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Oxytocin Increases Bias, but not Accuracy, in Face Recognition Line-Ups

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Abstract

Previous work indicates that intranasal inhalation of oxytocin improves face recognition skills, raising the possibility that it may be used in security settings. However, it is unclear whether oxytocin directly acts upon the core face-processing system itself, or indirectly improves face recognition via affective or social salience mechanisms. In a double-blind procedure, 60 participants received either an oxytocin or placebo nasal spray before completing the One-in-Ten task – a standardized test of unfamiliar face recognition containing target-present and target-absent line-ups. Participants in the oxytocin condition outperformed those in the placebo condition on target-present trials, yet were more likely to make false-positive errors on target-absent trials. Signal detection analyses indicated that oxytocin induced a more liberal response bias, rather than increasing accuracy per se. These findings support a social salience account of the effects of oxytocin on face recognition, and indicate that oxytocin may impede face recognition in certain scenarios.

Keywords: Oxytocin; face recognition; social salience; eye-witness.

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Oxytocin is a nonapeptide that plays a fundamental role in social cognition (Heinrichs et al., 2009). Recent evidence demonstrates that intranasal inhalation of oxytocin improves facial identity recognition in both typical participants (Guastella et al., 2008; Rimmele et al., 2009; Savaskan et al., 2008) and those with prosopagnosia (Bate et al., 2014), although the precise underpinnings of this effect remain unclear. Understanding the effects of oxytocin on face recognition is an important issue, given the hormone may be useful for specific face recognition tasks within security or forensic settings.

It is possible that oxytocin acts upon the core face-processing system (Haxby et al., 2000), and some neuroimaging evidence supports this possibility (e.g. Domes et al., 2010; Labuschagne et al., 2010). Alternatively, oxytocin may affect face-processing more indirectly by modulating affective or social salience mechanisms. The hypothesis that oxytocin increases social salience, either via an affective (Shamay-Tsoory et al., 2009; Theodoridou et al., 2013) or approach-withdrawal (Ditzen et al., 2009; Kemp & Guastella, 2011) mechanism, is supported by several lines of evidence. Firstly, neuroimaging studies suggest that oxytocin influences affective areas of the brain (e.g. Gamer et al., 2010; Petrovic et al., 2008). Secondly, in other areas of oxytocin research, such as economic games and social judgements, social salience hypotheses have been used to account for pro- (and sometimes anti-) social effects of the hormone (e.g. Shamay-Tsoory et al., 2009; De Dreu et al., 2010, 2011, DeClerk et al., 2010; Bartz et al., 2011). Finally, several studies examining the influence of oxytocin on facial identity recognition have found mixed results depending on the emotional expression displayed upon the face (Guastella et al., 2008; Saskavan et al., 2008). These investigations raise the possibility that oxytocin may only improve face recognition in certain social or affective conditions.

A novel means of exploring this issue is to investigate the influence of oxytocin on face recognition within line-up scenarios, where multiple faces are simultaneously displayed for recognition and a target face may or may not be present. Indeed, if oxytocin acts upon the face recognition system itself, performance should improve in both target-present and target-absent conditions. Alternatively, given the pro-social effects of oxytocin described above, the hormone may influence affective or social salience mechanisms, perhaps by making a perceiver's response bias more liberal. If this is the case, performance would be *impeded* in target-absent trials, due to a greater number of false-positive errors. Such findings would have important implications for real-world use of oxytocin, particularly if it encourages the misidentification of innocent individuals. The current study aimed to examine this hypothesis, by investigating the influence of oxytocin on performance on the One-in-Ten test (Bruce et al., 1999) – a standardized test of unfamiliar face recognition consisting of target-present and target-absent line-ups.

METHOD

Participants

60 participants (34 female; Mean age = 22.8 years, SD = 3.3) were randomly assigned in a double-blind between-subjects procedure to receive either oxytocin or placebo spray (gender was evenly dispersed between conditions). The exact protocols, including exclusion criteria and administration procedures, are described fully in Bate et al. (2014). Ethical approval was granted by Bournemouth University's Ethics Board, and participants received a small monetary payment in exchange for their time.

Stimuli and Materials

The One-In-Ten test: The face recognition task used in this study was the One-In-Ten test (Bruce et al., 1999): a test containing 20 target-present and 20 target-absent trials, that has been well-used and validated within the psychological literature (e.g. Bindemann et al., 2012; Megreya & Burton, 2007). In each of the 40 randomly-presented trials, participants study a single target face until they are confident they can identity it from a subsequent line-up. Target faces are extracted from high-quality video footage, and measure 155 pixels in width and 200 pixels in height at a screen resolution of 72(?) ppi. After the participant presses a key to indicate that encoding is complete, the target is instantly replaced by a line-up of ten faces, each measuring 132 pixels in width and 200 pixels in height. All faces display a neutral expression and are not cropped to exclude the external features, in order to maintain the ecological validity of the task.

Participants are required to use defined keys on the keyboard to indicate which face (if any) matches the target face. To encourage maximum performance, no time limits are imposed on the participant in any part of this task (see Bruce et al., 1999). For target-present trials, participants can make a correct identification (a 'hit'), or one of two incorrect responses: either a 'misidentification' (i.e. the incorrect identification of a distractor face) or a 'miss' (the incorrect response that a target is absent). In target-absent trials, the correct response is referred to as a 'correct rejection', and incorrect responses as 'false-positives'.

The Multidimensional Mood Questionnaire (MMQ): General affect was measured throughout the experiment using the MMQ (Steyer, Schwenkmezger, Notz, & Eid, 1997). This self-report questionnaire is composed of three sub-scales (good-bad, awake-tired and calm-nervous), and was used to assess the possible mood-altering effects of oxytocin, and to control for non-specific effects of attention and wakefulness.

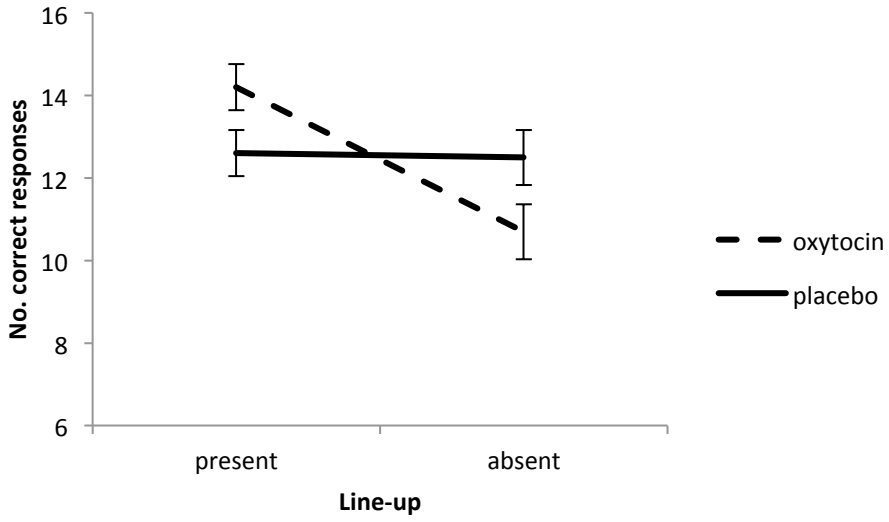
Procedure

Participants initially received a single intranasal dose of 24 IU of either oxytocin (Syntocinon Spray, Novartis) or placebo (identical to the experimental spray with the exception of the oxytocin) spray. Following inhalation, participants sat quietly for 45 minutes to allow central oxytocin levels to plateau (Born et al., 2002), and then completed the One-In-Ten task. Each participant was required to complete the MMQ at three intervals across the experiment: immediately following inhalation, after the 45 min resting period, and after the One-In-Ten test had been completed.

RESULTS

First, the time taken to encode target faces was examined, and no differences were observed between the oxytocin and placebo condition (all *p*s > .05). Second, we examined only the correct responses from the test phase (i.e. the hits and correct rejections). Specifically, a 2 (spray: oxytocin, placebo) x 2 (line-up: target-present, target-absent) mixed design analysis of variance (ANOVA) revealed a main effect of line-up, with a greater number of correct responses for target-present (M = 13.40, SE = .40) than target-absent (M = 11.60, SE = .48) trials, $F(1,58) = 9.373$, $p = .003$, $\eta_p^2 = .139$, 95% CI [.03-.27]. Although overall performance did not differ between the oxytocin (M = 12.47, SE = .46) and placebo (M = 12.53, SE = .46) sprays, $F(1,58) = .011$, $p = .919$, $\eta_p^2 = .001$, 95% CI [.00-.05], the two factors did interact $F(1,58) = 8.036$, $p = .006$, $\eta_p^2 = .122$, 95% CI [.02-.25] (see Figure 1).

Figure 1: Number of correct responses for target-present and target-absent line-ups, under oxytocin and placebo conditions.



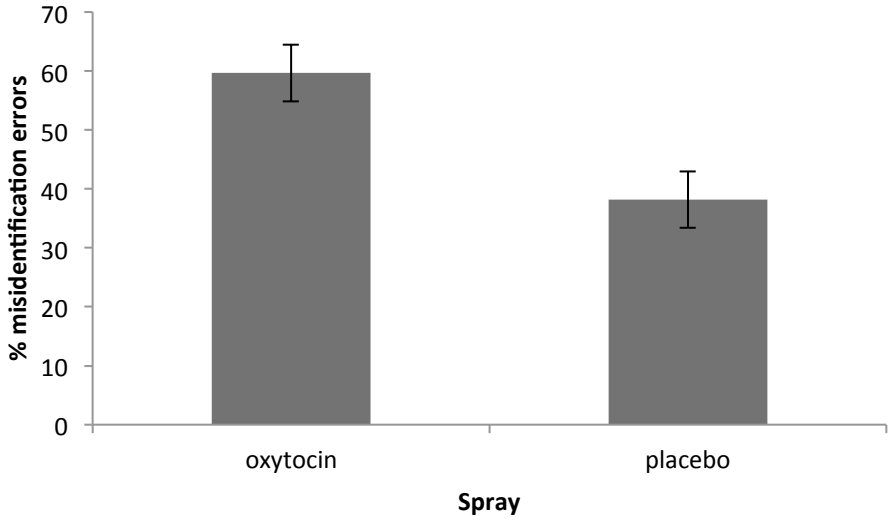
Planned follow-up analyses indicated that this interaction was facilitated by better performance in the oxytocin condition for target-present compared to target-absent trials, but there was no such difference in the placebo condition, $F(1,29) = 26.573$, $p = .001$, $\eta_p^2 = .478$, 95% CI [.24-.62] and $F(1,29) = .019$, $p = .891$, $\eta_p^2 = .001$, 95% CI [.00-.03], respectively. Further analyses indicated that performance in the target-present condition was indeed better in the oxytocin compared to the placebo condition, yet revealed a trend towards the converse pattern in the target-absent condition, $F(1,58) = 4.064$, $p = .048$, $\eta_p^2 = .065$, 95% CI [.00-.18] and $F(1,58) = 3.311$, $p = .074$, $\eta_p^2 = .054$, 95% CI [.00-.17], respectively.

Third, we analysed sensitivity (*d'* identification) and bias (criterion *c*), to examine whether oxytocin improved overall performance or changed participants' response bias. Sensitivity was calculated by combining hits with false-positive scores; bias was calculated by combining all positive responses across both trial types (hits, misidentifications, and false-positives: MacMillan and Creelman, 2005). A univariate ANOVA on each measure revealed that oxytocin did not improve overall performance (oxytocin *d'*: M = 0.71, SE = 0.15;

placebo *d'*: M = 0.69, SE = 0.15), $F(1,58) = .005$, $p = .946$, $\eta_p^2 = .000$, 95% CI [.00-.00], but participants in the oxytocin condition (c = -0.61, SE = .08) showed a more liberal response bias (i.e., more positive responses) than participants in the placebo condition (c = -0.22, SE = .08), $F(1,58) = 11.83$, $p = .001$, $\eta_p^2 = .169$, 95% CI [.05-.31].

Fourth, we examined the type of errors that were made within the target-present condition. Specifically, the proportion of misidentifications and misses were calculated for each participant, and an univariate ANOVA indicated that oxytocin participants made more misidentification errors, whereas placebo participants made more misses, $F(1,58) = 10.067$, $p = .002$, $\eta_p^2 = .148$, 95% CI [.03-.28] (see Figure 2).

Figure 2: Proportion of misidentification errors in target-present line-ups, under oxytocin and placebo conditions. The remaining errors are misses.



Finally, a mixed factorial MANOVA examined the MMQ scores and revealed a main effect of time, $F(6,53) = 5.103$, $p = .001$, $\eta_p^2 = .366$, 95% CI [.13-.45]. Specifically, regardless of spray, participants felt less 'good', 'awake', and 'nervous' at the end of the testing session: $F(2,116) = 4.698$, $p = .016$, $\eta_p^2 = .075$, 95% CI [.01-.15], $F(2,116) = 9.065$, $p = .001$, $\eta_p^2 =$

.135, 95% CI [.05-.22] and $F(2,116) = 4.939$, $p = .015$, $\eta_p^2 = .078$, 95% CI [.01-.16], respectively. No main effect of spray or interaction between time and spray was observed, $F(3,56) = .393$, $p = .759$, $\eta_p^2 = .021$, 95% CI [0-.06] and $F(6,53) = .884$, $p = .513$, $\eta_p^2 = .091$, 95% CI [0-.13], respectively, indicating that the findings cannot be attributed to potential mood-altering effects of oxytocin.

DISCUSSION

This study investigated the effect of intranasal inhalation of oxytocin on face recognition performance in target-present and target-absent line-ups. Oxytocin did not improve overall accuracy, but participants who inhaled oxytocin were more accurate in target-present trials and somewhat less accurate in target-absent trials compared to those who inhaled a placebo spray. When participants did make errors in the target-present trials, those in the oxytocin condition were more likely to make misidentification errors (responding "present" but selecting the wrong face) than misses (responding "absent"). In other words, participants in the oxytocin condition showed a general increase in bias to respond "present". This pattern of results could not be accounted for by a speed-accuracy trade-off or changes in mood or arousal.

Our pattern of results argues against the hypothesis that oxytocin acts directly on the face-processing system. At first glance, these results sit at odds with other studies that have found an increase in face recognition performance after inhalation of oxytocin (e.g., Hertzmann et al., 2013; Rimmele et al., 2009; Guastella et al., 2008; Saskavan et al., 2008). Indeed these are the first results to link oxytocin with a more liberal response bias – Blandon-Gitlin et al. (2013, Experiment 2) and Saskavan et al. (2008) found a more conservative

pattern of responding under oxytocin conditions. However, it is possible that the methodological differences between this and previous studies can account for the differing patterns of results. For example, previous studies have generally examined the influence of oxytocin on face memory (specifically, face encoding), as opposed to face matching – that is, oxytocin was administered prior to or just after encoding, and recognition tested in a separate block between 30 mins and 24 hours later (e.g., Herzmann et al., 2012; Guastella et al., 2008; Rimmele et al., 2009; Saskavan et al., 2008). The factors that could make oxytocin beneficial for face encoding (i.e., increased attention to socially salient elements of the face and/or increased emotional salience) could also be detrimental in matching tasks: if oxytocin increased the salience of all the line-up faces, participants could have mistaken this salience for familiarity, leading to the false positive errors observed in the current study.

Alternatively, the format of the test may explain the differences between the current results and previous studies. Research into oxytocin and face recognition has almost exclusively used old/new tests, and the introduction of a line-up may have allowed participants to use alternative decision strategies. Specifically, participants in the oxytocin condition may resort to a "next best" choice when the target is not present, whereas participants in the placebo condition may have judged each face on a match/no match criteria (analogous to proposed strategies used in simultaneous and sequential eyewitness line-ups, see Leach, Cutler, & Van Wallendael, 2009, for a review). Currently, though, it is unclear what mechanisms could support this strategy shift, and how they relate to the neural networks affected by oxytocin.

In sum, this study adds to the growing body of evidence that intranasal inhalation of oxytocin is not universally beneficial for social cognition (Bartz et al., 2011; Hertzmann et al., 2012). While oxytocin may improve face recognition under some circumstances, such as an old/new recognition task, there is no discernable benefit of oxytocin in a face-matching

task using line-up arrays. Currently, it is unclear which of these factors (matching vs encoding; old/new vs line-up; or a combination of both) resulted in the increased bias observed in the current study. Further research with simple face matching tasks, face memory tasks using line-ups, and oxytocin inhalation before recognition (as opposed to encoding), should clarify when and why oxytocin modulates face recognition. This in turn will provide guidance as to whether oxytocin is a viable tool in applied face recognition scenarios, such as eyewitness identification.

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