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REVIEW ARTICLE

# Facial expression of fear in the context of human ethology: Recognition advantage in the perception of male faces

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**Abstract**

Facial expression is one of the core issues in the ethological approach to the study of human behaviour. This study discusses sex-specific aspects of the recognition of the facial expression of fear using results from our previously published experimental study. We conducted an experiment in which 201 participants judged seven different facial expressions: anger, contempt, disgust, fear, happiness, sadness and surprise (Trnka *et al.* 2007). Participants were able to recognize the facial expression of fear significantly better on a male face than on a female face. Females also recognized fear generally better than males. The present study provides a new interpretation of this sex difference in the recognition of fear. We interpret these results within the paradigm of human ethology, taking into account the adaptive function of the facial expression of fear. We argue that better detection of fear might be crucial for females under a situation of serious danger in groups of early hominids. The crucial role of females in nurturing and protecting offspring was fundamental for the reproductive potential of the group. A clear decoding of this alarm signal might thus have enabled the timely preparation of females for escape or defence to protect their health for successful reproduction. Further, it is likely that males played the role of guardians of social groups and that they were responsible for effective warnings of the group under situations of serious danger. This may explain why the facial expression of fear is better recognizable on the male face than on the female face.

## INTRODUCTION

Facial expression is one of core issues in the ethological approach to the study of human behaviour (Eibl-Eibelsfeldt 1989; Klein 2000). Human ethologists and behavioural ecologists understand facial expressions as social signals or social tools that facilitate social interactions (Fridlund 1994). They are a kind of social releasers, because their main function is to communicate information from one individual to another (e.g. Plutchik 1980). Different types of facial expressions form cooperative signalling systems that bring benefits to the expressers as well as to the recipients (Schmidt & Cohn 2001).

Other scholars understand facial expressions more as emerging instrumental actions, action tendencies, or behavioural tendencies (Jakobs *et al.* 1997). This approach is based on the assumption that each element of behaviour is potentially informative and provides recipients who know the importance of this behaviour with information about what is likely to occur in the next phases of interaction (van Hooff 1981). Facial movements communicate the internal states of the expressers and indicate their subsequent behaviour to some extent (Plutchik 1980). This function allows participants in a social interaction to adapt their behaviour appropriately, e.g. to avoid conflict or facilitate mating behaviour.

## RECOGNITION OF HUMAN FACIAL SIGNALS

Facial processing covers plenty of areas like brain reactivity in response to viewing emotional faces (Zhang *et al.* 2011), lateralization of facial processing (De Winter *et al.* 2015; Bourne 2011), temporal characteristics of facial-emotion processing (Utama *et al.* 2009), mother's brain activation to infant's facial expressions (Strathearn *et al.* 2009; Strathearn *et al.* 2010), or recognition of facial expressions in people with mental disorders (Binelli *et al.* 2014; Thomas *et al.* 2014). One of paradigmatic research questions is: how are people able to distinguish individual facial expressions and what factors may influence recognition accuracy? Gaspar (2001) believed that understanding facial expressions is one of the oldest communication skills in human society, and the work of Paul Ekman suggested that some facial expressions are recognized across various cultures (Ekman *et al.* 1982; Ekman & Friesen 1986). These basic facial expressions are anger, contempt, disgust, happiness, sadness, surprise and fear. The problem of facial expressions of contempt is contentious, because there are arguments to include it among basic facial expressions as well as arguments against.

How are various facial configurations of the human face processed? The human brain has a specific part which has substantial influence on the processing of human faces and changes in the configuration of facial elements. The *gyrus fusiformis* (FFA, fusiform face area) is activated when participants process visual stimuli, included faces or facial expressions (Koukolik 2007). The level of activation is higher than in cases when processing non-facial stimuli. The function of the *gyrus fusiformis* is domain-specific (Rhodes *et al.* 2004). This means that this neuro-anatomical structure is specialized for the processing of human faces and facial expressions.

Let's turn our attention to the underlying cognitive mechanism that is responsible for processing human faces and changes in the configuration of facial elements. The human cognitive system processes presented faces using several functional components (Bruce & Young 1986). Analysis of the configuration of facial features and analysis of facial speech are present in the early stage of face processing, during so-called "structural encoding". The meaning of a seen configuration of facial features is derived during expression analysis, which is based on the experiences stored in the semantic memory. Expression-independent descriptions are further used for a face-recognition unit. Each face-recognition unit contains stored structural codes describing one of the faces known to a person. The cognitive system analyzes the resemblance of a seen face to the stored descriptions. Person recognition is supported by identity-specific semantic codes held in the associative memory, the so-called "person identity nodes" (Bruce & Young 1986).

It is reasonable to expect that facial morphology may influence the processing of human facial expressions. Our cognitive system is able to clearly distinguish if the observed face is male or female. From this position, one may ask how the sex of the expresser influences recognition accuracy for facial expressions. This was also the challenge for our previous study. We conducted an experiment in which 201 participants judged seven standardized facial expressions: anger, contempt, disgust, fear, happiness, sadness and surprise (Trnka *et al.* 2007). Photographs of facial expressions were presented using a data-projector on the projecting screen in the experimental room while participants judged individual facial expressions of emotion. The number of male and female faces in this study was the same. Regardless of gender, respondents did not recognize facial expressions more easily on female faces than on male faces. However, the facial expression of fear was recognized significantly more easily on male faces than on female faces. There were no significant interactions between the sex of expresser and the other specific emotions – anger, contempt, disgust, happiness, sadness and surprise – in the above-mentioned study. Females recognized the facial expression of fear in 90% of the male faces shown, and males recognized the same expression in 80% of the male faces shown. In the case of perception of the female facial expression of fear, the recognition accuracy was 69% for female perceivers and 62% for male perceivers. Ex-post chi-square tests revealed that females also recognized the facial expression of fear

significantly better than males (Trnka 2006). The question is: why was only the facial expression of fear better recognized on the male face than on the female face?

## ADAPTIVE SIGNIFICANCE OF FEARFUL FACIAL SIGNALS

Human ethology traditionally seeks explanations for the function of communication signals in their significance for survival of the individual or social group. Fear is the primordial emotion within the fight-flight system (Keltner & Haidt 2001) with a specialized neural mechanism for the perception of fearful facial signals (Santos *et al.* 2008). Fear activates the individual to avoid death by predation or serious physical attacks. In contemporary humans, fear may be related to a specific trigger, for example, pain-related fear (Raudenska *et al.* 2013).

The interconnection of physiology and behaviour has been reported by studies in various fields of neuroendocrinology (e.g., Fischer-Shofty *et al.* 2010; Putman *et al.* 2007). The amygdala contains specialized areas that scan incoming sensory information for patterns that may be associated with potential danger (Mattavelli *et al.* 2014; Betz *et al.* 2013; Adams *et al.* 2010). This cue may also be a fearful facial expression of another member of a social group (Vuilleumier & Schwartz 2001; Pourtois *et al.* 2004). The reaction of the amygdala is very quick. The amygdala can trigger a fear response even before the incoming information has been sent to the occipital cortex for full cognitive processing (LeDoux 1996). When an individual experiences fear, the hypothalamic-pituitary-adrenocortical axis pumps a quick dose of cortisol and other stress hormones into the bloodstream and these prepare the organism for fight or for flight.

Wu *et al.* (2012) pointed out that individuals behave on the basis of identifying others' facial expressions. Correct recognition of a facial display reflects good discriminability within a given species according to animal communication theory (Rowe 1999). Signals designed to stimulate other group members to escape should be clear, with high discriminability. The facial expression of fear probably informed other members of the group about serious threats and dangers in early hominids; that is, it worked as a kind of alarm signal (Figure 1).

Our previous experiment revealed that there are some sex-specific differences in decoding the facial expression of fear. Females recognized the facial expression of fear significantly better than males. The question is: why does the fearful facial expression have this recognition advantage in females? The importance of clear recognition of fear was probably very high for females in the human past, and we can turn our attention to the reproductive significance of females in the social groups of early hominids.

The crucial role females play in nurturing and protecting offspring is fundamental for the reproductive potential of the whole group. Reproduction is a fundamental factor for species survival, and the good health of females is a key precondition for successful mating. The maintenance of good female somatic and psychological health was also very important for quality investment in any existing offspring.

Taking all of these matters together, it is reasonable to hypothesize that quick a clear recognition of a fearful alarm signal (van Heijnsbergen *et al.* 2007) was more important for females than for males. Under a threatening situation, females should quickly and correctly detect a fearful alarm signal to initiate an adequate behavioural reaction, for example to escape. The study of Schwabe *et al.* (2013) revealed also different effects of stress mediator noradrenaline on fear processing in men and women. The potential impacts of situations in which a perceiver fails to recognize an alarm signal would be very high (for example serious injury or death). This is one of the explanations for why females recognized the facial expression of fear significantly better than males in our previous study.

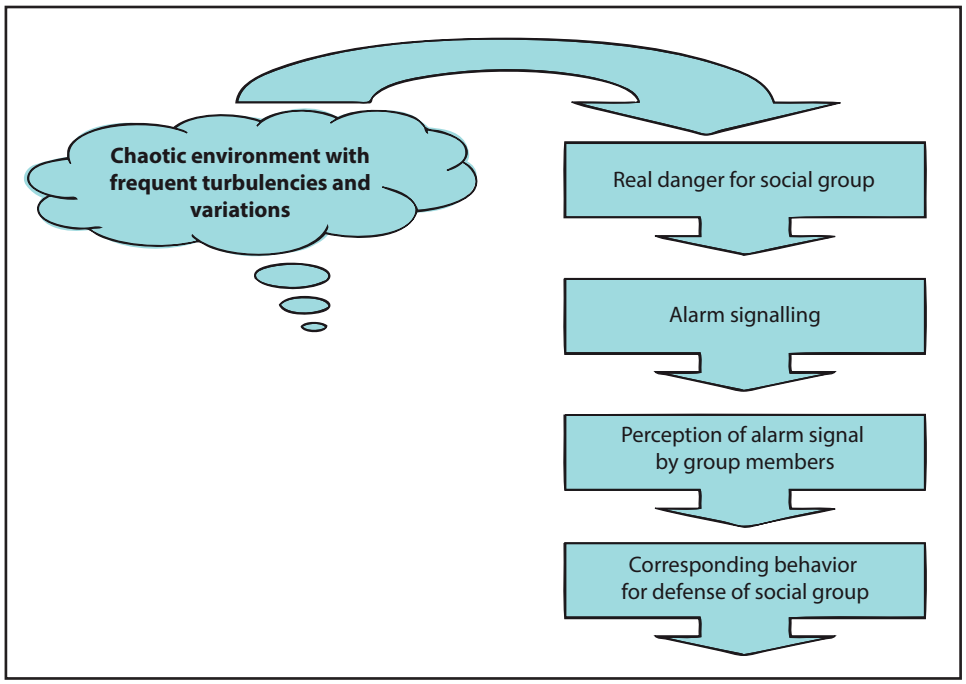


**Fig. 1.** General schema of alarm signalling.

However, the facial expression of fear was also recognized significantly more easily on a male face than on a female face. It is not likely that this advantage is caused by more expressive facial behaviour of males. Indeed, previous experimental research has indicated that females are generally considered to be more emotionally expressive than males (Gross *et al.* 2000; Hall *et al.* 2000), with more expressive faces than males (Shields 1991). Therefore, we should seek another explanation.

It is likely that males played the role of guardians of the social unit in early hominid evolution because of their more sturdy physical constitution. Males should detect potential danger and inform other members in the group. Therefore, it is hypothesized that alarm signals were probably produced more often by males than by females. For this reason, the facial configuration of fear might be better recognizable on male faces.

There are also processes that might accompany the communication of a fearful signal between members of the social group. Affective resonance, emotional contagion, facial mimicry or the so-called "Chameleon Effect" – all these concepts are names relating to the same effect in social interaction. People reflexively mimic facial movements in response to the perception of such states in other people (Gump & Kulik 1997). In the case of facial expressions, the recipient simultaneously and symmetrically mirrors the emotional expression of another person (Dimberg *et al.* 2000), which induces him or her into a very similar emotional state. This reflexive and unconscious imitation may lead directly to physiological changes that cause an emotional state similar to that being experienced by the interacting partner. This is an automatic process that does not depend on the simultaneous processing of intended goals during the interaction. It makes affective resonance a very powerful mechanism for passive transmission of emotional information, which facilitates the sharing of feelings and behaviours in socially living mammals.

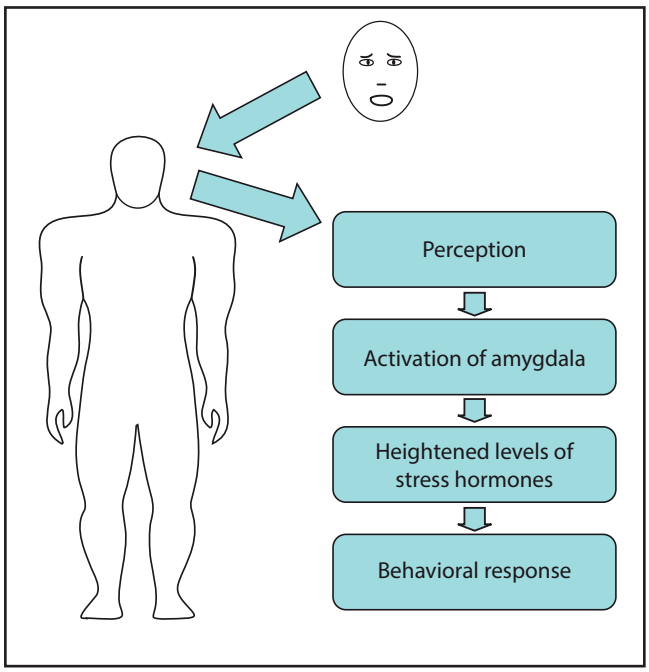


**Fig. 2.** Neuroendocrinological responses to fearful facial signal.

Scholars have assumed that the cause of emotional contagion is closely related to the individual facial feedback effect (Blairy *et al.* 1999). Individual facial feedback means that changes in facial configuration also cause changes in the emotional state of the individual. Proprio-receptive feedback of the face depends on the level of activity of facial muscles. People pretending the facial expression of some emotion tend to experience that particular emotion. Specific muscle contractions present in the facial expression of fear and sadness induced a similar emotional experience in the experiment of Blairy *et al.* (1999).

Emotional contagion and individual facial feedback framed the function of fearful facial expression as an alarm signal. We may expect that these processes were also present in the minds of our ancestors in the past. Male guardians produced alarm signals under a situation of serious danger in a group of early hominids. The alarm signals were seen and then re-produced by other group members, eliciting similar physiological changes in them. When taking into account the hypothalamic-pituitary-adrenocortical axis that pumps out a quick dose of cortisol and other stress hormones in a situation when an individual experiences fear, we may expect the complex system of fearful signalling to be very effective (Figure 2). Such kind of physiological changes is situation-focused and this link between physiology and behaviour is different than in the case of physiological changes relating with stable personal dispositions (Galecki *et al.* 2013). Good discriminability of the facial expression of fear with the work of emotional contagion and individual facial feedback represent an adaptive feature for mobilizing the whole group under the situation of serious danger. Clear informing of group members about actual threats might constitute the basis for an effective defence of the group and survival of the species.

Current research provides further arguments implicitly supporting the above-mentioned interpretations of sex differences in the perception of facial expression of fear. Archer (2009) discussed greater risk-taking by males and greater fear of physical danger by females in relation to sexual selection and sex differences in aggression. Females are more prone to avoid serious physical conflicts because of their reproductive role. Archer (2009) suggested that these factors represent the way the motivational system underlying aggression responded to evolutionary costs and benefits. Although heightened sensitivity for fearful signals is considered maladaptive (Williams *et al.* 2007), the costs of failure in the detection of the true facial signal of fear might have a detrimental effect for individuals in groups of early hominids. Fear and risk-taking seem to be very impor-

tant variables when discussing the function of communication signals and their evolutionary significance.

## CONCLUSIONS

Human nonverbal perceptual abilities were shaped over thousands and thousands of years during the course of evolution of the human brain. We used the theoretical background of human ethology for a better understanding of sex differences in perception of facial expressions. The ethological paradigm has, however, some limitations when searching for evolutionary origins of human behaviour. For example, it is difficult to imagine how our ancestors communicated, because fossils provide us with only limited information about patterns of communication. Recent human social interactions are accessible for empirical investigation; however, we cannot approach the patterns that emerged in the early stage of human evolution directly. Reconstructions of the communication of early hominids are, therefore, mostly based on the hypothetical thinking and on parallels with recent species.

Further, the ethological approach is mostly focused on the evolutionary context of communication signals and on the relationship to survival of the individual or social group. However, current research also stresses developmental influences on shaping the human mind (Hruby *et al.* 2013). Gender-specific aspects of a newborn's interactions with the mother as well as further socialization in the family and peer-groups may be crucial for the development of, for example, the different attention to facial behaviour in males and females during their development. Such gender-specific learning of nonverbal signal decoding is suggested as another important factor possibly influencing the different recognition of fear in males and females.

This study provides several insights into the complexity of human communication systems. We utilized an ethological approach, focusing our attention on the problem of sex-specific patterns in decoding the facial expression of fear. Participants in our previous study were able to recognize the facial expression of fear better on a male face than on a female face. Females also recognized fear generally better than males. We argue that one possibility is to consider the adaptive function of the fearful facial expression. Detection of fear as an alarm signal might be crucial for females to protect their health from the viewpoint of their reproductive function in groups of early hominids. On the other hand, it is likely that males played the role of guardians of the social group in early hominid evolution, which explains why the facial expression of fear is better recognizable on the male face than on the female face. The theoretical basis provided by the present study may inspire future ethological research of human communication and bring a new interpretative framework for experimental research on the recognition of facial expressions.

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