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The Devil is in the Details – the Meanings of Faces and How They Influence the Meanings of Facial Expressions

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1. Introduction

Facial expressions have a primary role in signaling emotional states. As such they are an important source of information in social interactions and have been the focus of a large body of research in psychology and allied disciplines. This research has been drawn upon extensively in the creation of avatars and computer controlled agents in order to facilitate human-machine interactions. A great deal of effort has gone into attempting to translate the temporal and pattern features of human emotional expressions into a credible computer generated display. However, what has been ignored in this process is the fact that faces and facial movements provide other information in addition to the apparent emotional state of the individual. Specifically, facial expressions also signal behavioral intentions - such as intentions to approach or to avoid - as well as personality characteristics of the person such as dominance and affiliativeness. For example, anger signals dominance and an intention to approach, whereas fear signals submissiveness and an intention to withdraw. In this sense facial expressions not only provide information on what emotion a person is feeling, but also tell us about who a person is and what to expect from them behaviorally.

It is also important to note that a great deal of socially relevant information is transmitted via other cues directly linked to the face, in particular by physiognomy and gaze direction. Because these cues serve as the immediate context for facial expressions they can plausibly affect the interpretation we give to the facial movement. Stereotypic beliefs elicited by facial appearance, such as beliefs that men are more likely to show anger and women more likely to smile, also can impact our interpretation of expressions. It is our view that gaze, physiognomy and emotion expressions use a shared signal system in which some signals are functionally equivalent whereas others serve to reinforce each other. This means that certain combinations of expressive, gaze and physiognomic cues present a coherent message and reinforce each other, whereas others may conflict or contradict each other. Put another way, the face on which emotional expressions appear is not an empty canvas, rather, as

noted above, it serves as the context within which the expression occurs and modulates the meaning of that expression.

This chapter will review and elaborate upon recent findings from research on human-human interaction. These studies demonstrate that supposedly 'tangential' aspects of an emotional signal such as eye gaze and the type of face that shows the expression can affect the perceived meaning of the expression. A central implication of this research is that the implementation of believable emotional facial expressions on avatars or other quasi-human forms will require more than just the creation of appropriate facial movement patterns. Rather, we hope to demonstrate that it is important to consider the facial appearance of the agent and the types of beliefs that people unconsciously associate with the appearance of any particular agent since these may serve to bias their perceptions of and reactions to the simulated emotional displays on the part of the agent.

2. Emotions in human computer interaction

Individuals spend more and more of their work or leisure time interacting with computers and computer controlled machines. Humans tend to treat computers in these interactions largely as they would treat humans (Reeves & Nass, 1996) and this has led to demands to make human-computer interfaces more realistically sociable. In this framework computer agents and robots have been designed that can interpret human emotions and, importantly, also signal emotions via facial expressions (e.g., Breazeal, 2003; Koda & Maes, 1996; Pelachaud & Bilvi., 2003). However, research on human-human interaction suggests that this very attempt at naturalness may mean that an agent may fail to convey the intended message because of the way it looks and the biases in perception and interpretation that this may entrain. Specifically, the human receiver is not a passive receptacle for emotion information. Rather humans actively decode this information and in this process use information other than the facial movement associated with specific expressions. One of these sources is the very face on which these expressions appear. As noted above, this implies that the relatively static appearance of the face is not an empty canvas but rather "actively" contributes to emotion communication. In what follows we will present findings from human-human interaction that demonstrate the importance of such seemingly incidental information on the decoding of emotion expressions.

3. The face and the decoding of emotions

When we see the emotional facial expressions of others we are usually able to attach some label to these, such as "he looks sad", or "she looks happy." This decoding process can be based on either or both of two important sources of information: the sender's emotion displays and the perceiver's knowledge about the sender (Kirouac & Hess, 1999). It is with regard to this second source of information that the cues present in the face in addition to movement patterns becomes critical.

Emotion displays are often quite ambiguous (Motley & Camden, 1988) and even if they seem quite clear need to be put into a context. For example, a given expression of happiness in a person we know to be very gregarious may be interpreted as suggesting less happiness than would the same expression when shown by a person known to be very socially shy.

If the sender and the receiver know each other well, the receiver usually is aware of the sender's personality, beliefs, preferences, and emotional style. This knowledge then permits the receiver to take the perspective of the sender and to deduce which emotional state the sender most likely experiences in the given situation. But what happens when we do not know the other person well?

Studies in which people are asked to judge the likely personality of complete strangers show that people can and do draw conclusions about a person's personality from no more information than is provided by the face, even though accuracy varies widely and is dependent on both encoder and decoder personality (e.g., Ambady et al., 1995). Yet more importantly, faces tell us the social categories into which our interaction partner fits. That is, faces tell us the sex, age, and race of the other person and this knowledge can be used by observers to predict the likely emotional reaction of the sender.

More recently, it has become obvious that facial expressions and knowledge or beliefs about the expresser are not the only sources of information that people use. In fact, gaze direction has to be added to the list of cues that need to be taken into account.

4. Gaze and emotion

Gaze direction has traditionally not been considered to be part of the emotional expression itself (see Fehr & Exline, 1987). Direct gaze was seen to play an important role only for the perception of the intensity of the emotion but not of it's quality (Argyle & Cook, 1976; Kleinke, 1986). And indeed, nearly all expression decoding studies have used stimuli where the encoders' gaze is directed at the perceiver. However, a set of recent studies by Adams and his colleagues and others (Adams et al., 2003; Adams & Kleck, 2003, 2005; Ganel et al., 2005; Graham & LaBar, 2007; Hess et al., 2007) serves to illustrate the important role that gaze plays in the social communication of emotions. Their specific interest was the role that gaze direction might play in the decoding of emotion expressions. They argued that the direction of a person's gaze points to the likely object of the expresser's emotion and should also be related to the intention of the expresser. And in fact, happiness and anger, which are approach emotions, tend to be expressed with direct rather than averted gaze. Conversely, emotions associated with a tendency to withdraw, such as embarrassment and sorrow, tend to be communicated more often with averted gaze (see e.g., Argyle & Cook, 1976; Fehr & Exline, 1987). References to looking behavior are also commonly used in our lexicon to describe different emotional states (e.g., downcast eyes to describe someone who is sad).

In this vein, Adams and Kleck (2003; 2005) found that direct gaze facilitates the processing of facially communicated approach-oriented emotions (e.g., anger and joy), whereas averted gaze facilitates the processing of facially communicated avoidance-oriented emotions (e.g., fear and sadness). This interaction between perceived emotion and gaze direction has also been demonstrated on the neural level (Adams et al., 2003).

Together, the studies published by Adams and his colleagues support the *shared signal hypothesis,* demonstrating that the gaze direction of the encoder can affect the efficiency with which a given display is processed as well as determine the quality of the emotion that will be perceived in a blended or ambiguous expression. They argue that when different facial cues such as the specific expression and the direction of gaze share the same signal value (e.g., approach or avoidance) the shared signal facilitates overall processing efficiency.

Similar findings were obtained for head position which was found to strongly influence reactions to anger and fear but less so in the case of sadness and happiness. For example, direct anger expressions were more accurately decoded, perceived as less affiliative, and elicited higher levels of anxiousness and repulsion, as well as less desire to approach than did head averted anger expressions (Hess, Adams et al., 2007).

However, the role of gaze seems to be a bit more complicated. Gaze direction does not only provide emotional information in the sense described above, but also has an indirect influence on emotion processing by influencing attention allocation. Specifically, direct gaze attracts attention to a larger degree than does averted gaze. In sum, the meaning of facial expressions can be clarified or obscured by gaze direction. An angry expression with gaze directed at me will lead me to think that I am the object of the anger and elicit corresponding emotions. Conversely, a fear expression directed to a point behind me will lead me to think that a dangerous object is behind me. As people – and computer agents – tend to move their heads when interacting with others, mismatches between facial and gaze signals can give rise to misunderstandings or ambiguously encoded emotional signals.

5. Beliefs about emotions

As noted above, facial expressions and gaze direction are not the only sources of emotion information transmitted by the face. Rather, since the appearance of the face tells us something about who the person is, it is reasonable to assume that this information will enter into our emotion judgments. We already know that individuals hold stereotypical beliefs about the emotions of others based on information such as their sex, their age, their culture, their status and their personality. Thus, for example, women are expected to smile more and in fact also do smile more than men. By contrast, men are expected to show more anger but do not seem to in fact do so (Brody & Hall, 2000; Fischer, 1993). These expectations are socialized early and can have dramatic consequences for the perception of emotion in male and female others. For example, even children as young as 5 years tend to consider a crying baby as "mad" when the baby is purported to be a boy but not when it is purported to be a girl (Haugh et al., 1980). Thus, the 'knowledge' that a baby is a boy or a girl, biases the perception of an otherwise ambiguous emotion display.

People also have beliefs about age and emotionality. In a recent study we showed participants photos of individuals from four different age groups (18-29; 30-49; 50-69; 70+) and asked them to indicate how likely they thought it would be that the person shown in the photo would express each of four emotions (happiness, sadness, anger, and fear) in everyday life. The responses differed with regard to both the sex and age of the stimulus persons. Thus, as they get older men were perceived to be less likely to show anger, whereas the reverse was the case for women. Men were also perceived as more likely to show sadness as they aged.

Beliefs about the emotional behavior of different ethnic groups have been most consistently studied in the context of research on decoding rule differences between collectivist Japanese and individualist US American decoders (Matsumoto, 1992; Matsumoto et al., 1999; Matsumoto & Kudoh, 1993; Yrizarry et al., 1998). Decoding rules (Buck, 1984) are the flip side of display rules. Display rules are culturally learned norms that define what emotion to show as well as when and how to show it (Ekman & Friesen, 1971). Conversely, people who

are aware of such rules will adjust their interpretation of the emotional expressions of others to take account of the display rules that helped shape the expressions. For example, US Americans are usually encouraged to show emotions, especially positive emotions and tend to show emotion more intensely than is warranted by the underlying feeling state. This is not the case in Japan. Consequently, US Americans attribute less intense underlying emotions to expressions of the same intensity than do Japanese (Matsumoto et al., 1999), that is, they "correct" their estimate of a person's feeling state based on the decoding rule that people are likely to exaggerate their expressions.

Status is another characteristic that people take into account when considering the emotions of others. Thus, high status individuals are less bound by the display rules mentioned above and are presumed to be freer to express their emotions. In addition, there are also beliefs about status and emotion for rather specific situations. For example, Tiedens et al., (2000) found that participants believed that in failure situations, a high-status person would feel more angry than sad or guilty as opposed to a person with lower status who is expected to feel more sad and guilty than angry. In contrast, in response to positive outcomes, the high-status individual is expected to feel more pride and the low-status person is expected to feel more appreciation.

An individual's perceived personality is yet another source of strong beliefs that may affect our emotional attributions. Hess et al., (2005), for example, have shown that dominant individuals are believed to be more likely to show anger than are submissive ones. In fact, Hess et al. could show that some of the stereotypical beliefs about men's and women's emotions can in fact be traced to beliefs about personality – specifically to beliefs about dominance and affiliation. What makes this observation even more important in the present context is that facial expressions per se also signal these traits.

6. Facial expressions signal dominance and affiliation

Emotional facial expressions are powerful signals of dominance and affiliation. Specifically, drawing the eyebrows together in anger leads to increased attributions of dominance, whereas smiling leads to increased attributions of affiliation (Hess et al., 2000; Knutson, 1996). At the same time, anger expressions are perceived as threatening (e.g., Aronoff et al., 1988), whereas smiles are perceived as warm, friendly, and welcoming (see e.g., Hess et al., 2002). Similarly, it has been argued that fear expressions elicit affiliative reactions in conspecifics (Bauer & Gariépy, 2001; Marsh et al., 2005).

As mentioned above, people make personality judgements based on no more than a glimpse of a face. Faces that appear dominant tend to look more masculine as the features associated with dominance such as a square jaw and prominent eye-brows (Keating, 1985; Senior et al., 1999) are more typical for men than for women. At the same time men are perceived as more likely to be angry (Fischer, 1993) and angry faces appear more dominant. Thus, there is a reinforcing relationship between a dominant facial appearance and an angry expression which makes men's anger appear more intense (Hess et al., 1997) and threatening (Hess et al., 2007). Conversely, the features that make a person seem more warm and welcoming, babyfacedness (Berry & McArthur, 1985), are more common in women. Consistent with this women are perceived as more likely to express happiness and happy faces appear more affiliative, creating a reinforcing relationship between being affiliative and showing

happiness, all of which serves makes women's smiles appear happier (Hess et al., 1997) and more appealing (Hess et al., 2007).

Darwin (1872/1965) was one of the first to note the equivalence between certain emotional behaviors in animals and more enduring morphological appearance characteristics. For example, he argued that piloerection and the utterance of harsh sounds by 'angry' animals are 'voluntarily' enacted to make the animal appear larger and hence a more threatening adversary (see for example, p. 95 and p.104).

This notion, in combination with the observations detailed above, led Hess et al., (2007) to propose that some aspects of facial expressive behavior and morphological cues to dominance and affiliation are equivalent in both their appearance and their effects on emotional attributions. This functional equivalence between morphology and expression also implies that there are important interactions between facial expressions and facial morphology in the decoding of expressions of emotion.

7. The functional equivalence hypothesis

We initially tested the functional equivalence hypothesis by examining differences in the attribution of emotions to men and women (Hess et al., 2004; Hess et al., 2005). As mentioned above, there is a high degree of overlap in the facial cues associated with maleness, perceived dominance and perceived anger. Likewise there are similarities in the facial cues that signal femaleness, social affiliation and happiness. In fact, this overlap in cues associated with emotional expressions, perceived dominance and affiliation, and gender is so strong that emotional displays can affect the perception of sex. Specifically, in a recent study (Hess, Adams, Grammer & Kleck, 2008) we found that an androgenous appearing avatar who shows a happy or fearful expression is perceived as more likely to represent a woman and the same avatar who looks angry is considered to be less likely to represent a woman (see Figure 1).

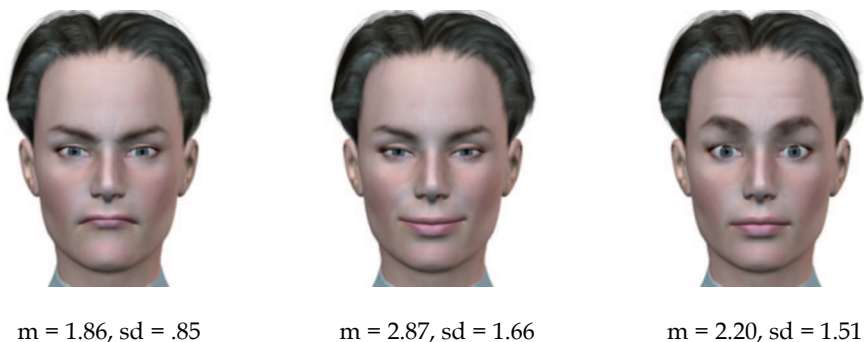m = 1.86, sd = .85   m = 2.87, sd = 1.66   m = 2.20, sd = 1.51

Figure 1. Rated likelihood "that this person is a woman" for an avatar showing an angry, smiling, or a fearful expression.

That this perceptual overlap explains the beliefs that people have about men's and women's emotionality was shown by Hess et al. (2005). They asked separate groups of participants to rate men's and women's neutral faces either with regard to how dominant or affiliative they appeared or with regard to the likelihood that the person in the photo would show a series of emotions in everyday life. Mediational analyses showed that the tendency to perceive women as more likely to show happiness, surprise, sadness and fear was in fact mediated by their higher perceived affiliation and lower perceived dominance respectively. The tendency to perceive men as more prone to show anger, disgust, and contempt was partially mediated by both their higher level of perceived dominance and their lower level of perceived affiliation (see Figure 2). That is, if men and women were perceived to be equal on these dimensions, then we would not expect observers to rate their emotionality differently.
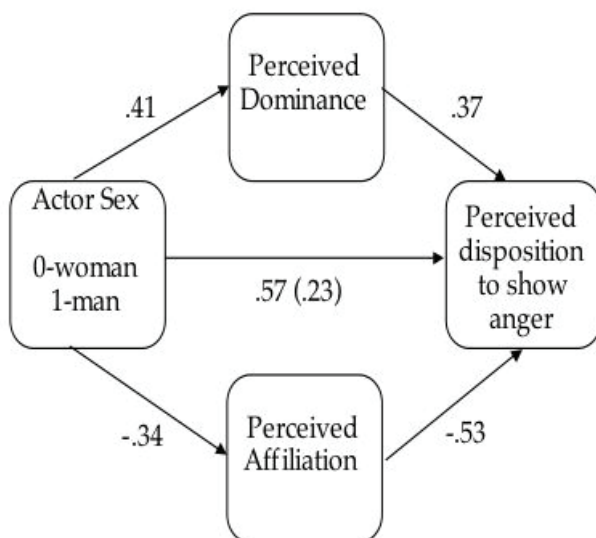

Figure 2. Mediation of expectations regarding men's and women's emotionality via perceptions of facial dominance and affiliation

More recently, we demonstrated that this is also the case for the beliefs concerning changes in emotionality over the lifespan. As reported earlier, men are perceived to be less prone to anger as they get older and women as more prone to this emotion. With happiness just the converse is the case. In our view this is mediated through the fact that as they get older men's faces appear less dominant and more affiliative, whereas women's faces appear more dominant and less affiliative.

We experimentally tested the impact of dominance and affiliation cues on perceptions of anger and fear in the context of gender manipulated facial expressions. Specifically, the interior of the face contains markers of dominance and affiliation (i.e., square versus rounded jaw, heavy versus light eyebrows), whereas hairstyle is a very potent marker of sex

but not of these social motives. Thus, by combining androgynous interior faces with male and female hairstyles, apparent men and women with identical facial appearance can be created (see Figure 3).

Figure 3. *Changing hairstyles to change perceived gender*

For both neutral faces and posed emotion displays (Adams et al., 2007, Study 4; Hess et al., 2004, Study 2) parallel findings obtained such that for ratings of anger and happiness, a pattern opposite to the gender stereotypical pattern was found. That is, when equated for facial appearance, apparent women were seen as more likely to show anger and less likely to show happiness than were apparent men. Similarly, expressions of anger by apparent women were rated as more intense and their expressions of happiness as less intense than when the identical expressions appeared on the faces of apparent men.

This reversal demands an explanation as it suggests that intrinsically, facial appearance being equal, women are perceived as more anger prone and less likely to be happy than are men. We propose that this reversal is due to the equivalence between morphological and expressive cues of dominance and affiliation, which leads to an interaction between these two sets of cues. That is, anger expressions emphasize some of the features that make a face appear dominant (e.g., the mouth region often appears especially square, and frowning reduces the distance between eyebrows and eyes). Conversely, smiling enhances the appearance of roundness of the face that is associated with perceived affiliation motivation and babyishness. Due to the manner in which the present stimuli were constructed, the expressive cues for anger and happiness were not 'compensated for' by gender typical

appearance (the faces were chosen specifically because they were androgynous and were credible as either male or female). In some ways one could say that by depriving the interior of the face of clear gender cues we actually amplified the expressive cues to anger in women and happiness in men. These cues are normally 'obscured' or reduced by the gender typical facial appearance, which also convey dominance and affiliation information. This notion that anger on a male face presents a clearer and less ambiguous anger signal than does anger on a female face and, conversely, that happiness on a female face is a clearer signal of happiness, has recently been confirmed by Hess et al. (2007).

8. Summary

In the preceding sections we have presented research relevant to the decoding of emotional facial expressions that focuses on information other than the actual facial expression. Much is known about the specific features that make a face appear sad, angry, fearful, happy, etc. and this information has been used in recent years to implement computer controlled agents with believable facial expressions (e.g., Pelachaud & Bilvi., 2003). The research we have reviewed, however, suggests that human do not restrict themselves to facial movement information when judging the emotions of others. Rather they use *all* of the available information provided by the face. This information consists at the very least of eye gaze direction and the person information contained in faces. These sources of information interact with the facial expression information in determining which emotions a perceiver will attribute to the individual. In our view eye gaze and facial morphology are parallel message systems. Both can reinforce or obscure the emotional message transmitted by the facial expressions. Eye gaze does this because it contains information on a person's tendency to withdraw or approach and facial morphology because it informs perceivers about the person's personality – especially the dominance and affiliation domains so important for a social species – which in turn are associated with beliefs about a person's emotionality.

Overall the research presented above outlines the impact that a face has on the perception of facial expressions. These findings have obvious implications for the design of the avatars and agents used in human computer interfaces.

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This book provides an overview of state of the art research in Affective Computing. It presents new ideas, original results and practical experiences in this increasingly important research field. The book consists of 23 chapters categorized into four sections. Since one of the most important means of human communication is facial expression, the first section of this book (Chapters 1 to 7) presents a research on synthesis and recognition of facial expressions. Given that we not only use the face but also body movements to express ourselves, in the second section (Chapters 8 to 11) we present a research on perception and generation of emotional expressions by using full-body motions. The third section of the book (Chapters 12 to 16) presents computational models on emotion, as well as findings from neuroscience research. In the last section of the book (Chapters 17 to 22) we present applications related to affective computing.

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