

Can Victoria's Secret change the future?  
A subjective time perception account of sexual cue effects on impatience

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## SUBJECTIVE TIME PERCEPTION AND IMPATIENCE

### Abstract

Sexual cues influence decisions not only about sex, but also about unrelated outcomes such as money. Previous research has emphasized the power of sexual cues to induce a strong general psychological desire to obtain all available rewards. In the case of money, that motivated appetite would enhance the perceived value of *immediate* monetary rewards. We propose a different psychological mechanism to explain this effect: the induction of impatience by sexual cues through their ability to lengthen the perceived temporal distance to *delayed* rewards. That is, sexual cues make the wait seem subjectively longer, resulting in greater impatience for the delayed monetary reward. Our findings support this mechanism, demonstrating that “hot” cues can work through a “cold” cognitive process to shape intertemporal preferences.

*Keywords: sexual cue, time discounting, impatience, time perception*

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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 in a non-aroused state (Ariely & Loewenstein, 2006; Blanton & Gerrad, 1997). Research has further showed that the effect of sexual cues on decision-making extends beyond sexual behavior to seemingly unrelated financial decisions. Men asked to rate 'hot' (physically attractive) females showed greater *impatience* when making intertemporal tradeoff decisions for monetary outcomes, choosing smaller immediate amounts over larger delayed amounts (Van den Bergh, Dewitte, & Warlop, 2008; Wilson & Daly, 2003).

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 these effects are important to understand, 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 under-saving for retirement to problems with self-control such as overeating and addiction (Ainslie, 1975; 1992).

The current explanation for the effect of sexual cues on impatience centers on a general motivation system (Van den Bergh et al., 2008; Wilson and Daly, 2003). The human motivation system processes various rewarding stimuli similarly (Aharon et al., 2001; Knutson et al., 2000; Stark et al., 2005; Thut et al., 1997). Thus, heightened appetitive responses to rewarding cues in one domain might generally foster an approach toward other rewards. Although this general motivation system view predicts increased impatience for monetary outcomes in the presence of sexual cues, it only provides partial explanation for greater impatience in intertemporal decisions,

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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 is a simple but important point, because it implies that when sexual cues affect impatience to get 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 aim to demonstrate that sexual cues induce impatience not only by changing the *perceived value* of immediate rewards, but also by influencing the *perceived temporal distance* to delayed rewards.

Recent findings in intertemporal choice literature suggest that individuals' intertemporal preference may simply be driven by how long or short they perceive delays to be (Kim & Zauberman, 2009; Zauberman et al., 2009; Wittmann & Paulus, 2007). In the context of the current article, it implies that any changes in time perception in the presence of sexual cues will be reflected in individuals' relative preferences for immediate versus delayed outcomes, by influencing perceived temporal distance to delayed outcomes. That is, if individuals perceive the same prospective durations to be longer once exposed to sexual cues, they will be more impatient as reflected in intertemporal choice of monetary rewards, compared with individuals who are not exposed to these cues.

Although emotionally arousing images have been shown to increase the perception of time (Droit-Volet, Brunot, & Niedenthal, 2004; Thayer & Schiff, 1975; Watts & Sharrock, 1984), these results do not directly apply to the current research because they involve the perception of

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elapsed time (time that has actually passed), whereas our interest is in future time that has not yet passed (time that have yet to be experienced), about which very little research exists. But there are theoretical reasons to expect that they are related. Even if we assume that future time is a purely abstract construct, not governed by the same process governing the perception of elapsed time (such as an internal clock), judgment of abstract information (in this context, future time) has been shown to be influenced by individual experiences in related more concrete domains (Lakoff & Johnson, 1999; Landua, Meier, & Keefer, 2010). When individuals judge future time, their perceptions of current or elapsed time constitute the most relevant temporal inputs that can be used to form their perception of future time. Therefore, arousing stimuli (such as sexual cues), which have been shown to affect the perception of elapsed time, may also influence future time judgment.

To explore this prediction, study 1 tested whether sexual cues lead prospective durations to be perceived as longer. Study 2 further tested whether the impact of sexual cues on impatience for money could be explained by these changes in time perception. Study 3 directly measured preference for immediate and delayed rewards separately and examined whether sexual cues indeed decreased preference for delayed rewards.

### **Study 1**

Study 1 examined whether sexual cues change future time perception. We estimated a psychophysical function of future time perception and tested whether sexual cues make future durations perceived as longer overall.

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### Method

Fifty-nine self-reported heterosexual male undergraduates were randomly assigned to either hot or neutral conditions. They were presented with two separate studies. In the photo evaluation study, participants were sequentially presented with 15 photographs of neutral objects or female models wearing lingerie (taken from the Victoria's Secret online catalogue), and indicated how attractive the person or object in the photograph was on an 11-point scale (1-not attractive at all, 11-very attractive). In the time perception study, participants' subjective time perception was measured for 12 durations ranging from 1 month to 23 months, presented in random order for each participant, by their adjusting a length of a computerized physically-unbounded line scale.

### Results and Discussion

The measured length of the line scale was transformed into month units by setting the overall mean distance for the 1-month duration as the baseline unit for the subjective perception made by each participant (e.g., all responses were divided by 32.71mm; see Table 1 for raw data). This transformation allowed for easier interpretation and did not influence any of the statistical analyses or results.

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 Insert Table 1 about here  
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We fitted the subjective time perception data using a power function (Stevens, 1957).

$$T = \alpha \cdot t^\beta$$

The  $\beta$ -parameter in the above equation captures the degree of a non-linear scaling in subjective time perception. The  $\alpha$ -parameter is a scaling parameter (e.g., unit of time used) that also captured the overall degree of time contraction (i.e., how long or short individuals perceived

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time to be overall), especially when there was no difference in the degree of non-linear scaling.

The resulting estimated non-linear functions were (see also Figure 1):

$$\text{Hot condition: } T=1.0t^{.68}$$

$$\text{Neutral condition: } T=.61t^{.73}$$

First, we observe that  $\beta < 1$  for both conditions, demonstrating non-linear scaling in time perception (e.g., Stevens' Power Law). That is, for both conditions, participants' subjective perception of an equal duration (e. g., 1 month) became shorter as the total duration grew longer. More importantly, we found that the  $\beta$ -parameter estimates did not differ between conditions,  $t(57)=-.87, p=.39$ . However, the  $\alpha$ -parameter values were significantly greater in the hot condition than in the neutral condition,  $t(57)=2.18, p=.03$ , indicating that participants who were exposed to the sexual cue perceived the same future durations to be longer compared to those in the neutral condition.

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 Insert Figure 1 about here  
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### Study 2

In study 2, we further test our theory by examining how sexual cues altered time perception, increasing impatience for monetary rewards. We did this by extending the paradigm we used in study 1 to include a third task designed to capture impatience for monetary outcomes.

#### Method

One hundred and sixteen self-reported male heterosexuals participated in the experiment consisted of three parts: a photo evaluation study, a time perception study, and a gift certificate study. The procedure and materials utilized in the photo evaluation study were similar to those used in study 1. In the time perception study, all participants indicated the magnitude of the

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perceived duration (3 and 12 months) by adjusting the length of an unbounded line scale. In the gift certificate study, which was designed to measure participants' impatience levels (Thaler, 1981), participants imagined receiving a \$65 gift certificate valid on that day and redeemable at any department at Amazon.com, and indicated the gift certificate dollar amount they would require instead if they had to wait for it for 3 months (and 12 months).

### Results and Discussion

As in study 1, the physical length of the line scale was transformed into month units by setting the mean distance for the 3-month duration as the basic unit for the subjective estimates made by each participant ( $M_{3\text{ month}}=117.44\text{mm}$ ). A repeated measures ANOVA with future duration (3 vs. 12 months) as a within-subjects factor and the experimental manipulation (sexual cues vs. neutral images) as a between-subjects factor revealed a significant main effect of the sexual cue manipulation on subjective time estimates,  $F(1,114)=7.14, p<.01$ , indicating that those in the hot condition perceived the same future durations to be longer than those in the neutral condition (see Table 2). The sexual cue by future duration interaction, which tests the difference in the diminishing sensitivity to future time, was again not significant,  $F(1,114)=1.77, p>.19$ . That is, participants were not different in terms of the diminishing sensitivity to time but different only in how long or short they perceived future time to be in general.

Next, participants' degree of impatience was calculated based on the following hyperbolic discount function (Mazur, 1994):

$$\delta(t) = \frac{1}{(1 + kt)}$$

Higher values of  $k$  indicate that individuals were more impatient (i.e., they preferred to receive a smaller reward immediately rather than wait for a larger but delayed reward). Because  $k$  values are not normally distributed, a natural-logarithm transformation was applied. Analysis

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revealed that participants in the hot condition discounted delayed rewards more steeply ( $\ln(k)=1.63$ ) than those in the neutral condition ( $\ln(k)=1.04$ ),  $t(114)=2.02, p<.05$ . That is, participants who rated the photographs of female models in lingerie requested a greater amount in delayed money compared with those who rated neutral photographs. Importantly, using the bootstrapping method (Preacher & Hayes, 2004), we confirmed that participants' subjective time perception statistically mediated the effect of sexually arousing images on the degree of impatience (see Figure 2 for details).

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 Insert Table 2 and Figure 2 about here  
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### Study 3

The standard temporal discounting approach of measuring a relative intertemporal preference, applied in most intertemporal choice literature as well as in our study 2, does not allow us to isolate whether increased impatience is driven by the immediate outcome looking *more* attractive or the delayed outcome looking even *less* attractive. Therefore, in study 3, we measured participants' preference for immediate and delayed rewards separately by asking them to indicate predicted happiness from receiving money when it was immediate or delayed, and examined whether predicted happiness changed for one or both of the rewards after the sexual cue manipulation.

### Method

Fifty-four self-reported heterosexual male undergraduates participated in this experiment with three parts presented as separate studies: a time and money (1), a photo evaluation study, and a time and money (2). The procedure and materials used in the photo evaluation study were similar to those used in studies 1 and 2. In time and money studies that were administered before

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and after the photo evaluation study, each participant's predicted happiness upon receiving monetary rewards was measured separately for immediate ("today") and delayed ("one month from now") rewards. Specifically, participants imagined that they recently won a raffle with a \$100 cash prize scheduled to arrive on that day, and indicated how happy they would be if they received and spent the \$100 on that same day. They indicated their happiness by manipulating a computerized horizontal line similar to the line scale used in studies 1 and 2, such that if they thought the magnitude of happiness to be high, then they pulled the line to the length they felt expressed that magnitude. They repeated a similar task for the scenario of receiving the cash prize one month later.

### Results and Discussion

Responses of happiness using the computerized line scale were coded in millimeters (overall  $M=117.15\text{mm}$ ,  $SD=73.01\text{mm}$ ). A repeated measure ANOVA on happiness ratings before the sexual cue manipulation, with the manipulation (sexual vs. neutral images) as a between-subjects factor and the timing of rewards (immediate vs. one month later) as a within-subjects factor, revealed no main effect of the sexual cue manipulation,  $F(1, 52)<1$ , or sexual cue by timing of rewards interaction,  $F(1, 52)<1$ , indicating that participants were not different in their happiness over receiving monetary rewards prior to the sexual cue manipulation. However, demonstrating that delayed outcomes were discounted, there was a significant main effect for the timing of rewards,  $F(1, 52)=17.3$ ,  $p<.001$ , with expected happiness being higher for immediate monetary reward ( $M=138.83\text{mm}$ ) than for delayed monetary reward ( $M=104.07\text{mm}$ ).

Next, we examined whether the sexual cue manipulation changed happiness over receiving immediate, delayed monetary reward, or both. A repeated measure ANOVA on happiness ratings, with the sexual cue manipulation (sexually arousing vs. neutral images) as a

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between-subjects factor, and both timing of rewards (immediate vs. one month later) and timing of measurement (before vs. after the manipulation) as within-subjects factors, revealed a marginally significant sexual cue manipulation by timing of reward by timing of measurement interaction ( $F(1, 52)=3.07, p<.09$ ). Importantly, this three-way interaction was driven by a significant sexual cue by timing of measurement interaction for happiness ratings for *delayed* monetary rewards ( $F(1, 52)=7.04, p=.01$ ). Specifically, for delayed monetary rewards, participants in the sexual cue condition demonstrated decreased happiness after the manipulation ( $M_{before}=102.01$ mm vs.  $M_{after}=84.83$ mm;  $F(1, 52)=7.92, p<.01$ ), while happiness ratings in the neutral condition were not difference before and after the manipulation ( $M_{before}=139.84$ mm vs.  $M_{after}=129.01$ mm;  $F(1, 52)<1$ ). For immediate monetary rewards, however, neither a main effect of the sexual cue ( $F(1, 52)<1$ ) nor the sexual cue by timing of measurement interaction was revealed ( $F(1, 52)<1$ ), indicating that participants' happiness about immediate monetary rewards was not significantly changed by the sexual cue manipulation.

Supporting our hypothesis that sexual cues generate impatience by making delayed rewards seem even less attractive, we found that preference for delayed rewards decreased after the sexual cue presentation. However, we did not find, find support for the prediction of the general motivation system as a driver for the sexual cue impact on impatience. This is not to claim that the general reward system does not favor the immediately available rewards. Although speculative, we conjecture that the specific type of outcome (e.g., hypothetical money) would matter in those pathways. That is, hypothetical monetary rewards are still relatively psychologically distant even when presented as immediate rewards, and thus they might not be sufficiently attractive to induce greater desire after the sexual cue manipulation

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**General Discussion**

In this article, we propose and demonstrate that the effect of sexual cues on impatience for monetary outcomes can be explained, at least in part, by changes in time perception, rather than by a stronger desire for immediate money alone. That is, sexual cues induce impatience not only by changing the *perceived value* of immediate rewards, but also by influencing the *perceived distance* to delayed rewards. Taken together with the previous research, our results confirm that at least two distinct pathways that could increase individuals' impatience: one a relatively more "hot" pathway enhancing desire for *immediate* rewards via a generalized reward system, and the other a relatively more "cold" pathway decreasing the perceived value of *delayed* rewards by influencing time perception.

Our results also offer further intriguing implications for future behavioral and neuroimaging research. Neuroimaging studies of intertemporal choice examined the neural correlates proposed by competing theories. Some theories proposed a dual value system in which different brain regions are associated separately with immediate and delayed outcomes (McClure et al., 2004; McClure et al., 2007; Tanaka et al., 2004). That is, in broad terms, the limbic system is associated with valuation of immediate rewards whereas the prefrontal cortex is more involved with valuation of delayed rewards. More recent work challenges this dual-value system interpretation by demonstrating that a relative preference between immediate and delayed outcome is directly represented in certain brain regions, pointing to a single value system (Kable & Glimcher, 2007). Although the current findings may appear to support the dual value system, it is not necessarily the case. These neurobiological findings are about neural correlates representing intertemporal preference (or discounting as the end state of intertemporal decisions), while the current research is about *processes* leading to the end state of preference. That is,

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sexual cues can influence intertemporal preference in multiple ways, via a general motivation system or subjective time perception, whereas a given brain region may be associated with the representation of the resulting aggregated intertemporal preference rather than representing preference separately for immediate and delayed rewards. In this sense, the current research is more in line with two systems view of psychological processes in decision-making (Metcalf & Mischel, 1999; Shiv & Fedorikhin, 1999) than with the dual-value system of intertemporal preference. But we leave to future research the question of how these multiple psychological processes view relate to a single or dual value systems in the brain.

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Table 1

*Time Perception in Months (And In Millimeters) As a Function of Experimental Conditions*

Duration	Hot condition	Neutral condition
1 month	1.13 months $\pm$ .76 (37.04 mm $\pm$ 24.75)	.88 months $\pm$ .43 (28.80 mm $\pm$ 14.08)
3 months	2.39 months $\pm$ 1.67 (78.09 mm $\pm$ 54.66)	1.89 months $\pm$ 1.44 (61.93 mm $\pm$ 47.25)
5 months	3.35 months $\pm$ 1.76 (109.68 mm $\pm$ 57.42)	2.30 months $\pm$ 1.25 (75.16 mm $\pm$ 40.96)
7 months	3.91 months $\pm$ 2.05 (127.80 mm $\pm$ 66.98)	2.89 months $\pm$ 1.70 (94.51 mm $\pm$ 55.56)
9 months	4.61 months $\pm$ 2.65 (150.64 mm $\pm$ 86.62)	3.49 months $\pm$ 1.97 (114.30 mm $\pm$ 64.44)
11 months	5.77 months $\pm$ 3.09 (188.80 mm $\pm$ 101.00)	4.05 months $\pm$ 2.31 (132.51 mm $\pm$ 75.72)
13 months	6.06 months $\pm$ 3.66 (198.34 mm $\pm$ 119.63)	4.51 months $\pm$ 2.59 (147.62 mm $\pm$ 84.80)
15 months	6.46 months $\pm$ 3.12 (211.31 mm $\pm$ 103.27)	4.99 months $\pm$ 2.59 (163.27 mm $\pm$ 84.75)
17 months	7.32 months $\pm$ 4.19 (239.74 mm $\pm$ 136.95)	5.35 months $\pm$ 2.87 (175.02 mm $\pm$ 94.01)
19 months	7.92 months $\pm$ 4.19 (259.09 mm $\pm$ 137.12)	5.85 months $\pm$ 2.91 (191.22 mm $\pm$ 95.28)
21 months	8.85 months $\pm$ 5.40 (289.32 mm $\pm$ 176.69)	6.43 months $\pm$ 3.46 (210.35 mm $\pm$ 113.11)
23 months	8.90 months $\pm$ 4.17 (291.08 mm $\pm$ 136.37)	7.32 months $\pm$ 3.67 (239.37 mm $\pm$ 119.62)

*Note.* Data are means  $\pm$  SDs.