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2 **Oxytocin amplifies sex differences in human mate choice**

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24 **Abstract**

25 Infidelity is the major cause of breakups and individuals with a history of infidelity are more
26 likely to repeat it, but may also present a greater opportunity for short-term sexual
27 relationships. Here in a pre-registered, double-blind study involving 160 subjects we report
28 that while both sexes valued faithful individuals most for long-term relationships, both single
29 men and those in a relationship were more interested in having short-term relationships with
30 previously unfaithful individuals than women. Oxytocin administration resulted in men rating
31 the faces of unfaithful women as more attractive but in women rating those of unfaithful men
32 as less attractive and also finding them less memorable. Oxytocin also increased men's
33 interest in having short-term relationships with previously unfaithful women whereas it
34 increased women's interest in having long-term relationships with faithful men. Thus,
35 oxytocin release during courtship may first act to amplify sex-dependent priorities in
36 attraction and mate choice before subsequently promoting romantic bonds.

37

38 **Keywords:** oxytocin, sex difference, mate choice, attraction, infidelity

39

40 **1 Introduction**

41 Individuals who have previously been unfaithful in a relationship are over 3 times more likely
42 to repeat this in subsequent ones (Knopp et al., 2017), and infidelity is the most common
43 cause of divorce (Lansford, 2009). Infidelity in a partner represents a long-term relationship
44 risk to both sexes that can particularly impact negatively on females in terms of loss of
45 support for raising offspring but for males may also increase the risk of being cuckolded and
46 raising another male's offspring (Buss and Schmitt, 1993). Indeed, it is argued that this
47 difference in the perceived risk of infidelity by the sexes is reflected in women being more
48 concerned by emotional infidelity but men by sexual infidelity (Buss, 2018; Buss et al., 1992).
49 However, while both sexes clearly prefer fidelity in a prospective long-term partner men are
50 more likely to pursue short-term relationships and engage in casual sex in order to increase
51 their reproductive potential (Buss and Schmitt, 1993; Oliver and Hyde, 1993), although
52 women may do so to maximize their chance of reproducing with more masculine men who
53 have the highest levels of genetic fitness (Penton-Voak et al., 1999). There is also an element
54 of social learning in mate choice: “wanting women other men want or vice versa”, known as
55 “mate-choice copying” (Place et al., 2010) which could be evidenced by knowledge that
56 individuals have had multiple affairs. As Scott Fitzgerald wrote of Gatsby's perception of
57 Daisy in “The Great Gatsby” (Fitzgerald, 1925): “It excited him, too, that many men had
58 already loved Daisy – it increased her value in his eyes”. Overall therefore, individuals with a
59 previous history of infidelity could be considered as more attractive for short-term
60 relationships, due to a greater perceived potential availability for reproduction opportunities
61 and possibly greater genetic fitness.

62 In terms of the biological underpinnings of evolutionary sex-differences in human mate
63 choice strategy, one potential candidate is the highly evolutionarily conserved neuropeptide
64 oxytocin (OXT) which plays a key role in the formation and maintenance of affiliative and
65 partner bonds in a number of species (Cavanaugh et al., 2014; Donaldson and Young, 2008;
66 Kendrick et al., 2017), including humans (Preckel et al., 2014; Scheele et al., 2012, 2013),
67 as well as in social learning (Hu et al., 2015) and conformity (De Dreu and Kret, 2016; R.
68 Luo et al., 2017). In humans, OXT facilitates sex-dependent differences in social priorities,
69 particularly in terms of positive or negative social attributes (Gao et al., 2016; L. Luo et al.,
70 2017; Scheele et al., 2014). Oxytocin can also sex-dependently facilitate approach or
71 avoidance behavior towards attractive strangers of the opposite sex although its effects can be
72 modulated by relationship status (Scheele et al., 2012). However, it is currently unknown
73 whether OXT may influence sex-differences in human mate-choice priorities.

74 Against this background we have therefore investigated whether sex-dependent biases in
75 patterns of mate choice revealed by knowledge of previous emotional or sexual
76 fidelity/infidelity in men and women who are either currently single or in a committed
77 relationship, are influenced by intranasal OXT administration. We hypothesized firstly that
78 under placebo (PLC) control conditions men would exhibit a preference for women who had
79 been unfaithful in a previous relationship whereas women would exhibit an aversion to
80 unfaithful men and instead prefer men who had previously been faithful. Secondly, we
81 hypothesized that under OXT such sex differences in mate preference would be enhanced and
82 particularly in single individuals who should have a greater priority for finding a partner than
83 those already in an established relationship.

84

85 **2 Methods**

86 **2.1 Participants.** 160 heterosexual human subjects (80 males, age range 18-27 years) from
87 the University of Electronic Science and Technology of China (UESTC) were recruited to
88 take part in a double-blind, placebo-controlled, between-subject design experiment. An initial
89 power analysis showed that with this number of subjects the study had 80.7% statistical
90 power for detecting treatment and sex effects with a medium effect size of 0.45 (fpower.sas).

91 All subjects had normal or corrected-to-normal vision, were not color-blind and reported no
92 history of or current neurological or psychiatric disorders. Subjects were free of regular and
93 current use of medication and instructed to abstain from caffeine, nicotine and alcohol intake
94 the day before and on the day of the experiment. None of the female subjects was pregnant or
95 using oral contraceptives or tested at specific stages of their menstrual cycle. Using onset date
96 of previous menses and cycle length (mean \pm sem: 30.83 ± 0.37 days) provided by the
97 subjects we estimated (backward counting (Gangestad et al., 2016)) whether they were in
98 follicular phase (between the end of menses and ovulation, high conception risk) or luteal
99 phase (after ovulation and before the onset of menses, low conception risk) on the
100 experimental day (Penton-Voak et al., 1999). Eight females reported having irregular
101 menstrual cycles and were excluded for menstrual cycle related analysis. The proportion in
102 their follicular ($n = 39$; 22 in the OXT group) or luteal ($n = 33$; 16 in the OXT group) phases
103 did not differ between the groups (Fisher's exact test: $p = 0.636$, two-sided). There were no
104 significant menstrual cycle effects found for results obtained in the study itself (see SI). Both
105 subjects who were currently single ($n = 82$; 39 males) and those who were currently in a

106 committed relationship of > 6 month duration (32.00 ± 2.45 months; $n = 78$; 41 males) were
107 included since relationship status can modulate OXT effects in men (Scheele et al., 2012;
108 Zhao et al., 2018). All single subjects were interested in finding a romantic partner and those
109 in a relationship reported that it was a stable exclusive one (indeed subjects in a relationship
110 scored significantly higher on the passionate love scale than single subjects (102.09 ± 1.55 vs.
111 96.46 ± 1.70 - $t(158) = 2.442$, $p = 0.016$, $d = 0.387$) providing further support for their being
112 in love). All subjects signed written informed consent and received monetary compensation
113 for their participation. The study was approved by the local ethics committee at the
114 University of Electronic Science and Technology of China and was in accordance with the
115 latest revision of the Declaration of Helsinki. The study was also pre-registered on the NIH
116 registration website (Trial ID: NCT02733237;
117 <https://clinicaltrials.gov/ct2/show/NCT02733237>).

118 To control for potential confounds, before intranasal treatment all subjects completed a
119 range of validated questionnaires (Chinese versions) measuring mood, personality traits and
120 attitudes toward love, trust and forgiveness (See SI). Univariate ANOVAs on questionnaires
121 and age showed no significant differences between the OXT- and PLC-treated males and
122 females (sex x treatment interaction: all $p > 0.070$; See Table 1).

123 **2.2 Intranasal administration.** Subjects were randomly assigned to receive intranasal
124 administration of either OXT ($n = 80$, 40 males and 40 females; 40 IU; OXT-Spray, Sichuan
125 Meike Pharmaceutical Co. Ltd, China; 5 puffs of 4 IU per nostril with a 30s interval between
126 each puff) or PLC ($n = 80$, 40 males and 40 females; identical sprays with the same
127 ingredients other than the neuropeptide, i.e., glycerin and sodium chloride) following a

128 standardized protocol (Guastella et al., 2013). In previous studies, we have found similar
129 behavioral and neural effects of 24 and 40 IU OXT doses, although the higher dose tended to
130 produce more consistent results (Geng et al., 2018; Xu et al., 2015; Zhao et al., 2017) and this
131 was recently supported by a study from another group showing dose-dependent effects using
132 these same doses (Shin et al., 2018). We therefore decided to use the higher 40 IU dose here
133 to try and maximize effects. Although we could not measure blood or cerebrospinal fluid
134 OXT concentrations following intranasal application other studies have reported that they
135 produce only relative small increases within the general physiological range (Quintana et al.,
136 2018; Striepens et al., 2013). While it is currently unclear whether intranasal OXT produces
137 direct effects on the brain or also indirectly via peripheral effects, it has been established that
138 OXT administered via this route does enter into the brain cerebroventricular system in
139 monkeys (Lee et al., 2018) and alters cerebral blood flow in an extensive number of brain
140 regions known to express OXT receptor mRNA in humans (Paloyelis et al., 2016). A recent
141 study comparing functional and brain effects of intranasal and intravenous OXT
142 administration also only found effects when it is given intranasally (Quintana et al., 2016).
143 For allocation of the participants to the two treatment groups a computer-generated list of
144 random numbers was used (groups, n = 2; numbers per group, n = 40; simple randomization).
145 Treatment allocation was done by an experimenter not involved in data acquisition and
146 analyses. Subjects and experimenter were blind to drug condition. In post experiment
147 interviews subjects were unable to guess better than chance whether they had received OXT
148 or PLC treatment (81 subjects guessed correctly; $\chi^2 = 0.025$, $p = 0.874$). In line with
149 standardized recommendations (Guastella et al., 2013) and two studies reporting

150 pharmacodynamics of central effects of intranasal OXT in humans (Paloyelis et al., 2016;
151 Spengler et al., 2017) the experimental paradigm started 45 minutes after intranasal
152 treatment.

153 **2.3 Stimuli.** Before the formal experiment, we generated 54 sentences describing a behavior
154 indicative of fidelity or infidelity (either emotional or sexual; 12~14 sentences for each
155 behavior type) that a male or female individual had performed during a past relationship.
156 Sexual and emotional infidelity were defined as in Takahashi et al (Takahashi et al., 2006).
157 Sexual infidelity (or fidelity) included situations where a (or no) sexual relationship or deep
158 physical contact with other members of the opposite sex was indicated explicitly or implicitly.
159 Emotional infidelity (or fidelity) included situations indicating some (or no) form of romantic
160 emotional response or commitment to other members of the opposite sex. Each sentence was
161 written in Chinese, used the past tense and had male and female versions (i.e. “She.....” for
162 male subjects in the study and “He.....” for female subjects). In a pre-study, an independent
163 sample of forty volunteers (21 males) were asked to decide whether the behavior described
164 was an example of emotional or sexual infidelity/fidelity and also to rate how strong it was
165 using a 9-point scale. Based on the data from this pre-study, we selected 40 sentences (10 for
166 each behavior type) with a high discrimination between sexual and emotional fidelity or
167 infidelity (i.e. all the chosen sentences were correctly classified as representing fidelity or
168 infidelity behaviors by the raters and with a mean accuracy of 87.6% for distinguishing
169 emotional from sexual examples). There were no differences between male and female
170 examples in terms of discrimination accuracy or strength (all $ps > 0.258$). Table S1 gives
171 examples of the emotional or sexual fidelity/infidelity behavior sentences.

172 Facial images of 80 males and 80 females with neutral expressions were selected from an
173 in-house database of 260 face images following a pilot rating by 36 subjects (17 males) of
174 valence, attractiveness, likeability, trustworthiness of the faces from the opposite sex as well
175 as how aroused they were by them. All face images were carefully edited (removing
176 accessories or background details, but keeping hair, ears and neck) and presented in full color
177 at a 600×800 Pixel resolution on a black background (faces life-size). All selected faces were
178 rated as having a neutral valence (range 4.3-6.0; mean = 5.09) and average attractiveness
179 (range 4.0-5.9, mean= 4.79), likeability (range 4.1-5.8, mean= 4.81) and trustworthiness
180 (range 4.2-6.0, mean= 5.07). Half of the faces used for the rating task were divided randomly
181 into four groups (i.e. 10 faces per group for each sex). Mean valence, attractiveness,
182 likeability, trustworthiness and arousal ratings of the faces in each group did not differ
183 significantly for both male and female faces (ANOVAs all $ps > 0.964$). Each group of faces
184 was assigned for pairing with sentences describing one of the four different fidelity/infidelity
185 types. Additionally, to control for possible face/sentence-group differences, the pairings of
186 face group and sentence type were randomized across individual subjects in the main study.
187 The remaining faces were used as novel stimuli in the recognition memory test and had
188 equivalent valence, attractiveness, likeability, trustworthiness and arousal ratings compared to
189 the faces paired with sentences for both sexes (all $ps > 0.661$).
190 **2.4 Procedure.** The experimental task (see Fig. 1) was presented on a computer with a
191 27-inch monitor (screen resolution: 1920*1080 pixels; refresh rate: 60 Hz). In the rating task,
192 subjects viewed neutral expression face pictures of 40 unfamiliar members of the opposite
193 sex with average attractiveness paired with verbal information describing examples of how

194 they had been either emotionally or sexually faithful or unfaithful during a previous
195 relationship (see Table S2). We included fidelity type as a factor since previous research has
196 reported that men are more influenced by sexual infidelity and women by emotional infidelity
197 (Buss, 2018; Buss et al., 1992). Subjects were told that these individuals were currently single
198 and instructed to view their faces, read the sentences describing their previous behavior
199 silently and then rate (on a 9-point scale) their facial attractiveness, likeability,
200 trustworthiness and arousal elicited by them based on their overall impression of them. Next,
201 subjects were asked whether they would like to have a short- or long-term romantic
202 relationship with the person (response options: “yes”, “maybe” or “no” - see Fig.1). There
203 was no time limitation for subjects’ responses. The percentage of “yes/maybe” responses
204 made by each subject for each condition indicated their willingness to have a relationship
205 with this kind of person.

206 Finally, subjects completed a surprise recognition memory test for these 40 faces
207 intermixed with another 40 novel faces (order of stimuli randomized). Each trial started with
208 a 600-800 ms fixation cross followed by a face presented for 1500 ms and subjects responded
209 whether the face was familiar or not without any time limitation. Four subjects had to be
210 excluded from this part of the analysis due to technical failures during data acquisition.

211 **2.5 Statistical Analysis.** All data analyses were performed using SPSS 23.0 software (SPSS
212 Inc., Chicago, Illinois, USA). In all cases, data from rating scores, recognition memory
213 accuracy and percentage of “yes/maybe” responses for having a short- or long-term
214 relationship with a target individual were subjected to four (analysis of the PLC group alone)
215 or five (analysis of the PLC vs. OXT treatment groups) factor repeated-measures ANOVAs

216 and significant ($p < 0.05$) main effects and relevant interactions were reported. Significant
217 interactions were explored using Simple Effect Tests, which were all Bonferroni-corrected
218 for multiple comparisons. For both ANOVAs and post-hoc tests measures of effect size are
219 given (Partial eta squared (η^2_p) or Cohen's d). Small, medium, and large effects were
220 represented respectively as 0.01, 0.06, and 0.14 for η^2_p , 0.20, 0.50, and 0.80 for Cohen's d
221 (Cohen, 1988).

222

223 **3 Results**

224 **3.1 Sex-differences on the impact of knowledge of previous fidelity or infidelity**

225 To identify treatment-independent sex differences on evaluations of a potential partner who
226 had previously displayed emotional or sexual fidelity or infidelity in a relationship, we first
227 analyzed data from the PLC control group using four-way repeated-measures ANOVAs with
228 fidelity (fidelity vs. infidelity) and type (emotional vs. sexual) as within-subject factors and
229 sex and relationship status as between-subject factors.

230 For attractiveness, likeability, trustworthiness and arousal ratings of the face pictures
231 paired with examples of fidelity or infidelity behaviors there were no significant fidelity x sex
232 interactions (all $ps > 0.328$). However, there was a significant type x sex interaction for
233 likeability ratings ($F(1,76) = 5.447, p = 0.022, \eta^2_p = 0.067$). Post hoc comparisons revealed
234 that women rated men who showed emotional fidelity or infidelity (4.15 ± 0.10 , 95% CI =
235 [3.96, 4.34]) more likeable than those who showed sexual fidelity or infidelity (3.94 ± 0.10 ,
236 95% CI = [3.74, 4.15]; $p = 0.001, d = 0.366$ – see Fig. S1a). Thus, the most likeable potential
237 partners for men were those who showed sexual fidelity while for women they were those

238 who showed emotional fidelity. There was also a similar trend for this with attractiveness
239 ratings although the interaction was only marginally significant ($F(1,76) = 3.731, p = 0.057$,
240 $\eta^2_p = 0.047$ – see Fig. S1b). There were no significant interactions involving type and sex for
241 recognition memory accuracy (all $p > 0.094$).

242 For short-term relationship preferences, analysis in the PLC group revealed a significant
243 fidelity x sex interaction ($F(1,76) = 8.807, p = 0.004, \eta^2_p = 0.104$). Post-hoc Bonferroni
244 corrected comparisons showed that $31.8 \pm 3.6\%$ (95% CI = [24.6%, 38.9%]) of responses
245 made by men expressed interest (i.e. “yes” or “maybe” decisions) in having a short-term
246 relationship with an unfaithful individual, whereas only $17.0 \pm 3.6\%$ (95% CI = [9.8%,
247 24.1%]) of responses made by women did ($p = 0.005, d = 0.658$ – see Fig. 2). There were no
248 sex-differences for long-term relationship preferences (all $p > 0.109$), with both men ($44.1 \pm$
249 4.9%, 95% CI = [34.4%, 53.9%]) and women ($47.9 \pm 4.9\%$, 95% CI = [38.1%, 57.6%])
250 showing an equivalent and greater preference for partners exhibiting previous fidelity ($p =$
251 0.589).

252 A separate analysis on female subjects found no evidence for a significant influence of
253 menstrual cycle stage (i.e. whether women were at a stage representing either a high or low
254 risk of conception) on any of the measures taken (see SI).

255 **3.2 Effects of intranasal oxytocin on sex-differences in mate choice**

256 To examine the effects of OXT on evaluations of potential partners showing previous fidelity
257 or infidelity, five way repeated-measures ANOVAs with fidelity (fidelity vs. infidelity) and
258 type (emotional vs. sexual) as within-subject factors and treatment, sex and relationship status
259 as between-subject factors were performed on rating scores, recognition memory accuracy

260 and percentage of “yes/maybe” responses for having a short- or long-term relationship with a
261 target individual.

262 There were significant fidelity x treatment x sex interactions for attractiveness ($F(1,152)$
263 $= 8.454, p = 0.004, \eta^2_p = 0.053$ – see Fig. 3a) and likeability ratings ($F(1,152) = 6.694, p =$
264 $0.011, \eta^2_p = 0.042$ – see Fig. 3b). Post-hoc Bonferroni corrected comparisons showed that in
265 men OXT increased both face attractiveness ($p = 0.047, d = 0.421$) and likeability ($p = 0.017,$
266 $d = 0.513$) of previously unfaithful women, while in women OXT decreased face
267 attractiveness ($p = 0.016, d = 0.529$) and likeability ($p = 0.181$) of previously unfaithful men.
268 Thus, unlike the PLC group, in the group treated with OXT there were significant sex
269 differences in face attractiveness ($p < 0.001, d = 1.033$) and likeability ($p < 0.001, d = 1.006$)
270 of previously unfaithful individuals. There were no significant OXT effects on face
271 attractiveness or likeability ratings given to previously faithful men and women (all $ps >$
272 0.461). And OXT did not alter the pattern of female subjects giving higher attractiveness or
273 likeability ratings than men for emotionally compared to sexually faithful individuals
274 (interactions involving type, treatment and sex: all $ps > 0.260$). No significant interaction
275 effects involving treatment, sex, fidelity or type were found for trustworthiness (all $ps >$
276 0.075) or arousal ratings (all $ps > 0.134$) indicating that sex-dependent effects of OXT on
277 attraction ratings were specific.

278 Analysis of recognition memory accuracy for faces revealed a significant fidelity x
279 treatment x sex interaction ($F(1,148) = 6.036, p = 0.015, \eta^2_p = 0.039$; note: for this analysis 4
280 subjects were excluded due to incomplete data). Post-hoc Bonferroni corrected comparisons
281 demonstrated that women in the OXT group ($59.1 \pm 2.5\%, 95\% \text{ CI} = [54.3\%, 64.0\%]$) were

282 less likely than women in the PLC group ($68.8 \pm 2.4\%$, 95% CI = [63.9%, 73.6%]) to
283 remember the faces of individuals who had previously exhibited infidelity ($p = 0.006$, $d =$
284 0.608 – see Fig. 3c). Oxytocin therefore effectively increased the chances that women would
285 only remember men with a history of being faithful. No other significant interaction effects
286 involving treatment, sex, fidelity or type were found (all $ps > 0.243$).

287 For short-term relationship preference, analysis revealed a fidelity x treatment x sex x
288 relationship status interaction ($F(1,152) = 4.082$, $p = 0.045$, $\eta^2_p = 0.026$). Post-hoc Bonferroni
289 corrected comparisons showed that the percentage of yes/maybe responses given by single
290 men for having a short-term relationship with unfaithful women were increased from $30.0 \pm$
291 4.9% (95% CI = [20.4%, 39.6%]) in the PLC group to $45.8 \pm 5.0\%$ (95% CI = [35.9%,
292 55.7%]) in the OXT group ($p = 0.025$, $d = 0.643$ – see Fig. 4a). No other significant
293 interaction effects involving treatment, sex, fidelity or type were found (all $ps > 0.06$).

294 For interest in having a long-term relationship there was a significant fidelity x treatment
295 x sex x relationship status interaction ($F(1,152) = 5.439$, $p = 0.021$, $\eta^2_p = 0.035$). Post-hoc
296 Bonferroni corrected comparisons showed that the percentage of yes/maybe responses made
297 by single women for having a long-term relationship with faithful men were increased from
298 $41.8 \pm 6.9\%$ (95% CI = [28.2%, 55.3%]) in the PLC group to $64.1 \pm 6.4\%$ (95% CI = [51.5%,
299 76.8%]) in the OXT group ($p = 0.018$, $d = 0.699$ – see Fig. 4b). No other significant
300 interaction effects involving treatment, sex, fidelity or type were found (all $ps > 0.266$).

301 A separate analysis on female subjects found menstrual cycle stage did not influence the
302 OXT effects found above (see SI).
303

304 **4 Discussion**

305 Overall, our findings demonstrate firstly that knowledge of previous fidelity and infidelity in
306 a prospective heterosexual partner effectively reveals sex differences in mate choice strategy.
307 Thus, men in the control PLC treated group generally exhibited greater interest in having a
308 short-term relationship with previously unfaithful individuals than women, and independent
309 of relationship status. There was no sex difference in the context of long-term relationships,
310 with both sexes showing an equivalent and greater preference for partners exhibiting previous
311 fidelity. Following OXT administration both men and women respectively exhibited
312 enhanced and reduced attraction to unfaithful individuals and women also found them less
313 memorable. Additionally, single men showed an increased preference for have a short-term
314 relationship with previously unfaithful women whereas single women showed an increased
315 preference for having a long-term relationship with previously faithful men.

316 In support of our hypothesis our findings in the PLC group demonstrate a clear
317 sex-dependent bias in mate choice with men expressing a greater interest than women in
318 having short-term relationships with previously unfaithful individuals. This therefore tends to
319 support proposed evolutionary sex-differences in mate choice priorities (Buss & Schmitt,
320 1993; Oliver & Hyde, 1993). In addition, we found some evidence to support previous
321 studies arguing that a sex difference in the perceived risk of infidelity is reflected in women
322 being more concerned by emotional infidelity but men by sexual infidelity (Buss, 2018; Buss
323 et al., 1992). Females more liked emotionally faithful males and males more liked sexually
324 faithful females.

325 Again in support of our original hypothesis OXT administration increased
326 sex-differences in mate-choice priorities. Thus, in contrast to the PLC group, subjects in the
327 OXT group exhibited sex-differences in the influence that knowledge of previous fidelity or
328 infidelity had on attractiveness and likeability ratings and memory for prospective partners.
329 Importantly however, OXT administration had no effect on potential confounders such as
330 arousal and trustworthiness ratings and effects were also independent of relationship status.
331 More specifically, OXT increased men's attractiveness and likeability ratings of previously
332 unfaithful women but correspondingly decreased those for unfaithful men by women.
333 Furthermore, following OXT administration women found the face pictures of men
334 associated with previous infidelity less memorable, suggesting that they would be more likely
335 to only remember faithful individuals. Interestingly however, OXT did not alter the
336 sex-specific preferences for the attractiveness and likeability ratings given to individuals who
337 had previously exhibited emotional (female) as opposed to sexual (male) fidelity. This may
338 reflect the fact that the sex-dependent effects of OXT were mainly in the context of interest in
339 previous infidelity or that it may have less influence on such strongly established within-sex
340 patterns of preference. Both the sex-differences observed in the PLC group and in response to
341 OXT treatment were robust with all achieving medium or large effect sizes, thereby
342 confirming the appropriateness of the power analysis for the study.

343 While the sex-dependent effects of OXT on attraction and likeability ratings and
344 memory for faces occurred irrespective of relationship status, those for increasing interest in
345 having short or long-term relationships were restricted to single individuals. This finding
346 supports our hypothesis that OXT would enhance sex-dependent social and reproductive

347 priorities (Gao et al., 2016; Hurlemann and Scheele, 2016) but particularly in single
348 individuals who have a higher priority for seeking a potential partner than those already in an
349 established relationship. That OXT primarily increased single men's interest in having
350 short-term relationships with women who had previously been unfaithful may reflect a high
351 priority for gaining sexual access to females. Similarly, single women's increased interest in
352 faithful males, and decreased interest in and memory for unfaithful ones, may reflect both a
353 higher priority for avoiding potential philandering males and preference for faithful
354 individuals who are more likely to provide a stable and secure relationship.

355 Oxytocin release associated with partner bonding across species is primarily evoked by
356 mating or sexual arousal as well as by affective touch (Hurlemann and Scheele, 2016; Li et
357 al., 2019), and can even occur in response to visual cues from the face (Fabre-Nys et al.,
358 1997). While there is some evidence that OXT can increase the perceived attractiveness of
359 the faces of unfamiliar members of the opposite sex (Hurlemann and Scheele, 2016) our
360 current findings emphasize that its release during initial social interactions might serve to
361 focus attention on pertinent information concerning a prospective partner's behavior and
362 history and not merely on their physical appearance. Indeed, previous studies have also
363 demonstrated that intranasal OXT administration can potently, and sex-dependently, alter
364 behavioral and neural responses to faces when they are paired with information on positive or
365 negative social qualities (Gao et al., 2016) and reduce recognition speed for positive romantic
366 and bonding-related words (Unkelbach et al., 2008). Thus, while OXT release can ultimately
367 promote the formation of partner bonds, it may first play a key role in highlighting the

368 attractiveness of personal characteristics in a prospective partner which best match an
369 individual's current priorities.

370 The current study has several potential limitations. Firstly, the paradigm used of rating
371 attractiveness and mating preference for individuals based purely on their face pictures
372 associated with a verbal descriptor is commonly used, it is relatively artificial and it is
373 possible that results in contexts involving real social interactions might have been different.
374 Secondly, the subjects used in the study were primarily students and those in a relationship
375 had relatively short durations (>6 months). It is possible that both sex-differences in the PLC
376 group and the effects of OXT might have been influenced by age and also relationship
377 durations.

378 **5 Conclusions**

379 In summary, our findings demonstrate firstly that in the context of knowledge of a
380 prospective partner's fidelity or infidelity in previous relationships men who are either single
381 or in a relationship are more interested than women in having short-term relationships with
382 unfaithful individuals. Following OXT treatment this sex difference is both amplified and
383 extended such that men are even more interested in having short-term relationships with
384 unfaithful individuals and women even less so. Furthermore, women exhibit a greater interest
385 in faithful individuals than do men in the context of long-term relationships. In terms of mate
386 choice therefore, the sexes exhibit a differential interest in prospective partners who are
387 "stayers" or "strayers", and for single individuals with a current priority for finding a
388 prospective partner OXT release during romantic encounters may act to further widen this

389 sex difference. Thus, OXT release may function first to influence sex-dependent mate-choice
390 priorities before subsequently promoting romantic bonds with the most appropriate partners.

391

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396 **Author Contributions**

397 LX and KMK designed the experiment. LX, RL, XZ and WZ carried out the experiment. LX,
398 KMK, BB and QZ analyzed the experiment and LX, KMK and BB wrote the paper. All authors
399 contributed to the conception of the study and approved the paper.

400

401 **Declaration of Interests**

402 The authors declare that they have no competing interests.

403

404 **References**

405 Buss, D.M., 2018. Sexual and emotional infidelity: Evolved gender differences in jealousy
406 prove robust and replicable. *Perspect. Psychol. Sci.* 13, 155–160.

407 <https://doi.org/10.1177/1745691617698225>

408 Buss, D.M., Larsen, R.J., Westen, D., Semmelroth, J., 1992. Sex differences in jealousy:
409 Evolution, physiology, and psychology. *Psychol. Sci.* 3, 251–256.

410 <https://doi.org/10.1111/j.1467-9280.1992.tb00038.x>

411 Buss, D.M., Schmitt, D.P., 1993. Sexual Strategies Theory: An evolutionary perspective on
412 human mating. *Psychol. Rev.* 100, 204–232.
413 <https://doi.org/10.1037/0033-295X.100.2.204>

414 Cavanaugh, J., Mustoe, A.C., Taylor, J.H., French, J.A., 2014. Oxytocin facilitates fidelity in
415 well-established marmoset pairs by reducing sociosexual behavior toward opposite-sex
416 strangers. *Psychoneuroendocrinology* 49, 1–10.
417 <https://doi.org/10.1016/j.psyneuen.2014.06.020>

418 Cohen, J., 1988. The Effect Size index: d, in: *Statistical Power Analysis for the Behavioral*
419 *Sciences*. pp. 20–26.

420 De Dreu, C.K.W., Kret, M.E., 2016. Oxytocin conditions intergroup relations through
421 upregulated in-group empathy, cooperation, conformity, and defense. *Biol. Psychiatry*
422 79, 165–173. <https://doi.org/10.1016/j.biopsych.2015.03.020>

423 Donaldson, Z.R., Young, L.J., 2008. Oxytocin, Vasopressin, and the Neurogenetics of
424 Sociality. *Science*. 322, 900–904. <https://doi.org/10.1126/science.1158668>

425 Fabre-Nys, C., Ohkura, S., Kendrick, K.M., 1997. Male faces and odours evoke differential
426 patterns of neurochemical release in the mediobasal hypothalamus of the ewe during
427 oestrus: an insight into sexual motivation? *Eur. J. Neurosci.* 9, 1666–1677.
428 <https://doi.org/10.1111/j.1460-9568.1997.tb01524.x>

429 Fitzgerald, F.S., 1925. *The Great Gatsby*. Charles Scribner's Sons, New York.

430 Gangestad, S.W., Haselton, M.G., Welling, L.L.M., Gildersleeve, K., Pillsworth, E.G.,

431 Burris, R.P., Larson, C.M., Puts, D.A., 2016. How valid are assessments of conception
432 probability in ovulatory cycle research? Evaluations, recommendations, and theoretical

433 implications. *Evol. Hum. Behav.* 37, 85–96.

434 <https://doi.org/10.1016/j.evolhumbehav.2015.09.001>

435 Gao, S., Becker, B., Luo, L., Geng, Y., Zhao, W., Yin, Y., Hu, J., Gao, Z., Gong, Q.,

436 Hurlemann, R., Yao, D., Kendrick, K.M., 2016. Oxytocin, the peptide that bonds the

437 sexes also divides them. *Proc. Natl. Acad. Sci. U. S. A.* 113, 7650–7654.

438 <https://doi.org/10.1073/pnas.1602620113>

439 Geng, Y., Zhao, W., Zhou, F., Ma, X., Yao, S., Hurlemann, R., Becker, B., Kendrick, K.M.,

440 2018. Oxytocin enhancement of emotional empathy: Generalization across cultures and

441 effects on amygdala activity. *Front. Neurosci.* 12, 512.

442 <https://doi.org/10.3389/fnins.2018.00512>

443 Guastella, A.J., Hickie, I.B., McGuinness, M.M., Otis, M., Woods, E.A., Disinger, H.M.,

444 Chan, H.K., Chen, T.F., Banati, R.B., 2013. Recommendations for the standardisation of

445 oxytocin nasal administration and guidelines for its reporting in human research.

446 *Psychoneuroendocrinology* 38, 612–625.

447 <https://doi.org/10.1016/j.psyneuen.2012.11.019>

448 Hu, J., Qi, S., Becker, B., Luo, L., Gao, S., Gong, Q., Hurlemann, R., Kendrick, K.M., 2015.

449 Oxytocin selectively facilitates learning with social feedback and increases activity and

450 functional connectivity in emotional memory and reward processing regions. *Hum.*

451 *Brain Mapp.* 36, 2132–2146. <https://doi.org/10.1002/hbm.22760>

452 Hurlemann, R., Scheele, D., 2016. Dissecting the role of oxytocin in the formation and loss of

453 social relationships. *Biol. Psychiatry* 79, 185–193.

454 <https://doi.org/10.1016/j.biopsych.2015.05.013>

455 Kendrick, K.M., Guastella, A.J., Becker, B., 2017. Overview of human oxytocin research, in:

456 Hurlemann, R., Grinevich, V. (Eds.), *Behavioral Pharmacology of Neuropeptides*:

457 Oxytocin. Springer, Cham, pp. 321–348. https://doi.org/10.1007/7854_2017_19

458 Knopp, K., Scott, S., Ritchie, L., Rhoades, G.K., Markman, H.J., Stanley, S.M., 2017. Once a

459 Cheater, Always a Cheater? Serial Infidelity Across Subsequent Relationships. *Arch.*

460 *Sex. Behav.* 46, 2301–2311. <https://doi.org/10.1007/s10508-017-1018-1>

461 Lansford, J.E., 2009. Parental divorce and children's adjustment. *Perspect. Psychol. Sci.* 4,

462 140–152. <https://doi.org/10.1111/j.1745-6924.2009.01114.x>

463 Lee, M.R., Scheidweiler, K.B., Diao, X.X., Akhlaghi, F., Cummins, A., Huestis, M.A.,

464 Leggio, L., Averbeck, B.B., 2018. Oxytocin by intranasal and intravenous routes reaches

465 the cerebrospinal fluid in rhesus macaques: determination using a novel oxytocin assay.

466 *Mol. Psychiatry* 23, 115. <https://doi.org/10.1038/mp.2017.27>

467 Li, Q., Becker, B., Wernicke, J., Chen, Y., Zhang, Y., Li, R., Le, J., Kou, J., Zhao, W.,

468 Kendrick, K.M., 2019. Foot massage evokes oxytocin release and activation of

469 orbitofrontal cortex and superior temporal sulcus. *Psychoneuroendocrinology* 101,

470 193–203. <https://doi.org/https://doi.org/10.1016/j.psyneuen.2018.11.016>

471 Luo, L., Becker, B., Geng, Y., Zhao, Z., Gao, S., Zhao, W., Yao, S., Zheng, X., Ma, X., Gao,

472 Z., Hu, J., Kendrick, K.M., 2017. Sex-dependent neural effect of oxytocin during

473 subliminal processing of negative emotion faces. *Neuroimage* 162, 127–137.

474 <https://doi.org/10.1016/j.neuroimage.2017.08.079>

475 Luo, R., Xu, L., Zhao, W., Ma, X., Xu, X., Kou, J., Gao, Z., Becker, B., Kendrick, K.M.,

476 2017. Oxytocin facilitation of acceptance of social advice is dependent upon the

477 perceived trustworthiness of individual advisors. *Psychoneuroendocrinology* 83, 1–8.

478 <https://doi.org/10.1016/j.psyneuen.2017.05.020>

479 Oliver, B.M., Hyde, S.J., 1993. Gender Differences in Sexuality: A Meta- Analysis. *Psychol.*
480 *Bull.* 114, 29–51. <https://doi.org/doi: 10.1037/0033-2909.114.1.29>

481 Paloyelis, Y., Doyle, O.M., Zelaya, F.O., Maltezos, S., Williams, S.C., Fotopoulou, A.,
482 Howard, M.A., 2016. A spatiotemporal profile of in vivo cerebral blood flow changes
483 following intranasal oxytocin in humans. *Biol. Psychiatry* 79, 693–705.

484 <https://doi.org/10.1016/j.biopsych.2014.10.005>

485 Penton-Voak, I.S., Perrett, D.I., Castles, D.L., Kobayashi, T., Burt, D.M., Murray, L.K.,
486 Minamisawa, R., 1999. Menstrual cycle alters face preference. *Nature* 399, 741.

487 <https://doi.org/10.1038/21557>

488 Place, S.S., Todd, P.M., Penke, L., Asendorpf, J.B., 2010. Humans show mate copying after
489 observing real mate choices. *Evol. Hum. Behav.* 31, 320–325.

490 <https://doi.org/10.1016/j.evolhumbehav.2010.02.001>

491 Preckel, K., Scheele, D., Kendrick, K.M., Maier, W., Hurlemann, R., 2014. Oxytocin
492 facilitates social approach behavior in women. *Front. Behav. Neurosci.* 8, 191.

493 <https://doi.org/10.3389/fnbeh.2014.00191>

494 Quintana, D.S., Westlye, L.T., Alnæs, D., Rustan, Ø.G., Kaufmann, T., Smerud, K.T.,
495 Mahmoud, R.A., Djupesland, P.G., Andreassen, O.A., 2016. Low dose intranasal
496 oxytocin delivered with Breath Powered device dampens amygdala response to
497 emotional stimuli: A peripheral effect-controlled within-subjects randomized
498 dose-response fMRI trial. *Psychoneuroendocrinology* 69, 180–188.

499 <https://doi.org/10.1016/j.psyneuen.2016.04.010>

500 Quintana, D.S., Westlye, L.T., Smerud, K.T., Mahmoud, R.A., Andreassen, O.A., Djupesland,
501 P.G., 2018. Saliva oxytocin measures do not reflect peripheral plasma concentrations
502 after intranasal oxytocin administration in men. *Horm. Behav.* 102, 85–92.

503 <https://doi.org/10.1016/j.yhbeh.2018.05.004>

504 Scheele, D., Striepens, N., Gunturkun, O., Deutschlander, S., Maier, W., Kendrick, K.M.,
505 Hurlemann, R., 2012. Oxytocin modulates social distance between males and females. *J.*
506 *Neurosci.* 32, 16074–16079. <https://doi.org/10.1523/JNEUROSCI.2755-12.2012>

507 Scheele, D., Striepens, N., Kendrick, K.M., Schwering, C., Noelle, J., Wille, A., Schläpfer,
508 T.E., Maier, W., Hurlemann, R., 2014. Opposing effects of oxytocin on moral judgment
509 in males and females. *Hum. Brain Mapp.* 35, 6067–6076.

510 <https://doi.org/10.1002/hbm.22605>

511 Scheele, D., Wille, A., Kendrick, K.M., Stoffel-Wagner, B., Becker, B., Güntürkün, O.,
512 Maier, W., Hurlemann, R., 2013. Oxytocin enhances brain reward system responses in
513 men viewing the face of their female partner. *Proc. Natl. Acad. Sci. U. S. A.* 110,
514 20308–20313. <https://doi.org/10.1073/pnas.1314190110>

515 Shin, N.Y., Park, H.Y., Jung, W.H., Kwon, J.S., 2018. Effects of Intranasal Oxytocin on
516 Emotion Recognition in Korean Male: A Dose-Response Study. *Psychiatry Investig.* 15,
517 710. <https://doi.org/10.30773/pi.2018.02.19>

518 Spengler, F.B., Schultz, J., Scheele, D., Essel, M., Maier, W., Heinrichs, M., Hurlemann, R.,
519 2017. Kinetics and dose dependency of intranasal oxytocin effects on amygdala
520 reactivity. *Biol. Psychiatry* 82, 885–894. <https://doi.org/10.1016/j.biopsych.2017.04.015>

521 Striepens, N., Kendrick, K.M., Hanking, V., Landgraf, R., Wüllner, U., Maier, W.,

522 Hurlemann, R., 2013. Elevated cerebrospinal fluid and blood concentrations of oxytocin

523 following its intranasal administration in humans. *Sci. Rep.* 3, 3440.

524 <https://doi.org/10.1038/srep03440>

525 Takahashi, H., Matsuura, M., Yahata, N., Koeda, M., Suhara, T., Okubo, Y., 2006. Men and

526 women show distinct brain activations during imagery of sexual and emotional infidelity.

527 *Neuroimage* 32, 1299–1307. <https://doi.org/10.1016/j.neuroimage.2006.05.049>

528 Unkelbach, C., Guastella, A.J., Forgas, J.P., 2008. Oxytocin selectively facilitates recognition

529 of positive sex and relationship words. *Psychol. Sci.* 19, 1092–1094.

530 <https://doi.org/10.1111/j.1467-9280.2008.02206.x>

531 Xu, L., Ma, X., Zhao, W., Luo, L., Yao, S., Kendrick, K.M., 2015. Oxytocin enhances

532 attentional bias for neutral and positive expression faces in individuals with higher

533 autistic traits. *Psychoneuroendocrinology* 62, 352–358.

534 <https://doi.org/10.1016/j.psyneuen.2015.09.002>

535 Zhao, W., Geng, Y., Luo, L., Zhao, Z., Ma, X., Xu, L., Yao, S., Kendrick, K.M., 2017.

536 Oxytocin increases the perceived value of both self-and other-owned items and alters

537 medial prefrontal cortex activity in an endowment task. *Front. Hum. Neurosci.* 11, 272.

538 <https://doi.org/10.3389/fnhum.2017.00272>

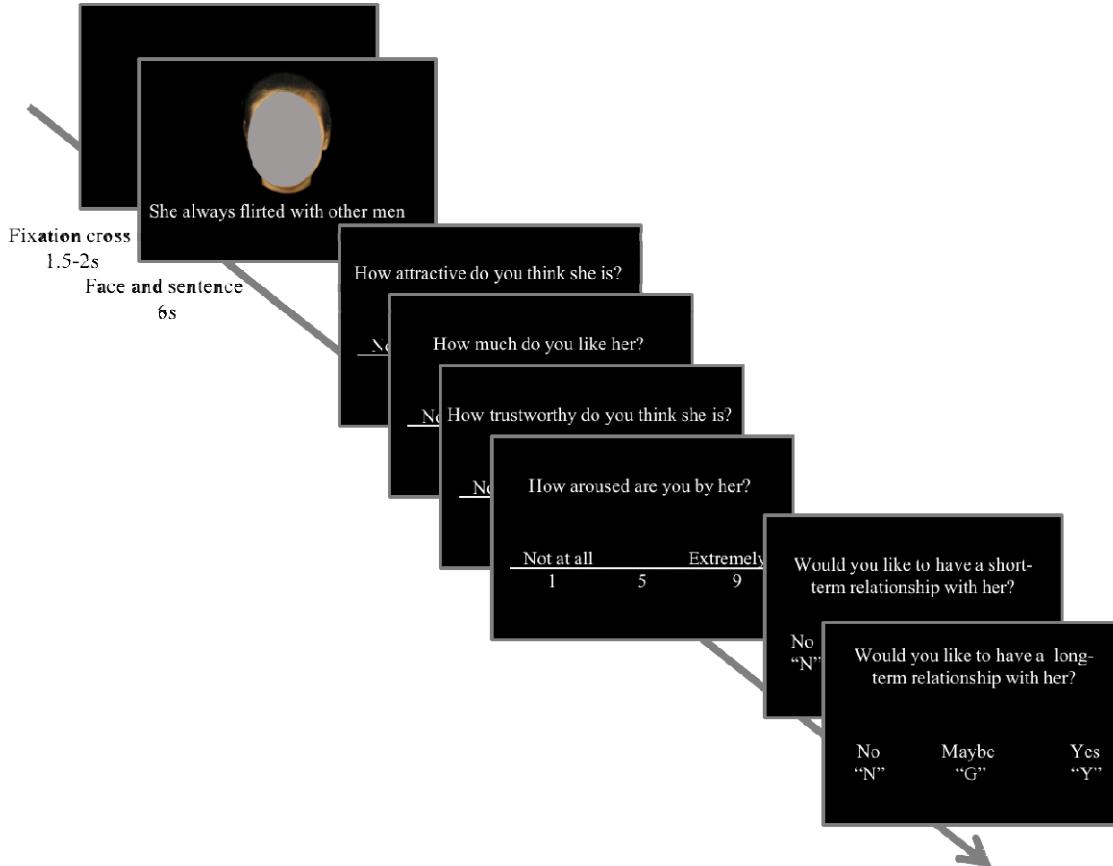
539 Zhao, W., Ma, X., Le, J., Ling, A., Xin, F., Kou, J., Zhang, Y., Luo, R., Becker, B., Kendrick,

540 K.M., 2018. Oxytocin biases men to be more or less tolerant of others' dislike dependent

541 upon their relationship status. *Psychoneuroendocrinology* 88, 167–172.

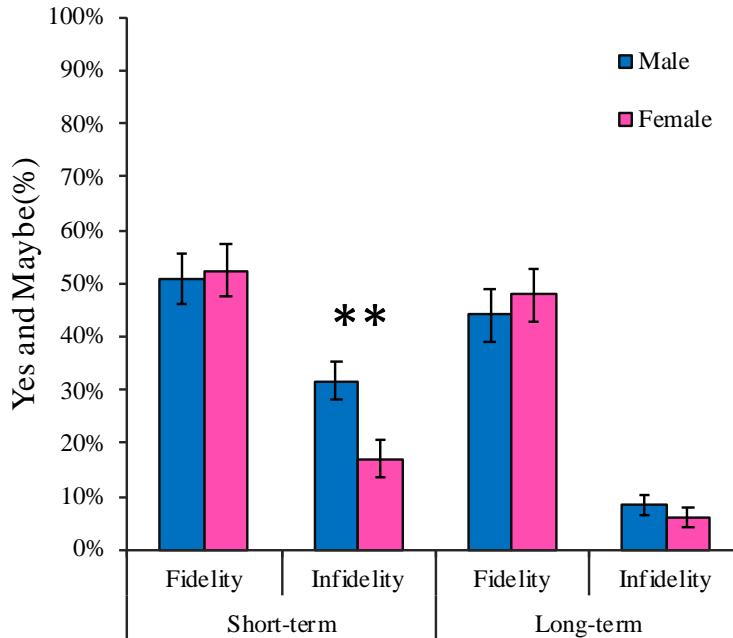
542 <https://doi.org/10.1016/j.psyneuen.2017.12.010>

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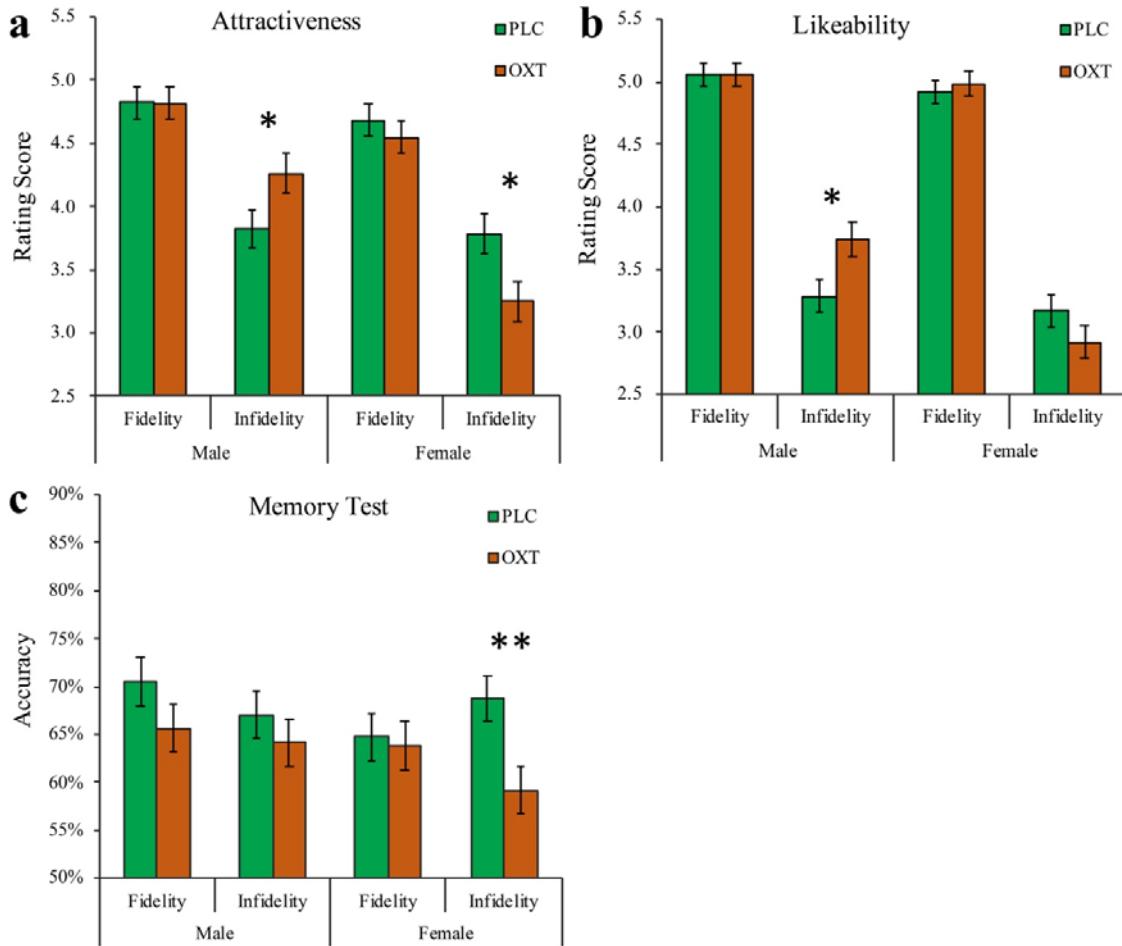
545 **Fig. 1.** Example of a single trial in the rating task. Following a 1.5~2 second fixation cross,
546 each facial picture (unknown, opposite sex) was shown for 6 seconds and paired with a
547 sentence describing a behavior indicative of fidelity or infidelity (either emotional or sexual)
548 he/she exhibited during a previous relationship. Each subject viewed 10 trials for each
549 fidelity/infidelity type - emotional fidelity, sexual fidelity, emotional infidelity and sexual
550 infidelity.



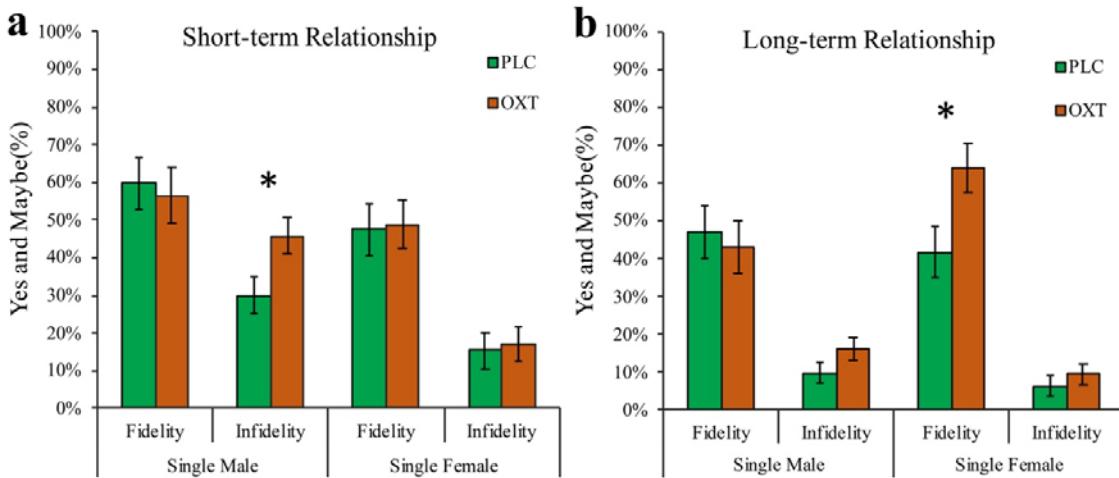
551

552 **Fig. 2.** Sex difference in the percentage of yes/maybe responses made by subjects for having
553 a short-term, but not long-term, relationship with individuals showing previous infidelity in
554 the placebo treated group. Data from single individuals and those in a relationship are
555 combined. Bars represent means and standard errors. ** $p < 0.01$ for males vs. females.

556



557 **Fig. 3.** Effects of oxytocin (OXT) on attractiveness (a) likeability (b) and recognition
558 memory (c) for faces of the opposite sex associated with previous fidelity or infidelity in all
559 male and female subjects. Bars represent means and standard errors. * $p < 0.05$, ** $p < 0.01$
560
561 OXT vs. placebo (PLC).
562



563

564 **Fig. 4.** Effect of oxytocin (OXT) on percentage of yes/maybe responses in single male and
565 female subjects for having a short-term (a) or long-term relationship (b) with an individual of
566 the opposite sex associated with previous fidelity or infidelity. Bars represent means and
567 standard errors. * $p < 0.05$ OXT vs. placebo (PLC).

568

569 **Table 1.** Ages and questionnaire scores in the four experimental groups (mean±S.E.M.)

Measurements	Placebo		Oxytocin		Sex x Treatment <i>p</i> -value
	Male	Female	Male	Female	
Age(years)	23.0±0.3	22.8±0.3	22.9±0.3	22.7±0.3	0.872
Positive and Negative Affective Scale (PANAS) -Positive	31.6±0.8	29.2±0.9	28.8±0.9	28.5±1.0	0.237
Positive and Negative Affective Scale (PANAS) -Negative	21.7±1.3	18.1±1.1	19.2±1.1	18.0±1.0	0.306
NEO-Five Factor Inventory-Agreeableness	42.4±0.7	41.4±0.6	40.7±0.6	40.9±0.8	0.365
NEO-Five Factor Inventory-Conscientiousness	42.7±0.8	41.7±0.7	41.4±0.8	42.3±0.8	0.220
NEO-Five Factor Inventory-Extraversion	41.2±0.8	38.8±1.0	39.9±1.0	40.8±0.8	0.070
NEO-Five Factor Inventory-Neuroticism	33.8±1.3	34.5±1.1	34.4±1.1	34.1±1.2	0.667
NEO-Five Factor Inventory-Openness	40.4±0.7	38.2±0.9	39.8±0.8	39.3±0.8	0.275
Self-Esteem Scale (SES)	30.6±0.7	31.3±0.6	30.5±0.6	30.8±0.8	0.811
Interpersonal Reactivity Index (IRI)	50.0±1.6	51.9±1.5	45.0±1.4	50.8±1.6	0.200
Autism Spectrum Quotient (ASQ)	20.0±0.7	20.7±0.9	20.7±0.6	19.7±0.8	0.254
Beck Depression Inventory (BDI-II)	8.1±0.9	7.9±1.2	8.8±1.3	7.2±0.9	0.512
Liebowitz's Social Anxiety Scale (LSAS)-Avoid	20.8±1.9	19.1±1.8	20.2±1.4	21.5±1.9	0.421
Liebowitz's Social Anxiety Scale (LSAS)-Fear	24.7±2.0	21.6±1.6	22.2±1.5	25.3±2.1	0.089
Passionate Love Scale (PLS)	103.4±2.4	99.0±2.3	97.8±2.0	96.7±2.5	0.476
Love Attitude Scale (LAS)-Agape	26.9±0.6	22.0±0.5	25.2±0.6	20.8±0.5	0.686
Love Attitude Scale (LAS)-Eros	24.1±0.5	23.5±0.5	23.4±0.6	23.6±0.6	0.529
Love Attitude Scale (LAS)-Ludus	19.3±0.7	19.0±0.6	19.9±0.5	18.9±0.5	0.573
Love Attitude Scale (LAS)-Mania	21.2±0.7	19.7±0.7	21.0±0.6	19.9±0.7	0.706
Love Attitude Scale (LAS)-Pragma	22.6±0.7	23.1±0.6	20.9±0.7	23.0±0.6	0.213
Love Attitude Scale (LAS)-Storge	22.8±0.7	21.5±0.7	21.3±0.7	21.7±0.8	0.261
General Trust Scale (GTS)	32.0±0.5	31.6±0.6	31.2±0.6	31.8±0.7	0.380
Tendency to Forgive Scale (TTF)	14.3±0.5	14.3±0.5	14.1±0.6	13.9±0.7	0.846
Attitudes toward Forgiveness Scale (ATF)	28.5±0.7	27.9±0.7	27.4±0.6	26.5±0.7	0.808
Trait Forgivingness Scale (TFS)	32.7±0.9	32.5±0.9	32.0±0.8	30.9±1.0	0.614

570

571

572 **Supporting Information**

573 **Oxytocin amplifies evolutionary sex differences in human mate choice**

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576

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579 **Supplementary Methods**

580 To control for potential confounds, before intranasal treatment all subjects completed a range
581 of validated questionnaires (Chinese versions) measuring mood, personality traits and
582 attitudes toward love, trust and forgiveness. These included: Positive and Negative Affective
583 Schedule – PANAS (Watson et al., 1988); NEO-Five Factor Inventory – NEO-FFI (Costa
584 and Mccrae, 1989); Self-Esteem Scale – SES (Rosenberg, 1965); Interpersonal Reactivity
585 Index – IRI (Davis, 1980); Autism Spectrum Quotient – ASQ (Baron-Cohen et al., 2001);
586 Beck’s Depression Inventory – BDI (Beck et al., 1996); Leibowitz’s Social Anxiety Scale –
587 LSAS (Liebowitz, 1987); Passionate Love Scale – PLS (Hatfiled and Sprecher, 1986); Love
588 Attitude Scale – LAS (Hendrick and Hendrick, 1986); General Trust Scale – GTS (Siegrist et
589 al., 2005); Tendency to Forgive Scale – TTF (Brown, 2003); Attitudes toward Forgiveness
590 Scale – ATF (Brown, 2003); Trait Forgivingness Scale – TFS (Berry et al., 2005). Univariate
591 ANOVAs on questionnaires and age showed no significant differences between the OXT-
592 and PLC-treated males and females (sex x treatment interaction: all $p > 0.070$; See Table 1).

593 **Supplementary Results**

594 Repeated-measures ANOVAs added menstrual cycle as a between-subject factor in
595 female subjects suggested that the stage of their menstrual cycle did not influence our
596 findings. There were no significant interactions of menstrual cycle and fidelity or interactions
597 of menstrual cycle and type for rating scores, memory and short-term or long-term
598 relationship preferences in the PLC group (all $ps > 0.100$). For the effects of OXT there were
599 also no significant interactions of menstrual cycle, treatment and fidelity for rating scores,
600 memory and short-term or long-term relationship preferences (all $ps > 0.390$).

601

602 **References**

603 Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., Clubley, E., 2001. The
604 autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning
605 autism, males and females, scientists and mathematicians. *J. Autism Dev. Disord.* 31,
606 5–17. <https://doi.org/10.1023/A:1005653411>

607 Beck, A.T., Steer, R.A., Brown, G.K., 1996. Beck depression inventory-II. The Psychological
608 Corporation, San Antonio, TX.

609 Berry, J.W., Worthington, E.L., O'Connor, L.E., Parrott, L., Wade, N.G., 2005.
610 Forgivingness, vengeful rumination, and affective traits. *J. Pers.* 73, 183–226.
611 <https://doi.org/10.1111/j.1467-6494.2004.00308.x>

612 Brown, R.P., 2003. Measuring Individual Differences in the Tendency to Forgive: Construct
613 Validity and Links with Depression Measuring Individual Differences in the Tendency
614 to Forgive: Construct Validity and Links With Depression. *Personal. Soc. Psychol. Bull.*

615 29, 759–771. <https://doi.org/10.1177/0146167203029006008>

616 Costa, P., McCrae, R.R., 1989. The NEO-PI/NEO-FFI manual supplement. Psychological
617 Assessment Resources, Odessa, FL.

618 Davis, M.H., 1980. A multidimensional approach to individual differences in empahty. Cat.

619 Sel. Doc. Psychol. 40, 3480.

620 Hatfiled, E., Sprecher, S., 1986. Measuring passionate love in intimate relations. J. Adolesc. 9,

621 383–410. [https://doi.org/10.1016/S0140-1971\(86\)80043-4](https://doi.org/10.1016/S0140-1971(86)80043-4)

622 Hendrick, C., Hendrick, S., 1986. A theory and method of love. J. Pers. Soc. Psychol. 50,

623 392–402. <https://doi.org/10.1037/0022-3514.50.2.392>

624 Liebowitz, M.R., 1987. Social phobia, in: Anxiety. Karger Publishers, pp. 141–173.

625 <https://doi.org/10.1159/000414022>

626 Rosenberg, M., 1965. Society and the adolescent self-image. Princeton university press

627 Princeton, NJ.

628 Siegrist, M., Keller, C., Barle, T.C., Gutscher, H., 2005. Effects of general trust on

629 cooperation in the investment game and in a social dilemma Unpublished manuscript,

630 Institute for Environmenta.

631 Watson, D., Clark, L.A., Tellegen, A., 1988. Development and validation of brief measures

632 of positive and negative affect: the PANAS scales. J. Pers. Soc. Psychol. 54, 1063–1070.

633 <https://doi.org/10.1037/0022-3514.54.6.1063>

634

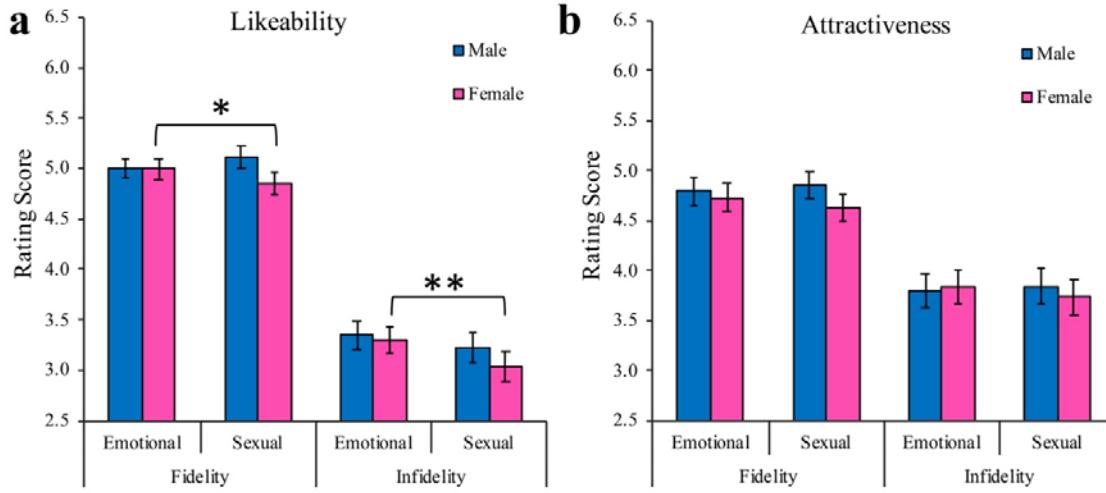
635 **Table S1.** Examples of sentences describing sexual and emotional fidelity or infidelity

Type	Sentence Examples
Emotional Fidelity	He/She always ignored other women/men who tried to flirt with him/her.

He/She always refused to go out on a date with other women/men.	
Sexual Fidelity	He/She threw wine on his/her female/male client's face when she/he tried to seduce him/her.
	He/She refused to have sex with his/her boss even though that would have resulted in gaining a promotion.
Emotional Infidelity	He/She expressed his/her love to another woman/man without his/her girlfriend/boyfriend knowing.
	He/She sent many romantic text messages to another woman/man.
Sexual Infidelity	He/She had sex with girlfriend's/boyfriend's best friend.
	He/She gave another woman/man oral sex.

636

637



638

639 **Fig. S1.** Sex difference in likeability and attractiveness ratings in the placebo (PLC) treated

640 group. * $p < 0.05$, ** $p < 0.01$.

641