Journal of Experimental Psychology: General
2013, Vol. 142, No. 2, 328–335

0096-3445/13/$12.00 DOI: 10.1037/a0028954

Can Victoria's Secret Change the Future? A Subjective Time Perception Account of Sexual-Cue Effects on Impatience

B. Kyu Kim
University of Southern California

Gal Zauberman
University of Pennsylvania

Sexual cues influence decisions not only about sex, but also about unrelated outcomes such as money. In the presence of sexual cues, individuals are more *impatient* when making intertemporal monetary tradeoffs, choosing smaller immediate amounts over larger delayed amounts. Previous research has emphasized the power of sexual cues to induce a strong general psychological desire to obtain not only sex-related but all available rewards. In the case of money, that heightened appetite enhances the perceived value of *immediate* monetary rewards. We propose a different psychological mechanism to explain this effect: Sexual cues induce impatience through their ability to lengthen the perceived temporal distance to *delayed* rewards. That is, sexual cues make the temporal delay seem subjectively longer, resulting in greater impatience for monetary rewards. We attribute this process to the arousing nature of sexual cues, thus extending findings on arousal and overestimation of elapsed time to the domain of future time perception and intertemporal preferences.

Keywords: sexual arousal, time discounting, impatience, time perception

Supplemental materials: http://dx.doi.org/10.1037/a0028954.supp

Sexual cues pervade everyday life, in personal interactions, advertising, and the media, exerting a strong and broad influence on decision making. For example, sexually aroused males reported greater intention to engage in morally questionable or unsafe sexual behavior, compared with those who were not aroused (Ariely & Loewenstein, 2006; Blanton & Gerrard, 1997). Research has further shown the effect of sexual cues on decision making goes beyond sexual behavior to seemingly unrelated financial decisions. Men asked to rate "hot" (physically attractive) women showed greater *impatience* when making intertemporal monetary tradeoffs, choosing smaller immediate amounts over larger delayed amounts (Van den Bergh, Dewitte, & Warlop, 2008; Wilson & Daly, 2004).

The effect of sexual cues on sex-relevant outcomes demonstrates an organism's heightened motivation to satisfy a specific craving. But the effects of such cues on outcomes in unrelated domains, including a relatively abstract resource such as money, seem more complicated and somewhat puzzling. Yet understanding these effects is important because in addition to the theoretical significance of isolating causes of impatience, the resulting impatience can lead to a wide range of suboptimal decisions, from undersaving for retirement to self-control problems such as overeating and addiction (Ainslie, 1975, 1992).

This article was published Online First June 11, 2012.

B. Kyu Kim, Department of Marketing, Marshall School of Business, University of Southern California; Gal Zauberman, Department of Marketing, Wharton School, University of Pennsylvania.

Correspondence concerning this article should be addressed to B. Kyu Kim, Department of Marketing, Marshall School of Business, University of Southern California, University Park Campus, Los Angeles, CA 90089. E-mail: kyu.kim@marshall.usc.edu

The current explanation for the effect of sexual cues on impatience centers on a general motivation system (Van den Bergh et al., 2008; Wilson & Daly, 2004). Because the human motivation system processes various rewarding stimuli similarly (Aharon et al., 2001; Knutson, Westdorp, Kaiser, & Hommer, 2000; Stark et al., 2005; Thut et al., 1997), heightened appetitive responses to rewarding cues in one domain might foster a general approach to rewards in other domains. This explanation, however, might provide only a partial explanation for greater impatience in intertemporal decisions, which involve a *relative* tradeoff between immediate and delayed rewards. That is, impatience is a product of two distinct preferences relative to each other: preference for immediate rewards and preference for delayed rewards (Bechara, 2005). Thus, if one of the preferences changes, impatience—which is relative to both immediate and delayed rewards—will also change. This point is simple but important because it implies that when sexual cues affect impatience for money, increased impatience can be driven not only by escalated desire for immediately available money, as predicted by the general motivation system view, but also by reduced desire for delayed money, for which a different psychological process must be involved. Specifically, in this article, we demonstrate that sexual cues induce impatience by influencing the *perceived temporal distance* to delayed rewards, diminishing the value of future rewards.

Sexual cues used in previous research, such as photographs of female models in lingerie, are not only psychologically rewarding (thus activating a general motivational system), but are also physiologically arousing. Research in cognitive psychology has shown that physiological activation influences how people perceive elapsed time. For instance, administering dopaminergic agents such as methamphetamine was shown to expand perceived time in both humans and nonhumans (Maricq, Roberts, & Church, 1981; Matell, King, & Meck, 2004; Meck, 1996). Participants who

jumped from a high position overestimated the duration of their fall (Stetson, Fiesta, & Eagleman, 2007). More directly relevant to the current research, participants who were presented with human faces expressing intense emotions such as happiness or anger judged the duration of exposure to be longer than those were presented with emotionally neutral faces (Droit-Volet, Brunot, & Niedenthal, 2004). These results, however, might not directly apply to the current research, because they involve the perception of elapsed time (time that has actually passed), whereas our interest is in future time that has not yet passed (temporal inputs that have yet to be experienced), about which very little research exists. In the current article, we aimed to test whether sexual cues influence perception of future time and its implications.

If sexual cues are indeed shown to change the perception of future time, as we predicted, the next question is whether such changes in time perception could account for the impact of sexual cues on impatience for money. Recent findings suggest that individuals' intertemporal preference may be driven not by direct changes in the value of rewards, but by how long or short they perceive delays to be (Kim & Zauberman, 2009; Wittmann, 2009; Zauberman, Kim, Malkoc, & Bettman, 2009). In the context of the current article, this perceived-time-based account of intertemporal preference implies that changes in time perception in the presence of sexual cues will result in changes in the relative preference for immediate versus delayed outcomes. That is, if individuals perceive the same future waiting time to be longer once they are exposed to sexual cues, they will be more impatient for immediate monetary rewards because delayed rewards seem further away and thus even less attractive.

To test our predictions, we conducted Studies 1 and 2 to determine whether sexual cues lead individuals to perceive future time as longer. In Study 3, we further tested whether these changes in time perception can explain the effect of sexual cues on impatience for money. Study 4 measured separately preference for immediate and delayed rewards and examined whether sexual cues indeed decreased preference for delayed rewards rather than increased preferences for immediate rewards. To examine whether our predicted effects were driven by the rewarding aspect or arousing nature of sexual cues, we compared in Study 5 the effects of sexual cues with the effects of other arousal stimuli (e.g., fear-inducing images) on future time perception. Across all studies, participants were self-identified heterosexual males.

Study 1

In Study 1, we tested our prediction that participants exposed to sexual cues (e.g., female models in lingerie) judge the same future time to be longer than do those exposed to nonsexual cues (e.g., neutral objects).

Method

Fifty-nine self-identified heterosexual male undergraduate students participated in a computerized study. We presented each participant with two separate studies (repeating participation consent, instruction pages, and entering subject identification for each "study"). In the photo-evaluation study, we presented participants in the "hot" condition ($n = 28$) with 15 sequential photographs, taken from the Victoria's Secret online catalog (http://www.victoriassecret.com), of female models wearing lingerie, whereas we presented those in the control condition ($n = 31$) with 15 photographs of neutral objects (e.g., rocks or trees). The presentation duration of these images was self-paced. For each image, we asked participants in the hot condition to imagine they were on a date with the woman shown in the picture and to indicate how attractive she was on an 11-point scale (1 = *not attractive at all*, 11 = *very attractive*). Participants in the control condition evaluated the attractiveness of each object on the same 11-point scale.

Next, in the time-perception study, we informed all participants beforehand that they would be judging 12 future durations, ranging from 1 month to 23 months, in 2-month increments (presented in a random order for each participant). We measured participants' future time perception for each of the 12 durations according to their adjustment of a computerized string,[1] which is a computerized version of a method applied in psychophysics to measure loudness of a sound (e.g., cutting a string of embroidery floss to a length that indicates perceived loudness; see Epstein & Florentine, 2005). Kim and Zauberman (2009) used a similar computerized version of a string to measure future time perception. In the current study, at the beginning of each trial, a short line (measuring about 10 mm on a 20-inch monitor) was shown on the left side of the computer screen. When participants pressed the arrow keys, the line length extended or shortened accordingly. When the length of the line exceeded the physical boundary of the screen (which is about 395 mm from the left end of the bar on a 20-inch monitor), the screen generated a scroll bar at the bottom of the screen to allow participants to look over the entire length of their response; thus the theoretical boundary of the scale was infinite.

Results and Discussion

Because the computerized string generated skewed data, we transformed the data using natural logarithm. A repeated-measure analysis of variance (ANOVA) with future durations as a within-subjects factor and the sexual-cue manipulation as a between-subjects factor revealed a significant main effect of the sexual-cue manipulation, $F(1, 57) = 4.58$, $p < .05$, $\omega^2 = .06$.[2] But a sexual-cue-by-duration interaction was not significant, $F(11, 627) = .79$, $p = .65$, $\omega^2 = 0$. See Figure 1.

We further analyzed the data by directly fitting a time-perception function. Specifically, we transformed the measured length of the line scale into month units by setting the overall mean distance for the 1-month duration as the baseline unit for the time judgment each participant made (i.e., all responses were divided by 32.71 mm). This linear transformation allowed for easier interpretation and did not influence any of the statistical analyses or results. We fitted the future-time-perception data using a power function (Stevens, 1957):

$$T = \alpha t^{\beta}.$$

The β parameter captured the degree of a nonlinear scaling in future-time perception. The α parameter is a scaling parameter

[1] See the supplemental material for the empirical validation of this scale compared to numeric magnitude estimation, which is more commonly used in psychophysics.

[2] All effect size values we report are partial ω^2 (Keren & Lewis, 1979).

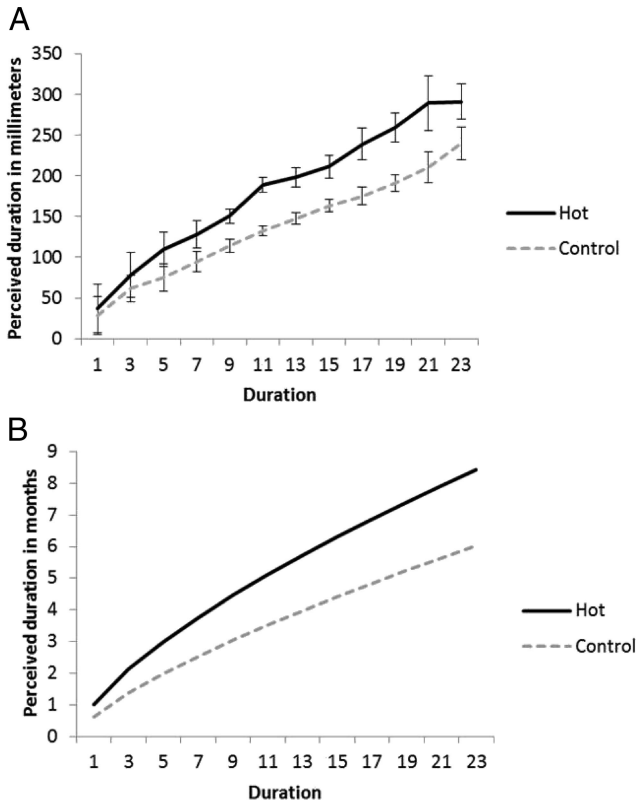

Figure 1. Perceived duration as a function of experimental conditions in Study 1. The graph on the top (A) shows actual mean responses in millimeters, and the graph on the bottom (B) shows estimated psychophysical functions. Error bars represent within-subjects 95% confidence intervals (Cousineau, 2005).

(e.g., unit of time used) that also captured the overall degree of time contraction (i.e., how long or short individuals perceived time to be overall), especially when no difference was present in the degree of nonlinear scaling. The estimated function was $T = .998t^{.68}$ for the hot condition and $T = .61t^{.73}$ for the control condition. The estimated function shows $\beta < 1$ for both conditions, demonstrating diminishing sensitivity to longer durations in time perception (e.g., Stevens' [1957] power law). That is, for both conditions, participants' subjective perception of an equal future duration (e.g., 1 month) became shorter as the total duration grew longer. We also found the β parameter estimates did not differ between conditions, $t(57) = -0.87$, $p = .39$, $\omega^2 = 0$. However, the α parameter values were significantly greater in the hot condition ($\alpha_{hot} = .998$) than in the control condition($\alpha_{control} = .61$), $t(57) = 2.18$, $p < .05$, $\omega^2 = .06$, indicating participants who were exposed to the sexual cue perceived the same future durations to be longer than did those in the control condition.

Study 2

Study 2 further tested the effect of sexual cues on future time perception, but we used human photographs for the control condition (e.g., less arousing photographs of female athletes) instead of photographs of nature. In addition, we implemented several methodological changes, such as the number of photographs presented to each participant, the duration of exposure of each photograph (e.g., fixed interval rather than self-paced as in Study 1), and a time-perception scale (e.g., a more standard line scale rather than a computerized string used in Study 1). These methodological changes were designed to test whether our predicted effect was due to the specific methods used in Study 1.

Method

We sequentially presented 76 self-identified male heterosexual undergraduates with seven photographs of nude females (hot condition; $n = 37$]) or female athletes in swimsuits or athletic clothing (control condition; $n = 39$]). For sexual images, we used photographs from the International Affective Picture System (IAPS; 4008, 4085, 4141, 4180, 4210, 4225, & 4235). Mean arousal rating from the IAPS manual (Lang, Bradley, & Cuthbert, 2008) was 7.16 ($SD = 0.43$) on a 9-point rating scale. We modified some photographs to make parts showing body hair invisible. Pictures of female athletes were sampled through an online search engine and pretested on participants from an online panel ($n = 41$) using the same arousal scale (e.g., Self-Assessment Manikin) detailed in the IAPS manual (Lang et al., 2008). The mean rating of these photographs was 2.58 ($SD = 1.49$) on a 9-point scale.

Participants viewed each photograph for 7 s before being prompted to rate the attractiveness of the woman in the photograph. Next, we measured participants' future time perception for 3 and 6 months (we informed participants about both durations before the task). Specifically, we asked participants to think about a day 3 months in the future and to indicate on a computerized bar scale (anchored by *very short* on the left and *very long* on the right) how long or short they considered the duration from now to that day to be. This scale was about 112 mm long on a 20-inch monitor. At the start, the end of the bar was located at the center of the scale. and participants moved the bar end to the left (short) or right (long) to indicate their perceived duration. No numeric values were presented on the screen. We coded this scale from 0 to 100. Participants repeated the task for 6 months.

Finally, to examine whether the effect of sexual cues is specific to judgment of future time or applies more generally to other magnitude judgments, we measured participants' perception of a line length. Specifically, participants were told, "People subjectively feel the same length of a line to be different. That is, the same length of a line is felt to be longer to some people while shorter to others." Because we could not measure the perceived length of a line using a line scale, which would have led to a length-matching process rather than a subjective assessment of magnitude, we applied a numeric magnitude estimation method (e.g., assigning positive numbers to indicate perceived stimulus intensity; see Gescheider, 1988, for a review). To avoid the possibility that participants would attempt to measure the actual (rather than subjective) length of the line and use it for their responses, we provided a modulus such that they were first given a shorter line (50 mm long on a 20-inch monitor) and asked to assume their subjectively perceived magnitude of the line was equivalent to the number 10. Then we showed participants a target line (148 mm long) and asked them to judge its length by assigning positive numbers compared with the perceived magnitude of the shorter line.

Results and Discussion

A repeated-measures ANOVA with future duration (3 vs. 6 months) as a within-subjects factor and the sexual-cue manipulation (hot vs. control) as a between-subjects factor revealed a significant main effect of the sexual-cue manipulation on future time perception, $F(1, 74) = 5.58$, $p < .05$, $\omega^2 = .06$, indicating those in the hot condition perceived the same future durations to be longer than did those in the control condition. The sexual-cue manipulation by future duration interaction was not significant, $F(1, 74) = 0.02$, $p = .89$, $\omega^2 = 0$, indicating the effect of sexual cues on perception of future time did not differ by duration (3 vs. 6 months). Participants' judgment of a line length was not different across conditions ($M_{hot} = 39.19$, $SD = 13.45$ vs. $M_{control} = 36.26$, $SD = 11.86$), $F(1, 74) = 1.01$, $p = .32$, $\omega^2 = .0001$, suggesting the effect of sexual cues is specific to the time judgments rather than a general effect on any magnitude judgments.[3] See Figure 2.

Study 3

In Study 3, we examined the implications of the time-perception shift for changes in intertemporal preferences. That is, we further tested our theory by examining whether sexual cues impact impatience for money through changes in future time perception. To do so, we extended the paradigm we used in Study 1 to include a third task designed to capture impatience for monetary outcomes.

Method

We randomly assigned 116 self-identified male heterosexual undergraduates to either hot ($n = 64$) or control ($n = 52$) conditions. Keeping the study as close as possible to the prior study reporting the sexual-cue impact on impatience (Van den Bergh et al., 2008), we presented participants in the hot condition with 15 photographs of female models wearing lingerie (taken from the Victoria's Secret online catalog), and presented participants in the control condition with photographs of nature objects (e.g., rocks or trees). All participants then judged 3- and 12-month durations using the computerized string.

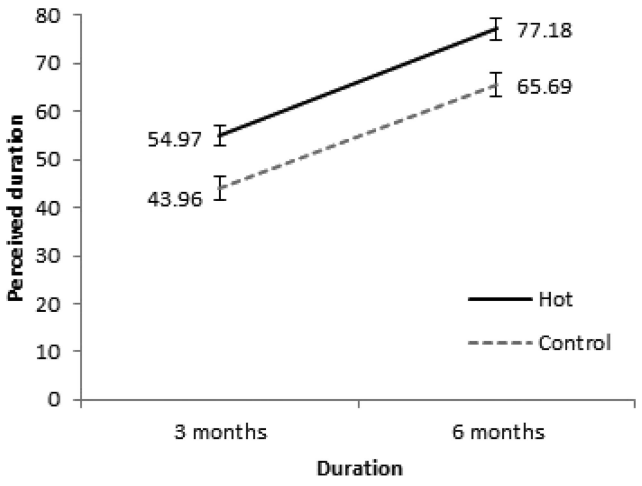

Figure 2. Perceived duration as a function of experimental conditions in Study 2. Error bars represent within-subjects 95% confidence intervals (Cousineau, 2005).

Next, we measured participants' impatience levels, using a standard discounting task. Participants imagined receiving a $65 gift certificate valid on that day and redeemable at any department at Amazon.com. Then they imagined a 3-month delay for the receipt and indicated the dollar amount they would require for having to wait. They repeated this task for a 12-month delay.

Results and Discussion

Because the computerized string generated skewed data, we applied a natural logarithm transformation. A repeated-measures ANOVA with future duration (3 vs. 12 months) as a within-subjects factor and the sexual-cue manipulation as a between-subjects factor revealed a significant main effect of the sexual-cue manipulation on future time perception, $F(1, 114) = 7.29$, $p < .01$, $\omega^2 = .05$, indicating those in the hot condition perceived the same future durations to be longer than did those in the control condition (see Figure 3).[4] The interaction between sexual cue and future duration was again not significant, $F(1, 114) = 1.22$, $p = .27$, $\omega^2 = .002$.

Next, we calculated participants' degree of impatience, using the area under the curve method (Myerson, Green, & Warusawitharana, 2001), which allows us to measure the degree of discounting independent of a specific functional form. In addition, although discount-rate data are often skewed, this method generates normally distributed data, allowing standard statistical tests. Analysis revealed participants in the hot condition were more impatient (requested a greater amount in delayed money) than those in the control condition, $F(1, 114) = 4.09$, $p < .05$, $\omega^2 = .03$. See Figure 4.

We further examined whether participants' future time perception statistically mediated the effect of sexual cues on the degree of impatience (see Preacher & Hayes, 2004, for methodological details). Because participants judged two durations (3 and 12 months), we calculated their perception per month (i.e., we divided responses by the months they judged) and averaged these scores. We computed the effect of the sexual-cue manipulation (0: control, 1: hot) on future time perception ($a = .29$, $p < .01$) and the effect of future time perception on impatience, holding the manipulation constant ($b = -.04$, $p = .08$). The overall effect of the sexual-cue manipulation on impatience was significant ($c = -.06$, $p < .05$) but became insignificant after controlling for the mediator ($c' = -.05$, $p = .12$). The 95% confidence interval (CI) of the "indirect effect"—the effect of the sexual-cue manipulation on impatience through future time perception—did not include zero ($a \times b = -.01$; 95% CI, $-.04$ to $-.001$), indicating changes in time perception account for the effect of sexual cues on impatience.

Study 4

In Study 4, to isolate whether increased impatience due to sexual arousal reported in the literature and observed in Study 3 is driven

[3] A separate group of online panel subjects ($N = 40$) completing the line-judgment task immediately after the manipulation replicated this effect. Line judgment did not differ between hot and control conditions, $F(1, 38) = 0.03$, $p = .86$, $\omega^2 = 0$.

[4] Analysis of raw responses without log transformation revealed similar results, $F(1, 114) = 7.14$, $p < .01$, $\omega^2 = .05$.

by the immediate rewards being *more* attractive (as predicted by the *general motivation system view*) or the delayed rewards being even *less* attractive (as predicted by our *subjective time-perception view*), we separately measured participants' preferences for immediate and delayed rewards and examined whether the attractiveness of the reward changed for one or both of the rewards after the sexual-cue manipulation.

Method

Fifty-four self-identified male heterosexual undergraduates participated in this three-part experiment presented as separate studies: time and money study (A), photo-evaluation study, and time and money study (B). The procedure and materials we used in the photo-evaluation study were similar to those used in Study 3, except for the number of photographs presented (seven in each condition). We administered the time and money studies before and after the photo-evaluation study (A before and B after). In these tasks, participants predicted their happiness upon receiving the monetary rewards separately for immediate ("today") and delayed ("1 month from now") rewards. Specifically, participants imagined they had recently won a raffle with a $100 cash prize scheduled to arrive that day, and, using a computerized string similar to the scale used in Studies 1 and 3, indicated how happy they would be if they received and spent the $100 that same day. They then repeated the task for the delayed-rewards scenario.

Results and Discussion

For consistency with our analyses of time estimates using this same measurement scale, we log-transformed happiness ratings measured using a computerized string.[5] A repeated-measure ANOVA of happiness ratings measured before the sexual-cue manipulation, with the manipulation (sexual vs. nature images) as a between-subjects factor and the timing of rewards (immediate vs. delayed) as a within-subjects factor, revealed no main effect of the sexual-cue manipulation, $F(1, 52) = 0.54$, $p = .47$, $\omega^2 = 0$, or

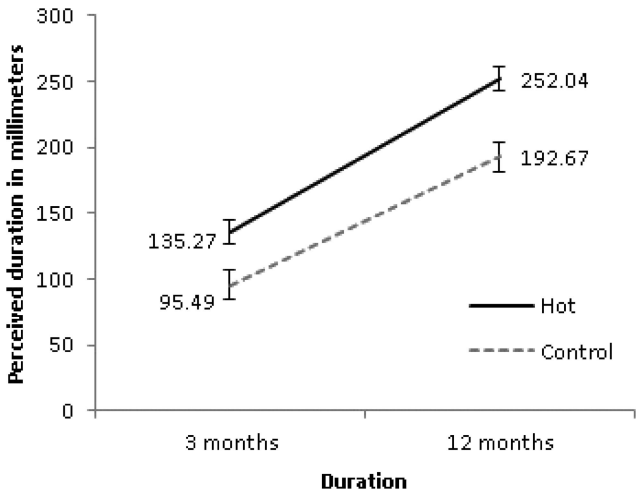

Figure 3. Perceived duration in millimeters as a function of experimental conditions in Study 3. Error bars represent within-subjects 95% confidence intervals (Cousineau, 2005).

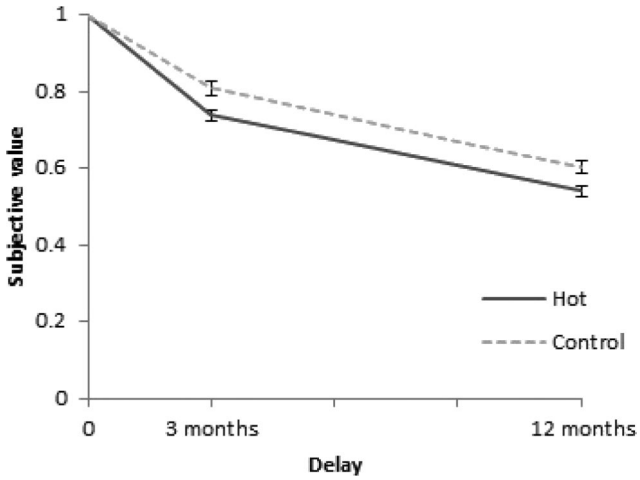

Figure 4. Discounted subjective value as a function of experimental conditions in Study 3. Values in ordinate indicate the proportion the value of a gift certificate is discounted by delays (1 = no discounting). The area under each curve indicates how much an outcome is discounted by its delay (Myerson et al., 2001). When no discounting occurs, the area under the curve is 1. Error bars represent within-subjects 95% confidence intervals (Cousineau, 2005).

sexual cue by timing of rewards interaction, $F(1, 52) = 0.004$, $p = .95$, $\omega^2 = 0$, indicating participants did not differ in their baseline happiness for receiving monetary rewards. Demonstrating that delayed outcomes were discounted, a significant main effect emerged for the timing of rewards, $F(1, 52) = 11.68$, $p < .001$, $\omega^2 = .17$, with expected happiness being higher for immediate (overall $M = 138.83$ mm, $SD = 83.73$) than for delayed monetary rewards (overall $M = 104.07$ mm, $SD = 59.14$).

Next we examined whether the sexual-cue manipulation affected happiness over receiving immediate or delayed monetary rewards or both. A three-factor repeated measure ANOVA on happiness ratings, with the sexual-cue manipulation as a between-subjects factor and both timing of rewards (immediate vs. delayed) and timing of measurement (before vs. after the manipulation) as within-subjects factors, revealed a significant three-way interaction of sexual-cue manipulation, timing of reward, and timing of measurement, $F(1, 51) = 3.92$, $p = .05$, $\omega^2 = .05$. To explore the nature of the three-way interaction, we performed a two-factor ANOVA separately for immediate rewards and delayed rewards.

First, we performed a repeated measure ANOVA, with the sexual-cue manipulation as a between-subjects factor and timing of measurement (before vs. after the manipulation) as a within-subjects factor, on happiness ratings for *immediate* monetary rewards (see the left graph in Figure 5). This analysis did not reveal a main effect of timing of measurement, $F(1, 51) = 2.26$, $p = .14$, $\omega^2 = .02$, a main effect of the sexual cue, $F(1, 51) = 0.21$, $p = .67$, $\omega^2 = 0$, or the interaction of sexual cue and timing of measurement, $F(1, 51) = 1.09$, $p = .30$, $\omega^2 = .002$. This nonsignificant interaction effect for immediate monetary rewards indicates the

[5] One response of zero value was treated as missing for the analysis using log transformation. All results are similar without log transformation that includes this missing value.

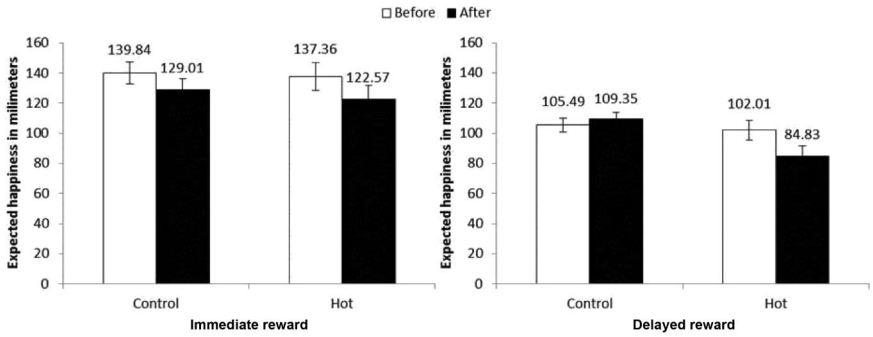

Figure 5. Expected happiness before and after the sexual-cue manipulation as a function of experimental conditions in Study 4. Error bars represent within-subjects 95% confidence intervals (Cousineau, 2005).

sexual-cue manipulation did not change participants' happiness about immediate rewards, thus failing to support the general motivation system account.

Second, we performed a two-factor ANOVA with the sexual-cue manipulation as a between-subjects factor and timing of measurement as a within-subjects factor on happiness ratings for *delayed* monetary rewards (see the right graph in Figure 5). Neither a main effect of timing of measurement, $F(1, 52) = 1.50$, $p = .23$, $\omega^2 = .01$, nor a main effect of the manipulation $F(1, 52) = 1.48$, $p = .21$, $\omega^2 = .01$, was significant. Importantly, the two-way interaction of sexual cue with timing of measurement for happiness ratings was significant, $F(1, 52) = 4.54$, $p < .05$, $\omega^2 = .06$, driving the three-way interaction.[6] Specifically, for delayed monetary rewards, participants in the hot condition demonstrated decreased happiness after the manipulation ($M_{before} = 102.01$ mm, $SD = 57.76$ vs. $M_{after} = 84.83$ mm, $SD = 48.89$), $F(1, 52) = 4.74$, $p < .05$, $\omega^2 = .06$,[7] whereas happiness ratings in the control condition were the same before and after the manipulation ($M_{before} = 105.49$ mm, $SD = 60.95$ vs. $M_{after} = 109.35$ mm, $SD = 60.13$), $F(1, 52) = 0.50$, $p = .48$, $\omega^2 = 0$.

Supporting our hypothesis that sexual cues induce impatience by making delayed rewards seem even less attractive, we found that preference for delayed rewards decreased after the sexual-cue presentation, but immediate rewards did not become more attractive. Although we did not find support for the prediction of the general motivation system that attractiveness of the immediate rewards increases after sexual cues, we do not claim that in all cases the general reward system does not lead to impatience by favoring the immediately available rewards. We conjecture the specific type of outcome would matter. The hypothetical monetary rewards we used are relatively psychologically distant and thus might not be sufficiently attractive to induce greater desire after the sexual-cue manipulation. That is, use of more emotional or appetitive rewards such as foods might show results more consistent with the general motivation system view than what we found in this study.

Study 5

In Study 5, we examined whether the effect of sexual cues on future time perception is driven by the rewarding value of sexual cues or by the arousing nature of sexual cues. For this purpose, we compared the effect of sexual cues with that of other arousing images (i.e., fear-inducing images) on future time perception.

Method

We randomly assigned 180 self-identified male heterosexuals from an online panel to either the hot ($n = 55$), athlete (control; $n = 61$), or arousal conditions ($n = 64$). Similar to Study 2, we sequentially presented participants in the hot or control conditions with seven photographs of nude females (IAPS picture numbers: 4008, 4090, 4225, 4250, 4659, 4668, & 4698) or female athletes in swimsuits or athletic clothing (see Study 2). We presented participants in the arousal conditions with seven arousing photographs taken from IAPS (3530, 6230, 6260, 6350, 6550, 6563, & 9940). We included arousing pictures that did not differ from sexual cues in their arousal ratings reported in the IAPS manual, $t(12) = 0.86$, *ns*, but that did differ in their emotional-valence ratings ($M_{hot} = 7.59$, $SD = 0.50$ vs. $M_{arousal} = 2.46$, $SD = 0.49$), $t(12) = 19.27$, $p < .001$. That is, the pictures in the arousal condition were as arousing as the pictures in the hot condition, but negative in valence. For example, one of the arousing photographs showed a scene of a woman being threatened by a man with a knife. We presented each of these photographs for 7 s. As some photograph in the arousal condition did not show a woman, participants in all conditions rated the quality of each picture instead of the attractiveness of the woman shown in the picture (11 point scale: 1 = *very poor*, 11 = *very good*). Participants then judged two future durations (3 and 6 months) using the same line scale as in Study 2.

Results and Discussion

A repeated-measure ANOVA with the duration judged (3 vs. 6 months) as a within-subjects factor and the type of photographs as a between-subjects factor revealed only a main effect of the photograph manipulation, $F(2, 177) = 4.93$, $p < .01$, $\omega^2 = .02$, and no manipulation by duration interaction, $F(2, 177) = 0.03$, $p = .97$, $\omega^2 = 0$. A planned contrast revealed a significant time-perception difference between hot and athlete conditions, $F(1, 177) = 9.62$, $p < .01$, $\omega^2 = .05$, and between arousal and athlete conditions, $F(1, 177) = 3.78$, $p = .05$, $\omega^2 = .02$. However, time perception did not differ between hot and arousal conditions, $F(1, 177) = 1.55$, $p = .22$, $\omega^2 = .003$. See Figure 6.

[6] Without log transformation, $F(1, 52) = 7.04$, $p = .01$, $\omega^2 = .10$.

[7] Without log transformation, $F(1, 52) = 7.92$, $p < .01$, $\omega^2 = .11$.

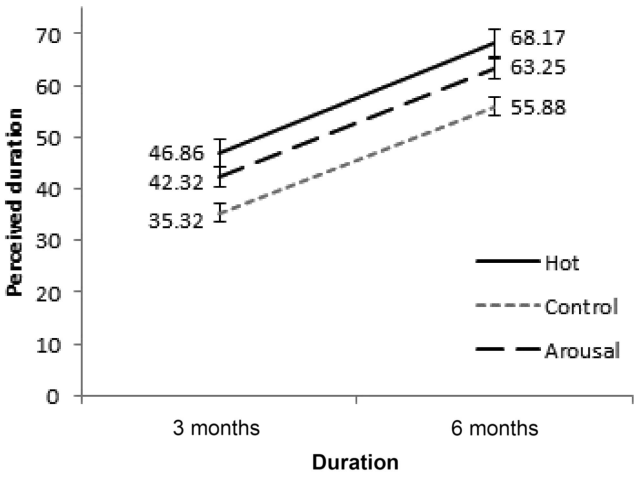

Figure 6. Perceived duration as a function of experimental conditions in Study 5. Error bars represent within-subjects 95% confidence intervals (Cousineau, 2005).

Our results show that participants exposed to sexual cues judged future time as being of similar duration as did those exposed to negative-valence images and judged the same future time to be longer than did those exposed to female athletes (control). These results suggest physiological arousal alone may be sufficient to change future time perception. We further discuss the implication of these results in the general discussion.

General Discussion

In this article, we proposed and demonstrated that sexual cues induce impatience by influencing the *perceived distance* to delayed rewards, suggesting that sexual cues increase individuals' impatience via two distinct pathways: one, established in prior work, enhances desire for *immediate* rewards via a generalized reward system; the other, the focus of our work, decreases the perceived value of *delayed* rewards by influencing future time perception such that every future delay seems even further away.

Our results also suggest that differences in impatience that the intertemporal choice literature has reported may, at least partly, be attributable to differences in future time perception. Prior studies have found substance abusers are more impatient for monetary outcomes than are normal controls (Bickel, Odum, & Madden, 1999; Kirby & Petry, 2004; Madden, Petty, Badger, & Bickel, 1997; Mitchell, 1999) and that smokers judge the time remaining until they can smoke to be longer when they are craving nicotine (Sayette, Loewenstein, Kirchner, & Travis, 2005). Together, these lines of research suggest substance abusers may show impatience for money, not only because their visceral states directly change the value of the target reward, but because their perception of waiting time is subjectively expanded. Future research may address this and other variables previously shown to predict individual differences in impatience, such as age, education, income, and intelligence.

One remaining question is the exact process by which arousal influences future time perception. Prior research demonstrating the impact of arousal on elapsed time perception has attributed the effect to the changes in the speed of the internal clock (e.g., Maricq et al., 1981): When individuals are aroused, their internal clocks speed up, generating more pulses accumulated for the same elapsed time (i.e., more time units must be counted for the same duration). However, because judgments of short elapsed time are different from those of long future time, the process involving the speed of the internal clock is unlikely to underlie the observed effect of sexual cues on future time perception. We conjecture that two processes might drive this effect.

The first possible mechanism relates to the link between judgments of elapsed time and judgments of future time. Although the working of the internal clock may not govern future time perception directly, individuals' perception of time currently passing may be used as a perceptual input and guide their perception of future time. For instance, individuals who feel time is passing quickly may judge the same future time to be shorter compared with those who feel time is passing slowly. Then arousing stimuli, which influence individuals' perception of current time passage, may indirectly influence future time perception.

The second possible mechanism centers on the role of arousal in shifting temporal attention. Arousal involves activation of the autonomic nervous system (Mandler, 1975), which prompts an organism to act promptly and appropriately for its survival (Levenson, 1988). Arousal also induces a narrow and focused attention process (Easterbrook, 1959). Therefore, in the case of future time perception, physiological activation may narrow individuals' temporal attention to the present while decreasing the attention focused on the future, and as a result, the future seems more distant when individuals are physiologically activated. We believe that both of these processes—indirect input from elapsed time perception and narrowed temporal attention—might be involved in the sexual-cue effects on future time perception. In future research, investigators may systematically examine how these and other possible mechanisms influence future time perception.

Finally, we acknowledge some limitations of the current research. Study 5 provides initial support that arousal might be sufficient to explain the effect of sexual cues on future time perception. However, in this study, we compared sexual cues to negative arousal only. Future research might better isolate this effect and determine whether positive and negative arousal operate similarly, as well as whether the specific source of that arousal produces unique effects (sexual, fear, excitement, and so on). In terms of the implications for intertemporal preferences, in our studies, we used only hypothetical outcomes. Although we cannot rule out the possibility that people may behave differently when real money is at stake, empirical studies comparing intertemporal preferences for real and hypothetical outcomes have not found relevant systematic differences (Johnson & Bickel, 2002; Madden, Begotka, Raiff, & Kastern, 2003). However, even if intertemporal preferences might change due to the type of outcomes, our subjective time-perception account of sexual-cue effects on impatience should hold, because our process does not rely on valuation of outcomes, but only on perception of future time. Thus we expect that the use of hypothetical monetary outcomes does not undermine our findings. Use of real money, which is more rewarding, might show an effect of sexual arousal on increasing preferences for immediate outcome, a result we did not find in our studies.

In conclusion, the current studies provide consistent evidence that sexual cues induce impatience by influencing the perceived temporal distance to delayed rewards, thereby decreasing the perceived value of delayed rewards, resulting in higher impatience.

Our results further suggest that the perception of future time might play an important role in other previously established and new phenomena in intertemporal choice.

References

Aharon, I., Etcoff, N., Ariely, D., Chabris, C. F., O'Conner, E., & Breiter, H. C. (2001). Beautiful faces have variable reward value: FMRI and behavioral evidence. *Neuron, 32,* 537–551. doi:10.1016/S0896-6273(01)00491-3

Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin, 82,* 463–496. doi:10.1037/h0076860

Ainslie, G. (1992). *Picoeconomics.* Cambridge, England: Cambridge University Press.

Ariely, D., & Loewenstein, G. F. (2006). The heat of the moment: The effect of sexual arousal on sexual decision making. *Journal of Behavioral Decision Making, 19,* 87–98. doi:10.1002/bdm.501

Bechara, A. (2005). Decision making, impulse control and loss of willpower to resist drugs: A neurocognitive perspective. *Nature Neuroscience, 8,* 1458–1463. doi:10.1038/nn1584

Bickel, W. K., Odum, A. L., & Madden, G. J. (1999). Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology, 146,* 447–454. doi:10.1007/PL00005490

Blanton, H., & Gerrard, M. (1997). Effects of sexual motivation on men's risk perception for sexually transmitted disease: There must be 50 ways to justify a lover. *Health Psychology, 16,* 374–379. doi:10.1037/0278-6133.16.4.374

Cousineau, D. (2005). Confidence intervals in within-subject designs: A simpler solution to Loftus and Masson's method. *Tutorials in Quantitative Methods for Psychology, 1,* 42–45.

Droit-Volet, S., Brunot, S., & Niedenthal, P. M. (2004). Perception of the duration of emotional events. *Cognition and Emotion, 18,* 849–858. doi:10.1080/02699930341000194

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behaviour. *Psychological Review, 66,* 183–201. doi:10.1037/h0047707

Epstein, M., & Florentine, M. (2005). A test of the equal-loudness-ratio hypothesis using cross-modality matching functions. *Journal of the Acoustical Society of America, 118,* 907–913. doi:10.1121/1.1954547

Gescheider, G. A. (1988). Psychophysical scaling. *Annual Review of Psychology, 39,* 169–200. doi:10.1146/annurev.ps.39.020188.001125

Johnson, M. W., & Bickel, W. K. (2002). Within-subject comparison of real and hypothetical money rewards in delay discounting. *Journal of the Experimental Analysis of Behavior, 77,* 129–146. doi:10.1901/jeab.2002.77-129

Keren, G., & Lewis, C. (1979). Partial omega squared for ANOVA designs. *Educational and Psychological Measurement, 39,* 119–128. doi:10.1177/001316447903900116

Kim, B. K., & Zauberman, G. (2009). Perception of anticipatory time in temporal discounting. *Journal of Neuroscience, Psychology, and Economics, 2,* 91–101. doi:10.1037/a0017686

Kirby, K. N., & Petry, N. M. (2004). Heroin and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. *Addiction, 99,* 461–471. doi:10.1111/j.1360-0443.2003.00669.x

Knutson, B., Westdorp, A., Kaiser, E., & Hommer, D. (2000). FMRI visualization of brain activity during a monetary incentive delay task. *NeuroImage, 12,* 20–27. doi:10.1006/nimg.2000.0593

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual* (Technical Report A–8). Gainesville, FL: University of Florida.

Levenson, R. W. (1988). Emotion and the autonomic nervous system: A prospectus for research on autonomic specificity. In H. Wagner (Ed.), *Social psychophysiology and emotion: Theory and clinical applications* (pp. 17–42). London, England: Wiley.

Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology, 11,* 139–145. doi:10.1037/1064-1297.11.2.139

Madden, G. J., Petty, N. M., Badger, G. J., & Bickel, W. K. (1997). Impulsive and self-control choices in opioid-dependent patients and non-drug-using control participants: Drug and monetary rewards. *Experimental and Clinical Psychopharmacology, 5,* 256–262. doi:10.1037/1064-1297.5.3.256

Mandler, G. (1975). *Mind and emotion.* New York, NY: Wiley.

Maricq, A. V., Roberts, S., & Church, R. M. (1981). Methamphetamine and time perception. *Journal of Experimental Psychology: Animal Behavior Processes, 7,* 18–30. doi:10.1037/0097-7403.7.1.18

Matell, M. S., King, G. R., & Meck, W. H. (2004). Differential modulation of clock speed by the administration of intermittent versus continuous cocaine. *Behavioral Neuroscience, 118,* 150–156. doi:10.1037/0735-7044.118.1.150

Meck, W. H. (1996). Neuropharmacology of timing and time perception. *Cognitive Brain Research, 3,* 227–242. doi:10.1016/0926-6410(96)00009-2

Mitchell, S. H. (1999). Measures of impulsivity in cigarette smokers and non-smokers. *Psychopharmacology, 146,* 455–464. doi:10.1007/PL00005491

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior, 76,* 235–243. doi:10.1901/jeab.2001.76-235

Preacher, K. J., & Hayes, A. W. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, and Computers, 36,* 717–731. doi:10.3758/BF03206553

Sayette, M. A., Loewenstein, G., Kirchner, T. R., & Travis, T. (2005). Effects of smoking urge on temporal cognition. *Psychology of Addictive Behaviors, 19,* 88–93. doi:10.1037/0893-164X.19.1.88

Stark, R., Schienle, A., Girod, C., Walter, B., Kirsch, P., Blecker, C., . . . Vaitl, D. (2005). Erotic and disgust-inducing pictures: Differences in the hemodynamic responses of the brain. *Biological Psychology, 70,* 19–29. doi:10.1016/j.biopsycho.2004.11.014

Stetson, C., Fiesta, M. P., & Eagleman, D. M. (2007). Does time really slow down during a frightening event? *PLoS ONE, 2,* e1295. doi:10.1371/journal.pone.0001295

Stevens, S. S. (1957). On the psychophysical law. *Psychological Review, 64,* 153–181. doi:10.1037/h0046162

Thut, G., Schultz, W., Roelcke, U., Nienhusmeier, M., Missimer, J., Maguire, R. P., & Leenders, K. L. (1997). Activation of the human brain by monetary reward. *Neuroreport, 8,* 1225–1228. doi:10.1097/00001756-199703240-00033

Van den Bergh, B., Dewitte, S., & Warlop, L. (2008). Bikinis instigate generalized impatience in intertemporal choice. *Journal of Consumer Research, 35,* 85–97. doi:10.1086/525505

Wilson, M., & Daly, M. (2004). Do pretty women inspire men to discount the future? *Proceedings of the Royal Society London, Series B: Biological Sciences, 271,* S177–S179. doi:10.1098/rsbl.2003.0134

Wittmann, M. (2009). The inner experience of time. *Philosophical Transactions of the Royal Society London, Series B: Biological Sciences, 364,* 1955–1967. doi:10.1098/rstb.2009.0003

Zauberman, G., Kim, B. K., Malkoc, S., & Bettman, J. R. (2009). Time discounting and discounting time. *Journal of Marketing Research, 46,* 543–556. doi:10.1509/jmkr.46.4.543

Received February 17, 2011
Revision received May 11, 2012
Accepted May 11, 2012 ■