Oxytocin and Pareidolia Face Detection Using the Visual Search Task

A double blind, placebo-controlled within-subject design study using eye tracking and intranasal oxytocin

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Abstract

Face pareidolia is the human tendency to see illusory human-like faces, for example in random patterns exhibiting configural properties of a face. Past research on humans' show that oxytocin has a crucial role in enhancing facial processing. By leading to an increased focus on the face in general, and eyes especially, alter the encoding and conceptual recognition of social stimuli, enhancing sensitivity to 'hidden' emotions in facial expressions, and enhancing the ability to interpret the facial cues of others, oxytocin has been proposed to promote prosocial behavior in humans. In this study, we evaluated whether oxytocin modified responses to illusory face perception at an earlier perceptual, bottom-up stage of processing during limited time in the visual search task. In a double blind, randomized, placebo-controlled, within-subject design, oxytocin (24 IU) and placebo was administered to 24 healthy volunteers in two different sessions. Results revealed that random elements were perceived as a face when organized together within a configural facial distance, showing that illusory facial elements both attract pre-attentive attention resources and stands out from background of other objects and natural elements. Random elements presented in a scrambled fashion were not perceived as faces. Oxytocin did not, however, influence the accuracy of detecting pareidolia compared to placebo. Neither response time, nor confidence, gaze toward illusory faces or eyes were enhanced by the neuropeptide. The results of this study suggest that oxytocin may not influence the detection of illusory faces at early perceptual levels of processing. On the other hand, oxytocin may prove to have greater influence in altering the cognitive processing of social valence at more conceptual and elaborate levels of processing.

Key words: oxytocin, pareidolia, face perception, eye tracking

Background

Face Detection and Perception

Of all the visual information a person is surrounded by, few stimuli, if any, can match the biological and social importance of the human face. Even a brief look at a person's face can provide an enormous amount of biologically and socially important information, and the failure to notice the presence of a face within our visual environment would unavoidably lead to a loss of this information. The ability to detect faces therefore not only characterizes one of the most fundamental, but also one of the most important aspects of face processing, and more generally, of human social cognition (Burton & Bindemann, 2009). As a byproduct of the ability to detect faces in our environment, we sometimes misperceive novel visual shapes as facial features. We get a strong impression that a face is present in some objects, and this impression is also accompanied by activity in the face-responsive areas of the brain (Hadjikhani, Kveraga, Naik, & Ahlfors, 2009). Despite the fact that face pareidolia is a well-documented phenomenon, little is known about the underlying neural mechanisms.

The neuropeptide oxytocin (OT) plays a central role in various aspects of social behavior when it comes to focusing on the face, like emotion perception from facial cues (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007), and gaze to the eye region of human faces (Guastella, Mitchell, & Dadds, 2008). And while OT's role in face perception and evaluation of emotional cues in the face is well studied (Domes et al., 2010; Ellenbogen, Linnen, Grumet, Cardoso, & Joober, 2012; Guastella et al., 2008), the ability to detect faces in our visual surroundings remains poorly understood (Burton & Bindemann, 2009), and OT's function in the detection process even less known. In this study we wish to explore why illusory face detection occurs where no face exists, and try to answer whether illusory face detection is facilitated by the hormone oxytocin. In this paper, the term 'face perception' covers the whole process behind detecting, recognizing, and monitoring faces, while 'face detection' is used when the detection process is discussed in particular. And since the most basic aspect of face perception is simply detecting the presence of a face, we will first look at the mechanism behind discovering a face.

Studies have demonstrated that faces are among the most informative stimuli we ever perceive, and humans' skill in perceiving, recognizing and understanding faces is attributed to configural processing – processing not just the shapes of individual features but also the relations among them (Maurer, Grand, & Mondloch, 2002). This leads to the process behind

face perception being multi-faceted: We are able to detect a visual stimuli as a face among non-facial stimuli, we recognize one specific individual in a crowd of faces, and we monitor faces to obtain a continuous stream of social information, varying from communicative gestures to emotional and attentive states (Tsao & Livingstone, 2008). Face detection is fairly easy for humans, since it is facilitated by the fact that all faces share the same ordinal relations of features, which is two eyes aligned with each other and positioned above the nose, which is above the mouth (Dakin & Watt, 2009). The detection of a face requires only the extraction of features that it has in common with other faces, and the simple and universal T-shaped schematic face (two eyes, one nose, and one mouth) suggests that a simple template-like process may be enough to accomplish face detection (Tsao & Livingstone, 2008). Tsao and Livingstone (2008) claim that the processes of face detection and face identification have two opposing demands: While the identification of an individual necessitates a fine-grained analysis to extract the ways in which that face differs from other faces, despite the fact that all faces share the same basic T-shaped configuration, detection of a face requires extracting what is common to all faces. To function optimally, a good detector should be poor at individual recognition, and an individual recognizer should be poor at detecting. Authors argue that the logic behind detection and identification being separate processes is that detection can act as a domain-specific filter, ensuring that costly resources for face recognition and identification are only used if the stimulus passes the threshold of being a face. They further propose that the benefit of detecting something before you identify it is that the detection mechanism would automatically accomplish face segmentation, i.e., isolate the face from the background clutter, and facilitate the aligning of the face to a standard template. Face perception is in this sense known to differ from object perception. Unlike other object categories, faces can, because of the same ordinal relations of features, be superimposed, and the resulting composite retains a face-like structure (Mondloch et al., 2013). This face perception ability is thought to depend in part on configural processing, in which faces are perceived by the spatial relationships between the elements of the face rather than simply a piecemeal analysis of the independent parts (Diamond & Carey, 1986). The detection of faces presumably also involves configural processing, since recognizing the presence of facial elements in particular spatial relationships (e.g., two eyes, a mouth, and a nose), is essential to the detection of a stimulus as a face (Maurer et al., 2002). These ordinal relations have been described as the ‘first-order relations’ of faces and they seem to differ from the first-order relations among the features of other objects (Diamond & Carey, 1986). That’s why people are able to detect a stimulus as a face even when some of the individual features are missing;

e.g. a simple line drawing with two dots as the eyes, a line for the nose, but no line the for mouth, as long as the components can be construed as having the correct first-order relations for a face (Mondloch et al., 2013).

Slaughter, Stone, and Reed (2004) argue that this sensitive detection ability for faces has in an evolutionary sense its own ontological status. They claim that man through natural selection has developed their own face processing mechanisms in the brain. Schematic faces, smileys and different objects having a face configuration are instantly perceived as faces (Sagiv & Bentin, 2001). Research suggests that this face detection ability is something we are born with; that we may have an innate disposition for face perception (Goren, Sarty, & Wu, 1975; M. H. Johnson, 2005). Goren et al. (1975), for example, found that nine-minutes-old infants preferred to look at face stimuli than non-face stimuli, a preference that might be mediated subcortically (M.H. Johnson & Morton, 1991). Palermo and Rhodes (2007) suggest that face perception seems to be a rapid, automatic and subconscious process, and that it appears to be already present in human newborns. For example, in their research they showed that infants seem to orient towards simple schematic face-like patterns. In adult patients with visual neglect, faces also seem to play a special role in capturing attention, as a face presented in the neglected hemifield is more likely to be detected than a scrambled face, a name, or a meaningless shape (Vuilleumier, 2000). The author therefore suggests that substantial analysis and categorization of visual input may take place in the visual system before information is selected for, or excluded from, attentive vision; which again may give clues regarding the mechanism behind seeing faces in objects.

In spite of extremely high computing requirements when it comes to detecting and recognizing faces, humans are considered to be experts in face perception (Kanwisher, 2000; Tanaka, 2001). People can distinguish hundreds of faces from one another (Rhodes, Tan, Brake, & Taylor, 1989), and mastering the art of face perception is valuable in the sense that it gives us important information in a very short time (Kanwisher & Moscovitch, 2000). When we have detected a face, we can immediately determine if the individual in front of us is a known or unknown person, angry or happy. Because we largely and extensively relate to other people, we dedicate much time to face perception (Kanwisher & Moscovitch, 2000). This experience makes us face experts. From an evolutionary perspective, it is common to assume that it is essential for human survival as a species that we are able to detect and distinguish faces from each other (McKone, Kanwisher, & Duchaine, 2007). One obvious reason that we are seemingly hardwired this way is most likely evolutionary: It is clearly an adaptive advantage to locate and collect information from faces, which is vital for perceiving

personal identity, possible kin relationships, facial expressions and personality, and possible action tendencies. In order for us to protect our family and ourselves, we must determine whether the person in front of us is known or unknown, friend or foe (Gauthier & Curby, 2005). This hyperactive face-detection 'device' has most likely evolved because the adaptive advantage of detecting every agent is much higher than the costs of being mistaken. In evolutionary terms, it would be of great advantage to be able to detect a face, since it allows us to further decipher the emotional, social, or sexual cues signalled by different features in the detected face. It could through your lifespan help keep you fed, save your life, or increase your chances to reproduce - all of which are crucial for the propagation of your genes.

Pareidolia

The tendency to project a face, which is not actually present, onto an undefinable entity like an object, a shadow, an inkblot or arbitrary wisps of a cloud, is known as the phenomenon pareidolia. The term originates from the Greek 'para' (beside or beyond) and 'eidōlon' (form or image), and describes the human visual system's tendency to extract patterns from noise (Melcher & Bacci, 2008). Common examples include the Man in the Moon, the face in the Cydonia region of Mars, and the faces of numerous religious icons in toasted food (Rieth, Lee, Lui, Tian, & Huber, 2011). The phenomenon is captured by projective psychological measures like the Rorschach test, and even though these object stimuli are not mistaken for actual faces, they bring to mind the percept of a face in a persuasive manner. The pareidolia phenomenon must not be confused with false face recognition, which is the mistaking of one face for another. On the contrary, illusory face detection is the reported detection of a face when no face image actually exists (Rieth et al., 2011). The processes underlying face detection in general, and illusory face detection specifically, are not well understood at the behavioral level (Lewis & Ellis, 2003), but since pareidolia often involves the false perception of faces as opposed to other objects, the mechanism of pareidolia has been mostly investigated in studies of face perception.

The study of perception gave rise to the Gestalt school of psychology, with its emphasis on holistic approach, and the human ability to see illusory forms, shapes and images convinced the early Gestalt psychologists that 'the whole is greater than the sum of its parts' (Wagemans et al., 2012). They claimed that people tend to perceive a group of elements not as individual features, but as a whole. The tendency to see patterns that do not actually exist are called apophenia, defined as the unmotivated seeing of connections accompanied by a specific experience of an abnormal meaningfulness (Brugger, 2001).

Examples of apophenia include face- or figure-like images in shadows, clouds, and patterns with no deliberate design. The misperception of patterns in random data is called pareidolia specifically when a common human experience is to perceive faces in inanimate objects. With Gestalt psychology, the concept of perceptual grouping as a form of perceptual organisation was developed, and the debate regarding face detection and perception has since mostly concerned itself with the role of the whole versus its parts, and the question whether faces are coded holistically or analytically. In cognitive neuropsychology, this debate has been driven forward by a number of approaches, including experimental cognitive studies, neuropsychological studies of brain-damaged patients, and neuroscientific techniques with individuals who have normal cortical functioning (Kanwisher & Moscovitch, 2000). And discoveries of Gestalt psychology have parallels in modern neuroscience where one of the primary assumptions is that there are neurons sensitive to collinearity (Spillmann & Ehrenstein, 2004), e.g. the visual perception prefers continuous over broken transitions. The detection, perception, and processing of line directions and group of elements, as well as automatic supplementing of the missing parts of structures to connect them into coherent wholes is therefore seemingly an important part of the human perceptual system. This seems to be fundamental for the human brain's visual information processing system, and it is regarded to be essential for form recognition. The concept of grouping as a form of perceptual organisation seems to give humans a tendency to perceive a face in objects that have constituent parts resembling those of a face. According to Windhager et al. (2008) there seems to be a general perceptual approach in humans that leads to the phenomena of animism, which is the attribution of life to the non-living, and anthropomorphism, which is the interpretation of non-human beings and things in human terms. The human brain will seemingly try to construe even its non-social environment as principally social. Studies on behaviral responses, event-related potential responses and fMRI data with participants instructed to detect a face from pure-noise images where, in fact, no-face images existed, suggest that face pareidolia is not purely imaginary but has a basis in physical reality (B. C. Hansen, Thompson, Hess, & Ellemberg, 2010; Liu et al., 2014). Liu et al. (2014) argue that since pure-noise images do not actually contain faces, face pareidolia obviously requires considerable involvement of the brain's interpretive power to detect and bind the faint face-like features to create a match with an internal face representation. They further argue that pareidolia imply that the human visual system is highly tuned to perceive faces, likely due to the social importance of faces and our exquisite ability to process them.

The debate regarding holistic vs. analytical coding

In case of face perception and the mechanism behind the phenomenon of pareidolia, there are at least three distinct information processes investigated: First-order featural relational properties making a T-shaped template (the eyes above the nose, which is above the mouth), second-order relational properties (which constitute configural information of inter-eye distance, distance between the nose and the mouth), and holistic information (i.e., the face is processed as a whole unit) (Diamond & Carey, 1986; Maurer et al., 2002; Tanaka & Farah, 1993, 2003). Windhager et al. (2008) investigated how humans perceive face-like objects and demonstrated how people recognized the parts of a car front corresponding to facial features, such as the eyes. Sagiv and Bentin (2001) found that schematic faces, sets of fruits, vegetables, or other objects are instantly perceived as faces when organized in a face configuration. Studies like these indicate that the perception of both features and configuration of a face in a face-like object may work in the same manner in which one processes a real human face. By understanding how human beings perceive human faces, one might understand the detection of face-like objects.

According to the holistic face recognition hypothesis, isolated parts of a face will be disproportionately more difficult to recognize than the whole face, relative to recognition of isolated parts and wholes of other kinds of stimuli. Different experiments have confirmed that subjects are less accurate at identifying the parts of faces, presented in isolation, than they are at identifying whole faces. Other types of stimuli, such as scrambled faces, inverted faces, and houses, in contrast, did not show this disadvantage for part identification. This is often called the face superiority effect, according to which the parts of a face are better perceived if presented in the context of a whole face than in the context of a scrambled face (Tanaka & Farah, 1993, 2003). Laeng and Caviness (2001) argue that the explanation for holistic perception of faces depends on them being 'objects' made of a rigid, single, curved/smooth surface, providing the brain with an optimal representation with the above listed perceptual properties, which should be respectively metric, holistic, and smooth-surface- based. Such a perception would seem to require as its underlying representation a more faithful replica of the original image, a template. And such a representation must be holistic, not decomposed into readily perceivable independent attributes. In turn, this requires visual depth information, such as shading and textural cues, specifying the curvature gradients in order to capture the subtle differences that distinguish one individual from another. The whole head will in this way be represented as a 3-D holistic representation, a surface plus its contents inside. This way faces are represented as unparsed wholes without

any single representations of parts (Farah, Tanaka, & Drain, 1995; Tanaka & Farah, 1993). Suzuki and Cavanagh (1995) came to a similar conclusion in their experiments, showing that global representation dominates during speeded pattern discrimination, obscuring or preempting the lower level representations of the constituent parts. Global structures make patterns more detectable and discriminable than the sum of the constituent low-level features, indicating that a holistic perception of familiar organizations such as 3D objects, words, and faces are detected more robustly. The signal level required to detect the whole is less than that required detecting the constituent parts, and therefore only the holistic representation is 'visible' in a rapid discrimination process. The argument is that such a process can allow an observer to make better use of information than if each of the individual features is represented in isolation (Maurer et al., 2002).

Another possibility is that featural information (part-based information) and configural information (features of the face in relation to each other) are later combined into holistic face representations. The different features in a face, e.g. the eyes, the nose, the mouth, the ears, etc., are analyzed independently, and that face recognition involves integration all of the different elements of a face, also often called a piecemeal analysis (Maurer et al., 2002). Tanaka and Sengco (1997) demonstrated through the phenomenon called the face-inversion effect that featural and configural information are first represented separately before they are integrated into a holistic representation, and that faces, unlike most other objects, tend to be much more difficult to identify when they are inverted than when they are upright. The argument is that upright faces seem to be processed in a holistic manner, whereas the elements of inverted faces are processed in a piecemeal manner. Consequently, the extra information that is encoded for in an upright face will allow an observer to identify an upright face more quickly and accurately than an inverted face, suggesting that upright faces are processed in a configural and holistic manner, while the elements of inverted faces are processed in a featural and analytic manner. Inversion of faces may therefore be interpreted as disrupting the special processing that normally occurs for faces, and has historically been taken as evidence that inverted faces may be processed more similarly to objects and require analytical or feature-based processing, while upright faces may draw upon configural or holistic processing (Harris & Nakayama, 2008). Tsao and Livingstone (2008) agree with these conclusions, and argue that the detection step may use coarse, simple filters to screen out non-face images, and that these filters, or templates, require an upright, positive contrast face, with the standard arrangement of features. Images that do not fit the template are not recognized as faces and are analyzed only by the general object recognition system. Face

detection and processing seem in this way to be holistic, i.e. that we cannot process individual face parts without being influenced by the whole face. This is similar to the Gestalt notion that the whole is more than the sum of its parts; i.e. that a face is analyzed as a single unified entity as a result of the spatial relationships between the features that are encoded as part of the representation. The face-detection stage may therefore, in addition to gating access through filters, obligatorily segment faces as a whole for further processing. Tsao and Livingstone (2008) further argue, and agree with Kanwisher, McDermott, and Chun (1997), that this difference between non-faces and faces arises early in the fusiform face area.

The aforementioned idea is in line with Maurer et al. (2002), who suggested that configural face perception includes several levels of processing. On the primarily level generic first-order relational information is retrieved (e.g. two eyes above the nose, the nose above the mouth), which all together is combined into a holistic gestalt-like representation, making detection possible. On the next level, second-order relational information (i.e., spatial distances between facial features) is processed, which differentiates individual faces and forms the basis for face recognition and identification. Moscovitch, Winocur, and Behrmann (1997), who performed nineteen experiments on a person (CK) with visual object agnosia but normal face recognition, also argue that face perception might depend on both holistic and analytical representations. When CK was presented face-like images composed of objects or nature, he could see the face but rarely that it was composed of objects or e.g. fruit. They concluded therefore that face perception normally depends on two systems: First a holistic, face-specific system, which is dependent on orientation specific coding of second-order relational features, and second, a part-based object-recognition system. The holistic, face-specific system is intact in CK, while the part-based object recognition system is damaged, which contributed to face detection in pareidolia when the illusory faces were composed of objects, but not object detection.

This may help to explain why people experience vivid impressions of faces in random objects including natural formations (e.g., the man in the moon) or constructed objects (e.g., cars or faucets). Random elements are perceived as faces as the generic first-order relational information is retrieved on the primarily level and then combined into a holistic gestalt-like representation (Paras & Webster, 2013). Paras and Webster (2013) argue that the fact that illusory faces so easily can be seen in random patterns may partly reflect their salience as a stimulus class, but more importantly arise because the stimulus configurations required to elicit them must be weak enough so that they can occur with high probability. They further argue that this can point to the basic templates the visual system might use for the initial

coding of a stimulus as a face, regardless of it being a true face or a pareidolia. (Hadjikhani et al., 2009) found a similar response in the fusiform face area for both images of face-like objects and real faces, suggesting that our visual system has the propensity to rapidly interpret stimuli as faces based on minimal cues. This may be the result of our innate faculty to detect faces, and may rely on the activation of the subcortical route.

Fusiform Face Area

Kanwisher et al. (1997) have located an area in the brain that, according to the authors, is specialized in face detection and perception. With the use of functional magnetic resonance imaging (fMRI), they discovered a brain area associated with significantly higher signal change for faces compared to other object stimuli. The area specialized in face detection and perception is located in the right fusiform gyrus, and has been named 'fusiform face area' (FFA). Several studies have since confirmed Kanwisher et al. (1997) findings (see e.g. (Downing, Chan, Peelen, Dodds, & Kanwisher, 2006; Grill-Spector, Knouf, & Kanwisher, 2004; Kanwisher, Tong, & Nakayama, 1998; Yovel & Kanwisher, 2004). Gauthier and Curby (2005), on the other hand, argue that there is a high correlated activity in the same area of the human brain in response to non-face objects a person is an expert on, such as birds or cars, and not only to faces. Both ERP studies and fMRI recordings reveal that object expertise and face processing are very closely related in the brain, both in space and in time. They agree on the possibility that there exist two functionally independent systems, object and face recognition, that today's technology is not able to tell apart, but cognitive neuroscience may in the future need to bridge these two traditionally separated fields of research.

There are several brain areas in addition to FFA that has been established as face-selective regions. fMRI studies have revealed an occipital face area in the ventral occipital cortex (Ishai, Ungerleider, Martin, Schouten, & Haxby, 1999), another one in the superior temporal sulcus (Haxby et al., 1999), and a third one located anteriorly in the temporal lobe (Kriegeskorte, Formisano, Sorger, & Goebel, 2007). Research on face detection, however, has mainly focused on the FFA. The different areas involved in face perception may be explained in terms of the levels of processing involved. And detection tasks appear to stem from relatively basic visual categorization processes, probably processes depending on simple spatial properties.

(Hadjikhani et al., 2009) found a similar response in the FFA for both images of face-like objects and real faces, suggesting that our visual system has the tendency to rapidly interpret stimuli as faces based on minimal cues. This may be the result of our innate ability

to detect faces, suggesting that the perception of these objects as faces is not a post-recognition cognitive re-interpretation process; rather, the face elements in the face-like objects are perceived early in the detection process. The authors argue that this detection process may be supported by the subcortical network shown to process behaviorally relevant unseen visual events (M. H. Johnson, 2005).

Thus, the evidence from face detection tasks suggests the initial identification of faces occurs in distinct areas of the brain, and is consistently correlated with activation in the FFA, located in the ventral temporal lobe. The more complex recognition task, in contrast, recruits several different complex processes that analyze configural properties, identify individuals, and assign meaning to perceived facial cues (Slaughter et al., 2004). The FFA area appears to be activated more by exposure to new faces compared with faces one previously has been exposed to (Mur, Ruff, Bodurka, Bandettini, & Kriegeskorte, 2010), which confirms its detection properties. It is also evident that the area can be activated by not only an exposure to a physical face, but also by being exposed to objects with face-like elements (Hadjikhani et al., 2009).

Rieth et al. (2011) argue that illusory face perception not only is affected by bottom-up processes, such as visual input when one is viewing an actual face, but also is highly affected by top-down processes, such as expectations and previous experiences. The FFA has in different paradigms been shown to be active during top-down face processing; for example when imagining faces (O'Craven & Kanwisher, 2000), when anticipating faces (Esterman & Yantis, 2010), and when interpreting bistable images as faces (Andrews, Schluppeck, Homfray, Matthews, & Blakemore, 2002; Hasson, Hendler, Ben Bashat, & Malach, 2001). In a recent study, Rieth et al. (2011) described an experiment where participants looked at scattered dark patches and were told to look for either faces or letters in the image. The target faces or letters were more or less difficult to detect, and some of the images were just pure noise. Even when there were no faces in the images but only pure noise, they found that participants detected illusory faces, suggesting that illusory face detection can be a heavily top down process creating false perceptions of faces or facial parts, and might be less constrained by task expectations. Paras and Webster (2013) found some of the same results in their experiments, that once random visual stimulus in an image is coded as a face, the remaining variations and features in the image are re-interpreted to be consistent with this representation. They argue that top-down inferences shape and perceptually complete the interpretation, so that random lines suddenly become for example cheekbones or eyebrows. The fact that visual noise in an image can be interpreted as a particular face with specific details suggests a

strongly holistic process. One noise feature interpreted as e.g. eyes can completely change the perception of other nearby features (Tanaka & Farah, 1993), and these processes could explain the seeming paradox that illusory faces can be seen almost anywhere.

Oxytocin

The neuropeptide oxytocin (OT) is a mammalian neurohypophysial and neuromodulatory hormone comprised of nine amino acids, which is produced in the supraoptic and paraventricular nuclei of hypothalamus and released into the bloodstream via the posterior pituitary gland (Buijs, De Vries, Van Leeuwen, & Swaab, 1983). OT is critical for parturition in mammals, and is endogenously released following child birth (Donaldson & Young, 2008) when it goes to peripheral destinations to stimulate uterine contractions during labor and milk ejection during lactation (Ellenbogen et al., 2012). In humans, endogenous OT levels are highly correlated with infant-directed care behaviors in both men and women, and are critically involved in mammalian maternal behavior (Gordon, Zagoory-Sharon, Leckman, & Feldman, 2010). However, as Ebitz, Watson, and Platt (2013) argue that, as with most correlative studies of endogenous OT levels, it is uncertain whether OT is the cause or consequence of these affiliative parental behaviors.

As a peptide molecule, OT cannot cross the blood-brain barrier and enter the central nervous system directly, but animal studies nonetheless suggest that intranasal oxytocin might get to the brain via some other route. And a recent neuropharmacological study demonstrates that the cerebrospinal fluid that surrounds the spinal cord and the brain has increased concentrations of the peptide after intranasal administration in humans (Striepens et al., 2013), suggesting a pathway to the brain in which OT passes the blood–brain barrier. In addition, results from behavioral studies in animals and humans show that exogenous OT delivery also promotes a wide array of prosocial behaviors, where the term ‘prosociality’ refers to behaviors that are beneficial to a social partner, such as reward-sharing in macaques and marmosets, flocking in the zebra finch, huddling and grooming in squirrel monkeys and marmosets, and increased eye gaze in macaques. In humans, prosocial behaviors resulting from the exogenous delivery of OT promote resource sharing, trusting decisions, increased eye gaze and eye contact, and positive social signals during conflict (Ebitz et al., 2013). Together, these findings are consistent with the hypothesis that exogenous OT delivery passes the blood-brain barrier and alters behaviors in both animals and humans.

Several midbrain regions in the human limbic system are rich in OT-receptors, including the limbic-hypothalamic system, midbrain regions, and brain stem (Landgraf &

Neumann, 2004), suggesting that the brain is a target organ for oxytocin, and that this peptide may function as a neurotransmitter or neuromodulator in the central nervous system (Heinrichs, Meinlschmidt, Wippich, Ehlert, & Hellhammer, 2004). As a neuromodulator or neurotransmitter, OT is being synthesized and stored in the paraventricular nucleus of the hypothalamus and released directly in the central nervous system to act on receptors distributed through neural pathways to central destinations, interacting with the dopamine and opioid systems (Insel, 2003).

Oxytocin and the detection of illusory faces

As social animals, humans need to strike a balance between approach and avoidance behavior toward others. Avoidance may diminish the risk of harm, while approach is necessary for different social activities, including mating, protection of offspring, feeding, and group formation. OT, a nanopeptide produced within hypothalamic paraventricular nuclei, is acting on a wide range of the neural sub-systems that presumably alter social behavior, including both dopaminergic reward-related and limbic threat-related pathways (Ellenbogen et al., 2012). Although the underlying neural mechanism is not fully understood, recent neuroimaging studies suggest that OT modulates amygdala responsiveness to emotional stimuli (Domes, Heinrichs, Glascher, et al., 2007; Gamer, Zurowski, & Buchel, 2010). This way it is thought to facilitate prosocial behavior by both increasing approach but also suppressing avoidance, perhaps by attenuating early automatic threat processing and increasing the salience of social stimuli, and thereby altering the processing of social information in the environment (Bartz & Hollander, 2006). Heinrichs et al. (2004) argue for a biological evolutionary model to explain these effects, which suggests that OT enhances the perception of cues important for social interaction and bonding, while at the same time reducing the impact of threatening and socially aversive cues. Haxby, Hoffman, and Gobbini (2002) found that OT reduced amygdala activation, particularly on presentation of social threat stimulus, leading authors to argue that OT reduces social threat perception and thereby helping individuals to feel more at ease when viewing faces. Ebitz et al. (2013) show that while OT promotes gaze to the face, it seems to fundamentally shift the purpose of social gaze. After OT delivery, social vigilance is reduced while social gaze is sustained, but directed towards the eyes of the face. The authors suggest that this is thought to happen through the down-regulation of goal-directed attention and species-typical social vigilance, and seems to be an intriguingly simple mechanism through which OT promotes eye contact. It seems that OT reduces the attentional salience of threatening social signals, which makes

sense from an adaptive perspective, since social attention comes with time and opportunity costs, making it maladaptive to maintain a state of high social vigilance when the absence of social threat already has been communicated through affiliative signals. Further they hypothesize that OT by regulating social vigilance may have facilitated the evolution of prosocial behaviors in humans. Reducing the salience of important social information by OT would result in the individual making decisions less responsive to the irregular challenges of the external environment and be more dependent on her preexisting biases. With OT changing the attentional priority of social information, the individual would conserve energetic and attentional resources for the pursuit of other goals, such as socializing and foraging (Ebitz et al., 2013).

Ellenbogen et al. (2012) propose that the reason OT attenuates early threat processing is to allow for greater focus on the empathic recognition of complex facial expressions, principally around the eyes. For example, it has been shown that using a nasal spray to administer OT to the central nervous system in humans enhances the perception of emotions, increases accuracy for socially relevant information and the ability to infer the mental and emotional states of others from subtle facial cues, to increase eye gaze to neutral and emotional human faces (Andrews et al., 2002; Domes, Heinrichs, Michel, et al., 2007; Domes et al., 2013; Leknes et al., 2013). OT also enhances allocation of early attention towards the face searching for positive social emotions (Marsh, Yu, Pine, & Blair, 2010), and elicit longer gaze to the eye region of human faces, relative to placebo (Guastella, Carson, Dadds, Mitchell, & Cox, 2009; Guastella et al., 2008). Marsh et al. (2010) suggest that OT's facilitation of interpersonal trust and prosocial interactions could reflect the fact that it enhances sensitivity to signs of trustworthiness, such as increased ability to interpret subtle signs of positive facial expressions. Domes et al. (2010) propose that OT affects allocation of attention resources towards salient areas for social stimuli, such as the eyes and mouth in regard to facial expressions, enhancing sensitivity and increasing ability to interpret subtle signs in the face. Striepens et al. (2013) point to several studies showing that OT plays a key role in human social cognition and behavior and modulates activity in the brain regions involved in socio-emotional processing, with altered amygdala activation in response to facial expressions being one of the most consistent findings. These findings indicate that the attentional prioritization of faces has evolved in humans and seems to be an important determinant of fitness. OT suppressing vigilance toward potential social threat may have played a basic role in regulating social vigilance and facilitated the evolution of prosocial behaviors in humans.

The present study

In the present study we examined the influence of OT on illusory face detection with artifact face pictures and non-face pictures shown on a computer screen, while an eye tracker monitored the participants' eye movements. Artifact pictures are pictures of scenes and artifacts in which elements such as the eyes and the mouth might be perceived as face-like features in the image, even though the picture includes no actual faces, animals or people. OT has been suggested to enhance eye gaze to facial stimuli, and the eye region in particular (Guastella et al., 2008), and we wanted to investigate how increased levels of central OT via nasal spray would affect the detection of pareidolia.

We designed a within-subject, placebo-controlled paradigm where participants were asked to try to detect illusory faces and rate how confident they were in their decision. In the detection task, we expected intranasal OT administration to enhance illusory face perception, leading to faster response and a higher number of illusory face detections, compared to placebo. Since we believe that OT will influence illusory face detection, we also expected a slightly higher rate of false positives in sessions where participants received OT compared with sessions where participants received placebo. Our first hypothesis is therefore that OT will lead participants to be more prone to illusory face perception, leading them to detect more illusory faces, compared to placebo. Our second hypothesis is that OT will lead participants to detect illusory faces earlier, and therefore to respond faster to illusory faces, compared to placebo. For the confidence ratings, we expected OT to make participants feel more confident about detecting faces, compared to placebo. Our third hypothesis is therefore that OT will lead participants to rate their confidence in detecting face-like images higher, compared to placebo, leading to higher confidence ratings. We also expected to find a longer and more frequent gaze toward the illusory face region in general, and the eye region in particular, indicated by an increased number of fixations and time spent fixating. Our fourth hypothesis is thus that OT will lead participants to gaze longer and more frequently toward the eye region of illusory faces, compared to placebo, leading to higher number of fixations and longer time gazing.

Materials and methods

Subjects

Twenty-four healthy volunteers (12 women and 12 men), age 20-52 (mean = 25.6, SD = 7.2), were recruited from the University of Oslo (UiO) in Norway, through ads put up on the University campus and through active recruiting of students at the university grounds.

Inclusion criteria were men and women aged between 18-55 years with normal or corrected-to-normal (contact lenses or laser surgery of the eyes) vision. Exclusion criteria were pregnancy and breast-feeding, since intravenous OT has been used for pharmacologic induction of labor, due to its ability to strengthen naturally accruing uterine contractions (even though in our study OT was not administered intravenously) (Ciray, Backstrom, & Ulmsten, 1998). Participants received information regarding the tasks that they were expected to perform, that they were expected to participate in two different sessions on two different days, and some basic information about OT without revealing how it relates to the purpose of the study. The information was given by either by e-mail or in written materiel, before the experiment. The information was repeated in the consent form (approved by the Local Ethics Committee), which they had to read and sign before participating in the study. In addition, we encouraged the participants to refrain from caffeine and nicotine minimum three hours before the experiment.

Participants were informed that all data would be stored anonymously, and that they were free to leave the experiment at all times without any form of consequences. Information regarding the menstrual cycle and birth control was collected for female participants. Participants were compensated with 200 NOK at the end of session two. Information regarding the main purpose of the study was not revealed to the participants until testing was completed. Participants could leave their e-mail address if they wanted to receive the results when the study was over.

Experimenter

The experiments were conducted by a student at the master program in psychology at the University of Oslo, attending the 10th semester of education.

Design

The participants were tested in two sessions on separate days in a within-subjects placebo-controlled design. They were randomly assigned in a double-blind manner to receive OT or placebo through self-administration of a nasal spray: Either 24 intranasal units (IU) of OT (three puffs per nostril, each containing 4 IU), or an identical dose of placebo containing saline only. The participants received the spray with OT or placebo 30-45 minutes before testing started, and were told to sit alone in a room, where they would be allowed to relax, read and go to the bathroom, but not allowed to engage socially with someone else. Eye movements were recorded during the experimental task, which was similar in both sessions. Each session lasted for about 90 minutes.

Stimuli

160 images of objects, face-like objects, natural displays and face-like natural displays were adapted from a study by Riekki, Lindeman, Aleneff, Halme, and Nuortimo (2013), where the authors investigated if paranormal and religious believers are more prone to illusory face perception than skeptics and non-believers. All of the face-like pictures had a face-like area where one, at the minimum, could perceive two eyes and a mouth. The face-like elements in the pictures were evenly distributed around different areas of the photographs. The pictures depicted different items, objects, buildings, furniture, rooms, and landscapes, but there were no humans or animals in any of the images. When possible, the face-like pictures had a control non-face picture taken by the same camera in the same setting, portraying the same theme with the same lighting (see Figure 1 for examples).

Fig. 1: Two control pictures (left column) and two pictures with face-like elements (right column).

There were no face-like areas in the non-face pictures, and to keep the pictures as natural as possible, they were not adjusted or processed in any way except for resizing them to 640 x 640 pixels. The total of 160 images were pseudo-randomized into two test protocols for use in sessions 1 and 2 (protocols A and B, each consisting of 80 images; 40 face-like pictures and

40 control pictures). The order of presentation of the protocols (A, B, and their reversed-order counterparts A-reversed and B-reversed) was counterbalanced between participants so that all images were presented during both sessions, but each image was presented only once.

Questionnaires

Before being presented with a spray and starting the first session of the experiment, participants filled out a questionnaire probing their knowledge about OT. The questionnaire was a VAS consisting of six different statements, with the anchors Agree – Disagree, in which the candidates were asked to mark on the line how much they agreed or disagreed with different statements. In addition, the females were asked if they were using a contraceptive pill and how many days had passed since the first day of their last period (see Appendix). This was done to control for possible changes in hormonal levels that may interact with OT, which has been found in rodents (McCarthy, McDonald, Brooks, & Goldman, 1996). After the second session of the experiment, each participant filled out a second questionnaire where they were asked to write down why they wanted to participate in the study, what they thought the reason behind the study was, and when they thought they got placebo and when they got OT (see Appendix).

Apparatus

The Remote Eye Tracking Device, (R.E.D.; SMI-SensoMotoric Instruments, Teltow, Germany), was employed to record the eye movements of the participants. The R.E.D. can operate at a distance of 0.5-1.5 m, and the distance between the computer screen and the participants' eyes was set to 60 cm. The pictures were presented on a flat color, LCD monitor, with the diagonal measure of 56 cm. The experiment was operated from a separate laptop as the experiment took place. The sampling rate for eye movements recording was 250Hz. The gaze location resolution accuracy was of about 0.1 degree. The eye-tracking device had two sources of infrared light dilator, mounted at each lateral side of the lower monitor frame, that determined the positions of the eyes based on the centroids of pupil and the corneal reflection while the participant looks at the screen. Presentation of stimulus images and recording of behavioral data was done with the use of Experiment Center software (version 3.2), while iViewX-software (version 2.8) recorded eye movements and fixations.

Procedure

The experimenter greeted the participants, completed the abovementioned formalities, and answered any questions from the partakers. Once the formalities were finished, the

experimenter checked the participant's candidate number in a pre-randomized list, indicating if the participant were to receive OT or placebo, and picked one out of two similar-looking nasal sprays identified by the shape of the cap. It was a double blind study, so neither the experimenter nor the participants had any knowledge of which of the spray bottles contained active oxytocin or placebo. The participants were presented the spray and a tissue and were instructed to self-administer three puffs from the nasal spray into each nostril (six in total). Several recent studies of the behavioral effects of OT involve testing at 30–60 min after administration (Churchland & Winkielman, 2012), and our participants were told to sit alone in a room during the waiting period of 30-45 min, for the nasal spray to take effect. They were allowed to relax, read and go to the bathroom, but they were instructed to not engage socially with anybody else. After the waiting period, but before the experiment starts, the height of the chair and the position of the eye tracker was adjusted to fit the participant, followed by specific instructions about the task, breaks, and the duration of the experiment. The participants were instructed to sit as still as possible during an independent calibration procedure of the eye tracker equipment where the apparatus localized the gaze and adjusted to individual eye properties in order to correctly record the eye movements and fixations.

Prior to the experiment, the participants started with two practice sections where they learned about the experiment, got used to operating the response keys and how to validate with the computer mouse how confident they were in their answer. In the first practice task, two face-like images and two non face-like images were used, presented one by one for 5 seconds. The participants were instructed to try to look for a face-like area in the image, and respond with the 'Yes'/'No' key. Next, the participants were instructed to indicate by using the computer mouse how confident they were seeing or not seeing an image with face-like features, by selecting an alternative from a seven-point Likert scale with the anchors 'Not confident' and 'Very confident'. In the second practice task, two new face-like images and two new non face-like images were used, presented one by one, but this time for only 1000 ms. The rest of the practice task followed as in the first practice session. The participants were given feedback by the experimenter throughout the practice sessions, and were asked if they understood the task at hand and what was anticipated from them.

The experiment consisted of 80 trials in total, with 40 face-like pictures and 40 non face-like pictures presented in randomized order. The pictures were presented in two different sets and were presented in a reversed order for half of the candidates. Every trail in each picture set consisted of four separate images (see Figure 2), with the first shown image being a luminance-adjusted gray (29 × 39 cm) rectangle with a fixation cross located in one of the

four corners of the screen. The function of the fixation cross was to remove the gaze bias to the center of the screen at the beginning of each trial. The positions of the fixation crosses in one of the four corners were pseudo-randomized when constructing the image set. The first image with the fixation cross was a triggering slide, which made sure that participants gazed at the fixation cross for minimum 300ms before the second image was presented. The second image was the picture of objects and natural displays with or without face-like elements in them. The presentation lasted for 1000ms, being replaced by the third picture, which was a luminance-adjusted gray rectangle image, lasting for 2000ms. The participants were told to respond with a designated keyboard key (B = yes) if they think they saw a face and with another keyboard key (N = no) if they think they did not see a face. They were instructed to respond as fast as possible, and at least within the 3000ms, during which the picture and the grey rectangle image were presented. Finally, the fourth picture was a questionnaire slide, which was presented for an unlimited time. The question was "How confident were you in your decision?" and there were seven possible alternatives ranging from 1 (not confident) to 7 (very confident).

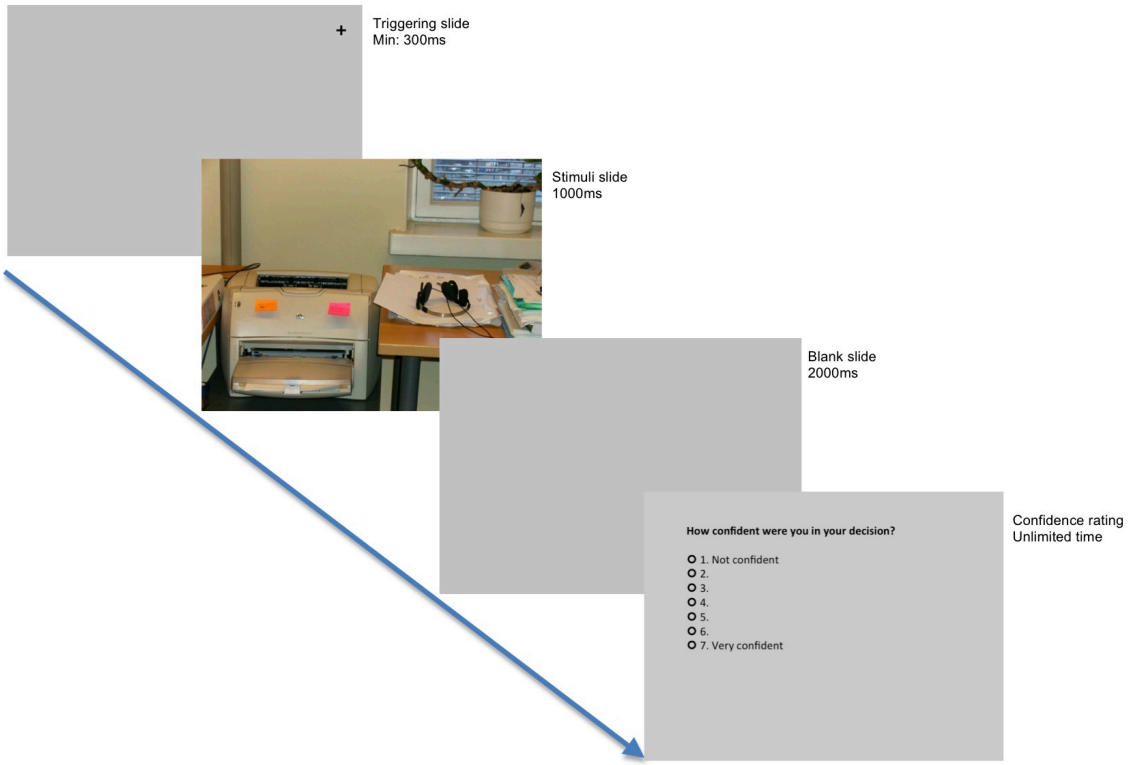

Fig 2: An outline of the sequences in each trial of the experiment.

All of the experiments were carried out in the eye tracking laboratory, which had a constant environmental luminance given by a single fluorescent ceiling lamp which was on

during all experiment runs. Each session lasted for about 90 minutes. After each session, the participants were asked how they felt or experienced anything out of the normal, if they thought they got oxytocin or placebo; and asked to indicate level of confidence on a scale from 0 to 10 where 0 is completely uncertain and 10 is completely certain. After session two, the participants were debriefed and compensated NOK 200 for their participation.

Statistical Analyses

Behavioral data

Behavioral data were participants' key responses and confidence rating, and were analyzed using Microsoft Excel and Statistical Package for the Social Sciences 18 (SPSS INC., Chicago, IL, USA). We performed a repeated-measures Analysis of Variance (ANOVA) on the mean scores of accuracy, reaction time and confidence ratings as the dependent variable, with picture (face-like and non face-like) and spray (OT and placebo) as within-subject variables and gender of the participant (female, male) and spray order (OT first or placebo first) as between-subjects factors. Specific a priori hypotheses were tested using paired, 1-tailed t-tests.

Gaze data

Gaze data were eye movements: Fixations counts and fixation time. In each picture with face-like elements (see Figure 3, first picture), two Areas Of Interest (AOI) were created, consisting of 1) the whole face region, and 2) the eye region. Region size varied according to the size of the face-like elements in the image (see Figure 3, second picture). Measures included number of fixations in the scan path (see Figure 3, third picture) toward an AOI, and fixation duration (total milliseconds time spent fixating on an AOI). BeGaze software (version 3.2) and standard statistical software (i.e. Excel, SPSS, Statview) were used analyzing the recorded data.

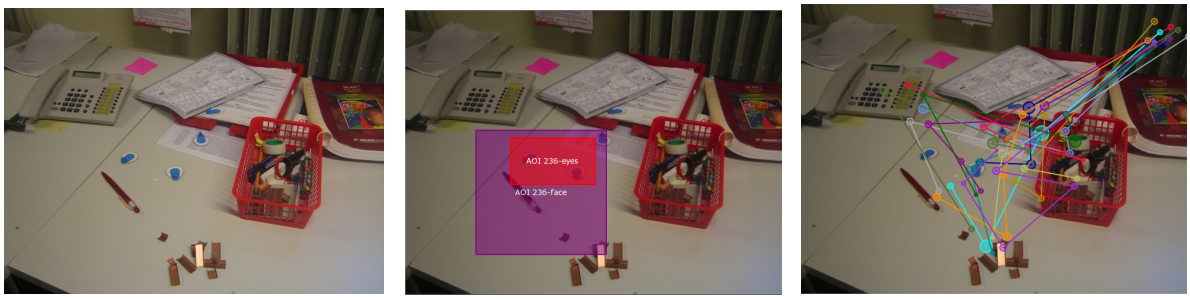

Fig 3: Illustration of picture with face-like elements (first picture), AOIs in the picture (second picture) and the scan path (third picture) from the different participants.

Results

Behavioral data

H1: Effects of OT on the Accuracy of illusory face detection.

Prediction: OT will lead participants to be more prone to illusory face perception, leading them to detect more illusory faces, compared with sessions where they were assigned to receive placebo.

To test if OT levels can modulate the participants perceptions in such a way that they will be more sensitive to illusory faces, we tested level of Accuracy by conducting a repeated measures analysis of variance (ANOVA) in SPSS with the within factors of Spray (OT and Placebo) and Picture (Face and Non-Face) and between-subject factors of Gender (Male and Female) and Order of Spray (OT first, Placebo first). The analysis revealed a significant main effect of Picture $F(1,20) = 108.802$, $p < .001$. These results demonstrate a larger attentional capture when face-like elements are placed in a face-like configural context, compared to the scrambled context. There was also a significant interaction effect of Spray and Gender, $F(1,20) = 4.945$, $p = .038$ (see Figure 4). A non-significant trend towards an interaction effect of Spray and Order of Spray was observed, $F(1,20) = 4.099$, $p = .056$. No significant interaction effect of Spray and Picture was observed, $F(1,20) = .586$, $p = .453$. Table 1 illustrates mean Accuracy and SDs for hits in predetermined face-like areas.

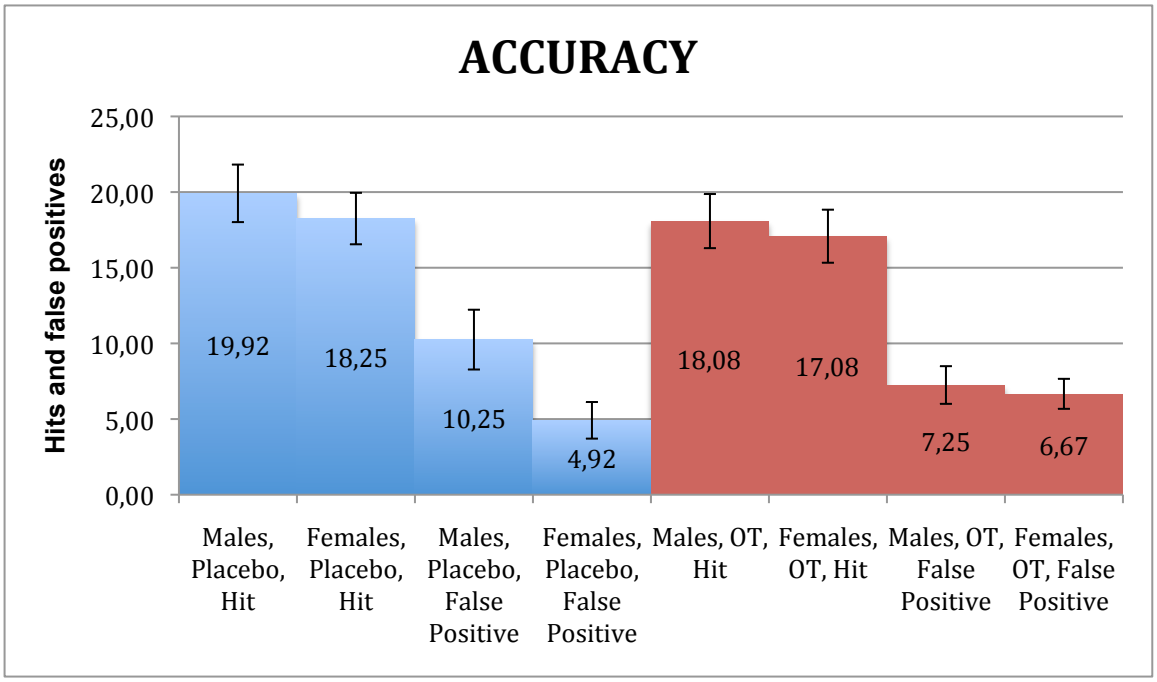

Fig. 4: Accuracy of detecting face-like images as a function of Spray and Gender. Error bars represent standard error of the mean. Bars indicate 95% confidence intervals for within-subject designs (Loftus & Masson, 1994).

Table 1: Behavioral data illustrating mean group responses and SDs for each condition.

	OT	Placebo
Hits in predetermined face-like areas	17.58 (7.12)	19.08 (7.03)
Miss outside predetermined face-like areas	21.50 (7.32)	20.29 (7.17)
False alarms for non face-like pictures	6.94 (3.28)	7.55 (5.75)
Correct rejections for non face-like pictures	33.33 (4.96)	32.38 (6.23)
Sensitivity d'	1.07 (0.33)	1.08 (0.46)
Response criterion C	0.67 (0.53)	0.58 (0.55)

H2: Effects of OT on response time

Prediction: OT will lead participants to detect illusory faces earlier, and therefore to respond faster to illusory faces, compared to placebo.

To test if OT levels can modulate the participants' perceptions in such a way that they will detect illusory faces faster than control images, we conducted a repeated measures ANOVA on the mean response times (RTs) for correct responses with the within-subject factors of Spray (placebo and OT) and Picture (face and no-face), and between-subject factors of Gender (male and female) and Order of Spray (OT first, placebo first), which revealed a non-significant trend towards a main effect of Picture, $F(1,20) = 3.629$, $p = .071$ (see Figure 5). There was no interaction effect of Spray and Picture, $F(1,20) = 1.108$, $p = .305$.

Post-hoc t-tests revealed, in accordance with accuracy results, that response time in ms for illusory faces were significantly shorter (M = 1131, SD = 324) than for non-faces (M = 1185, SD = 351), $t(23) = -2.49$, $p = .005$.

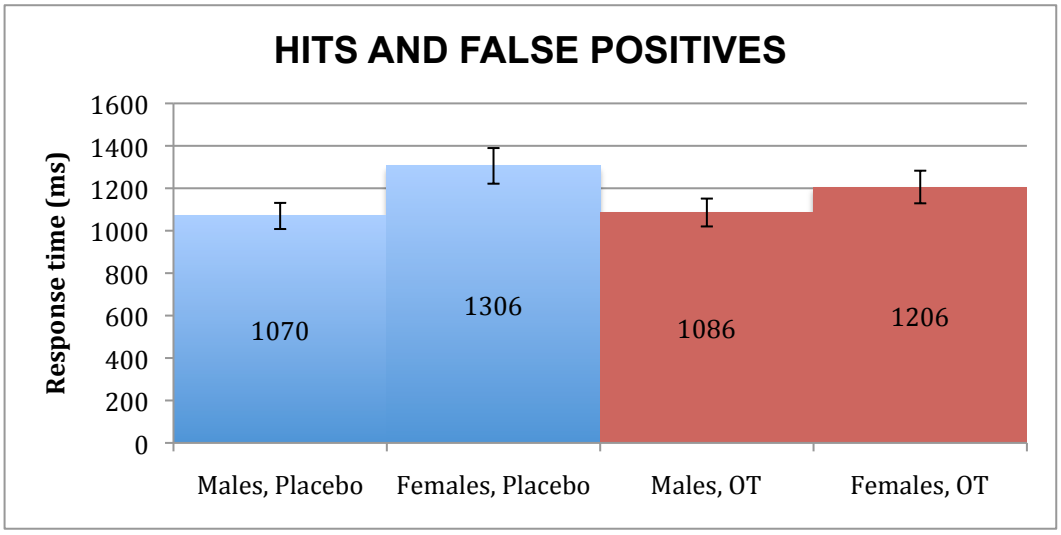

Fig. 5: Response times for detecting face-like images as a function of Spray and Gender. Error bars represent standard error of the mean. Bars indicate 95% confidence intervals for within-subject designs (Loftus & Masson, 1994).

H3: Effects of OT on confidence ratings

Prediction: OT will lead participants to rate their confidence in detecting face-like images higher, compared to placebo.

To test if OT levels can modulate the participants' perceptions in such a way that they will have more confidence in detecting illusory faces, we conducted a repeated measures ANOVA with the within factors of Spray (placebo and OT) and Picture (face and no-face) and between-subject factors of Gender (male and female) and Order of Spray (OT first, placebo first), which revealed a significant main effect of Picture $F(1,20) = 106.752$, $p < .001$ (see Figure 6). These results demonstrate, as with the accuracy and response time, a larger attentional capture and perception of faces when elements are placed in a face-like configural context, compared to when the face-like elements are in a scrambled context. No significant interaction effect of Spray and Picture, $F(1,20) = .069$, $p = .796$. The interaction Spray*Gender*Order was not significant (see table 2).

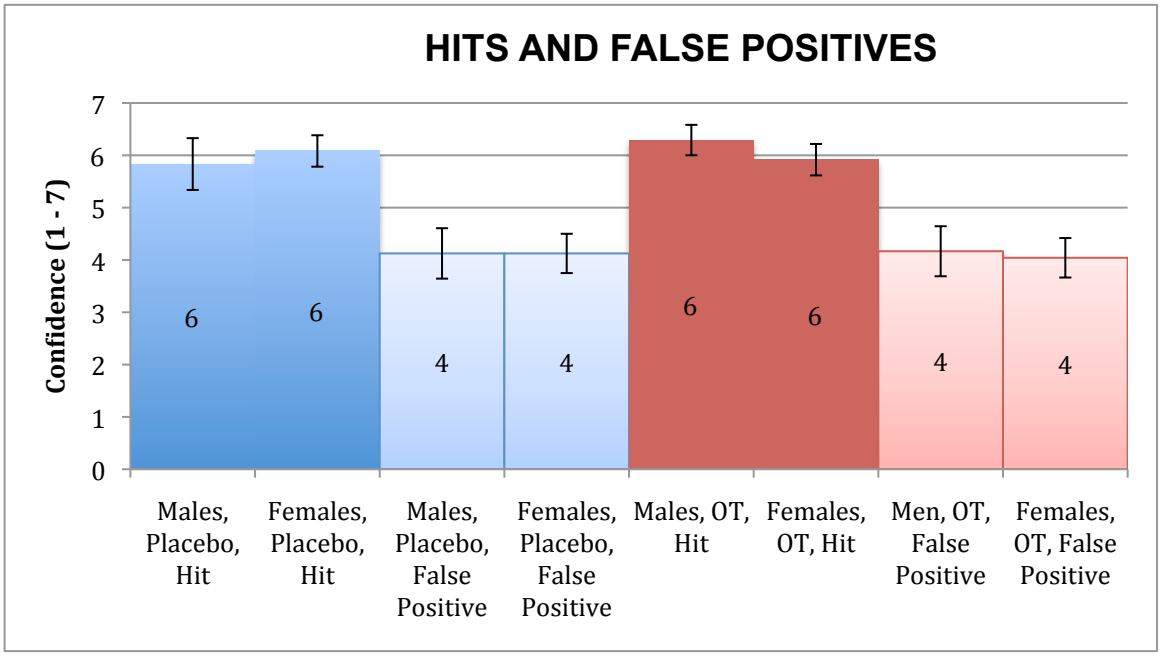

Fig. 6: Confidence of detecting face-like images as a function of Spray and Gender. Error bars represent standard error of the mean. Bars indicate 95% confidence intervals for within-subject designs (Loftus & Masson, 1994).

Table 2: Group means for confidence and within-subject SDs for each condition.

Condition	M	SD
Confidence, placebo, males	5.0	1.81
Confidence, placebo, females	5.1	1.49
Confidence, oxytocin, males	5.2	1.68
Confidence, oxytocin, females	5.0	1.46

Gaze data

H4: Effects of OT on fixations and gaze.

Prediction: OT will lead participants to gaze longer and more frequently toward faces and the eye region of illusory faces, leading to higher number of fixations and longer fixation time, compared to placebo.

To test if OT levels can modulate the participants' perceptions in such a way that they will gaze more frequently at illusory faces, we conducted a repeated measures ANOVA with the within factors Spray (placebo and OT) AOI (face and eyes) and between factors Gender (male and female) and Order (order of image set), which revealed a significant difference between faces and eyes, both when it comes to fixation counts $F(1,20) = 982.599$, $p < .001$ (see Figure 7) and fixation time in ms $F(1,20) = 661.054$, $p < .001$ (see Figure 8).

No significant interaction effect of Spray and AOI (face) was found when it came to fixation counts $F(1,20) = 1.797$, $p = .195$, or fixation time ms ; $F(1,20) = .915$, $p = .350$. The interactions of Spray and AOI (eyes), both fixation counts and fixation time ms, were not significant either (see Table 3).

To test if OT had an effect on Gender when it comes to AOI fixations (face), we conducted a separate paired t-test to compare the attentional capture effect. The results showed a significant difference in AOI fixations in the OT condition between females (M = 2.00, SD = 2.32) and males (M = 1.79, SD = 1.78), $t(11) = -2.42$, $p = .034$. The same t-test regarding an OT effect on Gender and AOI fixations (eyes), revealed no significant difference in AOI fixations ($p = .59$).

Post-hoc t-tests revealed that time spent fixating on the faces of face-like images where they had answered 'no face' (false negatives) were significantly shorter in the placebo condition (M = -114.75, SD = 232.25) than in the OT condition (M = -112.58, SD = 278.64), $t(23) = -2.42$, $p = .024$. This is contrary to what we had hypothesized.

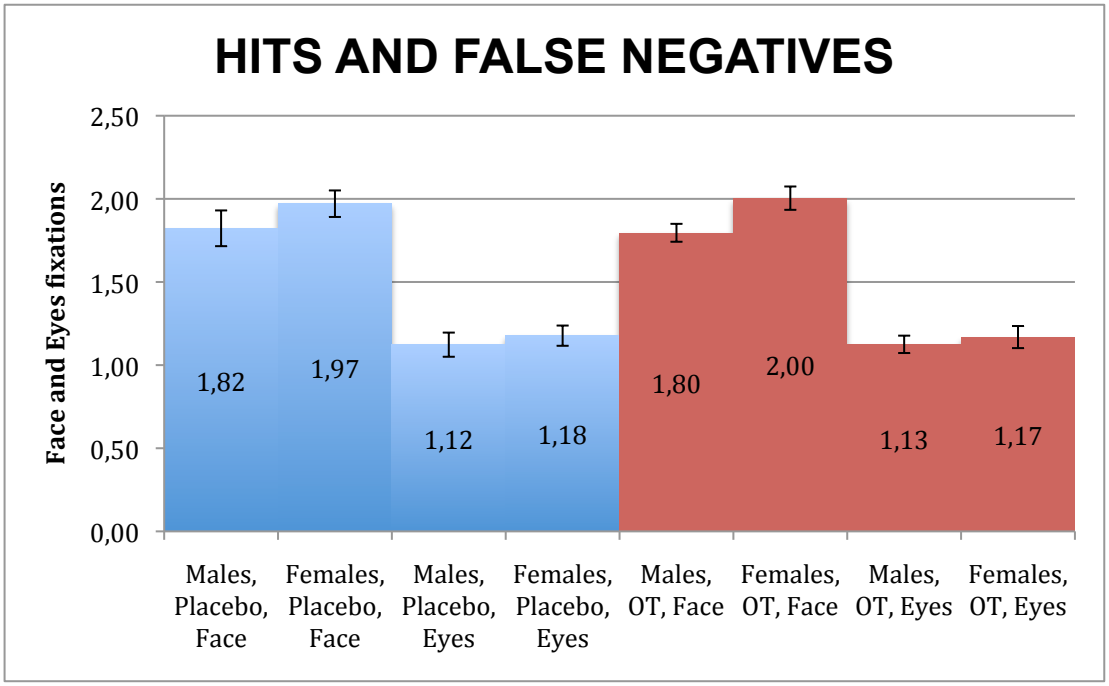

Fig 7: Number of fixations on faces and eyes as a function of Spray and Gender. Error bars represent standard error of the mean. Bars indicate 95% confidence intervals for within-subject designs (Loftus & Masson, 1994)

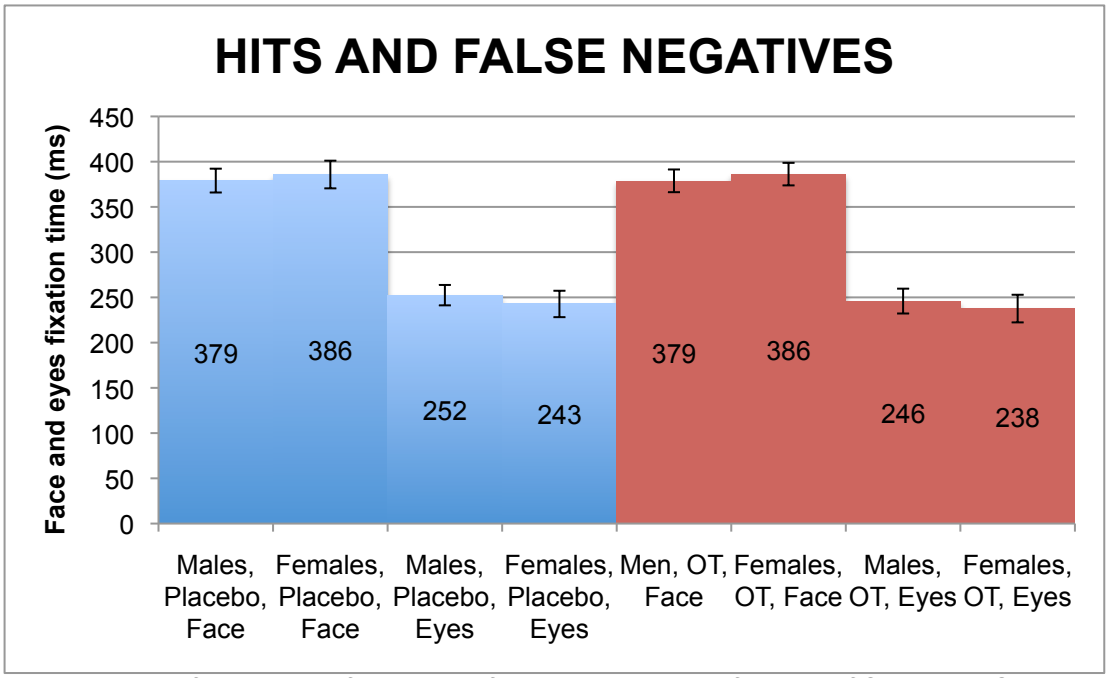

Fig 8: Number of millisecond fixations on faces and eyes as a function of Spray and Gender. Error bars represent standard error of the mean. Bars indicate 95% confidence intervals for within-subject designs (Loftus & Masson, 1994)

Table 3: Group means for fixations and fixation time and within-subject SDs for each condition.

	Fixations		Milliseconds	
	M	SD	M	SD
Face, placebo, males	1.8	0.36	379	43.6
Face, placebo, females	1.9	0.27	386	50.7
Eyes, placebo, males	1.1	0.24	252	37.4
Eyes, placebo, females	1.2	0.20	243	48.4
Face, oxytocin, males	1.8	0.18	379	41.6
Face, oxytocin, females	2.0	0.23	386	41.3
Eyes, oxytocin, males	1.1	0.17	246	45.5
Eyes, oxytocin, females	1.2	0.22	238	50.6

Prebriefing and debriefing

The mean scores from the answers from the questionnaire regarding participants' knowledge of OT were analyzed with a paired t-test, with a correlation alpha of $p = 0.96$. The p-value of 0.96 is greater than the alpha of 0.05 and suggests there that participants had a good knowledge of the effect of OT.

The answers from the questionnaire investigating if the participants could guess above chance level what type of spray they believed they had received, 14 out of 24 participants guessed correctly, which is just slightly above chance level. They were also asked to rate the certainty of their answer on a 1 – 10 scale (anchors: 1 = completely uncertain, 10 = completely certain. Average was 5.5 (SD = 2.41) on day 1 and 5.6 (SD = 1.88) on day 2.

Regarding the information females gave about their current phase in the menstrual cycle, the number of female participants tested in the experiment was relatively low (N=12), and the distribution along the menstrual cycle unbalanced, so it was not possible to perform analyses to control for the effects of menstrual cycle on pharmacological manipulation.

Discussion

In the present study we investigated how oxytocin influences the ability to detect face-like elements, the so-called pareidolia phenomenon, in pictures. To our knowledge, this is the first study to address what role oxytocin might play in detecting and perceiving pareidolia. The study shows that one of the most elementary tasks with pareidolia, the process by which illusory faces are detected in our visual environment, is clearly affected by the organization of facial elements. The visual elements of two illusory eyes and an illusory mouth not organized within a configural spatial frame were not perceived as part of a face, while the elements were perceived as part of a face when organized together within a configural facial distance.

Results, therefore, show that illusory facial elements both attract pre-attentive attention resources and stands out from background of other objects and natural elements, indicating that the experiment had a high internal validity. The results also revealed that males had shorter response times and more correct detections than females – but also more false positives than the females. This may indicate that males were more prone to be less conservative in their responses. Furthermore, our results did not show any general effects of enhanced detection abilities of face-like stimuli after administrating intranasal OT for either the accuracy of detection, the response time, or the confidence rating data. Analysis of the eye movements' data also did not reveal any statistically significant effects of OT for both fixation count and fixation time to AOIs. We believe that the absence of significant findings should be interpreted with caution, since this is the first experiment to investigate OT's potential role in detecting faces in pareidolia stimuli.

From several studies, OT is known for its fundamental role in regulation of social behavior and social cognition in humans (Heinrichs, von Dawans, & Domes, 2009). Since the ability to interpret another person's facial expression is a prerequisite for human social interaction, it is not surprising that OT facilitates the recognition of emotional expressions in images of faces (Domes, Heinrichs, Michel, et al., 2007; Leknes et al., 2013). Studies show that it is the exploration of the eye region that is likely to improve emotion recognition, because the eyes convey most of the relevant signals for emotion judgment (Guastella et al., 2008), and OT has been shown to increase gaze to the face, but especially to the subtle cues around the eye region, enhancing the ability to interpret another person's mental state (Domes, Heinrichs, Michel, et al., 2007; Guastella et al., 2010). In our experiment, we did not use natural faces, but rather elements in objects and natural scenes that more or less resembled facial features like the eyes and the mouth. Another difference between our study and earlier face-categorization studies addressing the role of OT in face perception is that they often are not strictly face-detection experiments. Faces with different emotional values are either presented on their own, or a stimulus with one expression is presented in a crowd of distractors with different emotional expressions (Guastella et al., 2009).

Schematic faces and single line-drawn facial figures have been used investigating the pareidolia phenomenon, and in a visual-search paradigm, Nothdurft (1993) explored whether schematic faces with different facial expressions would pop out when presented in a group of jumbled schematic non-faces. Half of the groups contained a face-like schematic face, and the other half did not, and the participants' task was to indicate whether a face was present or not. Time is a factor here, the authors argue, and search slope is normally measured by dividing the mean increase in overall response time by the number of additional items. Search slopes

of less than 10 ms per item are usually considered to reflect automatic search, while search slopes of more than 10 ms per item are considered to suggest serial or controlled visual search. Group sizes of face-like and scrambled schematic faces varied up to 48 items, and the relationship between group size and increased reaction time was found to be 113 ms per item, indicating a serial search process.

This is in line with results from other studies (Guastella et al., 2009; Suzuki & Cavanagh, 1992; White, 1995), which found that schematic faces are easily detected, and with a more flat search slopes for emotional schematic faces relative to neutral faces and non-faces. This indicates a 'pop out' effect for emotions in schematic faces – but not in neutral schematic faces. From their results they concluded that facial expressions are an important and 'emergent feature' that mediates efficient visual search. Sagiv and Bentin (2001) found similar results, but with a surprising difference. Although schematic and natural faces in all probability activate similar neural networks in the extrastriatal visual pathway, these mechanisms are not quite identical. While natural faces activate two specialized perceptual modules - one dedicated to detecting and processing physiognomic features in the visual field, and the other dedicated to holistic processing of faces, - schematic faces most likely trigger only the holistic processor but not the analysis of the components. In contrast to natural faces, the components of schematic faces do not seem to be perceived as carrying physiognomic information based on facial features out of the schematic face gestalt. They argued that the N170 is associated with structural encoding, and found evidence that schematic faces and natural faces are not processed identically. Inversion of natural faces enhanced the amplitude of the N170, while inversion of schematic faces reduced its amplitude. For both natural and schematic faces, the latency of the N170 peak was significantly delayed by inversion. They suggest that this pattern of results shows that the face-specific structural encoder can be triggered by a variety of stimuli, if they include some sort of face configuration. The process of encoding face information and forming a structural representation is therefore probably different when the physiognomic value of the stimuli depends upon holistic configuration in a real face, as opposed to individual elements that can be associated with faces, like schematic faces and other pareidolia.

This is in line with two other studies investigating the pareidolia phenomenon using EEG (Smith, Gosselin, & Schyns, 2012) and fMRI (Zhang et al., 2008), identified a network of brain regions showing greater activations when face pareidolia occurred, most notably in the FFA and in the inferior frontal gyrus (IFG). The authors suggest that these cortical regions might play a vital role in face pareidolia, perhaps by integrating bottom-up signals and top-down modulations as face pareidolia relies on a match between external information

and internally stored face templates. Increased activation in these regions while detecting illusory faces may be related to the retrieval and activation of internal face representations. Liu et al. (2014) argue that abovementioned regions not only is activated by faces, as FFA is also known to be activated by non-face objects with which we have expertise (Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999), and IFG is also known to be involved in the pareidolia of non-face objects; letters, with which we have expertise (Liu et al., 2010). Thus, it is unclear whether the FFA and its associated cortical network (e.g., IFG) are specifically involved in face pareidolia (the face specificity hypothesis) or in the pareidolia of any objects with which one have processing expertise (the object expertise hypothesis). It might well be that our brain is hardwired to detect stimuli that are important to us, with face-like configurations as the more important stimuli. It is perhaps highly adaptive to detect faces in ambiguous visual information given the extreme importance faces have in our social life and the high cost that comes from failure to detect a true face.

Our results in this paper seem to be in line with the abovementioned findings. We demonstrated that face pareidolia in objects and natural scenery are detected more efficiently and perceived as faces more often than control images, which contain the same face-like elements, but in a scrambled context. However, OT did not influence and enhance the early perceptual detection of faces or attribute to a further 'pop-out' effect. The lack of emotional expressions in the stimuli and situational factors may have played a vital role here, as we will soon see.

As the work of Ekman (1992) shows, there is evidence for a set of primitive or basic emotions that allow rapid responses to biologically relevant stimuli. In turn, these basic emotions are in humans associated with very detailed facial expressions that are recognized across different cultures. Neurophysiological studies have shown that a direct pathway leading from the thalamus to the amygdala allows mammals to respond defensively to an ambiguous stimulus before it is identified as either threatening or harmless (LeDoux, 1996). The visual processing of faces is therefore typically rapid and reflexive, and is a multistep process, involving pre-attentive processing, template fitting, and template evaluation. Detection of a face in a visual scene comes before any further processing, such as identification or emotional expression analysis (Lewis & Ellis, 2003). Liu et al. (2014) argue that the prefrontal cortex can exercise considerable influence on the visual cortex to facilitate the processing of sensory input, and Smith et al. (2012) found in a recent EEG study investigating illusory face perception in pure noise images increased neural activity in the frontal cortex prior to the occipitotemporal activation. Liu et al. (2014) suggest that when experiencing face pareidolia, neural regions in the upper stream of the face-processing

network may send modulatory signals to influence the activities in the FFA, leading the FFA to interpret the bottom-up signals from the visual cortex as containing face information. This way, face pareidolia involves both bottom-up attention, which is more automatic, and top-down processing, which is more elaborate, conceptually driven. Bottom-up attention is sensitive to the influence of the amygdala, while top-down processing is mediated by pre-frontal structures (Liu et al., 2014; Smith et al., 2012; Öhman, 2005). The pre-frontal structures is therefore often regarded as the primary site for cognitive regulation of emotion (Davidson, Putnam, & Larson, 2000), and consistent with this notion, Carlsson et al. (2004) found that the right dorsolateral prefrontal cortex (DLPFC) and the lateral orbitofrontal cortex (OFC) were less activated to the feared than to the fear-relevant but non-feared stimulus when the experiment allowed conscious processing of the stimuli. The authors argue that when participants had time to determine that the fear-relevant (but non-feared) stimulus in effect was harmless, prefrontal structures may inhibit the amydala response.

Guastella et al. (2009) wanted to explore OT's role in the bottom-up component of social approach, using a visual-search paradigm with schematic faces that were happy, neutral, or angry. An earlier study by Guastella et al. (2008) evaluated the influence of OT at a more elaborative and conceptually driven, top-down stage of information processing. They experimented with pictures of real faces and the results showed that OT increased the number of fixations and total gaze time toward the eye region, relative to placebo. This time, they wanted to evaluate the effects of OT nasal spray on schematic faces. The amygdala has been known as particularly important for the detection of early, pre-attentive threat (Öhman, 2005) and OT, in turn, has been shown to influence amygdala reactivity independent of social valence (Domes, Heinrichs, Michel, et al., 2007). As past research with real happy and angry faces in a crowd has shown (C. H. Hansen & Hansen, 1988), schematic faces used in the same paradigm reveal that the detection of angry faces is both fast and efficient, compared to the detection of other social stimuli, such as happy and neutral face stimuli (Fox et al., 2000). As the work by Guastella et al. (2009) demonstrated, although angry schematic faces both attracted and held attention more than neutral or happy schematic faces, OT did not enhance the initial, pre-attentive perceptual detection process. This was true for the early processing of both threatening social stimuli and positive social stimuli. These results failed to support the role for OT in the initial detection stage of visual attention to schematic faces at the bottom-up stage of information processing, i.e. a data-driven and perceptual level. However, as abovementioned studies show, it does indicate OTs role in later, more interactive cognitive and emotional stages of processing. Evidence suggests that at a more conscious and conceptual level of processing, the pre-frontal cortex is particularly important for cognition

(Öhman, 2005), and Guastella et al. (2009) argue that OT's evolutionary, adaptive and functional role might be to reduce the processing of threatening social cues after the initial threat has been detected, and not to bias the processing of social valence at an early stage. When there is an opportunity to conceptually process the meaning of the cue at later stages of information processing, OT may function to enhance positive social cues over social threat (Öhman, 2005), and thereby not contribute to an enhancing factor in the search and detection process. Taking the afore-mentioned reasoning into account, we propose that it is important to study both automatic and effortful information processing in the same experiment to see whether OT allows for increased subsequent effortful processing of neutral and emotional information at a later stage.

Limitations

Illusory face perception is a phenomenon that often occurs spontaneously with natural stimuli in ordinary surroundings. Despite the advantages of the present study, such as a randomized double-blinded design, a large set of natural-looking target and control stimuli positioned in multiple scenes in counterbalanced conditions, it had some limitations. The first one to mention is an ecological limitation. Our controlled laboratory paradigm differs from situations naturally occurring in everyday life, which may have led participants to respond differently from situations occurring outside of the laboratory. Another limitation might have been that the sample size in the present study (N=24) was rather small, since larger OT studies usually give more reliable results. Even though within-subjects designs have advantages over designs with an experimental and a control group, as they allow for a better control of potential confounding variables, it is still difficult to distinguish between a real effect and random variation that might stem from sex and individual differences in the sample. There might also have been a learning effect, even though a small or variable one between subjects, since we did not find any interaction effects with session order. Another possibility for not finding significant effects of OT on detection of illusory faces is a potential floor effect in the sense that the experiment might have been too easy for the participants, and thus was not able to reveal possible subtle effects of the OT manipulation.

Finally we would like to refer to Bartz, Zaki, Bolger, and Ochsner (2011) review of the human oxytocin literature that indicates that the effects of exogenous oxytocin on social cognition and prosociality are more nuanced than previously thought. More than 40% of the studies/outcomes tested they looked at indicated no main effect of oxytocin, and about 60% reported situational and/or individual difference moderators. A sizeable minority showed in addition that oxytocin could produce antisocial (i.e. not prosocial) effects under certain

conditions. They argue that although differences in the procedure or task introduced variance across studies, it seems that much of the variance observed is in fact systematic and a function of the context- and person-dependent nature of the social effects of oxytocin in humans. When they looked at different studies that employed the same procedure or task, the different studies showed situational and/or individual difference moderators.

Conclusion

Current study demonstrated that face-like elements in pictures attract pre-attentive awareness resources and make people see and report perceived presence of a face. Despite our predictions, the administration of intranasal OT failed to cause our candidates to see and report more illusory faces compared to placebo. We did not find any clear evidence that OT influenced the early perceptual detection process of faces or enhanced the early detection process of eyes in pareidolia as a social stimulus. Most studies on faces and OT have evaluated the influence of OT at a more elaborative and conceptually driven (i.e., top-down) level of information processing with real faces, while we in our study evaluated effects of OT at a more data-driven and perceptual (i.e., bottom-up) level on illusory faces. OT has already been shown to influence amygdala reactivity for the detection of early, pre-attentive threat, and amygdala seems to be particularly important for this type of information processing. However, evidence suggests that the prefrontal cortex is more important for cognition at more deliberate and conceptual levels of processing, and from the results of our and Guastella et al. (2009) study, we may therefore conclude that OT does not bias the detection of illusory faces at early, bottom-up perceptual stages of processing.

It seems clear that exogenous OT can alter the basic processing of social stimuli, for example the salience of interpersonal cues, which in turn could produce a wide variety of behavioral results depending on situational and/or dispositional factors (Bartz et al., 2011). Future research should therefore explore the interactive perspective of OT and investigate if OT has an effect on later, more social level evaluation of the stimuli. Animism and anthropomorphism, in that sense, refers to an assignment of human characteristics to a non-human entity, and it would be interesting to investigate if OT would influence the detection of moving pareidolia facial characters, like e.g. Humpty Dumpty and Mr. Potato Head in 'Toy Story'. This could help us to better understand the mechanism behind facial encoding and learn why humans have the tendency to see faces in non-living objects.

References:

Andrews, T. J., Schluppeck, D., Homfray, D., Matthews, P., & Blakemore, C. (2002). Activity in the fusiform gyrus predicts conscious perception of Rubin's vase-face illusion. *Neuroimage, 17*(2), 890-901.

Bartz, J. A., & Hollander, E. (2006). The neuroscience of affiliation: forging links between basic and clinical research on neuropeptides and social behavior. *Horm Behav, 50*(4), 518-528. doi: 10.1016/j.yhbeh.2006.06.018

Bartz, J. A., Zaki, J., Bolger, N., & Ochsner, K. N. (2011). Social effects of oxytocin in humans: context and person matter. *Trends Cogn Sci, 15*(7), 301-309. doi: 10.1016/j.tics.2011.05.002

Brugger, P. (2001). From Haunted Brain to Haunted Science: A Cognitive Neuroscience View of Paranormal and Pseudoscientific Thought. In J. Houran & R. Lange (Eds.), *Hauntings and Poltergeists: Multidisciplinary Perspectives* (pp. pp. 195-213). North Carolina: McFarland & Company, Inc. Publishers.

Buijs, R. M., De Vries, G. J., Van Leeuwen, F. W., & Swaab, D. F. (1983). Vasopressin and oxytocin: distribution and putative functions in the brain. *Prog Brain Res, 60*, 115-122. doi: 10.1016/S0079-6123(08)64379-4

Burton, A. M., & Bindemann, M. (2009). The role of view in human face detection. *Vision Res, 49*(15), 2026-2036. doi: 10.1016/j.visres.2009.05.012

Carlsson, K., Petersson, K. M., Lundqvist, D., Karlsson, A., Ingvar, M., & Ohman, A. (2004). Fear and the amygdala: manipulation of awareness generates differential cerebral responses to phobic and fear-relevant (but nonfeared) stimuli. *Emotion, 4*(4), 340-353. doi: 10.1037/1528-3542.4.4.340

Churchland, P. S., & Winkielman, P. (2012). Modulating social behavior with oxytocin: how does it work? What does it mean? *Horm Behav, 61*(3), 392-399. doi: 10.1016/j.yhbeh.2011.12.003

Ciray, H. N., Backstrom, T., & Ulmsten, U. (1998). Ineffectiveness of oxytocin on intercellular communication between term pregnant human myometrial cells before labor. *Am J Obstet Gynecol, 178*(4), 855-861.

Dakin, S. C., & Watt, R. J. (2009). Biological "bar codes" in human faces. *J Vis, 9*(4), 2 1-10. doi: 10.1167/9.4.2

Davidson, R. J., Putnam, K. M., & Larson, C. L. (2000). Dysfunction in the neural circuitry of emotion regulation--a possible prelude to violence. *Science, 289*(5479), 591-594.

Diamond, R., & Carey, S. (1986). Why faces are and are not special: an effect of expertise. *J Exp Psychol Gen, 115*(2), 107-117.

Domes, G., Heinrichs, M., Glascher, J., Buchel, C., Braus, D. F., & Herpertz, S. C. (2007). Oxytocin attenuates amygdala responses to emotional faces regardless of valence. *Biol Psychiatry, 62*(10), 1187-1190. doi: 10.1016/j.biopsych.2007.03.025

Domes, G., Heinrichs, M., Michel, A., Berger, C., & Herpertz, S. C. (2007). Oxytocin improves "mind-reading" in humans. *Biol Psychiatry, 61*(6), 731-733. doi: 10.1016/j.biopsych.2006.07.015

Domes, G., Lischke, A., Berger, C., Grossmann, A., Hauenstein, K., Heinrichs, M., & Herpertz, S. C. (2010). Effects of intranasal oxytocin on emotional face processing in women. *Psychoneuroendocrinology, 35*(1), 83-93. doi: 10.1016/j.psyneuen.2009.06.016

Domes, G., Sibold, M., Schulze, L., Lischke, A., Herpertz, S. C., & Heinrichs, M. (2013). Intranasal oxytocin increases covert attention to positive social cues. *Psychol Med, 43*(8), 1747-1753. doi: 10.1017/S0033291712002565

Donaldson, Z. R., & Young, L. J. (2008). Oxytocin, vasopressin, and the neurogenetics of sociality. *Science, 322*(5903), 900-904. doi: 10.1126/science.1158668

Downing, P. E., Chan, A. W., Peelen, M. V., Dodds, C. M., & Kanwisher, N. (2006). Domain specificity in visual cortex. *Cereb Cortex, 16*(10), 1453-1461. doi: 10.1093/cercor/bhj086

Ebitz, R. B., Watson, K. K., & Platt, M. L. (2013). Oxytocin blunts social vigilance in the rhesus macaque. *Proc Natl Acad Sci U S A, 110*(28), 11630-11635. doi: 10.1073/pnas.1305230110

Ekman, P. (1992). Facial expressions of emotion: an old controversy and new findings. *Philos Trans R Soc Lond B Biol Sci, 335*(1273), 63-69. doi: 10.1098/rstb.1992.0008

Ellenbogen, M. A., Linnen, A. M., Grumet, R., Cardoso, C., & Joober, R. (2012). The acute effects of intranasal oxytocin on automatic and effortful attentional shifting to emotional faces. *Psychophysiology, 49*(1), 128-137. doi: 10.1111/j.1469-8986.2011.01278.x

Esterman, M., & Yantis, S. (2010). Perceptual expectation evokes category-selective cortical activity. *Cereb Cortex, 20*(5), 1245-1253. doi: 10.1093/cercor/bhp188

Farah, M. J., Tanaka, J. W., & Drain, H. M. (1995). What causes the face inversion effect? *J Exp Psychol Hum Percept Perform, 21*(3), 628-634.

Fox, E., Lester, V., Russo, R., Bowles, R. J., Pichler, A., & Dutton, K. (2000). Facial Expressions of Emotion: Are Angry Faces Detected More Efficiently? *Cogn Emot, 14*(1), 61-92. doi: 10.1080/026999300378996

Gamer, M., Zurowski, B., & Buchel, C. (2010). Different amygdala subregions mediate valence-related and attentional effects of oxytocin in humans. *Proc Natl Acad Sci U S A, 107*(20), 9400-9405. doi: 10.1073/pnas.1000985107

Gauthier, I., & Curby, K. M. . (2005). A Perceptual Traffic Jam on Highway N170. Interference Between Face and Car Expertise. *Current Directions in Psychological Science, 14*(1), 30-33.

Gauthier, I., Tarr, M. J., Anderson, A. W., Skudlarski, P., & Gore, J. C. (1999). Activation of the middle fusiform 'face area' increases with expertise in recognizing novel objects. *Nat Neurosci, 2*(6), 568-573. doi: 10.1038/9224

Gordon, I., Zagoory-Sharon, O., Leckman, J. F., & Feldman, R. (2010). Oxytocin and the development of parenting in humans. *Biol Psychiatry, 68*(4), 377-382. doi: 10.1016/j.biopsych.2010.02.005

Goren, C. C., Sarty, M., & Wu, P. Y. (1975). Visual following and pattern discrimination of face-like stimuli by newborn infants. *Pediatrics, 56*(4), 544-549.

Grill-Spector, K., Knouf, N., & Kanwisher, N. (2004). The fusiform face area subserves face perception, not generic within-category identification. *Nat Neurosci, 7*(5), 555-562. doi: 10.1038/nn1224

Guastella, A. J., Carson, D. S., Dadds, M. R., Mitchell, P. B., & Cox, R. E. (2009). Does oxytocin influence the early detection of angry and happy faces? *Psychoneuroendocrinology, 34*(2), 220-225. doi: 10.1016/j.psyneuen.2008.09.001

Guastella, A. J., Einfeld, S. L., Gray, K. M., Rinehart, N. J., Tonge, B. J., Lambert, T. J., & Hickie, I. B. (2010). Intranasal oxytocin improves emotion recognition for youth with autism spectrum disorders. *Biol Psychiatry, 67*(7), 692-694. doi: 10.1016/j.biopsych.2009.09.020

Guastella, A. J., Mitchell, P. B., & Dadds, M. R. (2008). Oxytocin increases gaze to the eye region of human faces. *Biol Psychiatry, 63*(1), 3-5. doi: 10.1016/j.biopsych.2007.06.026
Hadjikhani, N., Kveraga, K., Naik, P., & Ahlfors, S. P. (2009). Early (M170) activation of face-specific cortex by face-like objects. *Neuroreport, 20*(4), 403-407. doi: 10.1097/WNR.0b013e328325a8e1
Hansen, B. C., Thompson, B., Hess, R. F., & Ellemberg, D. (2010). Extracting the internal representation of faces from human brain activity: an analogue to reverse correlation. *Neuroimage, 51*(1), 373-390. doi: 10.1016/j.neuroimage.2010.02.021
Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: an anger superiority effect. *J Pers Soc Psychol, 54*(6), 917-924.
Harris, A., & Nakayama, K. (2008). Rapid adaptation of the m170 response: importance of face parts. *Cereb Cortex, 18*(2), 467-476. doi: 10.1093/cercor/bhm078
Hasson, U., Hendler, T., Ben Bashat, D., & Malach, R. (2001). Vase or face? A neural correlate of shape-selective grouping processes in the human brain. *J Cogn Neurosci, 13*(6), 744-753. doi: 10.1162/08989290152541412
Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2002). Human neural systems for face recognition and social communication. *Biol Psychiatry, 51*(1), 59-67.
Haxby, J. V., Ungerleider, L. G., Clark, V. P., Schouten, J. L., Hoffman, E. A., & Martin, A. (1999). The effect of face inversion on activity in human neural systems for face and object perception. *Neuron, 22*(1), 189-199.
Heinrichs, M., Meinlschmidt, G., Wippich, W., Ehlert, U., & Hellhammer, D. H. (2004). Selective amnesic effects of oxytocin on human memory. *Physiol Behav, 83*(1), 31-38. doi: 10.1016/j.physbeh.2004.07.020
Heinrichs, M., von Dawans, B., & Domes, G. (2009). Oxytocin, vasopressin, and human social behavior. *Front Neuroendocrinol, 30*(4), 548-557. doi: 10.1016/j.yfrne.2009.05.005
Insel, T. R. (2003). Is social attachment an addictive disorder? *Physiol Behav, 79*(3), 351-357.
Ishai, A., Ungerleider, L. G., Martin, A., Schouten, J. L., & Haxby, J. V. (1999). Distributed representation of objects in the human ventral visual pathway. *Proc Natl Acad Sci U S A, 96*(16), 9379-9384.
Johnson, M. H. (2005). Subcortical face processing. *Nat Rev Neurosci, 6*(10), 766-774. doi: 10.1038/nrn1766
Johnson, M.H., & Morton, J. (1991). *Biology and cognitive development: The case of face recognition*. Oxford, England: Basil Blackwell.
Kanwisher, N. (2000). Domain specificity in face perception. *Nat Neurosci, 3*(8), 759-763. doi: 10.1038/77664
Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: a module in human extrastriate cortex specialized for face perception. *J Neurosci, 17*(11), 4302-4311.
Kanwisher, N., & Moscovitch, M. (2000). The cognitive neuroscience of face processing: an introduction. *Cogn Neuropsychol, 17*(1), 1-11. doi: 10.1080/026432900380454
Kanwisher, N., Tong, F., & Nakayama, K. (1998). The effect of face inversion on the human fusiform face area. *Cognition, 68*(1), B1-11.
Kriegeskorte, N., Formisano, E., Sorger, B., & Goebel, R. (2007). Individual faces elicit distinct response patterns in human anterior temporal cortex. *Proc Natl Acad Sci U S A, 104*(51), 20600-20605. doi: 10.1073/pnas.0705654104

Laeng, B., & Caviness, V. S. (2001). Prosopagnosia as a deficit in encoding curved surface. *J Cogn Neurosci, 13*(5), 556-576. doi: 10.1162/089892901750363163
Landgraf, R., & Neumann, I. D. (2004). Vasopressin and oxytocin release within the brain: a dynamic concept of multiple and variable modes of neuropeptide communication. *Front Neuroendocrinol, 25*(3-4), 150-176. doi: 10.1016/j.yfrne.2004.05.001
LeDoux, J. (1996). *The emotion brain*. New York: Simon & Schuster.
Leknes, S., Wessberg, J., Ellingsen, D. M., Chelnokova, O., Olausson, H., & Laeng, B. (2013). Oxytocin enhances pupil dilation and sensitivity to 'hidden' emotional expressions. *Soc Cogn Affect Neurosci, 8*(7), 741-749. doi: 10.1093/scan/nss062
Lewis, M. B., & Ellis, H. D. (2003). How we detect a face: A survey of psychological evidence. *International Journal of Imaging Systems and Technology, 13*(1), 3–7.
Liu, J., Li, J., Feng, L., Li, L., Tian, J., & Lee, K. (2014). Seeing Jesus in toast: Neural and behavioral correlates of face pareidolia. *Cortex*(53), 60-77.
Liu, J., Li, J., Zhang, H., Rieth, C. A., Huber, D. E., Li, W., . . . Tian, J. (2010). Neural correlates of top-down letter processing. *Neuropsychologia, 48*(2), 636-641. doi: 10.1016/j.neuropsychologia.2009.10.024
Loftus, G. R., & Masson, M. E. (1994). Using confidence intervals in within-subject designs. *Psychon Bull Rev, 1*(4), 476-490. doi: 10.3758/BF03210951
Marsh, A. A., Yu, H. H., Pine, D. S., & Blair, R. J. (2010). Oxytocin improves specific recognition of positive facial expressions. *Psychopharmacology (Berl), 209*(3), 225-232. doi: 10.1007/s00213-010-1780-4
Maurer, D., Grand, R. L., & Mondloch, C. J. (2002). The many faces of configural processing. *Trends Cogn Sci, 6*(6), 255-260.
McKone, E., Kanwisher, N., & Duchaine, B. C. (2007). Can generic expertise explain special processing for faces? *Trends Cogn Sci, 11*(1), 8-15. doi: 10.1016/j.tics.2006.11.002
Melcher, D., & Bacci, F. (2008). The visual system as a constraint on the survival and success of specific artworks. *Spatial Vision, 21(3–5)*, 347–362.
Mondloch, C. J., Segalowitz, S. J., Lewis, T. L., Dywan, J., Le Grand, R., & Maurer, D. (2013). The effect of early visual deprivation on the development of face detection. *Dev Sci, 16*(5), 728-742. doi: 10.1111/desc.12065
Moscovitch, M., Winocur, G., & Behrmann, M. (1997). What Is Special about Face Recognition? Nineteen Experiments on a Person with Visual Object Agnosia and Dyslexia but Normal Face Recognition. *J Cogn Neurosci, 9*(5), 555-604. doi: 10.1162/jocn.1997.9.5.555
Mur, M., Ruff, D. A., Bodurka, J., Bandettini, P. A., & Kriegeskorte, N. (2010). Face-identity change activation outside the face system: "release from adaptation" may not always indicate neuronal selectivity. *Cereb Cortex, 20*(9), 2027-2042. doi: 10.1093/cercor/bhp272
Nothdurft, H. C. (1993). Faces and facial expressions do not pop out. *Perception, 22*(11), 1287-1298.
O'Craven, K. M., & Kanwisher, N. (2000). Mental imagery of faces and places activates corresponding stiimulus-specific brain regions. *J Cogn Neurosci, 12*(6), 1013-1023.
Palermo, R., & Rhodes, G. (2007). Are you always on my mind? A review of how face perception and attention interact. *Neuropsychologia, 2007*(45), 75–92.

Paras, C. L., & Webster, M. A. (2013). Stimulus requirements for face perception: an analysis based on "totem poles". *Front Psychol, 4*, 18. doi: 10.3389/fpsyg.2013.00018
Rhodes, G., Tan, S., Brake, S., & Taylor, K. (1989). Expertise and configural coding in face recognition. *Br J Psychol, 80 (Pt 3)*, 313-331.
Riekki, T., Lindeman, M., Aleneff, M., Halme, A, & Nuortimo, A. (2013). Paranormal and religious believers are more prone to illusory face perception than skeptics and non-believers. *Applied Cognitive Psychology, 27*(27), 150-155.
Rieth, C. A., Lee, K., Lui, J., Tian, J., & Huber, D. E. (2011). Faces in the mist: illusory face and letter detection. *Iperception, 2*(5), 458-476. doi: 10.1068/i0421
Sagiv, N., & Bentin, S. (2001). Structural encoding of human and schematic faces: holistic and part-based processes. *J Cogn Neurosci, 13*(7), 937-951. doi: 10.1162/089892901753165854
Slaughter, V., Stone, V. E., & Reed, C. (2004). Perception of faces and bodies. Similar or different? *Current Directions in Psychological Science, 13*(6), 219-223.
Smith, M. L., Gosselin, F., & Schyns, P. G. (2012). Measuring internal representations from behavioral and brain data. *Curr Biol, 22*(3), 191-196. doi: 10.1016/j.cub.2011.11.061
Spillmann, L., & Ehrenstein, W.H. (2004). Gestalt factors in the visual neurosciences. In L. Chalupa & J. S. Werner (Eds.), *The Visual Neurosciences* (pp. 1573-1589). Cambridge: MA: MIT-Press.
Striepens, N., Kendrick, K. M., Hanking, V., Landgraf, R., Wullner, U., Maier, W., & Hurlemann, R. (2013). Elevated cerebrospinal fluid and blood concentrations of oxytocin following its intranasal administration in humans. *Sci Rep, 3*, 3440. doi: 10.1038/srep03440
Suzuki, S., & Cavanagh, P. (1992). Facial expression as an emergent feature in visual search. *Investigative Ophthalmology and Visual Science, 33*(4), 1355.
Suzuki, S., & Cavanagh, P. (1995). Facial organization blocks access to low-level features: An object inferiority effect. *Journal of Experimental Psychology: Human Perception and Performance., 21*, 901–913.
Tanaka, J. W. (2001). The entry point of face recognition: evidence for face expertise. *J Exp Psychol Gen, 130*(3), 534-543.
Tanaka, J. W., & Farah, M. J. (1993). Parts and wholes in face recognition. *Q J Exp Psychol A, 46*(2), 225-245.
Tanaka, J. W., & Farah, M. J. (2003). The holistic representation of faces. In M. A. P. G. R. (Eds.) (Ed.), *Perception of faces, objects, and scenes: Analytic and holistic processes* (pp. 53–74). Oxford, England: Oxford University Press.
Tanaka, J. W., & Sengco, J. A. (1997). Features and their configuration in face recognition. *Mem Cognit, 25*(5), 583-592.
Tsao, D. Y., & Livingstone, M. S. (2008). Mechanisms of face perception. *Annu Rev Neurosci, 31*, 411-437. doi: 10.1146/annurev.neuro.30.051606.094238
Vuilleumier, P. (2000). Faces call for attention: evidence from patients with visual extinction. *Neuropsychologia, 38*(5), 693-700.
Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure-ground organization. *Psychol Bull, 138*(6), 1172-1217. doi: 10.1037/a0029333
White, M.J. (1995). Preattentive analysis of facial expressions of emotion. *Cognition and Emotion*(9), 439-460.

Windhager, S., Slice, D. E., Schaefer, K., Oberzaucher, E., Thorstensen, T., & Grammer, K. . (2008). Face to face: The perception of automotive design. *Human Nature*(19), 331–346.

Yovel, G., & Kanwisher, N. (2004). Face perception: domain specific, not process specific. *Neuron, 44*(5), 889-898. doi: 10.1016/j.neuron.2004.11.018

Zhang, H., Liu, J., Huber, D. E., Rieth, C. A., Tian, J., & Lee, K. (2008). Detecting faces in pure noise images: a functional MRI study on top-down perception. *Neuroreport, 19*(2), 229-233. doi: 10.1097/WNR.0b013e3282f49083

Öhman, A. (2005). The role of the amygdala in human fear: automatic detection of threat. *Psychoneuroendocrinology, 30*(10), 953-958. doi: 10.1016/j.psyneuen.2005.03.019

Appendices

Appendix 1. A copy of the information the participants received regarding the study.

INSTRUCTIONS

Welcome to the study, and thank you for participating!

This is a research study to examine the role of the hormone oxytocin in healthy men and women. Oxytocin is a hormone that occurs naturally in the body, and is often found in particularly high concentrations in parents with young children. Rare side effects after oxytocin nasal spray might in seldom cases include headache and contractions of the uterus in women.

You can participate in the study if you are aged 18-55 years with normal or corrected vision (glasses, contact lenses or vision surgery).

You *cannot* participate if you are **pregnant** or breastfeeding.
We would like you to refrain from caffeine, nicotine and alcohol right before the experiment.

The study involves two visits of approximately two hours' duration at the Department of Psychology. At each visit you will be asked to self-administer six puffs from a nasal spray, three in each nostril, which either contains the active ingredient oxytocin or placebo (nasal spray without active substances). Then you will sit alone in a room in a waiting period of about 30-45 minutes, where you will be allowed to relax, read and go to the bathroom, but not to engage socially with someone else.

The experiment is divided into four short parts, which in total will take about 30-40 minutes. Instructions will be provided prior to each experiment.

You will be asked to sit as still as possible during testing, and preferably only move the eyes, but not the head. When the experiment starts, you will see instructions for the tasks on the computer screen, then a cross in one of the four corners of the screen, followed by a picture or movie of an object or nature. The photos and film clips will be shown only for a very short period, so you will have to pay attention.

Practical:

You will be presented written and oral information about the study, and we will try to answer any questions you might have. You will also be asked for your written consent to participate. Then you will be presented a prebriefing form, which we would like you to fill out.
After you have conducted the experiments on day two you will have a debriefing with the experimenter. Finally, you will fill out a fee form that ensures you get paid for your participation.

This is an anonymous survey, which means that no unauthorized persons can track the data or information back to the participant.

Good Luck!

Appendix 2. Prebriefing questionnaire regarding participants' knowledge about oxytocin.

Candidate No:

Date:

Prebrifing Questionnaire
(before session 1)

Please mark how much you 'agree' or 'disagree' with the statements below by placing a mark on the line.

Oxytocin makes you more interested in other people (RP)

Agree _____ Disagree

Oxytocin reduces your warm feelings for other people (CNP)

Agree _____ Disagree

Oxytocin makes you easily fall in love (CPP)

Agree _____ Disagree

Oxytocin can lead to increased jealousy (CPN)

Agree _____ Disagree

Oxytocin makes other people seem less nice (RN)

Agree _____ Disagree

Oxytocin can make you feel happy (CNN)

Agree _____ Disagree

IF YOU ARE <u>FEMALE</u>:

1. ARE YOU USING A CONTRACEPTIVE PILL? Yes ___ No ___

2. How many days have passed since the *<u>first day</u>* of your *last period*? ___

Appendix 3. Debriefing questionnaire presented at the end of the study.

Candidate No:

Date:

Debrifing Questionnaire
(after session 2)

Why did you want to participate in this study?
How did you experience being part of this study?
What do you think is the reason behind the study?
When do you think you got placebo and when did you get oxytocin (Specify why)?
Did you experience any side effects after the study?
Any other comments?

Appendix 4. Checklist, day 1 of the study.

CHECKLIST

Session number:

Saved as:

DAY 1 IN ADMINISTRATION ROOM:

1. Information, questions and consent form ☐
2. Name of participant_____ Date of birth_____
3. Gender___ Days since last menstruation_____ Contraceptive pill_____

4. Prebriefing with VAS scale ☐
5. Present tissues before presenting spray ☐
6. Time of intranasal administration _____ Write details of spray on back of sheet ☐

DAY 1 IN EXPERIMENTAL ROOM, EXPERIMENT 1:

7. Start up SMI Experiment Center and iVewX (250Hz) ☐
8. Put participant in front of eye tracker, cheek and forehead on headrest. ☐
9. Open 'Pareidolia experiment (1A, 1A_Rev, 2B, 2B_Rev). ☐
10. Lock & Record, and give participant the right trial number from Excel sheet. ☐
11. Calibration & Validation (values below 0.5). ☐
12. Instruct participant to look for 'faces' and answer with B or N + answer question. ☐
13. After ended experiment, 'Save' experiment. ☐
14. In addition: 'File' -> 'Save as' (candidate number & session) on memory stick. ☐

15. DEBRIEFING day 1:
    a. Ask if they thought they got oxytocin or placebo; ask them to indicate level of certainly on a scale from 0 to 10 where 0 is completely uncertain and 10 is completely certain:

       0 1 2 3 4 5 6 7 8 9 10

    b. Ask how they feel or if they experienced anything out of the normal:

       _____

       _____

16. Book/confirm new appointment with candidate for session 2:

    a. Date: _____ Time: _____

    b. Email: _____ Phone: _____

1

Appendix 5. Checklist, day 2 of the study.

CHECKLIST

Session number:

Saved as:

DAY 2 IN ADMINISTRATION ROOM:

1. Present tissues before presenting spray ☐
2. Time of intranasal administration _____ Write details of spray on back of sheet ☐

DAY 2 IN EXPERIMENTAL ROOM, EXPERIMENT 1:

3. Start up SMI Experiment Center and iVewX (250Hz) ☐
4. Put participant in front of eye tracker, cheek and forehead on headrest. ☐
5. Open 'Pareidolia experiment (1A, 1A_Rev, 2B, 2B_Rev). ☐
6. Lock & Record, and give participant the right trial number from Excel sheet. ☐
7. Calibration & Validation (values below 0.5). ☐
8. Instruct participant to look for 'faces' and answer with B or N + answer question. ☐
9. After ended experiment, 'Save' experiment. ☐
10. In addition: 'File' -> 'Save as' (candidate number & session) on memory stick. ☐

11. DEBRIEFING:
    a. Ask if they thought they got oxytocin or placebo; ask them to indicate level of certainly on a scale from 0 to 10 where 0 is completely uncertain and 10 is completely certain:

       0 1 2 3 4 5 6 7 8 9 10

    b. Ask how they feel or if they experienced anything out of the normal:

       _____

       _____

AFTER SESSION 2:

12. Do debriefing questions. ☐
13. Make candidate fill in 'Honorar' form with all the information. ☐

Appendix 6. Fee form.

UiO b.nr.:

HONORAR – AVTALE OG UTBETALING

Etternavn	**Fornavn**	**fødselsnummer / fødselsdato** (utlendinger uten norsk personnummer)
Privatadresse	Postnummer og sted	
Kjønn: M / K	Statsborgerskap:	
Bankkonto: Bare ved første utbetaling eller endring. Ved betaling til utlandet må eget vedleggsskjema benyttes.		

Avtale om honorar

Oppdraget består av: Deltakelse i forskningsprosjektet (kun nummer – IKKE navn) ……..……

Oppdraget honoreres med kr. _____

Dato: _____

.

dato	underskrift deltaker	dato	underskrift UiO

Lønnsutbetaling til én person som ikke overstiger 1.000 kroner fra én oppdragsgiver i løpet av et inntektsår, er skattefri for mottakeren. Dersom det tidligere i inntektsåret er utført oppdrag for UiO medfører dette skattetrekk på honoraret.

Er skattekort levert? ☐ Ja ☐ Nei (medfører 50% skattetrekk) ☐ Fritak pga beløp under 1000 kr

Kontering Artskonto	Sted	Prosjekt	Tiltak	**Antall**	**Sats**	**Beløp**
5112						
Attestasjon	Dato	Attestasjonsmyndighet			Telefon/e-post	Sum
Anvisning	Dato	Budsjettdisponeringsmyndighet				

Appendix 7. Consent form, page 1 (of 4).

Hormonet oxytocins rolle for sosial berøring – Hoveddel – 25.05.09

Forespørsel om deltakelse i forskningsprosjektet

"Hormonet oksytocins rolle for sosial oppgaveløsing"

Bakgrunn og hensikt
Dette er et spørsmål til deg om å delta i en forskningsstudie for å undersøke rollen hormonet oksytocin spiller for mellommenneskelig oppgaveløsing. Forsøket undersøker oksytocins rolle hos friske, voksne menn og kvinner. Oksytocin er et hormon som finnes naturlig i kroppen, og som ofte finnes i ekstra høy konsentrasjon hos foreldre med små barn. For å forstå sammenhengen mellom oksytocin, følelser og hjerneaktivitet har vi laget et forskningsprosjekt der vi vil høyne nivået av oksytocin ved hjelp av en nesespray. Det er frivillig å delta i forskningsprosjektet og du kan når som helst trekke deg uten å oppgi noen årsak. Dersom du ønsker å delta, vil vi måle hjerneaktiviteten din eller pupillstørrelse samtidig som du gjør oppgaver. Ansvarlig for forsøket er Universitetet i Oslo, ved Psykologisk Institutt.

Hva innebærer studien?
Studien innebærer to besøk av ca. to timers varighet, ved Psykologisk Institutt eller på Rikshospitalet. Ved hvert besøk vil du bli bedt om å fylle inn noen skjemaer med spørsmål om hvordan du har det nå (humør) og om hvordan du er (personlighet). Videre vil du ved hvert besøk bli bedt om å selv administrere opptil ti sprut av en nesespray som enten inneholder virkestoffet oksytocin, eller placebo (nesespray uten aktive virkestoffer). 30 min etter nesespray begynner selve forsøket, som handler om oppgaveløsing. Du vil få se bilder av ansikter av voksne og/eller barn, dyr osv.. Forsøkene vil finne sted enten ved Psykologisk Institutt (pupillmåling). Mer informasjon om pupillmåling og oksytocin nesespray finnes i vedlegg A.

Mulige fordeler og ulemper
En mulig fordel med å delta i denne studien er at du kan hjelpe til med å fremme forskning og kunnskapsnivået rundt mellommenneskelig oppgaveløsing. Mulige ulemper for deg som deltager i studien er midlertidig ubehag i forbindelse med fMRI-opptak (opptaket lager en del støy som kan være ubehagelig, og det trange rommet inne i maskinen kan oppleves som ubekvemt) eller oksytocin nesespray (sjeldne bivirkninger inkluderer hodepine og kontraksjoner av uterus hos kvinner).

Hva skjer med informasjonen om deg?
Informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger gjennom en navneliste.
Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Disse opplysningene slettes ved prosjektets slutt 01.07.2016.
Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Frivillig deltakelse
Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for din videre behandling. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det påvirker din øvrige behandling. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte Siri Leknes på 22845203.

Hormonet oxytocins rolle for sosial berøring – Hoveddel – 25.05.09

Ytterligere informasjon om studien finnes i kapittel *A* *– utdypende forklaring av hva studien innebærer.*
Ytterligere informasjon om biobank, personvern og forsikring finnes i kapittel B *– Personvern, biobank, økonomi og forsikring.*

Samtykkeerklæring følger etter kapittel B.

Hormonet oxytocins rolle for sosial berøring – Kapittel A og B – 25.05.09

Kapittel A- utdypende forklaring av hva studien innebærer

Oksytocin nesespray
Oksytocin nesespray er godkjent i Norge, andre europeiske land og i USA som et hjelpemiddel for amming. Intranasal oksytocin-behandling er forbundet med noen sjeldne bivirkninger, men ettersom behandlingen i dette studiet er begrenset til en enkelt dose forventes eventuelle bivirkninger å være kortvarige og av mild intensitet. Sjeldne bivirkninger av oksytocin nesespray (Syntocinon) er: hodepine, kvalme, og allergisk dermatitt. Mindre vanlige bivirkninger er kontraksjoner av uterus som kan være smertefulle. Andre studier som har benyttet samme teknikk har ikke funnet negative bivirkninger hos friske forsøkspersoner. Vi vil likevel legge vekt på at du kun bør delta i studien dersom du er helt sikker på at du ikke er gravid, og vil tilby frivillig graviditetstest dersom dette er ønskelig.

Pupillmåling
Pupillmåling er et vanlig mål i psykologiske undersøkelser, og er helt ufarlig. Vi bruker spesialutstyr som måler pupillstørrelsen automatisk mens du ser på bilder eller under berøring. Pupillens utvidelse gir oss en pekepinn på aktivitet i det sympatiske nervesystemet.

Dersom du ønsker å delta i studien
Deltagere bør være friske og i alderen 18-55 år. Du kan ikke være gravid. Dersom du melder deg frivillig til å delta i studien kan du likevel når som helst trekke deg fra studien uten å oppgi grunn. Forsøket består av to besøk av ca. to timer på to forskjellige dager. Det kan være aktuelt med kompensasjon for reiseutgifter og eventuell tapt arbeidsinntekt.

Kapittel B - Personvern, biobank, økonomi og forsikring

Personvern
Opplysninger som registreres om deg er kun navn, alder, kontaktdetaljer og data som samles inn i løpet av studien. Disse opplysningene er kun tilgjengelige for medarbeiderne som er direkte knyttet til studien.
Psykologisk Institutt (Universitetet i Oslo) ved administrerende direktør er databehandlingsansvarlig.

Rett til innsyn og sletting av opplysninger om deg og sletting av prøver
Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi og Universitets rolle
Studien er finansiert gjennom forskningsmidler fra Universitetet i Oslo. Det finnes ingen føringer eller potensielle økonomiske eller forskningsrelaterte interessekonflikter i forhold til denne finansieringen.

Forsikring
Universitetet i Oslo er selv-assurerende.

Informasjon om utfallet av studien
Som deltaker har du rett til å få informasjon om utfallet/resultatet av studien.

Hormonet oxytocins rolle for sosial berøring – Kapittel A og B – 25.05.09

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Stedfortredende samtykke når berettiget, enten i tillegg til personen selv eller istedenfor

---

(Signert av nærstående, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)