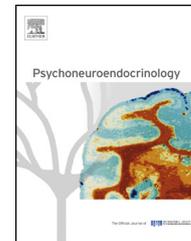




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SHORT COMMUNICATION

# Face or body? Oxytocin improves perception of emotions from facial expressions in incongruent emotional body context

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## KEYWORDS

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Social hormones;  
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Body context

**Summary** The neuropeptide oxytocin (OT) has been repeatedly reported to play an essential role in the regulation of social cognition in humans in general, and specifically in enhancing the recognition of emotions from facial expressions. The later was assessed in different paradigms that rely primarily on isolated and decontextualized emotional faces. However, recent evidence has indicated that the perception of basic facial expressions is not context invariant and can be categorically altered by context, especially body context, at early perceptual levels. Body context has a strong effect on our perception of emotional expressions, especially when the actual target face and the contextually expected face are perceptually similar. To examine whether and how OT affects emotion recognition, we investigated the role of OT in categorizing facial expressions in incongruent body contexts. Our results show that in the combined process of deciphering emotions from facial expressions and from context, OT gives an advantage to the face. This advantage is most evident when the target face and the contextually expected face are perceptually similar.

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## 1. Introduction

Over the past decade, the neuropeptide oxytocin (OT) has been of great interest due to findings of its essential role in

the regulation of social behavior and social cognition in humans (see Meyer-Lindenberg et al., 2011; Van IJzendoorn and Bakermans-Kranenburg, 2012 for reviews). It has been suggested that OT affects social behavior by enhancing the perceptual salience and/or processing of social cues, such as subtle facial expressions (e.g. Shamay-Tsoory et al., 2009). Since one of the fundamental aspects of social behavior is the understanding of emotions, it is not surprising that OT was found to enhance the recognition of emotions from facial expressions (Domes et al., 2007; Fischer-Shofty et al., 2010;

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Marsh et al., 2010). These studies mainly investigated whether emotion recognition is improved following the administration of OT for all emotions or specifically for positive (e.g. Marsh et al., 2010) or negative ones (Fischer-Shofty et al., 2010). While some studies show that OT increases gaze to the eye region (e.g. Guastella et al., 2008) and that OT enhances the ability to infer mental states from subtle cues around the eye region (Domes et al., 2007), others showed enhanced emotion recognition following OT administration, with no difference in participants' eye gaze (Lischke et al., 2012a). Notwithstanding the importance of these studies, they were all limited by relying primarily on isolated and decontextualized emotional faces.

Recent evidence, however, has indicated that the perception of basic facial expressions is not context invariant and can be categorically altered by context, especially affective body context, at early perceptual levels (e.g. Aviezer et al., 2008, 2011). Body context is broadly defined to comprise extra-facial information that includes body language, manipulation of affective paraphernalia, and situational context. Importantly, context has a strong effect on our perception of emotional expressions, especially when the actual target face and the contextually expected face are perceptually similar (Aviezer et al., 2008). Specifically, these authors show that in a body context of anger, a typical facial expression of disgust is *barely recognized* as such, and is instead, perceived as anger. This is less so in contexts of sadness and fear, which are perceptually less similar to disgust. Notably, this effect is so strong that it occurs even when participants are explicitly told and motivated to ignore the context and focus on the facial expression alone, suggesting that facial expressions and body contexts are integrated in an unintentional and uncontrollable manner (Aviezer et al., 2011). Disgust is an ideal emotion for testing contextual malleability of expressions of basic emotions. On the one hand it is highly recognizable when perceived in isolation (Ekman and Friesen, 1976a), yet at the same time it is differentially confusable with a range of face expressions (Aviezer et al., 2008). Hence, focusing on a single well characterized expression<sup>1</sup> has an advantage when systematically testing the influence of context on basic facial expressions with a new experimental manipulation (OT).

If indeed OT affects the recognition of emotion, and specifically from facial expressions, intranasal administration of OT is expected to reduce the profound effect of context, resulting in more accurate categorization of facial expressions in incongruent contexts. On the other hand, if OT has a general effect on improving emotion recognition, its administration will not have an effect on reducing the context effect. To examine these contrasting hypotheses, we carried out a within-subject, double-blind OT and placebo study. We manipulated the similarity between the face from which the facial expression is to be judged and the face typically associated with the emotional context, and asked participants to categorize the facial expression.

<sup>1</sup> In a recent research study the aforementioned context effect was demonstrated in a fully crossed design with a host of basic expressions (Aviezer et al., 2011) so it is clear that the effect is not specific to disgust.

## 2. Methods

### 2.1. Participants

30 participants (19 male) ranging in age from 21 to 59 (mean age 38.9, SD = 10.6) participated in the experiment in exchange for payment. All participants reported normal or corrected to normal visual acuity and had no history of psychiatric or neurological disorders, as confirmed by the Hebrew version of the Mini International Neuropsychiatric Interview (MINI) as a screening interview (Sheehan et al., 1998). The Helsinki committee of Rambam Health Care Campus approved the study protocol, as well did the Israel Ministry of Health.

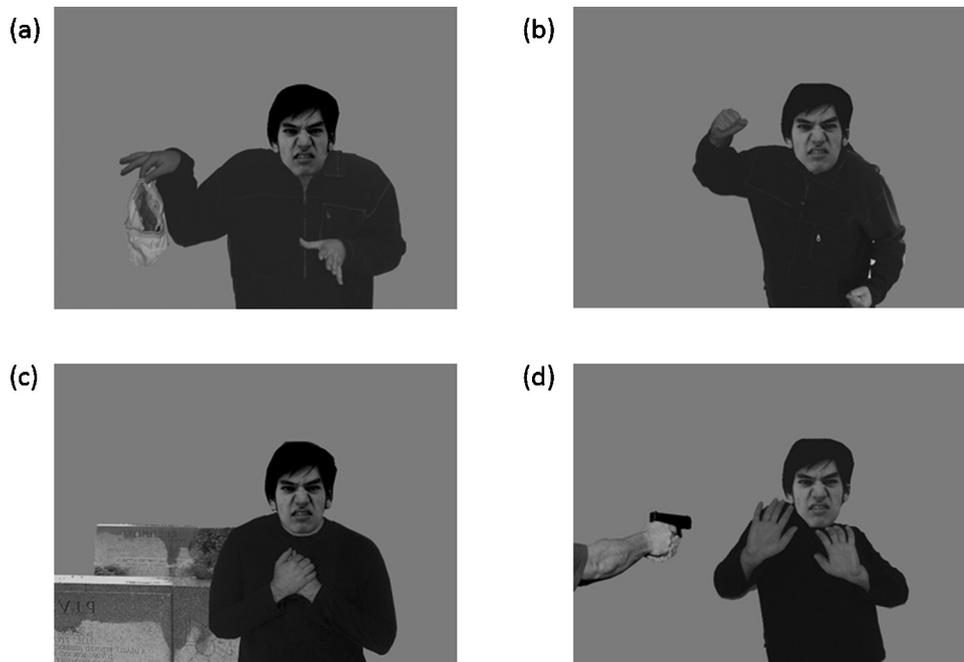
### 2.2. Design

Participants were invited to two appointments, around one week apart, on the same day of the week and time of day. All participants gave their signed informed consent before participation. During each appointment, each participant randomly received either 24 international units (250 ml) of intranasal OT (Syntocinon-Spray, Defiante, Sigma) or sterile saline as placebo treatment (PL, consisting of the same saline solution in which the hormone was dissolved but without the hormone itself). Both treatments were administered by the experimenter using a nasal spray, three puffs per nostril, with each puff containing 4 IU. Neither the experimenter nor the participant knew whether the participant was receiving OT or the placebo. Following administration, participants were asked to wait 45 min from the time of administration to ensure that the OT levels in the central nervous system would reach a plateau. At the end of these 45 min, the participants began the experiment.

### 2.3. Stimuli

The experimental stimuli and design were identical to those described in Aviezer et al. (2008) for experiment 1. Briefly, portraits of ten individuals presenting the basic facial expression of disgust were placed on body images of models in emotional contexts to form four levels of perceptual similarity between the facial expression of disgust and a body posture typically associated with one of the following four contexts: (a) disgust (full similarity); (b) anger (high similarity); (c) sadness (medium similarity); and (d) fear (low similarity; see Fig. 1). The body postures were taken from a set developed by Aviezer et al. (2008), and the faces were taken from Ekman and Friesen (1976b). The face-context composites were presented in random order for each participant. Ten isolated facial expressions and eight isolated emotional contexts (with blank ellipses covering the faces) served as control stimuli and were presented in a separate block. Each of the face-context composites appeared once, so that with the control stimuli the experiment comprised a total of 58 stimuli.

The stimuli were presented on a computer monitor one at a time. Participants were instructed that for each trial they should press a button indicating the category that "best describes the facial expression." They were to choose from a list of six basic emotion labels (sadness, anger, fear, disgust,



**Figure 1** Examples of stimuli exhibiting identical facial expressions of disgust appearing in different contexts: (a) disgust (full similarity); (b) anger (high similarity); (c) sadness (medium similarity); and (d) fear (low similarity).

happiness, and surprise) appearing under the image. Participants were allowed to freely explore the entire stimulus display, without time limits.

## 2.4. Statistical analysis

A table of descriptive measures can be found in the supplementary section. In a pre-analysis of the sample, we checked for the normality assumption needed to perform a repeated-measures ANOVA. Since this assumption was violated in every condition (all  $p$ 's  $\leq 0.001$ ), we decided to run two different non-parametric tests, as follows: (a) For each of the three contexts, we ran a Wilcoxon signed-rank test. To correct for multiple comparisons we used a Tmax permutation procedure (Blair and Karniski, 1993): OT and PL were permuted, and the Z-statistic for each of the three contexts was calculated simultaneously. In such a procedure one can derive not only point-wise  $p$ -values for each test, but also a value that accounts for the fact that all variables were tested at the same time. The maximum Z-statistic was recorded for 50,000 random permutations. Then, each observed Wilcoxon signed-rank test statistic was compared with the maximum of permuted statistics over all variables. In other words, such a  $p$ -value reflect the chance of seeing a test statistic as large as was observed, given as many tests as were performed. (b) For each of the three contexts, we analyzed the proportion of participants who accurately identified the facial expression of disgust at least once, and then analyzed this binary result using the McNemar's test, commonly used to study the effectiveness of treatment in non-parametric conditions. This analysis was used to estimate the width of the effect across participants, i.e. ignoring the percentage of correct responses for each participant and focusing on the number of participants who identified the expression correctly. It is important

to note that recognizing the expression once could be considered a result of chance, and should be treated cautiously. Therefore, this analysis was considered important only as a complementary to the previous one, and shows more intuitively the different proportions of participants recognizing disgust under each context.

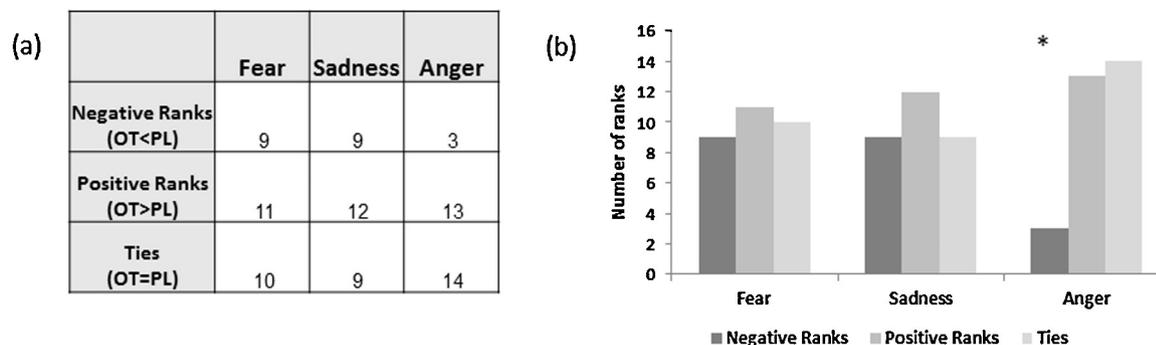
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## 3. Results

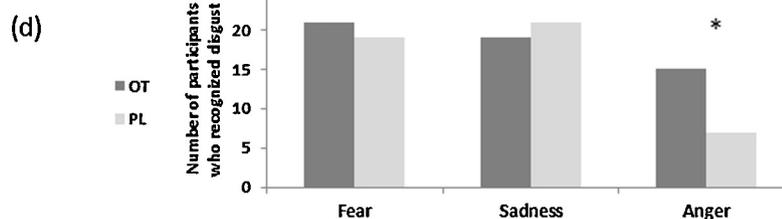
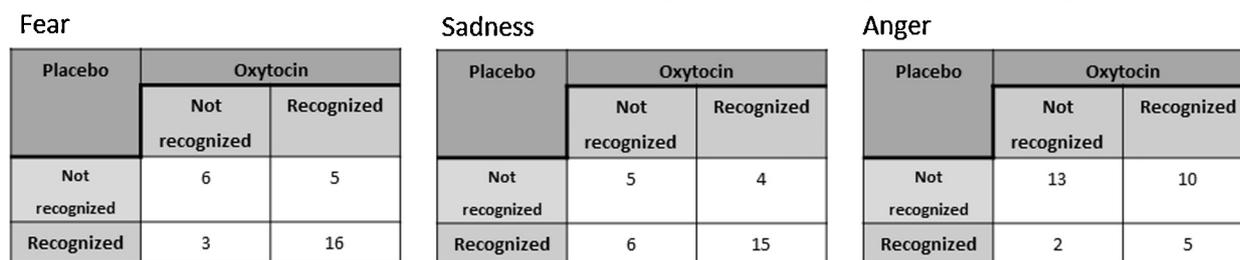
(a) The Wilcoxon signed-rank test revealed a significant difference between PL and OT only for identification of disgust in the anger context [Negative ranks (i.e. number of participants who had fewer identifications of disgust under OT than under PL) = 3; Positive ranks (i.e. number of participants who had more identifications of disgust under OT than under PL) = 13; Ties = 14;  $Z = 2.23$ ,  $p = 0.026$ ]. There was no significant difference between PL and OT for either the sadness or the fear contexts (Sadness: Negative ranks = 9, Positive ranks = 12, Ties = 9;  $Z = -0.3$ ,  $p = 0.76$ ; Fear: Negative ranks = 9, Positive ranks = 11, Ties = 10;  $Z = -0.55$ ,  $p = 0.58$ ; see Fig. 2). We then conducted a Tmax permutation procedure based on the Wilcoxon signed-rank, to compare OT to PL in the three emotional contexts (see Methods). The adjusted  $p$ -values for the PL and OT comparison in the anger context was 0.053, but no significant effect was found for the sadness ( $p = 0.83$ ) or fear ( $p = 0.66$ ) contexts.

In addition, there was also no effect of OT in recognizing disgust in the disgust context (Negative ranks = 12, Positive ranks = 8, Ties = 10;  $Z = -0.86$ ,  $p = 0.39$ ), and no effect of order (receiving OT or PL in the first or second session; Mann-Whitney  $Z = -1.285$ ,  $p = 0.24$ ).

The Wilcoxon signed-rank test results



(c) The McNemar test results (for correctly recognizing disgust at least once)



**Figure 2** Results: The Wilcoxon signed-rank test results for each of the different contexts, shown in a table (a) and a graph (b). Negative ranks signify the number of participants who identified disgust less often under OT than under PL. Positive ranks signify the number of participants who identified disgust more often under OT than under PL. The McNemar test distribution for each context (for correctly recognizing disgust at least once) is shown in a table (c) and a graph (d). In the table, note that of the 15 participants who accurately categorized the face as showing disgust in the anger context in the OT session, five also accurately categorized the face in the PL session, ten were new accurate categorizers, and only two accurately categorized disgust in the PL but not in the OT session.

(b) In an analysis of the proportion of participants who identified disgust in the anger context following PL or OT administration, the McNemar’s test revealed a significant effect of OT treatment, with more than twice as many participants identifying the facial expression following OT administration [15 following OT administration, 7 following PL;  $p = 0.039$ , Fig. 2d]. Fig. 2c shows the distribution of these proportions. In the OT session, of the 15 participants who accurately categorized the face as showing disgust in the anger context, five also accurately categorized the face in the PL condition, ten were new accurate categorizers, and only two accurately categorized disgust in the PL but not in the OT session. Such an effect was not found for the sadness or the fear contexts (categorization of disgust in sadness context: 19 following OT, 21 following PL,  $p = 0.75$ ; in fear context: 21 following OT, 19 following PL;  $p = 0.72$ ; for a detailed description see Fig. 2c). These findings indicate that OT improved the recognition of facial expressions of disgust in the context of anger.

Note that the effect of OT on identifying disgust in the anger context cannot be explained by differences in reaction time (RT), since RT did not differ significantly between the OT and placebo conditions for any of the expressions [Mean RTs (ms): Fear (PL) = 4197.33, Fear (OT) = 3703.82; Sad (PL) = 4054.18, Sad (OT) = 4023.18; Anger (PL) = 3540.18, Anger (OT) = 3477.70; Wilcoxon tests, all  $p$ 's > 0.4]. It also cannot be explained by differences in identification of the facial expression or the context alone, since neither were affected by OT [Wilcoxon tests; facial expression of disgust  $p = 0.4$ ; context of anger alone  $p = 0.57$ ].

#### 4. Discussion and conclusion

OT has been shown to increase the salience of social information (Shamay-Tsoory et al., 2009). Since faces play a major role in mediating social information, and since deciphering an individual’s facial expression from subtle features is an important aspect of social interactions, OT also plays an

important role in increasing the salience of the face. This study extends previous findings regarding the role of OT in deciphering the emotions of others, and is the first to show the effect of OT on recognizing facial expressions in context. Importantly, we show that in conditions where the context obliterates recognition of the original facial expression (based on many previous studies, and the current PL session), OT significantly enhances expression recognition. Specifically, we show that more than twice as many participants recognized the facial expression of disgust in the context of anger, an emotion with a very similar facial expression (Aviezer et al., 2008).

The fact that OT enhanced facial emotion recognition only in the most difficult context is in line with the results of Domes et al. (2007). These results showed that OT improved performance only with stimuli that were difficult to interpret in terms of the affective mental state they represent and were differentiated from other emotions by subtle social cues. Anger and disgust are very similar facial expressions, and differentiating between them requires paying attention to subtle facial cues.

Previous studies suggest that the integration of facial expressions and context occurs at early stages of processing, and is automatic, at least in the sense that it is uncontrollable and is not affected by cognitive load (Aviezer et al., 2011). The same research group also showed that the pattern of eye movements in response to faces in context was determined by the expression revealed by the context rather than the face itself (Aviezer et al., 2008), hinting at the early and profound effect of context. In the present study, we suggest that in the process of deciphering an emotion from both facial expression and context, OT gives facial expression an additional advantage, perhaps by increasing the focus on the face or by initiating a different pattern of eye movements. Alternatively, OT may increase the ability to identify the mismatch between facial expression and body posture. These hypotheses require further research. It may be that under complex conditions, such as categorizing the facial expression of disgust in the anger context, this aid is beneficial. In less conflictual conditions, however, this advantage no longer helps, and the contribution of facial expression reaches a ceiling effect. These results may have implications for clinical populations with deficits in emotion recognition (e.g., autism) or facial recognition (e.g., prosopagnosia), as OT may aid in increasing the ability of these individuals to interpret subtle facial cues.

A limitation of the current study is the small and unequal number of female participants compared to male participants, making sample sizes too small for further investigation of sex differences. In view of recent OT studies that suggest possible sex differences in oxytocinergic functioning (e.g. Domes et al., 2010; Lischke et al., 2012b), these differences should be considered and further investigated in future research.

Lastly, there has been a growing debate on whether OT facilitates emotion recognition by focusing more attention to the eye regions (e.g. Guastella et al., 2008; Lischke et al., 2012a). We did not measure eye movements in this study. Nevertheless, one of the subtle differences between anger and disgust is that whereas recognition of anger typically requires focusing on the eye regions, recognition of disgust requires focusing more on the mouth and nose (e.g. Calder

et al., 2000). Since in the current study OT improved participants' ability to recognize disgust in the context of anger, we believe that focusing specifically on the eye regions cannot explain our results, strengthening the notion that OT's effect is not specific to the eye regions, but is a general effect of increasing social salience, particularly by focusing on faces.

In conclusion, this study extends the role of OT in emotion recognition, suggesting that in the combined process of deciphering emotions from the face and context, OT gives an advantage to the face. This advantage is evident under conditions that are highly ambiguous, and does not seem to be specific to the eye regions.

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None.

## Conflict of interest statement

All authors declare that they have no conflict of interest.

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