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## Embodied Myopia

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## Embodied Myopia

One field study and five experiments show that seemingly irrelevant bodily actions influence consumer behavior. These studies demonstrate that arm flexion (where the motor action is directed toward the self) versus arm extension (where the motor action is directed away from the self) influence purchase behavior, product preferences and economic decisions. More specifically, arm flexion increases the likelihood of purchasing vice products (study 1a), leads to a preference for vices over virtues (study 1b & 2a) and for smaller, sooner over larger, later monetary rewards (studies 2b-4). The authors argue that arm flexion induces present-biased preferences through activation of approach motivation. The effect of bodily actions on present-biased preferences is regulated by the behavioral approach system (studies 3 & 4) and relies on the learned association between arm flexion and activation of this approach system (study 4). Implications for intertemporal decision making, embodied cognition and marketing practice are discussed.

Keywords: intertemporal choice, embodied cognition, approach motivation, hedonic consumption

Body movements not only express, but also influence how people feel and think (Barsalou 2008; Niedenthal 2007; Niedenthal et al. 2005). It even has been suggested that large corporations like Nintendo and Microsoft are using our bodies to hack our brains (Choi 2010). Indeed, game consoles controlled by physical gestures (e.g, Nintendo Wii, Microsoft Kinect, Playstation Move, etc.) may owe some of their extraordinary success to emotions that are triggered by specific body movements. Consistent with theories developed in the embodied cognition literature, the present research examines whether the enactment of body movements affects consumer decision making. More specifically, we test whether specific motor actions, such as extending or flexing one's arm, induce present-biased preferences in intertemporal choice (i.e., a preference for smaller, sooner over larger, delayed rewards). We demonstrate that arm flexor contraction makes individuals more likely to choose immediately pleasing options. We argue that the effect of arm flexion on present-biased preferences is regulated by the behavioral approach system and relies on the learned association between arm flexion and the activation of this approach system. In the following, we discuss prior research on embodied cognition, develop three hypotheses and present six studies demonstrating that motor actions affect intertemporal decision making.

### *EMBODIED COGNITION*

Traditional psychological theories view the mind as an abstract information processor whose connections to the outer world are of little importance. Perceptual/motor systems are thought to merely serve as input/output devices and are not considered relevant to understand “central” cognitive processes. The only function of sensory/motor systems is to deliver detailed representations of the external world and execute commands. However, embodied cognition

scholars argue that the mind needs to be understood in the context of its relationship to the body (Barsalou 2008; Niedenthal et al. 2005). Rather than relying solely on abstractions that exist independently of their physical instantiation, theories of embodied cognition argue that cognitive activity is fundamentally grounded in a physical context. Cognition is both supported and constrained by the architecture of bodies and brains. As a consequence, our body is capable of influencing consumer behavior. For example, merely nodding (versus shaking) your head results in more positive attitudes towards exposed products (Tom et al. 1991). Adopting an expansive bodily posture with open limbs (versus a contractive position with closed limbs) induces financial risk-taking (Carney, Cuddy, and Yap In press). Clenching a fist promotes altruistic behavior (Hung and Labroo In press) and sitting in a hard wooden chair (versus soft cushioned chair) decreases negotiation flexibility when purchasing a car (Ackerman, Nocera, and Bargh 2010). These and many other studies suggest that perceptual/motor systems are not the passive input/output devices deemed irrelevant to understand “central” cognitive processes (for reviews, see e.g. Niedenthal 2007; Niedenthal et al. 2005). On the contrary, these studies demonstrate that the body critically modulates consumer decision-making.

According to John Cacioppo and colleagues (1993), a lifetime of experience of motor actions paired with differential evaluative outcomes has established higher-order associations. For example, arm flexion (where the motor action is directed toward the self) is repeatedly associated with acquiring desired objects, while arm extension (where the motor action is directed away from the self) is repeatedly associated with rejecting undesired objects. These countless repetitions over an individual's lifetime of the pairing of bodily actions with evaluative contingencies foster an association between arm flexion and approach motivational orientations on the one hand, and arm extension and avoidance motivational orientations on the other hand

(Cacioppo, Priester, and Berntson 1993). Simple motor actions, such as flexing or extending an arm, may therefore induce motivational drive states that influence consumer decision-making. For example, merely flexing (versus extending) an arm increases the consumption of orange juice and chocolate cookies (Förster 2003) and results in more positive attitudes towards exposed products (Förster 2004). Most obviously, the consequences of these motor actions extend further than consumption related decisions. Induced approach motivation through arm flexion facilitates performance in tasks requiring insight problem solving and creative generation (Friedman and Förster 2000; Friedman and Förster 2002), broadens the scope of conceptual attention (Förster et al. 2006), and facilitates the retrieval of positively valenced information from long-term memory (Förster and Strack 1997; Förster and Strack 1998). In the present research, we argue that arm flexion (versus arm extension) induces present-biased preferences in intertemporal choice.

### *HYPOTHESES DEVELOPMENT*

#### *Arm Flexion Induces Present-Biased Preferences*

Approach motivation can be induced by motor actions (e.g., Cacioppo, Priester, and Berntson 1993), but also by exposure to rewarding stimuli. Indeed, a farmer uses a stick with a carrot on a string hoping that the mule will try to approach the carrot that dangles a few inches from its nose. Encounters with cues for a reward trigger pulses of approach motivation to pursue that reward as a goal (Carver and White 1994; Torrubia et al. 2001). The carrot on the string sets off behavioral approach tendencies aimed at satisfying desire in the exposed reward. Nowhere is this more evident than in studies employing the delay-of-gratification paradigm. In a typical experiment, a

child is confronted with the dilemma to receive an inferior reward immediately (e.g., 1 marshmallow) or wait 15 min and receive a superior reward (e.g., 2 marshmallows). When the rewards are out of sight, children succeed in delaying gratification, but when the rewards are within reach, none of the children is able to resist temptation (Mischel and Ebbesen 1970). Interestingly, this gratification-seeking tendency spills over to seemingly unrelated domains. That is, inducing desire in one domain (e.g., exposure to marshmallows) may increase the desirability of rewards in unrelated domains (e.g., soda pop). For example, sexual appetite induces impulsivity for unrelated rewards, such as money, candy bars and soft drinks (Van den Bergh, Dewitte, and Warlop 2008) and sampling a tasty beverage (e.g., Hawaiian punch) not only enhances subsequent consumption of other beverages (e.g., Pepsi) but also prompts people to seek anything rewarding (e.g., a massage) (Wadhwa, Shiv, and Nowlis 2008).

Because induced approach motivation sets off gratification seeking tendencies (Van den Bergh, Dewitte, and Warlop 2008; Wadhwa, Shiv, and Nowlis 2008), we propose that motor actions associated with approach motivation result in an increased motivation to engage in reward-seeking behaviors. First of all, we contend that arm flexion leads to a preference for immediately gratifying options in intertemporal dilemmas. More specifically, we predict that the enactment of motor actions associated with approach motivation induces a preference for smaller, sooner rewards (e.g., \$15 now) over larger, later rewards (e.g., \$20 next week). Second, we hypothesize that arm flexion leads to a preference for vices (e.g., chocolate cake) over virtues (e.g., fruit salad). Indeed, the preference ordering of vice and virtue goods changes with whether consumers evaluate immediate or delayed consumption consequences (Wertenbroch 1998): A vice option is able to provide relatively more immediate benefits than a virtue, while a virtue provides more delayed benefits than a vice (Li 2008). In sum, we hypothesize that the enactment of motor

actions associated with approach behavior induces present-biased preferences in intertemporal choice.

**H<sub>1</sub>**: Arm flexion, rather than arm extension, leads to present-biased preferences in intertemporal choice, that is:

**H<sub>1a</sub>**: a preference for smaller, sooner over larger, later rewards

**H<sub>1b</sub>**: a preference for vices over virtues

### *Behavioral Approach System Sensitivity Moderates Arm Flexion Effects*

When we choose between one marshmallow right now or two in 15 minutes, we may imagine the sugary taste, the sensations on our tongue and how our teeth sink through the soft candy. We move towards the marshmallow like the mule approaches the carrot dangling in front of its nose. However, some targets fail to elicit sensory or motor responses. Indeed, some goods are never associated with self-control failures. As noted by Daniel Read, *“if you offer me a choice between 1 pack of computer paper in 2 hours and 2 packs in 4 hours, I will take the 2 packs. I won’t change my mind even if you offer me the 1 pack immediately, and I won’t be tempted even if you are standing in front of me holding the pack in your hand. On the other hand, if you offer me a choice between a hamburger in 2 hours and a fine dinner in 4 hours I will take the fine dinner. If you offer me the hamburger immediately, I might well change my mind. This is even more likely if I can see and smell the hamburger right now”* (Read 2001, p.27). Although the embodied states produced when choosing between a hamburger and a fine dinner differ from those produced when choosing between packs of computer paper, few models of intertemporal choice do justice to how cognitive operations are fundamentally grounded in their physical context. For

example, discounted utility theory (Loewenstein and Prelec 1992) prescribes that the same temporal discount rate is applied to all outcomes. Some consumers do construe the choice between a hamburger and a fine dinner as if it was a choice between packs of computer paper, but not everyone remains indifferent when they encounter tasty rewards.

Research inquiries in different domains have independently identified two distinct motivational systems: One concerned with obtaining positive outcomes (“approach pleasure”), the other with avoiding negative outcomes (“avoid pain”). In Gray’s (1990; 1987) Reinforcement Sensitivity Theory, the Behavioral Approach System (BAS) is the conceptual substrate concerned with approaching rewards, while the Behavioral Inhibition System (BIS) is concerned with avoiding punishments. The purpose of the BAS is to initiate approach behavior that brings the organism closer to rewards and activity in this system causes the organism to begin or increase movement towards goals (approach motivation). The sensitivity of the BAS determines whether people are motivated to approach rewards or not. We propose that people who fail to respond with approach motivation when they encounter a tasty reward (e.g., they equate hamburgers with computer paper), will not display present-biased preferences in intertemporal choice upon approach motivation induction. In contrast, among consumers who respond to rewards with approach motivation (e.g., they don’t equate hamburgers with computer paper), reward-seeking tendencies should be most pronounced. Because the sensitivity of motivational approach and avoidance systems can vary substantially from one individual to the next (Carver and White 1994; Torrubia et al. 2001), we hypothesize that the effect of self-directed flexor movements (i.e., approach actions) on present-biased preferences is moderated by the sensitivity of the BAS. That is, the effect of induced *approach* (i.e., arm flexion) motivation should be dependent on Behavioral Approach System (BAS) sensitivity. Given that we investigate reward-seeking tendencies (e.g.,



choosing between chocolate versus fruit; choosing between a smaller, sooner, reward versus a larger, later reward) and the BIS regulates our responses towards punishments, the role of the BIS is most likely negligible in the present research.

**H<sub>2</sub>:** The effect of arm flexion, rather than arm extension, on present-biased preferences is dependent on the sensitivity of the Behavioral Approach System (BAS)

### *Classical Conditioning*

The countless repetitions over an individual's lifetime of the pairing of somatic actions with evaluative contingencies have fostered an association between arm flexion and approach motivational orientations (Cacioppo, Priester, and Berntson 1993). For example, in contacting an aversive stimulus, extending the arm is temporally associated with the onset of the aversive stimulus, whereas flexing the arm is coupled with its offset. In retrieving something desirable, arm flexion is more closely temporally associated to the acquisition of the desired object than arm extension. This is not to suggest that people never retreat from a pleasurable stimulus (e.g., delicious foods when dieting) or grasp and consume something unpleasant (e.g., unpalatable medicines and foods). However, these actions, in contrast to the pain-flexor reflex and the acquisition–consumption of appetitive stimuli, are less common (Cacioppo, Priester, and Berntson 1993).

Without countless repetitions (i.e., in the absence of a learning process) the association between flexion and approach orientation is most likely not or only weakly established. Evidence that provides support for a learning account of associating motor patterns with motivational orientations comes from the finding that stimuli presented during “leg flexion” are not rated

differently than stimuli presented during “leg extension” (Cacioppo, Priester, and Berntson 1993). That is, effects are not obtained when subjects sit on the edge of a desk and press their heels against that desk (i.e., leg flexion) or their toes against a second desk (i.e., leg extension). Presumably, leg positions have not been paired with differential evaluative outcomes and have not fostered higher-order associations. Further evidence providing support for a learning account of associating motor patterns with evaluative contingencies is found in studies comparing experts and novices. For example, skilled typists prefer letter dyads that, if typed, do not create motor interference, while novice typists do not show this preference (Beilock and Holt 2007; Van den Bergh, Vrana, and Eelen 1990). The effects of extending one’s middle finger or thumb (Chandler and Schwarz 2009) and the effects of head-nodding or shaking (Förster 2004) also point to the influence of learned movements, as opposed to innate motor movements, upon affect and cognition. Since individuals use their nondominant hand less often than their dominant hand, the association between arm flexion of the nondominant hand and approach orientation is most likely only weakly established. Thus, we hypothesize that the effect of arm flexion on the present-biased preferences will be stronger for arm positions of the dominant hand.

**H<sub>3</sub>:** The effect of arm flexion, rather than arm extension, on present-biased preferences via Behavioral Approach System activation is stronger for the dominant arm than the nondominant arm

### *Overview Of The Studies*

In the first two studies (study 1a & 1b), we test whether consumers using a shopping basket (i.e., arm flexion) are more likely to purchase products providing immediate benefits (i.e., vice

products) than consumers using a shopping cart (i.e., arm extension) (hypothesis 1b). In the follow up studies (studies 2-4), we use more standard manipulations of arm flexion to elicit present-biased preferences. Furthermore, we generalize the findings obtained from choices between products (studies 1a-2a) to more general measures of intertemporal preferences, such as choices between smaller, sooner and larger, later monetary rewards in studies 2b-4 (hypothesis 1a). The final two studies (studies 3 & 4) are designed to test the underlying psychological processes, namely that the effect of arm flexion on present-biased preferences is regulated by the Behavioral Approach System (hypothesis 2) and relies on the learned association between arm flexion and the activation of this approach system (hypothesis 3).

### *STUDY 1A*

To test the hypothesis that arm flexion instigates present-biased preferences, we investigate whether customers carrying a shopping basket (i.e., arm flexion) have a greater preference for products providing immediate benefits than consumers pushing a shopping cart (i.e., arm extension). In this non-experimental, correlational field study, we test whether customers using a shopping basket are more likely to purchase vice products than customers using a shopping cart.

#### *Method*

We tracked 136 customers in a hypermarket from their entry in the store until their exit. We randomly selected shoppers to minimize sampling bias. These shoppers received no incentive for participation. We inconspicuously tracked the customer's path in the store with a personal digital

assistant, the time spent in the store and the shopping support used (cart or basket). Based on the customer's purchase ticket collected at the end of the shopping trip, we obtained information about the (number of) products bought and the total amount of money spent. Table 1 lists the most important differences in shopping trip characteristics between the different categories of shoppers (cart and basket shoppers). As these differences may contribute to impulsive spending, we will control for these differences in the statistical analyses.

We hypothesized that activation of the arm flexion muscles instigates a preference for products offering immediate benefits. That is, we hypothesized that 'basket shoppers' would be more likely to purchase vice products than 'cart shoppers'. Because the different categories of shoppers visit different areas in the store and do so for a varied period of time, we compare purchase behavior of basket shoppers and cart shoppers at the cash register, as this is the only location in the store that all shoppers need to pass. We predict that basket shoppers are more likely to purchase vice products<sup>1</sup> (e.g., chocolate bars) than cart shoppers from the shelves located at the cash register.

[ Insert table 1 about here ]

### *Results & Discussion*

An ordered logistic regression (see specification [1] in table 2) demonstrates that Shopping Support (0 = cart; 1 = basket) predicts the likelihood of buying a vice product (0= not buying vice product; 1= buying vice product). Specifications [2], [3] and [4] indicate that the effect of Shopping Support remains significant when controlling respectively for Store visit duration, Amount spent, and Number of products bought. Specification [5], containing all three covariates,

suggests that Shopping Support still predicts whether customers purchase vice products at the cash register. In all five specifications, basket shoppers are more likely to purchase vice products. The ratio-changes reported in table 2 represent the change in the odds of purchasing a vice product for a one unit change in the predictor variable (e.g., a change from cart to basket). Specification [5] suggests that the odds of purchasing vice products at the cashier for a basket shopper is 6.84 times the odds of purchasing vices for a cart shopper, all other things being equal.

[ Insert table 2 about here ]

This non-experimental field study suggests that arm flexion instigates present-biased preferences: Customers carrying a shopping basket (i.e., arm flexion) are more likely to purchase products offering immediate benefits than customers pushing a shopping cart (i.e., arm extension). Despite our efforts to statistically control for possible confounds, this study suffers from the limitations that many, if not all, non-experimental studies suffer from (e.g., self-selection, unobserved differences, etc.). Therefore, we designed an experiment to demonstrate that basket shoppers are more likely to choose products offering immediate benefits than cart shoppers.

## *STUDY 1B*

### *Method*

In study 1b, participants<sup>2</sup> (n = 31; 10 women; participation for course credit) received a shopping list with twelve food categories (e.g., carbohydrates, proteins, vegetables, meat/fish, snacks,...).

They had to choose one product from each category displayed on tables arranged in a U-shape. Participants chose their preferred products while either holding a shopping basket or pushing a shopping cart (see appendix). To ensure that people continue to flex/extend for each of the consecutive choices, a digital picture of a person adopting a specific arm position (i.e., arm flexion while carrying a shopping basket versus arm extension while pushing the shopping cart) was included in the shopping list.

Ten out of twelve pairs of grocery products were filler items (e.g., carbohydrates: rice versus pasta; proteins: canned meat versus canned fish; breakfast: toast vs bread, etc.). The two target choices were choices between a vice (i.e., a chocolate bar) and a virtue (i.e., fruit) snack (snack 1: Twix® vs orange; snack 2: Mars® versus apple). To mimic the procedure of study 1a, the choices between the snacks had to be made near the end of the “shopping trip” (i.e., snack 1 was the tenth and snack 2 was the twelfth and final choice). We hypothesized that basket shoppers would be more likely to choose the vice over the virtue product (i.e., Twix® over the orange and the Mars® over the apple) than cart shoppers.

### *Results & Discussion*

A logistic mixed model with repeated measures (condition as a fixed factor and snack and condition×snack as random factors) was used for the analysis. Neither the main effect of snack nor the interaction between condition and snack yielded significant effects ( $F_s < 1$ ). Only the main effect of condition was significant ( $F(1, 29) = 7.12, p < .05$ ): Basket shoppers were more likely to choose the vice over the virtue than cart shoppers (probability of choosing Mars®: .60 versus .47; probability of choosing Twix: .31 versus .19). The odds ratio was 3.4 (95%

confidence interval 1.3 – 8.8), meaning that the odds of choosing the vice over the virtue is more than three times larger in the basket than in the cart condition. To generalize the findings beyond a shopping context (i.e., basket vs cart manipulations and vice vs. virtue products), we designed a number of follow-up experiments.

### *STUDY 2A & 2B*

In studies 2a and 2b, our aim is to generalize the findings of studies 1a and 1b. First, we will employ more generic manipulations of arm flexion/extension (studies 2-4) to generalize our findings across situations and contexts, to rule out the possibility that the effects are related to baskets or carts (e.g., priming of a shopping context). Second, to generalize our findings beyond product choices, we will investigate whether arm flexion induces present-biased preferences by using more direct measures of intertemporal preferences (study 2b-4), such as the choice between smaller, sooner and larger, later monetary rewards. Because study 2a & 2b are conceptually identical in design, we discuss them together.

#### *Method*

On arrival, participants (study 2a:  $n = 22$ ; 12 women; study 2b:  $n = 54$ ; 26 women, participation for course credit) were seated in partially enclosed cubicles, which prevented them from having contact with each other. Ostensibly to investigate the effect of brain hemispheric lateralization (Friedman and Förster 2000), participants were asked to press one of their hands against the table (Cacioppo, Priester, and Berntson 1993). We asked participants in the arm flexion (extension)

condition to put the palm of one of their hands under (on) the table and press upward (downward). To minimize potential misunderstanding of the instructions, a digital picture of a person adopting the specific arm position with his right arm was included in the task instructions. In both conditions, participants had to maintain a slight pressure against the table during the entire task and work through the computerized task using their one free hand. While participants maintained a slight pressure against the table, we offered them five (study 2a) / eight (study 2b) choices (Li 2008) (see table 3). In study 2a, participants chose between a vice and a virtue (e.g., camping versus studying over the weekend). In study 2b participants chose between a smaller, sooner and a larger, later monetary reward (e.g., €67 tomorrow vs. €85 in 70 days). Participants had to indicate on a 100-point visual analogue scale whether they preferred ‘option A’ (= 0) or ‘option B’ (= 100) with ‘indifferent’ as midpoint (= 50). We recoded and averaged the responses such that a higher score indicated a greater preference for vice options (study 2a) and for smaller, sooner monetary rewards (study 2b). Participants discontinued the arm position after indicating their preferences.

### *Results & Discussion*

In study 2a, participants showed a greater preference for vice options relative to virtues,  $t(20) = 2.57, p < .05$ , in the arm flexion condition ( $M = 59$ ) than in the arm extension condition ( $M = 43$ ). In study 2b, they had a greater preference for smaller, earlier rewards,  $t(52) = 2.43, p < .05$ , in the arm flexion condition ( $M = 53$ ) than in the arm extension condition ( $M = 39$ ).

[ Insert table 3 about here ]



These experiments show that enacting motor actions associated with approach leads to a preference for immediate over delayed benefits (i.e., present-biased preferences). Furthermore, they demonstrate that the effects generalize beyond product choice and beyond basket versus cart manipulations. In studies 3 & 4, we aim to uncover the underlying process giving rise to the effect.

### *STUDY 3*

The aim in Study 3 is to demonstrate that the effect of self-directed flexor movements (i.e., approach actions) on present-biased preferences is moderated by the sensitivity of the BAS. That is, the effect of induced approach (i.e., arm flexion) is dependent on Behavioral Approach System (BAS) sensitivity.

#### *Method*

We used the same laboratory setting and cover story as in studies 2a and 2b: Participants ( $n = 105$ ; mean age = 21; 59 women; participation in return for a participation fee [€6]) were asked to press one of their hands against the table and maintain a slight pressure against the table, while they equated two intertemporal options (e.g., €15 now = € \_\_\_\_ in one week). Participants specified the amount of money they would require in one week, one month, three months, six months and one year to make them indifferent to receiving €15 now (Van den Bergh, Dewitte, and Warlop 2008). This matching task allows us to specify a discounting function for each participant over a time interval of one year. Following Myerson, Green, and Warusawitharana

(2001), we consider the area under the empirical discounting function as a measure of temporal discounting. A smaller area under the curve indicates a greater preference for earlier rewards (i.e., present-biased preference) and this measure can vary between 0.0 (steepest possible discounting) and 1.0 (no discounting) - see (Myerson, Green, and Warusawitharana 2001) for details regarding the calculation of the area under the curve. This nonparametric measure provides a single and easy statistic that can be used to compare groups and does not depend on any theoretical assumptions regarding the form of the discounting function (Myerson, Green, and Warusawitharana 2001).

Afterwards, participants discontinued the arm position and we asked them how pleasant and how physically strenuous it was to press their hand against the table (1 = *not at all*, 7 = *very much*) and how they felt right now (1 = *very bad*, 9 = *very good*). Subsequently, they completed the Sensitivity to Punishment Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia et al. 2001), probably the most reliable and valid self-report index of BIS/BAS functioning (Caseras, Avila, and Torrubia 2003). This scale consists of 48 yes/no items such as “Do you often do things to be praised?” (SR) and “Are you often afraid of new or unexpected situations?” (SP). We summed the 24 Sensitivity to Reward (SR) items to obtain a SR score (Cronbach’s alpha = .74). SR is utilized in subsequent analyses because this scale focuses on the responses to rewards and is most relevant for the effect of somatic activity on activation of the motivational approach system. Including the Sensitivity to Punishment scale (i.e., measure of the sensitivity of the avoidance system) in statistical analyses didn’t produce any significant effects and is ignored in the remainder.

### *Results & Discussion*

Six outliers were removed. An observation is declared an outlier if it lies outside of the interval  $[Q1-1.5 \times IQR; Q3+1.5 \times IQR]$ , where  $IQR=Q3-Q1$  is called the Interquartile Range (Tukey 1977). We use this definition across the studies. A general linear model (GLM) analysis was used for the analysis. Muscle Contraction (flexion = 1, extension = -1) was entered as a discrete between subjects factor, whereas Sensitivity to Reward (SR) was mean centered and entered as a continuous between subjects factor. This GLM revealed no effect of Muscle Contraction on temporal discounting of money<sup>3</sup>,  $F(1, 95) = .96, p = .33$ , a marginally significant main effect of SR,  $F(1, 95) = 2.94, p = .09$ , and a significant interaction between Muscle Contraction and SR,  $F(1, 95) = 4.50, p < .05$ . Figure 1 shows the plot of this interaction.

[ Insert figure 1 about here ]

Analyses of simple slopes (Aiken and West 1991) indicated that participants with a highly sensitive BAS (1 *SD* above the mean) discount monetary rewards more steeply in the flexion than in the extension condition ( $\beta = -.063, t(95) = -2.19, p < .05$ ). This effect was not obtained ( $\beta = .024, t(95) = .817, p = .42$ ) among those with a rather insensitive BAS (1 *SD* below the mean). BAS sensitivity did predict delay discounting in the flexion condition ( $\beta = -.02, t(51) = -2.90, p < .01$ ), but did not predict discounting in the extension condition ( $\beta = .002, t(44) = .27, p = .79$ ), indicating that the effect of arm flexion on delay discounting of monetary rewards is dependent on the sensitivity of the BAS. Greater BAS sensitivity is associated with a preference for smaller, earlier rewards, but only while flexing the arm.

We obtained no significant differences in mood, strenuousness or pleasantness of the arm position between conditions and adjusting for these variables as covariates in the reported

analyses did not change the pattern of results reported above, suggesting that these variables do not mediate the effect of arm flexion on delay discounting.

This study shows that the effect of self-directed flexor movements (i.e., approach actions) on present-biased preferences is moderated by the sensitivity of the BAS: Only when the motivational approach system is sensitive enough to be activated by arm flexor contraction, a heightened preference for immediately available rewards was observed.

#### *STUDY 4*

Embodied cognition scholars assume that countless repetitions over an individual's lifetime of the pairing of bodily actions with evaluative contingencies have fostered an association between arm flexion and approach motivational orientations. However, this assumption has, to our knowledge, never been tested. Study 4 aims to provide support for such a learning account by showing that the effect of arm flexor contraction is moderated by hand dominance. In the absence of a learning process, the association between arm flexion and approach is most likely not or only weakly established.

#### *Method*

Participants were 120 students (69 women, mean age = 20). Two students participated in return for a participation fee (€6) and 118 students participated in return for course credit. We used the same laboratory setting and cover story as in the previous studies. In addition to a control condition, in which participants did not have to maintain an arm position, we asked participants

in the experimental conditions to press their dominant or nondominant hand<sup>4</sup> against the table (manipulated between subjects). We asked participants in the arm flexion condition to put the palm of their (non) dominant hand under the table and press upward, whereas participants in the arm extension condition had to put the palm of their (non) dominant hand on the table and press downward. In the four experimental conditions (dominant/nondominant hand × flexion/extension), we asked participants to maintain a slight pressure against the table during the temporal discounting task. In the control condition, participants did not have to maintain an arm position and could work through the computerized task using both free hands.

Participants chose between a smaller-sooner (SS) and a larger-later (LL) amount (e.g., Which would you prefer: €15 today or €30 one week from today?). The SS amount was fixed and participants adjusted the LL amount through successive choices. We instructed them to bring the SS and LL amounts toward an indifference point (where the two amounts have the same present value). Following a ‘splitting the difference’ procedure (Read 2001), LL was adjusted upwards if SS was preferred, while LL was adjusted downwards if LL was chosen. The indifference point was defined as the midpoint between the highest value judged as too low (called *highup*), and the lowest value judged as too high (called *lowdown*). A choice sequence was ended when the magnitude of the relative difference between highup and lowdown was smaller than 1% (i.e., an indifference point was reached). Indifference values (i.e., the value of the variable amount at the indifference point) were collected for time intervals of one week, one month, three months, six months and one year. The value of the SS amount was fixed at €15 and the starting value of the variable LL amount (i.e., €30) was kept constant across the different time intervals. This titration procedure allowed us to specify a discounting function for each participant over a time interval

of one year. As in study 3, we consider the area under the empirical temporal discounting function as a measure of temporal discounting (Myerson, Green, and Warusawitharana 2001). Afterwards, participants discontinued the arm position and we asked them how pleasant and how physically strenuous it was to press their hand against the table (1 = *not at all*, 7 = *very much*) and how they felt right now (1 = *very bad*, 9 = *very good*). Subsequently, they completed the Sensitivity to Reward Questionnaire (Torrubia et al. 2001), to assess the sensitivity of the Behavioral Approach System. A general Sensitivity to Reward (SR) index was created in a similar fashion as in study 3 (Cronbach's alpha = .77). Including the Sensitivity to Punishment scale in statistical analyses didn't produce any significant effects and is ignored in the remainder.

### *Results & Discussion*

Three outliers were removed. The temporal discounting measure was subjected to a GLM analysis with Muscle Contraction (flexion = 1, extension = -1), Hand (dominant = 1, nondominant = -1), and Sensitivity to Reward (mean centered and entered as a continuous factor), and all interactions as independent variables. The GLM analysis revealed a significant effect of Hand,  $F(1, 62) = 4.37, p < .05$ , and a marginally significant three-way interaction between Muscle Contraction, Hand and SR scores,  $F(1, 62) = 3.78, p < .06$ . To explore this interaction effect, we conducted two separate GLMs within the dominant and nondominant hand conditions. Within the dominant hand condition, a GLM with Muscle Contraction, SR scores and the interaction between the two variables, revealed no effect of Muscle Contraction,  $F(1, 31) = .09, p = .76$ , no effect of SR scores,  $F(1, 31) = 2.52, p = .12$ , but a significant interaction between Muscle Contraction and SR scores,  $F(1, 31) = 8.13, p < .01$ . Figure 2a shows the plot of this

interaction. Analyses of simple slopes indicated that participants with a highly sensitive BAS (1 *SD* above the mean) discount monetary rewards more steeply in the flexion than in the extension condition ( $\beta = -.101$ ,  $t(31) = -2.592$ ,  $p < .05$ ). Among those with a rather insensitive BAS (1 *SD* below the mean), there was a trend in the opposite direction ( $\beta = .077$ ,  $t(31) = 1.699$ ,  $p = .099$ ). BAS sensitivity did predict discounting in the flexion condition ( $\beta = -.03$ ,  $t(13) = -2.74$ ,  $p < .05$ ) but did not predict delay discounting in the extension condition ( $\beta = .009$ ,  $t(18) = 1.14$ ,  $p = .26$ ), indicating that greater sensitivity for reward is associated with a preference for smaller, earlier rewards, but only while flexing the dominant arm. Similar analyses within the nondominant hand condition, revealed no main effects, nor an interaction effect (all *F*s < 1): The association between SR scores and temporal discounting was nonsignificant in both the extension ( $\beta = -.006$ ,  $t(17) = -.47$ ,  $p = .64$ ) and the flexion ( $\beta = -.0007$ ,  $t(14) = -.06$ ,  $p = .95$ ) condition, see figure 2b. The control condition (no Muscle Contraction, and thus also no Hand manipulation) was analyzed independently: A subsidiary analysis within the control condition revealed no significant association between SR scores and temporal discounting either,  $\beta = -.0017$ ,  $t(46) = -.21$ ,  $p = .84$ , see figure 2c.

[ Insert figure 2 a, b, c about here ]

We obtained no significant differences in the strenuousness and pleasantness of the arm position between conditions and adjusting for these variables as covariates in the reported analyses did not change the pattern of results. Although participants in the extension condition ( $M = 5.64$ ) reported feeling significantly worse than those in the flexion condition ( $M = 6.32$ ),  $t(115) = 2.04$ ,  $p < .05$  and marginally worse than those in the control condition ( $M = 6.17$ ),  $t(115) = 2.04$ ,  $p = .07$ , including mood as a covariate in the analyses did not change the pattern of the results above, suggesting that mood does not mediate the effect of arm flexion on delay discounting.

This final experiment demonstrates that the effect of arm flexion on present-biased preferences is moderated by the sensitivity of the Behavioral Approach System, and probably owing to principles of conditioning, is restricted to arm flexion of the dominant arm. We suggest that actions of the nondominant arm have not fostered higher-order associations between motor actions and evaluative outcomes, and are not able to activate the BAS. In sum, the effect of arm flexion on preference for immediate gratification is restricted to BAS activation by means of the dominant arm.

### *GENERAL DISCUSSION*

A farmer uses a stick with a carrot on a string hoping that the mule tries to approach the reward that dangles a few inches from its nose. The commonplace assumption is that the motivation to consume the carrot is the source of approach behavior. However, this research demonstrates that the opposite may be equally valid. That is, the enactment of approach behavior may induce a motivation to consume the reward. More than 100 years ago, William James (1884) already proposed that, upon encountering a bear, we do not run because we are afraid, but that we are afraid because we run. James argued that we feel sorry because we cry, angry because we strike, and afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful. In a similar vein, we propose that we may not always approach rewards because we want them, but that we may want rewards because we are approaching them. In six studies we demonstrated that arm movements associated with approach motivation induce present-biased preferences. Simply flexing one's arm leads to a preference for vices over virtues and for smaller, earlier rewards over larger, later monetary rewards. In addition, we have



provided support for the hypothesis that the effect of arm flexion on present-biased preferences is regulated by the Behavioral Approach System and relies on the learned association between arm flexion and the activation of this approach system.

### *General Reward System and Incentive Motivation*

Our findings demonstrate that the effect of arm flexor contraction is dependent on the sensitivity of the Behavioral Approach System. To our knowledge, we are the first to show the role of the sensitivity of motivational systems in the effects of body movements. Our results provide an explanation for why arm flexion increases the consumption of orange juice and chocolate cookies, but does not affect the consumption of lukewarm water (Förster 2003). This finding resonates with the observation that our responses towards packs of computer paper and hamburgers differ dramatically (Read 2001). If the motivational approach system regulating our responses towards rewards (i.e., the BAS) is causing the increase in craving/appetite, it is not surprising to observe effects of arm flexion on the consumption of ‘*delicious chocolate cookies filled with sweet orange marmalade*’ and ‘*delicious orange juice from a luxurious brand*’, and no effects for neutral lukewarm water. Presumably, effects for lukewarm water may be obtained if the rewarding properties of lukewarm water are increased (e.g., when individuals are thirsty). Prior research has shown that arm flexion causes greater ‘liking’ for stimuli (Cacioppo, Priester, and Berntson 1993) and hence, it might seem straightforward that arm flexion causes greater consumption of orange juice and chocolate cookies, through an increased ‘liking’ of juice and cookies. However, arm positions did *not* affect taste ratings (Förster 2003), suggesting that arm flexion does not lead to a greater ‘liking’ (no effect on taste ratings), but to a greater ‘wanting’ of

food (increased consumption). Usually ‘liking’ and ‘wanting’ for pleasant incentives go together, but the two can be dissociated (Berridge 2004; Litt, Khan, and Shiv 2010). ‘Liking’ refers to the pleasurable hedonic impact that corresponds to experienced utility, while ‘wanting’ is not a sensory pleasure in any sense. For example, drugs such as heroin or cocaine may cause real-life ‘wanting’ without ‘liking’ because of long-lasting sensitization changes in brain mesolimbic systems (Berridge and Robinson 1995). ‘Liking’ without ‘wanting’ can be produced, and so can ‘wanting’ without ‘liking’ (Berridge 2004). Given the neurological dissociation between ‘liking’ and ‘wanting’, it is not straightforward to demonstrate effects of arm flexion on present-biased preferences in intertemporal choice. Indeed, increased liking of rewards could well lead to heightened preference for *larger* instead of *immediate* rewards.

‘Wanting’ might have been preserved separately from ‘liking’ to facilitate comparison and choice among incommensurate goals, such as thirst and hunger (Berridge 2004; Berridge and Robinson 2003). By channeling qualitatively different rewards, such as water and food, down a common path, the ‘wanting’ system may provide a common neural currency or a comparison yardstick when evaluating different ‘likes’. Without a common internal currency in our nervous system, we would be unable to assess the relative value of drinking water, smelling food, scanning for predators, sitting quietly in the sun, and so forth. To decide on an appropriate behavioral action, the nervous system must estimate the value of each potential action, convert them to a common scale, and use this scale to determine a course of action (Montague and Berns 2002; Sugrue, Corrado, and Newsome 2005). The existence of such a common yardstick probably explains the adaptive value of a general reward system and helps us understand why smokers and heroin addicts do not only seek gratification in their respective drugs, but also in monetary rewards (Field et al. 2006; Giordano et al. 2002), why sampling Hawaiian Punch leads

to ‘wanting’ a vacation in Bora Bora (Wadhwa, Shiv, and Nowlis 2008), why exposure to desserts leads to ‘wanting’ movie tickets (Li 2008) and why exposure to sexual cues leads to ‘wanting’ money, candy and soda pop (Van den Bergh, Dewitte, and Warlop 2008). In this research, we demonstrate that arm flexion activates this general reward system (i.e., the BAS system) responsible for out-of-domain effects.

### *Classical Conditioning*

According to Cacioppo and colleagues (1993), conditioned stimulus–unconditioned stimulus contingencies foster an association between arm flexion and approach motivational orientations. To our knowledge, no study has ever investigated the role of conditioning as the causal mechanism fostering higher order associations between motor actions of the arm and evaluative outcomes. In prior investigations, participants had to flex or extend either both arms at the same time (e.g., Cacioppo, Priester, and Berntson 1993), the right arm (e.g., Friedman and Förster 2000; 2005; 2002), the left arm (e.g., Förster 2003, experiment 1), the dominant arm (e.g., Centerbar and Clore 2006), or the nondominant arm (e.g., Förster 2004). To our knowledge, a theoretical rationale for the manipulation carried out (both arms / a single arm, left arm / right arm, dominant arm / nondominant arm) has never been given. Although it is virtually impossible to demonstrate that a learning process over an individual's lifetime is responsible for the establishment of these contingencies, the fact that the effect of arm flexion on present-biased preferences via BAS activation is stronger for the dominant arm, certainly lends credibility to that claim. The absence of effects of ‘leg flexion’ (Cacioppo, Priester, and Berntson 1993) and ‘arm flexion of the nondominant hand’, suggests that the differential effects of arm flexion and

extension are attributable to the countless repetitions over an individual's lifetime of the pairing of muscle contractions with differential evaluative outcomes. Nevertheless, future research is needed to resolve the inconsistency with studies demonstrating effects of arm flexion of the nondominant arm (e.g., Förster 2004). Presumably, associations between motivational tendencies and somatic actions of the nondominant arm can be established, provided they occur frequently enough. Still, if learning principles are underlying the effect of somatic actions, we would hypothesize that arm flexion of the dominant arm produces stronger effects than flexion of the nondominant arm.

#### *Future Research and Managerial Implications*

We believe that understanding why consumers weigh immediate benefits more heavily than delayed benefits is important (for example, to understand why we choose unhealthy snacks). We designed the present studies to understand the preference for immediate gratification and its possible antecedents. A limitation of the present research is that we have only focused on the role of arm flexion and the BAS. A complementary set of studies might well be carried out to investigate the consequences of arm extension and the potential role of the Behavioral Inhibition System (Carver and White 1994; Gray 1990; Gray 1987; Torrubia et al. 2001). It is not surprising that arm extension (e.g., pushing shopping carts) has no effect on intertemporal choice between rewards (see studies 3-4). Presumably, arm extension engages the motivational system regulating responses towards punishments (i.e., the BIS) and, as a consequence, does not affect choices between immediate and delayed rewards. Future research could investigate whether arm extension makes individuals more likely to buy insurances (i.e., avoiding negative outcomes) or

affects the choice between a smaller, immediate and a larger, delayed fine (e.g., pay €15 today or pay €20 next week). We consider these effects, and the potential moderating role of the BIS and/or arm dominance, as an interesting area for future research.

Most managers are probably not aware of the fact that perceptual/motor systems are more than passive input/output devices. Few car dealers take into account the fact that sitting in a hard, rather than a soft chair decreases the negotiation flexibility of potential customers (Ackerman, Nocera, and Bargh 2010). Few salespersons realize that offering customers a hot, rather than a cold, drink affects perceptions of their personality (Williams and Bargh 2008). Few copy-writers bear in mind that reading information in advertisements from the top to the bottom or from left to right may determine whether we are persuaded by product claims (e.g., Briñol and Petty 2003). Few advertisers realize that the horizontal versus vertical movement of a product in a commercial may influence our desire to buy the product (Förster 2004; Tom et al. 1991). Likewise, a minority of retail managers may have anticipated that pushing a cart versus carrying a basket would influence customers' purchases. Like many scholars, managers view perceptual/motor systems as simple input/output devices deemed irrelevant to understand purchase decisions, product attitudes or customers' feelings.

The implications of the present findings may be much broader than most managers would anticipate. For example, this research suggests that slot-machines are designed in a nifty way. Slot-machines for which you need to pull a lever may lead to bigger revenues than slot-machines where you need to push a lever/button. The fact that the lever is located on the right hand side of the slot machine, combined with the fact that most individuals are right-handed, increases the chances of instigating present-biased preferences in slot-machine gamblers (and not saving money for later, outside of the casino). Our studies also suggest that pulling a door to enter a

building, rather than pushing that same door, could lead to purchases of products that entail immediate benefits through activation of approach motivational tendencies. Shops selling vice products or companies selling insurances may want to consider how a customer needs to open a door. Likewise, we speculate that the manual or even the automatic gearbox in motor vehicles may play a role when ordering hamburgers in a drive-through. Although these examples may be far-fetched or unwarranted, we contend that the likelihood that our body hacks our brain is, if anything, underestimated.

*REFERENCES*

- Ackerman, Joshua M., Christopher C. Nocera, and John A. Bargh (2010), "Incidental Haptic Sensations Influence Social Judgments and Decisions," *Science*, 328 (5986), 1712-15.
- Aiken, Leona S. and Stephen G. West (1991), *Multiple regression: Testing and interpreting interactions*: Sage Publications.
- Barsalou, Lawrence W. (2008), "Grounded cognition," *Annual Review of Psychology*, 59, 617-45.
- Beilock, Sian L. and Lauren E. Holt (2007), "Embodied preference judgments: Can likeability be driven by the motor system?," *Psychological Science*, 18 (1), 51-57.
- Berridge, Kent C. (2004), "Motivation concepts in behavioral neuroscience," *Physiology & Behavior*, 81 (2), 179-209.
- Berridge, Kent C. and Terry E. Robinson (1995), "The Mind of an Addicted Brain: Neural Sensitization of Wanting Versus Liking," *Current Directions in Psychological Science*, 4 (3), 71-75.
- (2003), "Parsing reward," *Trends in Neurosciences*, 26 (9), 507-13.

Briñol, Pablo and Richard E. Petty (2003), "Overt head movements and persuasion: A self-validation analysis," *Journal of Personality and Social Psychology*, 84 (6), 1123-39.

Cacioppo, John T., Joseph R. Priester, and Gary G. Berntson (1993), "Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes," *Journal of Personality and Social Psychology*, 65 (1), 5-17.

Carney, Dana R., Amy J.C. Cuddy, and Andy J. Yap (In press), "Power Posing: Brief Nonverbal Displays Affect Neuroendocrine Levels and Risk Tolerance," *Psychological Science*.

Carver, Charles S. and Teri L. White (1994), "Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales," *Journal of Personality and Social Psychology*, 67 (2), 319-33.

Caseras, Xavier, Cesar Avila, and Rafael Torrubia (2003), "The measurement of individual differences in Behavioural Inhibition and Behavioural Activation Systems: a comparison of personality scales," *Personality and Individual Differences*, 34 (6), 999-1013.

Centerbar, David B. and Gerald L. Clore (2006), "Do approach-avoidance actions create attitudes?," *Psychological Science*, 17 (1), 22-29.



Chandler, Jesse and Norbert Schwarz (2009), "How extending your middle finger affects your perception of others: Learned movements influence concept accessibility," *Journal of Experimental Social Psychology*, 45 (1), 123-28.

Choi, Charles Q. (2010), "How Wii and Kinect Hack Into Your Emotions," in Wired available at <http://www.wired.com/wiredscience/2010/11/wii-emotion/> (accessed March 23, 2011).

Field, Matt, Mary Santarcangelo, Harry Sumnall, Andrew Goudie, and Jon Cole (2006), "Delay discounting and the behavioural economics of cigarette purchases in smokers: the effects of nicotine deprivation," *Psychopharmacology*, 186 (2), 255-63.

Förster, Jens (2004), "How Body Feedback Influences Consumers' Evaluation of Products," *Journal of Consumer Psychology*, 14 (4), 416-26.

--- (2003), "The influence of approach and avoidance motor actions on food intake," *European Journal of Social Psychology*, 33 (3), 339-50.

Förster, Jens, Ronald S. Friedman, Amina Özelsel, and Markus Denzler (2006), "Enactment of approach and avoidance behavior influences the scope of perceptual and conceptual attention," *Journal of Experimental Social Psychology*, 42 (2), 133-46.

Förster, Jens and Fritz Strack (1997), "Motor actions in retrieval of valenced information: A motor congruence effect," *Perceptual and Motor Skills*, 85 (3, Pt 2), 1419-27.

--- (1998), "Motor actions in retrieval of valenced information: II. Boundary conditions for motor congruence effects," *Perceptual and Motor Skills*, 86 (3, Pt 2), 1423-26.

Frederick, Shane, George F. Loewenstein, and Ted O'Donoghue (2002), "Time discounting and time preference: A critical review," *Journal of Economic Literature*, 40 (2), 351-401.

Friedman, Ronald S. and Jens Förster (2000), "The effects of approach and avoidance motor actions on the elements of creative insight," *Journal of Personality and Social Psychology*, 79 (4), 477-92.

--- (2005), "The influence of approach and avoidance cues on attentional flexibility," *Motivation and Emotion*, 29 (2), 69-81.

--- (2002), "The influence of approach and avoidance motor actions on creative cognition," *Journal of Experimental Social Psychology*, 38 (1), 41-55.

Giordano, Louis A., Warren K. Bickel, George F. Loewenstein, Eric A. Jacobs, Lisa Marsch, and Gary J. Badger (2002), "Mild opioid deprivation increases the degree that opioid-dependent outpatients discount delayed heroin and money," *Psychopharmacology*, 163 (2), 174-82.

Gray, Jeffrey A. (1990), "Brain systems that mediate both emotion and cognition," *Cognition & Emotion*, 4 (3), 269-88.

--- (1987), "Perspectives on anxiety and impulsivity: A commentary," *Journal of Research in Personality*, 21 (4), 493-509.

Hung, Iris W. and Aparna A. Labroo (In press), "From Firm Muscles to Firm Willpower: Understanding the Role of Embodied Cognition in Self-Regulation," *Journal of Consumer Research*.

James, William (1884), "What is an Emotion?," *Mind*, 9, 188-205.

Li, Xiuping (2008), "The effects of appetitive stimuli on out-of-domain consumption impatience," *Journal of Consumer Research*, 34 (5), 649-56.

Litt, Ab, Uzma Khan, and Baba Shiv (2010), "Lusting While Loathing: Parallel Counterdriving of Wanting and Liking," *Psychological Science*, 21 (1), 118-25.

Loewenstein, George F. and Drazen Prelec (1992), "Anomalies in Intertemporal Choice: Evidence and an Interpretation," *The Quarterly Journal of Economics*, 107 (2), 573-97.

Mischel, Walter and Ebbe B. Ebbesen (1970), "Attention in delay of gratification," *Journal of Personality and Social Psychology*, 16 (2), 329-&.

Montague, P. Read and Gregory S. Berns (2002), "Neural Economics and the Biological Substrates of Valuation," *Neuron*, 36 (2), 265-84.

Myerson, Joel, Leonard Green, and M. Warusawitharana (2001), "Area under the curve as a measure of discounting," *Journal of the Experimental Analysis of Behavior*, 76 (2), 235-43.

Niedenthal, Paula M. (2007), "Embodying emotion," *Science*, 316 (5827), 1002-05.

Niedenthal, Paula M., Lawrence W. Barsalou, Piotr Winkielman, Silvia Krauth-Gruber, and François Ric (2005), "Embodiment in Attitudes, Social Perception, and Emotion," *Personality and Social Psychology Review*, 9 (3), 184-211.

Oppenheimer, Daniel M., Tom Meyvis, and Nicolas Davidenko (2009), "Instructional manipulation checks: Detecting satisficing to increase statistical power," *Journal of Experimental Social Psychology*, 45 (4), 867-72.

Read, Daniel (2001), "Is time-discounting hyperbolic or subadditive?," *Journal of Risk and Uncertainty*, 23 (1), 5-32.

Sugrue, Leo P., Greg S. Corrado, and William T. Newsome (2005), "Choosing the greater of two goods: neural currencies for valuation and decision making," *Nature Reviews Neuroscience*, 6 (5), 363-75.

Tom, Gail, Paul Pettersen, Teresa Lau, Trevor Burton, and Jim Cook (1991), "The role of overt head movement in the formation of affect," *Basic and Applied Social Psychology*, 12 (3), 281-89.

Torrubia, Rafael, César Avila, Javier Molto, and Xavier Caseras (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 (6), 837-62.

Tukey, John W. (1977), *Exploratory Data Analysis*. Reading, MA: Addison-Wesley.

Van den Bergh, Bram, Siegfried Dewitte, and Luk Warlop (2008), "Bikinis instigate generalized impatience in intertemporal choice," *Journal of Consumer Research*, 35 (1), 85-97.

Van den Bergh, Omer, Scott Vrana, and Paul Eelen (1990), "Letters from the heart: Affective categorization of letter combinations in typists and nontypists," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16 (6), 1153-61.

Wadhwa, Monica, Baba Shiv, and Stephen M. Nowlis (2008), "A bite to whet the reward appetite: The influence of sampling on reward-seeking behaviors," *Journal of Marketing Research*, 45 (4), 403-13.

Wertenbroch, Klaus (1998), "Consumption self-control by rationing purchase quantities of virtue and vice," *Marketing Science*, 17 (4), 317-37.

Williams, Lawrence E. and John A. Bargh (2008), "Experiencing Physical Warmth Promotes Interpersonal Warmth," *Science*, 322 (5901), 606-07.

*FOOTNOTES*

1. Products bought at the cash register that are classified as vice products are chocolate bars (Twix, Mars); candy (La Vosgienne) and chewing gum (Hollywood, Eclipse). These products provide immediate benefits and could be consumed instantly. Other products bought at the cash register, but not classified as vice products because of their utilitarian nature for a future activity, are wrapping paper, batteries, mobile phone cards, plastic bags and TV-programme listings.
2. In all experimental studies we used a screening procedure to probe attention and motivation. Participants had to answer questions that identified possible random response behavior: We instructed them not to respond to a scale but to click a dot next to the question (Oppenheimer, Meyvis, and Davidenko 2009). Data from participants not following this instruction [study 2b:  $n = 2$  (i.e., 4%); study 2:  $n = 3$  (i.e., 3%); study 3:  $n = 7$  (i.e., 6%)] were discarded, because their responses on focal variables cannot be trusted.
3. The absence of a main effect is most likely a calibration issue. Comparing the results of choice tasks (study 1a & 1b, study 2a & 2b) with matching tasks or titration tasks (study 3, 4) is notoriously complex, because the various elicitation procedures may fail to isolate *pure* time preference. Different methods to assess temporal discounting may yield different discounting rates due to different confounding factors in the various elicitation procedures (Frederick, Loewenstein, and O'Donoghue 2002).
4. Although we did not manipulate hand dominance in the other studies, we assume that participants maintained the arm position with their right arm, as the person featured in the digital photograph in the task instructions demonstrated the arm position using his right arm. As most people are right-handed, we can safely assume that most participants carried out the arm position

task with their dominant arm. Participants in study 1b carried out the muscle contraction manipulation with their dominant arm.



TABLE 1.

DESCRIPTIVE CHARACTERISTICS: BASKET VERSUS CART SAMPLE (STUDY 1A).

	Basket (n=10)	Cart (n=126)
Average number of products purchased	10.6**	32
Average amount spent (€)	36.1**	74.2
Average store visit duration (min)	16**	35
Consumers buying vice products (%)	40***	4.8

\*\*  $p \leq .01$ ; \*\*\*  $p \leq .001$

TABLE 2.  
BASKET VERSUS CART PREDICTS LIKELIHOOD OF PURCHASING VICE PRODUCTS  
(STUDY 1A).

	[1]	[2]	[3]	[4]	[5]
Shopping Support	2.59*** (13.33)	2.47** (11.76)	2.73*** (15.32)	2.14* (8.49)	1.92* (6.84)
Store visit duration		0.00 (1.00)			.00 (1.00)
Amount Spent			.00 (1.00)		.04* (1.05)
Number of products purchased				-.03 (.97)	-.15* (.861)
Nagelkerke R <sup>2</sup>	.169	.171	.172	.185	.285

\*  $p \leq .05$ ; \*\*  $p \leq .01$ ; \*\*\*  $p \leq .001$ ;

Note. - Values in parentheses are ratio-changes

TABLE 3.  
ARM FLEXION INDUCES PRESENT-BIASED PREFERENCES

	Flexion	Extension
Study 2a		
Movie ticket vs. bookstore coupon	88*	62
Pay later with larger amount vs. pay now	17	15
An attractive vs. a competent job candidate	39	29
An apartment with great view vs. close to work	76	64
Camping vs. studying over the weekend	73†	48
Average	59*	43
Study 2b		
€10 tomorrow vs. €12 in 25 days	61†	45
€67 tomorrow vs. €85 in 70 days	54	43
€34 tomorrow vs. €35 in 43 days	69	62
€48 tomorrow vs. €55 in 45 days	57*	39
€40 tomorrow vs. €70 in 20 days	48*	27
€16 tomorrow vs. €30 in 35 days	40	32
€30 tomorrow vs. €35 in 20 days	53	41
€15 tomorrow vs. €35 in 10 days	42†	27
Average	53*	39

†  $p \leq .10$ ; \*  $p \leq .05$

Note. - All items are from Li (2008)



FIGURE 1.

ARM FLEXION INDUCES PRESENT-BIASED PREFERENCES AMONG PEOPLE WITH A SENSITIVE BEHAVIORAL APPROACH SYSTEM (STUDY 3).

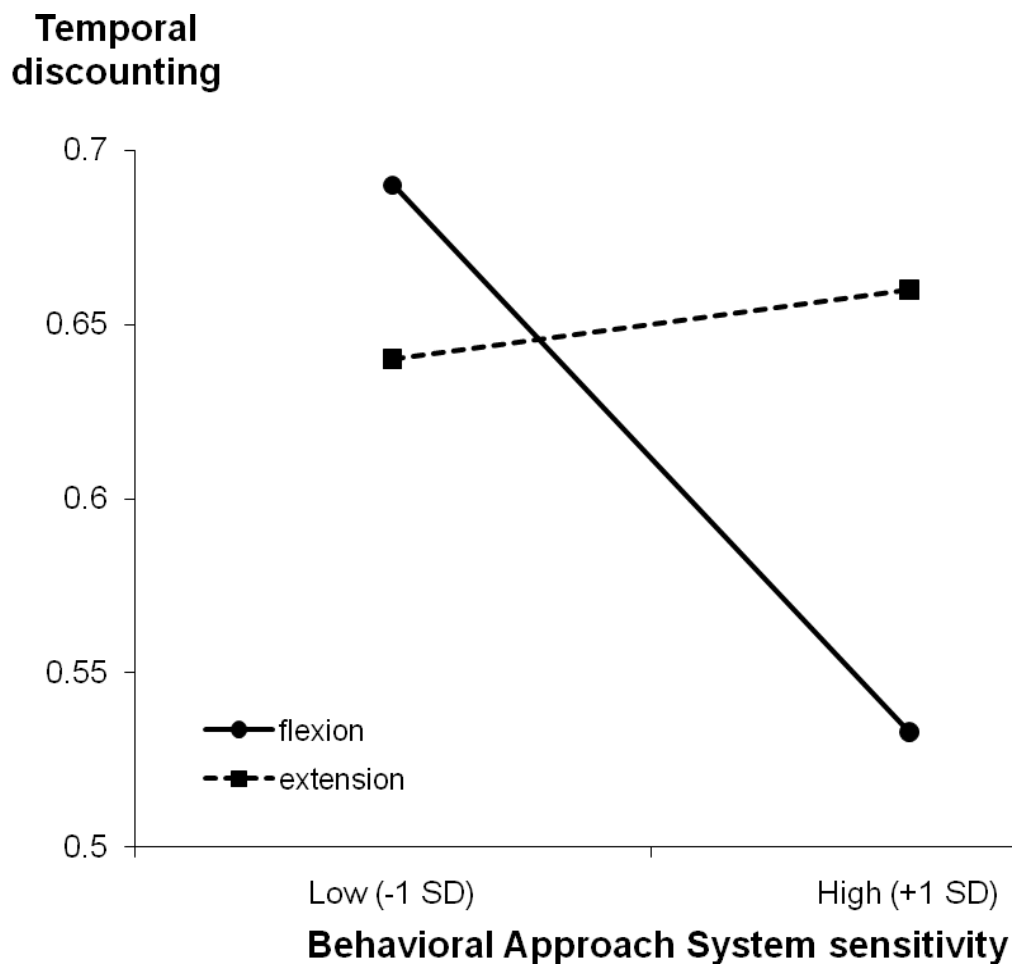


FIGURE 2a.

DOMINANT ARM FLEXION INDUCES PRESENT-BIASED PREFERENCES AMONG PEOPLE WITH A SENSITIVE BEHAVIORAL APPROACH SYSTEM (STUDY 4).

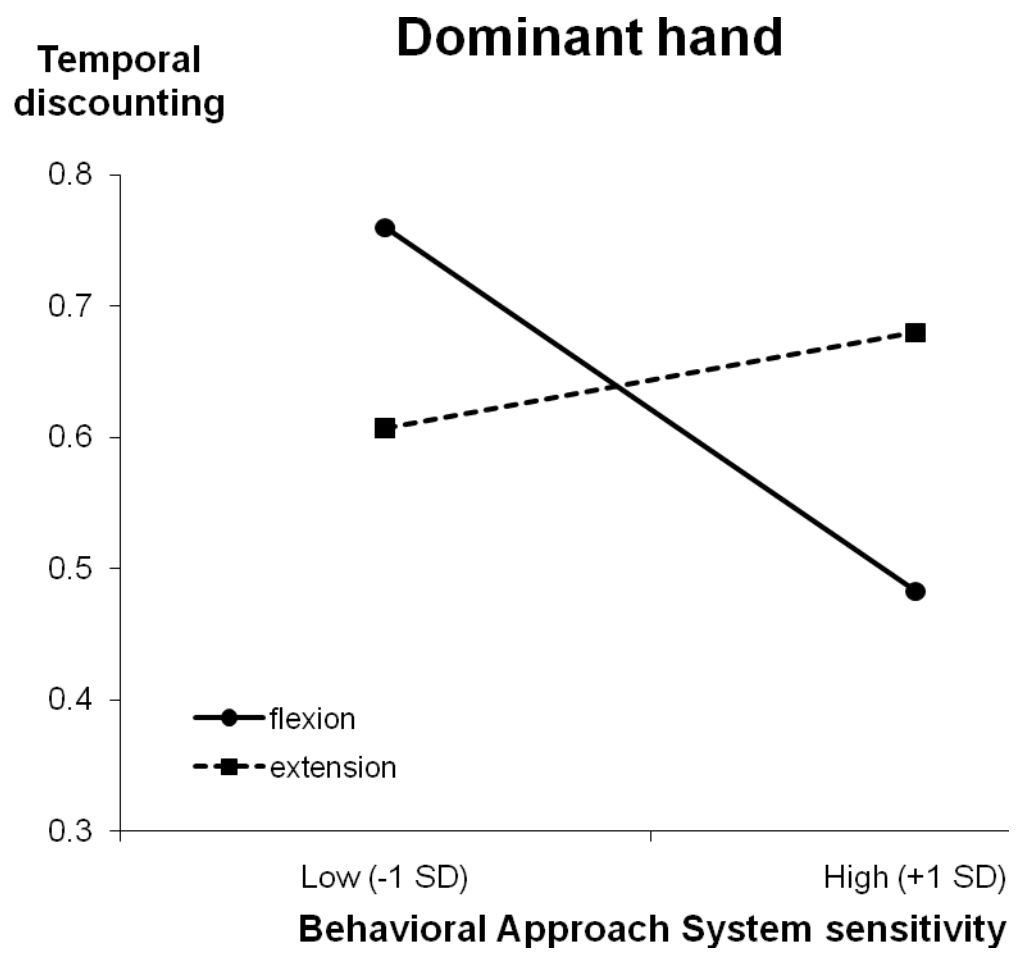


FIGURE 2b.

NONDOMINANT ARM FLEXION DOES NOT INDUCE PRESENT-BIASED PREFERENCES (STUDY 4).

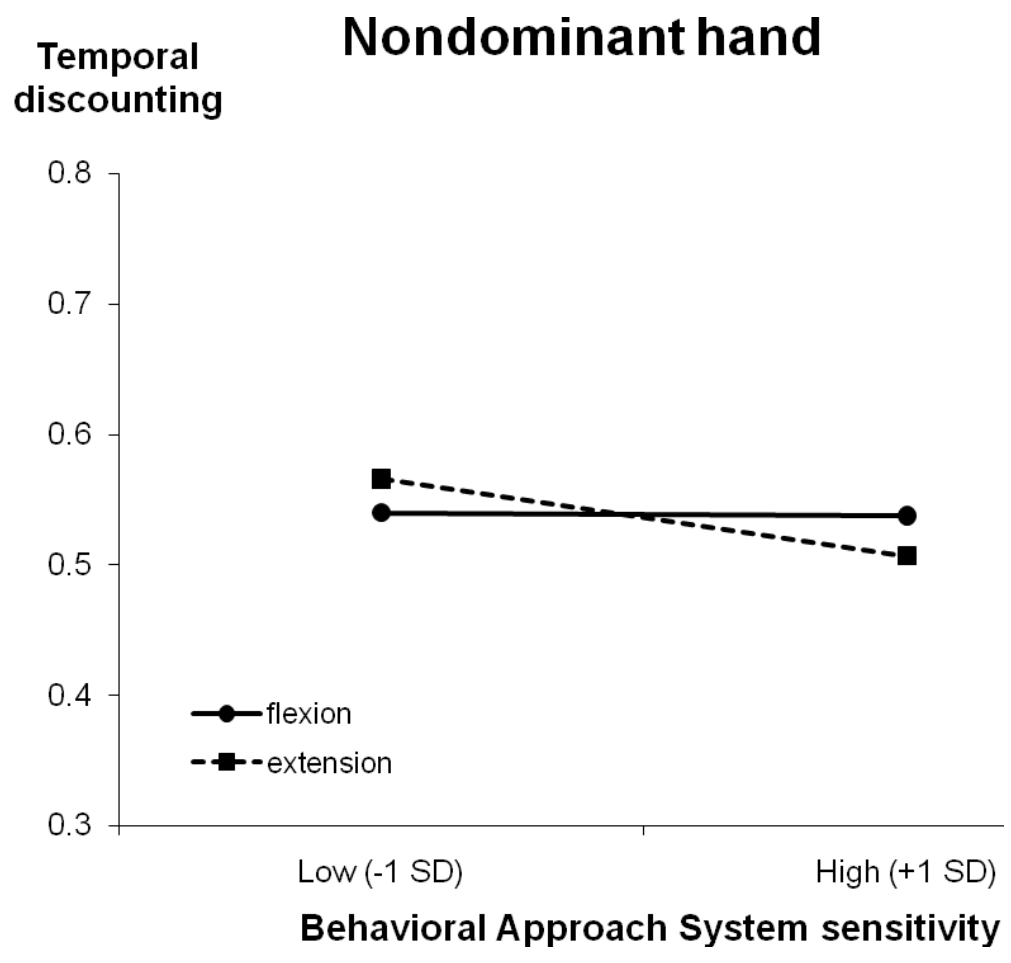
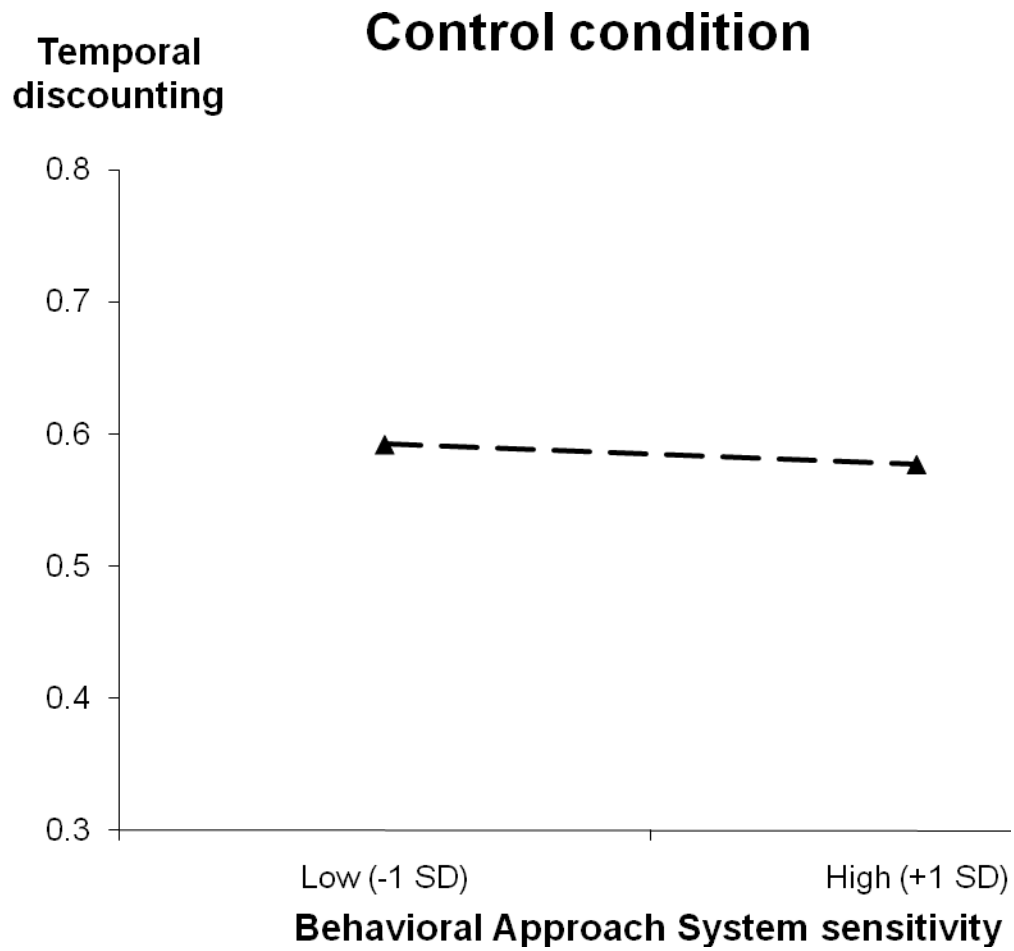


FIGURE 2c.

TEMPORAL DISCOUNTING OF A MONETARY REWARD (STUDY 4).





## APPENDIX.

Shopping support used in Study 1b. Participants in the flexion condition made their choices while holding the basket without using the trolley. Participants in the extension condition made their choices while pushing the trolley that supported the same basket.

