend to improve performance on control tasks and which conditions tend to impair performance on control tasks.

Future research is also needed to investigate whether spillover effects can originate not only from bladder pressure but also from other relatively automatic inhibitory responses. Gaining a greater understanding of the underlying process of inhibitory spillover effects and their boundary conditions will provide valuable insights into response inhibition (both physiological and cognitive), the existence of a general inhibition system, impulsive and self-control processes, and conditions that may improve impulse control.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Note

1. On average, an adult bladder usually contains 300 ml of urine and is reasonably full when it contains 500 ml. Liquid takes between 20 min and 3 hr to reach the bladder, depending on body size and liquid type (Marieb, Hoehn, Hutchinson, & Hutchings, 2007).

References

Amodio, D.M., Master, S.L., Yee, C.M., & Taylor, S.E. (2008). Neurocognitive components of the behavioral inhibition and activation systems: Implications for theories of self-regulation. *Psychophysiology*, *45*, 11–19.

Ariely, D., & Loewenstein, G. (2006). The heat of the moment: The effect of sexual arousal on sexual decision making. *Journal of Behavioral Decision Making*, *19*, 87–98.

Baumeister, R.F. (2002). Yielding to temptation: Self-control failure, impulsive purchasing, and consumer behavior. *Journal of Consumer Research*, *28*, 670–676.

Baumeister, R.F., Bratslavsky, E., Muraven, M., & Tice, D.M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology*, *74*, 1252–1265.

Baumeister, R.F., Vohs, K.D., & Tice, D.M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, *16*, 351–355.

Berkman, E.T., Burklund, L., & Lieberman, M.D. (2009). Inhibitory spillover: Intentional motor inhibition produces incidental limbic inhibition via right inferior frontal cortex. *NeuroImage*, *47*, 705–712.

Briers, B., Pandelaere, M., Dewitte, S., & Warlop, L. (2006). Hungry for money: The desire for caloric resources increases the desire for financial resources and vice versa. *Psychological Science*, *17*, 939–943.

Camerer, C., Loewenstein, G., & Prelec, D. (2005). Neuroeconomics: How neuroscience can inform economics. *Journal of Economic Literature*, *43*, 9–64.

Carver, C.S., & White, T.L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality and Social Psychology*, *67*, 319–333.

Dewitte, S., Bruyneel, S.D., & Geyskens, K. (2009). Self-regulating enhances self-regulation in subsequent consumer decisions involving similar response conflicts. *Journal of Consumer Research*, *36*, 394–405.

Dijksterhuis, A., & van Knippenberg, A. (1998). The relation between perception and behavior, or how to win a game of trivial pursuit. *Journal of Personality and Social Psychology*, *74*, 865–877.

Fitzsimons, G.J. (2008). Death to dichotomizing. *Journal of Consumer Research*, *35*, 5–8.

Gray, J.A. (1990). Brain systems that mediate both emotion and cognition. *Cognition & Emotion*, *4*, 269–288.

Griffiths, D. (2007). Imaging bladder sensations. *Neurourology and Urodynamics*, *26*, 899–903.

Griffiths, D., & Tadic, S.D. (2008). Bladder control, urgency, and urge incontinence: Evidence from functional brain imaging. *Neurourology and Urodynamics*, *27*, 466–474.

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.

Hung, I.W., & Labroo, A.A. (in press). From firm muscles to firm willpower: Understanding the role of embodied cognition in self-regulation. *Journal of Consumer Research*.

Lammers, J., Galinsky, A.D., Gordijn, E.H., & Otten, S. (2008). Illegitimacy moderates the effects of power on approach. *Psychological Science*, *19*, 558–564.

Li, X.P. (2008). The effects of appetitive stimuli on out-of-domain consumption impatience. *Journal of Consumer Research*, *34*, 649–656.

Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational Behavior and Human Decision Processes*, *65*, 272–292.

Marieb, E.N., Hoehn, K., Hutchinson, M., & Hutchings, R. (2007). *Human anatomy & physiology* (7th ed.). San Francisco, CA: Pearson International.

Nordgren, L.F., van der Pligt, J., & van Harreveld, F. (2006). Visceral drives in retrospect: Explanations about the inaccessible past. *Psychological Science*, *17*, 635–640.

Preacher, K.J., & Hayes, A.F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, *36*, 717–731.

Shackman, A.J., McMenamin, B.W., Maxwell, J.S., Greischar, L.L., & Davidson, R.J. (2009). Right dorsolateral prefrontal cortical activity and behavioral inhibition. *Psychological Science*, *20*, 1500–1506.

Shrout, P.E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, *7*, 422–445.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643–662.

Torrubia, R., Avila, C., Molto, J., & Caseras, X. (2001). The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences*, *31*, 837–862.

Van den Bergh, B., Dewitte, S., & Warlop, L. (2008). Bikinis instigate generalized impatience in intertemporal choice. *Journal of Consumer Research*, *35*, 85–97.

Vohs, K.D. (2006). Self-regulatory resources power the reflective system: Evidence from five domains. *Journal of Consumer Psychology*, *16*, 217–223.

Vohs, K.D., & Heatherton, T.F. (2000). Self-regulatory failure: A resource-depletion approach. *Psychological Science*, *11*, 249–254.

Wadhwa, M., Shiv, B., & Nowlis, S.M. (2008). A bite to whet the reward appetite: The influence of sampling on reward-seeking behaviors. *Journal of Marketing Research*, *45*, 403–413.

Zhao, X., Lynch, J.G., Jr., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *Journal of Consumer Research*, *37*, 197–206.