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ORIGINAL INVESTIGATION

Modulation of strategic status signaling: oxytocin changes men's fluctuations of status products preferences in their female partners' menstrual cycle

Honghong Tang[1] · Hongyu Fu[2,3,4] · Song Su[1] · Luqiong Tong[1] · Yina Ma[2,3,4] · Chao Liu[2,3,4]

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Abstract

Rationale Women exhibit subtle fluctuations in mating-related behaviors throughout their menstrual cycle, and men are capable of detecting these ovulatory cues. This ability may impact male mating behavior, prompting adjustments in their preferences for consumer products based on these signals. Nonetheless, the potential influence of oxytocin on men's preferences for status products, particularly in the context of their female partners' menstrual cycles, is not yet known.

Objectives This study aims to explore how oxytocin regulates men's responses to their female partners' ovulation in heterosexual romantic relationships by specifically examining changes in their preferences for status consumption.

Methods Through a pilot study (N=110) and two main studies (N_1=789, N_2=120), we analyzed how oxytocin influences fluctuations in men's preferences for status products throughout their female partners' menstrual cycles. In Study 1, we examined the impact of the female menstrual cycle on men's preferences for status products. In Study 2, we employed intranasal oxytocin to investigate its modulatory effect on the menstrual cycle's influence.

Results Findings revealed that men demonstrated a lower preference for status products during their partners' ovulation compared to non-ovulatory phases. Furthermore, intranasal oxytocin significantly reduced men's liking for status products during the ovulatory phase, but not during the menstrual phase, with a stronger effect observed among men with a heightened intuitive inclination.

Conclusions These results suggest that men in committed relationships strategically adapt their consumption of status products according to their female partners' menstrual cycles, with oxytocin playing a moderating role in this adaptation and individual differences influencing responses.

Keywords Oxytocin · Menstrual cycle · Status products · Intuition

Introduction

Mating is an essential process of reproduction. The selection of a mate is a strategic decision influenced by various situational factors, enabling individuals to choose partners that will optimize their reproductive success (Buss and Schmitt 1993; Gangestad and Simpson 2000). Examining the reasons and mechanisms behind variations in mating has emerged as a prominent topic of discussion, particularly emphasizing the influence of fertility and hormonal levels on women's preferences and behavior (Gangestad et al. 2004; Gildersleeve et al. 2014; Jones et al. 2019; Penton-Voak et al. 1999; Schleifenbaum et al. 2024). Furthermore, researchers also focused their attention on understanding how men respond to the fertility and hormonal fluctuations

Honghong Tang and Hongyu Fu contributed equally to this work.

✉ Yina Ma
yma@bnu.edu.cn

✉ Chao Liu
liuchao@bnu.edu.cn

1 Business School, Beijing Normal University, Beijing 100875, China

2 State Key Laboratory of Cognitive Neuroscience and Learning & IDG/ McGovern Institute for Brain Research, Beijing Normal University, Beijing 100875, China

3 Center for Collaboration and Innovation in Brain and Learning Sciences, Beijing Normal University, Beijing 100875, China

4 Beijing Key Laboratory of Artificial Intelligence Safety and Superalignment, Beijing Normal University, Beijing, China

in women (Gildersleeve et al. 2012; Miller et al. 2007; Miller and Maner 2010). According to sexual selection and parental investment theories, it is females who choose mating partners and invest heavily in producing offspring (Darwin et al. 1981; Trivers 1972). However, many men also invest their resources in parenting in human society (Geary 2000). By responding appropriately to women's fertility, men are able to increase their successful reproduction in evolution. One common way men may respond to women's fertility is through status-driven behaviors, such as status consumption. These behaviors are particularly significant in the context of mating, as they can increase men's attractiveness to potential partners or reinforce their value within existing relationships (Buss and Schmitt 2019; da Silva et al. 2024; Geary et al. 2004; Von Rueden and Jaeggi 2016). Moreover, status-driven behaviors may be influenced by reproductive cues, with men unconsciously adjusting their strategies to align with perceived changes in their partners' reproductive status (Cobey et al. 2013; French et al. 2017; Gildersleeve et al. 2012; Haselton and Gildersleeve 2011; Miller and Maner 2010, 2011).

Women typically have a 28-day menstrual cycle, which includes menstruation, ovulation, and the secretion of progesterone. Women's mating preferences tend to shift throughout the menstrual cycle, with a greater inclination towards sexual attraction during the ovulatory phase (Gangestad et al. 2004; Penton-Voak et al. 1999). However, their variations across the menstrual cycle are subtle. Many mammal species have evident ovulatory signs, such as exclusive solicitation in rats and body odor changes in Chacma baboons in the fertile phase (Burt 1992; Clarke et al. 2009; Erskine 1989). In contrast, women dress themselves more in a manner to attract male attention and flirt more in the ovulatory phase compared to other phases (Haselton et al. 2007; Cantú et al. 2014). Women's subtle variations are relationship type dependent. Specifically, they happen only when women consider a short-term relationship but not when women consider a long-term relationship (Gildersleeve et al. 2014). Thus, women's subtle variations across the menstrual cycle might be "lost" for men in couples. However, some studies suggest that men may detect their female partners' menstrual cycle phase through various cues, such as changes in scent, appearance, or behavior (Cobey et al. 2013; French et al. 2017; Gildersleeve et al. 2012; Miller and Maner 2010, 2011). Given this potential awareness, would men adjust their status-driven behaviors differently across the cycle?

The menstrual cycle and men's status signaling

It is quite possible that men act differently when their female partners are in the ovulatory phase as opposed to other times. As the sexual selection and parental investment theories state (Darwin et al. 1981; Trivers 1972), males, rather than females, need to be more competitive to obtain mating accesses. To maximize reproductive success, men's effective strategies might be seeking out more fertile women for short-term relationships and protecting their female partners in the long-term relationship from engaging in extra-pair mates during the ovulatory phase (Buss and Schmitt 1993; Lund and Miller 2014). Prior studies have demonstrated how men respond to their female partners' menstrual cycles (Cobey et al. 2013; Gangestad et al. 2002; Haselton and Gangestad 2006). Specifically, men perceive their female partners as more attractive during the ovulation phase compared to the luteal phase, enhancing their sexual interest in their partners (Cobey et al. 2013). Moreover, men exhibited heightened vigilance, possessiveness, jealousy, and exclusivity when their female partners were in their ovulatory phase, which heightened their focus on protecting their partners from male competitors (Gangestad et al. 2002; Haselton and Gangestad 2006).

We propose that men in a stable relationship alter their status signaling across their female partners' menstrual cycle by consuming status products. In most human societies, men possess the right to direct resources related to mates and offspring, including food, protection, money, and social status (Gangestad et al. 2005). In mating, women also prefer men who are high-status and resourceful more (Buss et al. 1990; Geary et al. 2004). Thus, conspicuous consumption is an effective strategy for men to signal their social status or their ability to direct resources related to mates and offspring in mating (Kruger 2008, 2024a,b). For women, men who possess status are perceived to have greater mating value (da Silva et al. 2024). Several studies show that men will do this by consuming conspicuously. For example, men increase spending and purchase of status products when they observe photos of attractive women and the presence of a physically attractive man (Griskevicius et al. 2007; Otterbring et al. 2018).

Further, men use status consumption as a short-term mating strategy rather than a long-term one (Kruger 2022; Sundie et al. 2011). A study found that men's purchase of status products was driven by their desires for short-term mates, and women perceived such purchases as a signal of men's desires for short-term mates (Sundie et al. 2011). Compared to men in committed relationships, single men tend to focus more on status products and show a greater interest in buying them in the presence of a sexily dressed woman (Hennighausen and Schwab 2014; Janssens et al. 2011). As mentioned above, men may perceive their long-term female partners more attractive during the ovulatory phase, which can lead to a decreased interest in short-term mating (Cobey et al. 2013). Additionally, men might become more

attentive to their partners to protect them from extra-pair mating (Buss and Schmitt 1993; Lund and Miller 2014). Consequently, the decreased interest in short-term mating and the heightened attention to their partners may result in a decrease in status consumption. Therefore, we hypothesize that men in a stable relationship may prefer status products less when their female partners are in the ovulatory phase compared to the non-ovulatory phase.

Modulation of oxytocin

Oxytocin functions significantly in the facilitation of social connections and the enhancement of social behaviors within societies (Donaldson andYoung 2008; Thurston et al. 2024; Zheng et al. 2021). Additionally, oxytocin has been considered as a "hormone of love" as endogenous oxytocin facilitates experienced love and pair bonding behaviors in humans (Algoe et al. 2017; Carter and Porges 2013; Feldman 2012; Gonzaga et al. 2006). Meanwhile, oxytocin's effects are context-dependent and not exclusively prosocial, as it can also intensify negative social tendencies, including aggression and envy, while fostering in-group favoritism and out-group derogation (De Dreu et al. 2011; Shamay-Tsoory and Abu-Akel 2016). Given its multifaceted role in shaping social behaviors and interpersonal relationships, we expect that oxytocin will modulate men's variance of status consumption in their female partners' menstrual cycle. However, it is difficult to predict the pattern of this modulation.

On the one hand, intranasal oxytocin has been shown to enhance human romantic relationships by promoting positive communication between couples (Ditzen et al. 2009). It also improves men's social cognition and foster positive interactions (Ditzen et al. 2009; Procyshyn et al. 2024). Furthermore, previous research has found that intranasal oxytocin can lead men in committed relationships to maintain a greater physical distance from an attractive woman during a first encounter compared to single men (Scheele et al. 2012). Moreover, it has been shown to increase men's perception of their female partner's attractiveness relative to unfamiliar women, while simultaneously activating the brain's reward system (Scheele et al. 2013). These findings suggest that oxytocin administration could enhance men's focus on their committed relationships and reduce their interest in behaviors associated with attracting short-term mates, such as status consumption. This reduction of status consumption may be more pronounced during their female partners' non-ovulatory phases than during the ovulatory phases, as men tend to be less attracted to their partners during the former (Buss and Schmitt 1993; Lund and Miller 2014). While men's oxytocin levels are not known to fluctuate across their female partners' menstrual cycle, oxytocin's effects on relationship maintenance behaviors may interact with men's perception of their partners' fertility cues (Ditzen et al. 2009; Bob-Manuel et al. 2023; Cobey et al. 2013; French et al. 2017). Specifically, during non-ovulatory phases, when female partners are perceived as less fertile and less attractive, oxytocin may further reduce men's motivation to engage in status signaling, as their attention is redirected toward maintaining the existing relationship rather than pursuing alternative mating opportunities.

On the other hand, research has demonstrated that oxytocin can promote male mate-guarding behaviors in animals (Cavanaugh et al. 2018; Yokoi et al. 2020). In humans, intranasal oxytocin increases emotional arousal in men when faced with couple conflict (Ditzen et al. 2013). It also triggers the amygdala in men to be more responsive to negative stimuli, reflecting an increased sensitivity to potential threat signals (Gao et al. 2016). During the ovulatory phase, when female partners are more fertile, men may perceive other males as potential competitors, representing a threat to their relationship (Buss and Schmitt 1993; Lund and Miller 2014). In this context, oxytocin may enhance men's mate-guarding behaviors by increasing vigilance and sensitivity to potential threats. This heightened focus on mate-guarding could reduce men's engagement in status consumption, as their attention shifts toward protecting their relationship rather than signaling to attract new mates. Furthermore, mate-guarding behaviors during the ovulatory phase may be particularly relevant in the context of status consumption. Previous research suggests that men often use status consumption as a strategy to attract short-term mates (Kruger 2022; Sundie et al. 2011). However, during the ovulatory phase, when the risk of extra-pair mating is perceived to be higher, oxytocin may redirect men's focus from outward signaling (e.g., status consumption) to inward relationship maintenance (e.g., mate-guarding). This shift in priorities may manifest as oxytocin reducing men's status consumption during this phase, as their primary concern becomes protecting their current relationship rather than seeking new mating opportunities.

Additionally, as men use status consumption to attract more short-term mates rather than long-term mates (Sundie et al. 2011), it is likely that men's status consumption is relatively spontaneous and intuitive, rather than a deliberating calculation. Further, prior studies have shown that the effects of intranasal oxytocin are moderated by individuals' intuitive and reflective inclination; that is, it is more sensitive to individuals with higher intuitive inclination (Ma et al. 2015; Ten Velden et al. 2017). Therefore, we anticipate that the modulation of oxytocin on men's status consumption will be more pronounced in those with a higher intuitive inclination.

In this work, we initially conducted a pilot study to confirm the validity of the materials used in the two main

experiments. In Study 1, we examined the effect of female partners' menstrual cycle on men's preference for status products. In Study 2, we further explored the modulation of intranasal oxytocin on men's preference for status products across their female partner's menstrual and ovulatory phases. We also tested the moderating role of an individual's intuitive inclination on the effect of oxytocin (see Fig. 1 for the conceptual framework).

Pilot study

Method

Three experimenters screened 20 status products and 20 function products (see details in Table S1), 20 new products (New flavor of potato chips, Smart Bracelet, Collapsible water bottle etc.) and 20 control products (Classic potato chips, Regular watch, Regular water bottle etc.) from hundreds of products. Then participants (N=110, 63 males, mean age (SD)=30.33 (3.9), ranging 18–40 years) rated the status (three dimensions: social status, achievement, wealth) (Truong et al. 2008), novelty (three dimensions: familiarity, novelty, and innovation), and functionality of all products using a 7-point Likert scale (from 1-Not at all to 7-Very) (Table S2).

Results

Status products (vs. function products) showed higher status (M_{status} (SD)=5.82(0.89) vs. $M_{function}$ (SD)=3.80(1.07), t (109)=19.87, p<.001), higher novelty (M_{status} (SD)=4.17(0.85) vs. $M_{function}$ (SD)=3.29(0.92), t (109)=13.63, p<.001), and lower functionality (M_{status} (SD)=5.66(0.79) vs. $M_{function}$ (SD)=5.84(0.83), t (109) = -2.74, p=.007) (Fig.S1). Status products have higher status than new products (t (109)=18.36, p<.001), indicating that status products are prominent in representing social status. New products (vs. control products) had higher novelty (M_{new} (SD)=4.86(0.74) vs. $M_{control}$ (SD)=3.42(0.86), t (109)=15.29, p<.001), higher status (M_{new} (SD)=4.19(1.11) vs. $M_{control}$ (SD)=3.71(1.11), t (109)=10.25, p<.001), and lower functionality (M_{new} (SD)=5.51(0.80) vs. $M_{control}$ (SD)=5.67(0.77), t (109) = -2.65, p=.009) (Fig.S2). New products have higher novelty than status products (t (109)=6.87, p<.001), indicating that new products are dominant in presenting novelty. All Cronbach's alphas of the items were greater than 0.90, indicating high reliability and internal consistency of the ratings (Table S3).

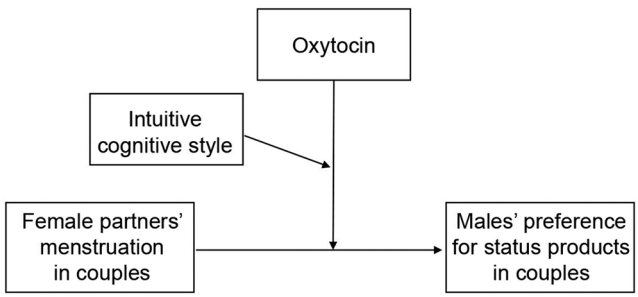

Fig. 1 The conceptual framework

Study 1: the menstrual effect on men's choice of status products

Study 1a

Method

Participants. We determined the sample size using a priori power analysis conducted with MATLAB (see Sample size determination in the Supplementary Materials). Based on a medium effect size of Cohen's f=0.25, a significance level (α) of 0.05, and a desired statistical power (1-β) of 0.80, the minimum required sample size was calculated to be 141 participants. Participants were recruited online through the Qualtrics platform. We only recruited male participants who met the following criteria: (1) being married or in committed relationships, (2) regularly interacting with their female partner in daily life, (3) reporting no prior personal or family history of any neurological or psychiatric disorders, major or hereditary diseases, and no personal history of medication/drug/alcohol abuse, and (4) having no use of hormonal medications, including oral or injectable contraceptives, by either partner in the committed relationship. A total of 435 men finished this study online and received monetary compensation. All participants provided electronic informed consent. This study was approved by Institutional Review Board (IRB). We only included participants (N=373, mean age (SD)=30.45 (5.38), ranging 20–49 years) who met the following criteria in the final dataset: (1) they provided information about their female partner's menstrual cycle, and the date they completed the study fell within the menstrual cycle (days 1–28); (2) the length of their female partner's menstrual cycle was less than 33 days (Fig.S3A). (3) their female partner had a regular menstrual cycle and did not exhibit any tendency towards amenorrhea. All participants reported a preference for heterosexual relationships.

Design and procedures. Participants rated their liking and possibility to buy of status and function products (10 items each product type) with a 7-point Likert scale (from 1-Not at all to 7-Very). After finishing all the tasks, all participants were instructed to acquire the detailed menstrual information from their female partner. They then provided

the menstrual information of their female partner, including the start date of the last menstrual period, the start date of the previous menstrual period, the estimated date of the next expected period, and the average duration of the menstrual cycle (Durante and Arsena 2015; Durante et al. 2014). We divided participants into three groups based on the date they finished this study within the menstrual cycle: the menstrual group (cycle days 1–8, $n=149$), the ovulatory group (cycle days 9–17, $n=111$), and the luteal group (cycle days 18–28, $n=113$). We also measured their behaviors in some decision tasks and the data will be reported elsewhere.

Results

The menstrual effect on status consumption. We conducted mixed ANOVAs to test whether the menstrual cycle affects men's attitude and purchase intention of status products. The product type (Product: status vs. function) was treated as a within-subjects factor, and the menstrual cycle phase (Cycle: menstrual vs. ovulatory vs. luteal) as a between-subject factor. Significant main effects of Product (F_{liking} (1,370)=101.93, $p<.001$, $\eta 2$ $p=.22$; $F_{\text{possibility to buy}}$ (1,370)=185.23, $p<.001$, $\eta 2$ $p=.33$) suggest that compared to function products, men like status products more but are less likely to buy them. Significant (marginally for liking) main effects of Cycle (F_{liking} (2,370)=2.72, $p=.067$, $\eta 2$ $p=.02$; $F_{\text{possibility to buy}}$ (2,370)=4.66, $p=.01$, $\eta 2$ $p=.03$) suggest that men's preference of products differs among female partner's menstrual phases. Then we focus on the interaction effects of Product × Cycle (F_{liking} (2,370)=0.74, $p=.48$; $F_{\text{possibility to buy}}$ (2,370)=7.89, $p<.001$, $\eta 2$ $p=.04$). We further found that men's attitude and purchase intention of status products varied with their female partner's menstrual cycle (F_{liking} (2,370)=3.79, $p=.023$, $\eta 2$ $p=.02$; $F_{\text{possibility to buy}}$ (2,370)=9.16, $p<.001$, $\eta 2$ $p=.05$). Specifically, men showed lower liking and possibility to buy of status products in their female partner's ovulatory days than that in the menstrual and luteal days (Menstrual vs. Ovulatory: t_{liking} (258)=2.61, $p=.029$, Cohen's $d=0.32$; $t_{\text{possibility to buy}}$ (258)=3.49, $p<.001$, Cohen's $d=0.44$; Luteal vs. Ovulatory (marginally significant for liking): t_{liking} (222)=2.08, $p=.058$, Cohen's $d=0.28$; $t_{\text{possibility to buy}}$ (222)=4.06, $p<.001$, Cohen's $d=0.54$; Fig. 2A-D & Table S4). No difference was observed between the menstrual and luteal days ($ts<0.73$, $ps>0.47$). However, we didn't find any significant menstrual effect on males' preference of function products ($Fs<1.61$, $ps>0.20$) (Figure. 2A-D). Moreover, we conducted ANCOVAs incorporating other demographic variables and found that the menstrual effect was not affected by age, income, relationship duration, or education level (Table S5). All pairwise comparisons in this study were adjusted using the False Discovery Rate (FDR) correction. These findings suggest that the menstrual effect on status consumption is significant for males in a committed relationship.

Mediation analysis. Consumption researchers suggest that a favorable attitude towards a product is the initial step in the consumption process. (Jager 2000; Vermeir and Verbeke 2006). Thus, the change in attitude might be a prerequisite for a change in purchase intention. Accordingly, we examined whether this potential relationship was observed in the present study. We then ran a 5,000-sample bootstrapping mediation analysis (model 4 in PROCESS) (Preacher and Hayes 2008) on males, treating the ovulatory group as the reference group (ovulatory = [0,0]; menstrual = [1,0]; luteal = [0,1]). Results showed that liking significantly mediated the effect of menstrual cycle on possibility to buy of status products (relative indirect effect of menstrual vs. ovulatory=0.23, 95% CI (confidence interval) = [0.06, 0.41]; relative indirect effect of luteal vs. ovulatory=0.20, 95% CI = [0.02, 0.40]) (Fig. 2E-F).

The findings from Study 1a suggest that men exhibit a reduced preference for status products when their female partner is in the ovulatory phase of her menstrual cycle, relative to the menstrual and luteal phases. To investigate whether the observed effect was distinct for men rather than women, we further conducted Study 1b to collect the data from women.

Study 1b

Method

Participants. The sample size determination and the minimum required sample size were identical to those described in Study 1a. Corresponding to Study 1a, we only recruited female participants who met the following criteria: (1) being married or in committed relationships, (2) regularly interacting with their male partner in daily life, (3) reporting no prior personal or family history of any neurological or psychiatric disorders, major or hereditary diseases, and no personal history of medication/drug/alcohol abuse, and (4) having no use of hormonal medications, including oral or injectable contraceptives, by either partner in the committed relationship. A total of 470 women participated in this online study through the Qualtrics platform and received monetary compensation. All participants provided electronic informed consent. This study was approved by IRB. Similar to Study 1a, we only included participants ($N=416$, mean age (SD)=29.63 (5.12), ranging 18–49 years) who met the following criteria in the final dataset: (1) they provided information about their menstrual cycle, and the date they completed the study fell within the menstrual cycle (days 1–28); (2) the length of their menstrual cycle was less

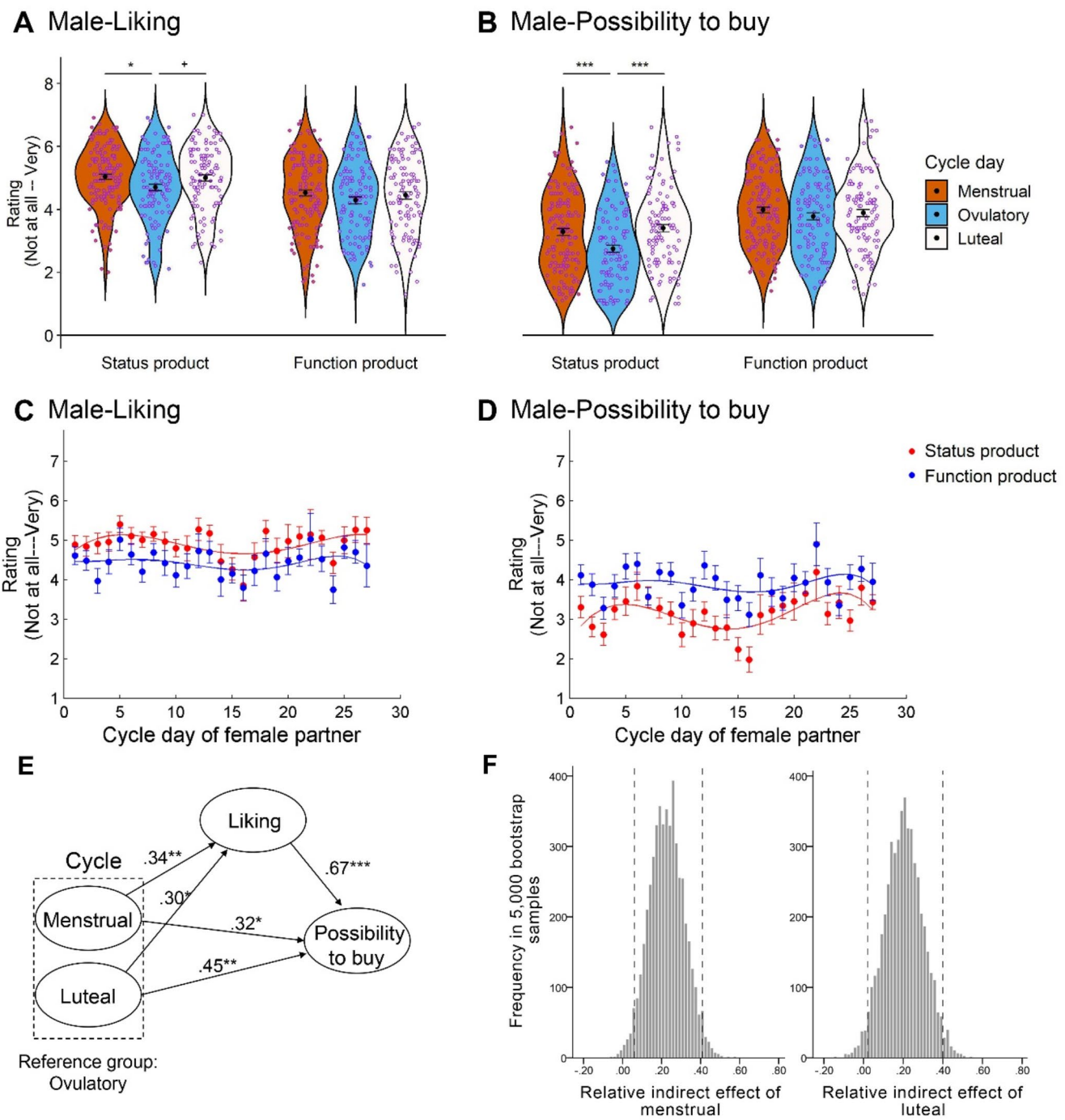

Fig. 2 Results from Study 1a: **A**-**D**) Mean liking and possibility to buy of status and function products of men in the menstrual, ovulatory, and luteal phases in female partners' menstrual cycle and in each day of the cycle. **E**-**F**) Mediation model shows that liking significantly mediated the effects of the menstrual cycle on males' possibility to buy status products. *** $p<.001$, ** $p<.01$, * $p<.05$, $^{+}p<.06$

than 33 days (Fig.S3A). (3) they had a regular menstrual cycle and did not exhibit any tendency towards amenorrhea. All participants reported a preference for heterosexual relationships, and their male partner did not participate in Study 1a.

Design and procedures. The procedures were identical to Study 1a. After finishing all the tasks, all participants provided their detailed menstrual information same as Study 1a. In line with Study 1a, we also divided participants into three groups: the menstrual group (cycle days 1–8, $n=145$), the ovulatory group (cycle days 9–17, $n=131$), and the luteal group (cycle days 18–28, $n=140$). We also measured their behaviors in some decision tasks and the data will be reported elsewhere.

Results

The menstrual effect on status consumption. Similar to Study 1a, we conducted mixed ANOVAs to test whether the menstrual cycle affects women's attitude and purchase intention of status products. Significant main effects of Product (F_{liking} (1,413) = 173.17, p < .001, $\eta 2$ p = .30; $F_{possibility\ to\ buy}$ (1,413) = 127.33, p < .001, $\eta 2$ p = .24) suggest that compared to function products, women like status products more but are less likely to buy them. The interaction effects of Product × Cycle were not significant (F_{liking} (2,370) = 1.53, p = .22; $F_{possibility\ to\ buy}$ (2,370) = 0.66, p = .52). We did not find any significant menstrual effect on females' preference of status or function products ($|t|$s < 0.89, ps > 0.37) (Fig. S4, Table S4). Moreover, we conducted ANCOVAs incorporating other demographic variables and found that the observed results were not affected by age, income, relationship duration, or education level (Table S5). These findings suggest that there was no significant effect of the menstrual cycle on status consumption among females in a committed relationship.

These results suggest that men and women differ in status-signaling behaviors. Specifically, the menstrual effect on preference for status products was observed only in men, but not in women. Although women have a preference for males of higher status and with more resources in mating (Buss et al. 1990; Geary et al. 2004), no evidence shows that women signal their own status to attract potential partners (Griskevicius et al. 2007; Hennighausen and Schwab 2014; Sundie et al. 2011). Given that the participants in Study 1a and Study 1b were independently recruited individuals rather than couples, we did not examine the four-way interaction effect incorporating gender as an independent variable. In Study 2, we recruited couples to further examine the male-specific menstrual effect on preference for status products, and investigated how the hormone oxytocin modulates the menstrual effect.

Study 2: Oxytocin modulates the menstrual effect on men's choice of status products

Method

Participants

Sample size was determined through a priori power analysis using MATLAB (see Sample size determination in the Supplementary Materials). We determined that the minimum required sample size was 54 couples for three-way interactions and 56 participants for four-way interactions, with Cohen's f = 0.25, α = 0.05, and 1-β = 0.80. Sixty-five heterosexual, healthy couples were recruited for this study. All the female participants had typical menstrual cycles of 26–32 days (They reported their menstrual cycle dates during recruitment). All the couples have lived together for more than half a year and have no children. All participants in this study reported no prior personal or family history of any neurological or psychiatric disorders, major or hereditary diseases, no personal history of medication/drug/alcohol abuse, and no use of hormonal medications (including oral or injectable contraceptives). They signed written informed consent. This study was approved by IRB. Five couples quitted the study, leaving 60 couples in the data analysis (N = 120, mean age (SD) = 27.66 (4.02), ranging 21–42 years). Half of the couples finished the study during the female participants' menstrual days in the cycle, and the other half finished the study during the female participants' ovulatory days in the cycle. All participants were instructed to not smoke or drink (except water) for two hours before the experiment.

Design and procedures

As this study aimed to extend the findings from Study 1 and investigate how oxytocin modulates men's preference for status product across their female partner's menstrual cycle, a mixed design was employed. We treated the date on which participants finished the study in the menstrual cycle phase as a between-subject factor (Cycle: Menstrual vs. Ovulatory), and the Treatment (intranasal oxytocin (OT) vs. placebo (PL) as a within-subject factor. During the recruitment, participants were informed that the study was to assess their understanding of themselves and their partner in a stable romantic relationship. They then provided demographic information and answered questions related to their romantic relationship. Females in the couples also reported the dates of their last and previous menstrual cycles, as well as the expected start date of their next one. Furthermore, we tracked the females' menstrual and ovulatory dates using ovulation test strips prior to the couples arrived at the lab. They were informed that the information would be served as additional references to evaluate their romantic relationships. We scheduled them to come into the lab either in the females' menstrual days or in the ovulatory days of the cycle. Participants finished this study in two experimental sessions (OT/PL treatment) separated by a one-month interval (the interval between the two cycles). The time of day for each participant's treatment was kept consistent across both sessions. In each session, upon arriving at the lab, participants filled out questionnaires about their current mood and their intuitive/reflective cognitive style in decision making in daily life. Then, experimenters instructed and supervised them to intranasally administer a single dose of 24 IU

of oxytocin or a placebo using a typical plastic pump-actuated nasal spray. OT and PL solutions were prepared less than three days before the experiment and stored in 10 ml sterilized nasal spray bottles at 4˚C until use. The OT solution was prepared using oxytocin (ProSpec, > 98.0% purity as determined by RP-HPLC, dissolved in saline), while the PL solution consisted of 0.9% normal saline. Participants administered the spray three times by themselves, with one inhalation of 4IU into each nostril each. The treatment was double-blind, so that neither the experimenter nor the participants knew whether the spray was oxytocin or a placebo. We adhered to the standardized oxytocin administration protocol delineated by Guastella et al. (2013). Approximately 35 min later, participants began to fill out measurements in the experiment.

Status consumption. Participants rated their liking and possibility to buy of the status and function products (10 items each product type, which were randomly presented in each session).

New products consumption. As our pilot study shows, status products have a higher degree of novelty than function products. Although no direct evidence shows that individuals vary their preference for novelty across the menstrual cycle, women have been found to have a higher variety-seeking preference in consumption during the ovulatory phase than in other phases (Durante and Arsena 2015). Given this, it is possible that men might vary their novelty-seeking preference with their female partner's menstrual cycle. Consequently, we further examine whether the novelty of products would interact with the menstrual and oxytocin effects on status consumption. Participants rated their liking and possibility to buy of the new and control products (10 items each of these product types, which were randomly presented in each session).

Intuitive-Reflective Cognitive Style. Participants' cognitive styles were measured twice in each session: once prior to the administration of oxytocin or placebo, and once after the completion of all tasks. We used two questions on a 10-point Likert scale (from 1- not important at all to 10-extremely important): (1) "To what extent do you think your intuition/first instinct is important in daily-life decision making?"; (2) "To what extent do you think reflection/careful reasoning is important in daily-life decision-making?" (Ma et al. 2015).

Other measures. After the administration of oxytocin or placebo, all participants filled out questionnaires about their partners' sexual and investment attractiveness, romantic relationship commitment and satisfaction level, the quality of their romantic relationship stratification alternative, their adult attachment bond for their romantic partner, their state of anxiety, and the Positive and Negative Affect Schedule (see Details about other measures in the Supplementary Materials). We also measured their behaviors in some decision tasks and the data will be reported elsewhere.

Results

Interaction of OT and menstrual effect on couples' status consumption

To investigate how oxytocin interacts with the menstrual effect on status consumption, we first calculated the average rating for each pair of participants. We used mixed ANOVAs with the females' cycle day (Cycle) as a between-subject factor (menstrual vs. ovulatory), Treatment (OT vs. PL) and Product (status vs. function) as two within-subject factors. Results revealed a significant main effect of Product and an interaction of Cycle × Product on the rating of couples (Fs > 7.6, ps < 0.01, Table S6). The results also suggested that couples showed marginally significant lower liking and lower possibility to buy during the ovulatory (vs. menstrual) days ($t_{PL-liking}$ (58) = -1.72, p = .09, Cohen's d = 0.44; $t_{PL-\ possibility\ to\ buy}$ (58) = -2.22, p = .06, Cohen's d = 0.57, Fig. 3A-B, Table S4). Although the main effect of Treatment or the interaction of Cycle × Treatment × Product were not significant, the paired t-tests showed that OT (vs. PL) tended to decrease couples' liking of status product during ovulatory days, but did not affect possibility to buy in those cycle days (t_{liking} (29) = -2.34, p = .027; $t_{\text{possibility to buy}}$ (29) = 0.42, p = .67; Fig. 3A-B, Table S4). OT (vs. PL) did not affect couples' preference of function product in the menstrual days (ts < 0.48, ps > 0.63). No significant OT or Menstrual effects were found on couples' preference of new product (Fig.S6A-B, Table S7). Thus, products' novelty did not affect these effects mentioned above.

Distinct OT and menstrual effects on men's status consumption

To examine whether the interaction of oxytocin and the menstrual cycle on status product differed between males and females in couples, we ran Gender × Cycle × Treatment × Product mixed ANOVAs. The four-way interactions were significant on liking but not on possibility to buy of status products (F_{liking} (1,116) = 4.59, p = .034, $\eta 2$ p = .04; $F_{\text{possibility to buy}}$ (1,116) = 1.01, p = .32), in which the interactions of Cycle × Treatment × Product on liking were only significant for males but not for females in couples (F_{male} (1,58) = 4.63, p = .036, $\eta 2$ p = .07; F_{female} (1,58) = 0.70, p = .41, Fig. 3C-F, Table S6). Moreover, OT (vs. PL) decreased males' liking of status products in the ovulatory days, suggesting that the OT effect is distinct for males' attitude (F (1,58) = 9.86, p = .003, Fig. 3C-F, Table S4). In addition, males showed lower liking (marginally significant) and

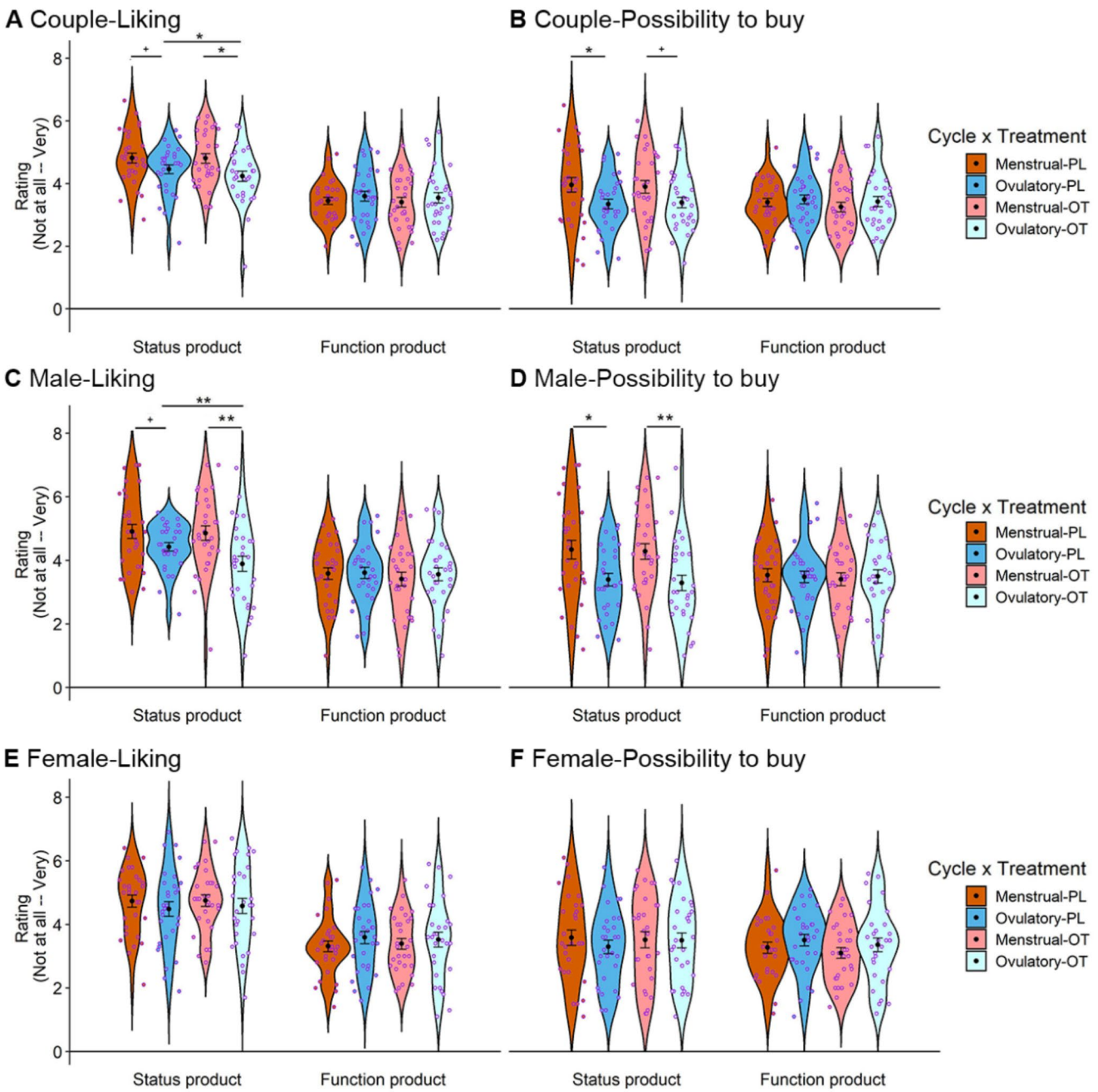

Fig. 3 Results from Study 2: Mean liking and possibility to buy of status and function products of couples (**A-B**), men (**C-D**), and women (**E-F**) in couples in the menstrual and ovulatory phases with administration of intranasal oxytocin or placebo. $^{**}p<.01$, $^{*}p<.05$, $^{+}p<.09$

lower possibility to buy of status products in the ovulatory (vs. menstrual) days ($F_{PL-liking}$ (1,58)=3.49, p=.067, $\eta 2$ p=.057; $F_{PL-\ possibility\ to\ buy}$ (1,58)=8.65, p=.005, $\eta 2$ p=.13, Fig. 3C-D), but females did not ($ps>0.57$, Fig. 3E-F), replicated Study 1. This further strengthens the findings that the menstrual effects of status products are distinct for males. No such effects were found on males' and females' preference of new products (Fig.S6C-F, Table S7). Therefore, the novelty of products did not affect the main findings above.

Distinct OT and menstrual effects men's status consumption vary with intuitive cognitive style

We further explored whether the OT and menstrual effects on status product preferences differed for individuals with different cognitive styles. We used a generalized linear mixed model (GLMM) with the lme4 package implemented in R (Bates et al. 2015; Team 2013; Zuur et al. 2009). Results revealed a significant interaction of

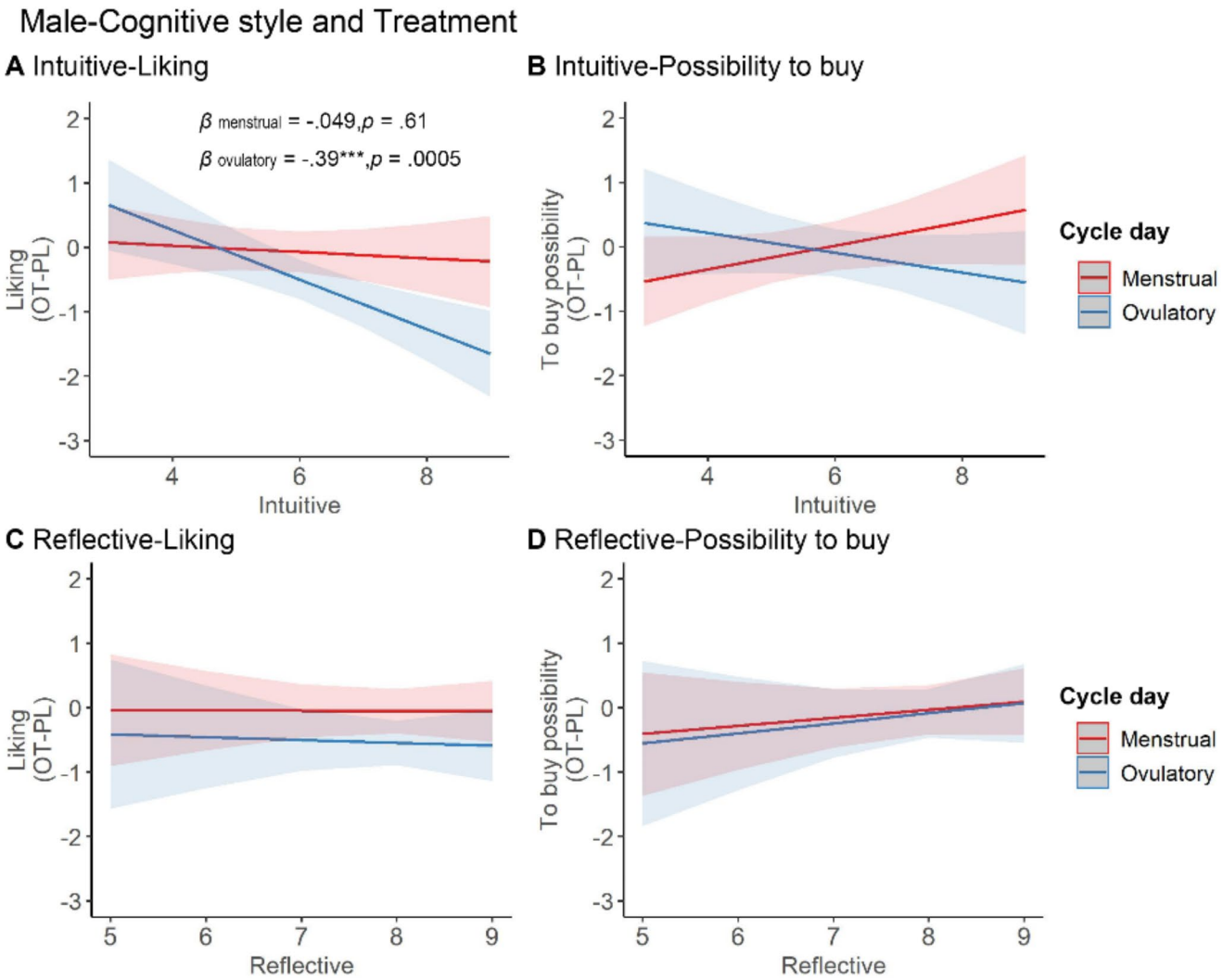

Fig. 4 Results from Study 2: **A-B**) The interaction of Intuitive× Cycle× Treatment on the difference (OT minus PL) of men's liking and possibility to buy of status products in couples (β and p in the figure denote the statistic results in the simple slope test of GLMMs). **C-D**) The interaction of Reflective × Cycle × Treatment on the difference (OT minus PL) of men's liking and possibility to buy of status products. Shadows around the lines denote the 95% confidence interval. *** p<.001

Intuitive × Cycle × Treatment on men's liking and possibility to buy of status product (β_{liking} = −0.34, t_{liking} = -2.37, p=.018; $\beta_{possibilityto\ buy}$ = −0.34, $t_{possibilityto\ buy}$ = -1.99, p=.047; Fig. 4A-B, Fig.S5A-B, Table S9). These findings suggest that the intuitive cognitive style moderated OT and menstrual effects of males' status consumption. We then ran simple slope analyses using the emmeans package in R to test how this moderation worked (Lenth 2021; Searle et al. 1980). In the ovulatory group, the slope of intuitive on liking is significantly decreased by OT (vs. PL) (β = −0.590, z = -3.688, p<.001, Fig.S5A, Table S10). It is significantly negative (vs. zero) under OT (β = −0.347, z = -2.428, p=.015). These findings indicate that the more intuitive the males in couples are, the more OT treatment decreases their liking of status products during the ovulatory days of their female partner. No significant results were found in the slope test of intuitive cognitive style on the possibility to buy. In addition, no significant interaction of Reflective × Cycle × Treatment on males' preference of status products was found (p>.20, Fig. 4C-D, Fig.S5C-D). Note that the participants' cognitive style scores were not affected by the administration of oxytocin or cycle days (p>.15, Table S8). In the GLMM analyses mentioned above, we used the cognitive style scores measured before the administration of the placebo.

Other measures. We also tested whether OT treatment affected other related measures and whether these measures moderated the OT effects on status product preference (see Details about other measures in the Supplementary Materials). No significant differences were observed between the aforementioned measures. Moreover, these measures didn't influence the OT effects on status product preference.

Discussion

Consumption of status products is an effective strategy for men to signal their social status during mating (Kruger 2008, 2024a, b). Nevertheless, our findings from two main studies reveal that men's preference for status products significantly decreases when their female partners are in the ovulatory phase. More importantly, intranasal oxytocin further reduces men's preference for status products during their female partners' ovulatory phase, but does not affect their preference during the menstrual phase. Additionally, the modulatory effect of intranasal oxytocin is influenced by individual differences. Specifically, for men with a stronger intuitive inclination, oxytocin has a greater impact on the decline in their preference for status products. Overall, the findings suggest that men strategically adjust their behavior in accordance with their female partners' menstrual cycles. Oxytocin moderates the menstrual effect, although individual differences are present. This work extends the understanding of how menstrual cycle in female partners can influence male consumer behavior.

Sexual selection and parental investment theories suggest that females selectively choose mating partners and invest significantly in offspring production (Darwin et al. 1981; Trivers 1972). During the mating process, women exhibit a preference for men with higher status and abundant resources (Buss et al. 1990; Buss and Schmitt 2019; Geary et al. 2004; da Silva et al. 2024). Consequently, status consumption emerges as an advantageous strategy for men to signal their social status in mating, particularly when pursuing short-term mating opportunities (Kruger 2008, 2024a, b; Griskevicius et al. 2007; Otterbring et al. 2018). Nevertheless, men may adjust their consumption behaviors in response to women's fertility cues as part of an adaptive reproductive strategy. In this work, our findings suggest that fluctuations in male status consumption associated with the female menstrual cycle may represent an evolutionary adaptation in romantic relationships (Lund and Miller 2014). Research has shown that men are more likely to employ status consumption as a short-term mating strategy rather than a long-term one (Sundie et al. 2011). Therefore, during their female partner's menstrual phase, men exhibit higher levels of status consumption, possibly to attract new potential short-term mates and increase reproductive opportunities (Buss and Schmitt 1993; Darwin et al. 1981; Lund and Miller 2014; Trivers 1972). Since the likelihood of conception with their current partner is lower during this time, men may shift their focus outward to seek additional mating opportunities through status signaling. Conversely, during the ovulatory phase, when female fertility peaks, men shift away from status consumption as a mate attraction strategy. Instead, they may prioritize direct partner guarding and increased relationship investment. This shift may occur because men perceive intimate interactions and emotional commitment as more effective strategies for maintaining the relationship and ensuring paternity certainty during this critical fertile period (Cobey et al. 2013; Gangestad et al. 2002; Haselton and Gangestad 2006). These behavioral patterns of strengthened emotional bonds and increased attentiveness may serve as mate retention strategies and function as protective mechanisms against intrasexual competition, reflecting men's reproductive vulnerabilities in long-term relationships (Buss, 2018). To maximize reproductive success, men must balance pursuing additional mating opportunities with ensuring relationship security. Resource allocation thus becomes a strategic trade-off: men may invest more in partner guarding when reproductive stakes are high, while turning to status consumption to signal attractiveness when immediate reproductive risks are lower. During their partner's ovulatory phase, men demonstrate adaptive mate retention behaviors by focusing on relationship enhancement rather than outward displays of status, thereby reducing the risk of mate poaching and preserving exclusivity (Trivers 1972; Buss, 2018).

Further, this study broadens our understanding of the role of oxytocin in pair bonding (Carter and Porges 2013; Ditzen et al. 2009; Feldman 2012; Scheele et al. 2012, 2013). Oxytocin may have evolutionary adaptive significance regarding male behaviors in committed relationships (Algoe et al. 2017; Carter and Porges 2013; Feldman 2012; Gonzaga et al. 2006; Roels et al. 2021). Our findings suggest that the oxytocin system may play a role in helping men regulate their mating signaling behavior. Specifically, although our study did not involve a competing context, the observed reduction in mating signaling behavior toward additional short-term mating opportunities indicates that intranasal oxytocin could modulate social behaviors in a manner that supports relationship maintenance (Cavanaugh et al. 2018; Yokoi et al. 2020). During the partner's ovulatory period, men may direct more attention toward their partners, potentially leading to increased protection of their partners from other potential mating opportunities. Previous research has shown that intranasal oxytocin can activate the male amygdala to enhance their responses to negative stimuli (Buss and Schmitt 1993; Ditzen et al. 2013; Eckstein et al. 2015; Gao et al. 2016). This increased sensitivity to threat signals aids men in safeguarding their partners from intrusions during same-sex competition. Therefore, intranasal oxytocin may reduce men's preferences for short-term mating and status products by promoting their protection and attention toward their female partners during the ovulatory phase. This behavioral pattern supports the notion that in periods of heightened fertility, oxytocin may promote men to become more attuned to the needs of their partner, prioritizing long-term

mating strategies over short-term mating. Additionally, the impact of oxytocin is contingent on men's level of intuition. It suggests that men's status signaling is more reliant on heuristics than on deliberated processing. It echoes previous findings that men's interest for status products could be activated by implicit ways without deliberate reasoning, such as by changing the appearance of a female experimenter in the lab (Janssens et al. 2011). However, in this study, we utilized only straightforward measures of intuition. Further research with implicit measures could gain a more comprehensive understanding of the relationship between intuition and oxytocin.

Additionally, the observed fluctuations in male status consumption patterns in response to the female menstrual cycle echo prior research findings related to sociosexuality and intimate relations. Specifically, women's sociosexual attitudes and behaviors have been shown to fluctuate across the menstrual cycle (Marcinkowska et al. 2021). They are more open to uncommitted sexual relationships in the ovulatory phases. As men are sensitive to pheromonal cues (Cutler et al. 1998), it is possible that men's sociosexual attitudes and behaviors vary with their female partners' menstrual cycles. That is, they may pay less attention to sociosexuality when their female partners are in the ovulatory phases, which results into less status consumption. Following studies which measure men's sociosexuality across their female partners' menstrual cycles would provide direct evidence for this possibility. Moreover, intimate behaviors have been found to elevate oxytocin concentrations in humans (Carmichael et al. 1987; Murphy et al. 1990). Research has also indicated that pairs have more intimate behaviors during the female partner's ovulatory phase compared to the menstrual phase (Johnston-Robledo and Chrisler 2020). Given this, the increased intimate behaviors the ovulatory phase may increase men's oxytocin, which in turn decrease their interest in status consumption. We did not directly measure men's oxytocin concentrations across their female partners' menstrual cycle in the current study. Yet, our findings that men show less interest in status products when their female partners are in the ovulatory phase, and that intranasal oxytocin administration further enhances this reduction support this possibility.

Our primary finding is that men adjust their consumption behavior based on their partners' menstrual cycles. It is important to note that this finding depends on the premise that men can detect these cycles. However, this premise remains contentious. Previous research has shown that men may be able to perceive cues related to women's ovulatory phases (Bob-Manuel et al. 2023; Cobey et al. 2013; French et al. 2017; Gildersleeve et al. 2012; Haselton and Gildersleeve 2011; Miller et al. 2007; Miller and Maner 2010, 2011). However, some studies have failed to replicate this finding, suggesting that men might not detect information related to women's ovulation or that such cues do not influence men's behavior (Roney et al. 2023; Schleifenbaum et al. 2022). One possible reason for these discrepancies is the differences in experimental tasks, stimulus materials, and measurement tools used. Additionally, the potential behavioral outcomes of experimental research may differ from the subjective report data collected through surveys, which could also lead to divergent conclusions. not assess whether male participants had specific knowledge of their partners' menstrual cycles prior to the experiment, which may be a limitation of the study. Nevertheless, study 1a required male participants to obtain detailed information about their partners' cycles after the experiment concluded, whereas studies 1b and 2 collected this information directly from the female participants. Consequently, the male participants may not have been explicitly aware of their partners' menstrual cycle states during the experiments. Therefore, the differences observed in men's consumption behavior regarding status products in this study cannot be attributed to subjective changes induced by the menstrual cycle. Instead, they likely reflect an unconscious evolutionary adaptation. Overall, our research suggests that men may may possess the ability to detect their female partners' menstrual cycles and exhibit adaptive consumption behaviors in response.

One limitation of our study is the absence of direct measurements of actual purchase behavior patterns for status items among male and female partners prior to the study. In line with previous research (El Hazzouri et al. 2020; Hudders et al. 2014), we focused on assessing participants' intentions regarding status consumption. However, this approach may not fully capture the complexities of real-world purchasing behaviors. As a result, it is challenging to extend our conclusions from measured behavioral tendencies to actual behaviors in real life. Additionally, we did not account for whether participants consistently disclose their actual purchases to their partners. The possibility that participants may conceal purchases from their partners could influence the dynamics of status consumption and signaling. Future studies should incorporate additional indicators of actual purchase behaviors for status items and consider the transparency of such behaviors between partners. Measuring actual purchasing patterns and the degree of disclosure to partners would provide more direct and robust evidence regarding the dynamics of status consumption. Another notable limitation that our study did not include a comparison group of single men or men in short-term relationships. While our findings suggest that the menstrual effect on status consumption is significant for males in committed relationships, the lack of data from single men or men in other types of relationships limits our ability to determine whether this effect is unique to committed relationships. It is possible that single men or men in

short-term relationships may exhibit similar or different patterns of status consumption in response to menstrual cues. Future research should include these comparison groups to better understand the role of relationship context in shaping status consumption behaviors. Lastly, this study primarily focused on the role of intuitive inclination when examining individual differences, neglecting other relevant personality traits. This narrow focus may overlook potential factors that could contribute to understanding how individual differences manifest in consumption scenarios. Therefore, future research should assess a broader range of personality traits related to consumption behaviors.

In conclusion, this study underscores men's capacity to adapt their status consumption in response to the menstrual cycle changes of their female partners. By highlighting these adaptive behaviors, it enhances our understanding of the complex interplay between gender, consumption, and reproductive strategies. Moreover, our findings shed light on the moderating role of oxytocin in the menstrual effects on consumption behavior and reveal how individual differences influence this dynamic. Specifically, understanding the role of oxytocin can help marketers tailor their strategies to align with the hormonal fluctuations that affect male consumers' preferences and behaviors. For instance, marketing campaigns could be timed to coincide with periods when male consumers are more likely to be influenced by their partners' ovulatory cycles, thereby enhancing the effectiveness of promotional efforts. Furthermore, these insights can inform future marketing strategies targeting male consumer groups by emphasizing products that resonate with their emotional and social needs during specific hormonal phases. While the direct use of intranasal oxytocin for marketing purposes may seem unrealistic, the underlying principles of how hormonal influences affect consumer behavior can guide the development of more effective marketing strategies that leverage emotional and relational aspects of consumption. This research advances our understanding of the interaction between biology and consumer behavior, providing practical implications for marketers seeking to engage male consumers more effectively.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00213-025-06783-1.

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Data availability The data and materials that support the findings of this study are available on OSF (https://osf.io/8abhp/?view_only=28406f148e004d758e74e0e8307b9d96).

Declarations

Ethical approval All studies involving human participants were reviewed and approved by the local Research Ethics Committee at the State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University (IRB protocol number: CNL_A_0005_001), in full compliance with ethical standards and the principles outlined in the Declaration of Helsinki.

Informed consent Informed consent was obtained from all participants prior to their involvement in the study, confirming their voluntary and informed participation.

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

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