The influence of context on emotion recognition in humans

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Abstract— **Facial expressions do not typically occur in a social vacuum. Rather, they are seen and understood in a social context. Specifically, the understanding of the more ambiguous facial expressions shown in everyday interactions tends to be influenced not only by the knowledge we have about the situation in which the emotion eliciting event occurred but also by knowledge of social norms and rules and by the motivations and goals of the perceiver. Finally, the face itself is not an empty canvas and facial morphology interacts with facial expression.**

I. INTRODUCTION

Traditionally, for research on facial emotion perception in humans, participants will see carefully cropped images showing only the face (e.g., *1, 2*) or even just ovals of faces without hair (*3, 4*) in an effort to eliminate context as much as possible. Similarly, in research on vocal (*5*) and postural (*6*), efforts are made to eliminate any "extraneous" features, that is, anything that is not immediately part of the expression *per se*. But what about context? Is it not important? This is the question we will try to answer in this paper.

II. HOW DO HUMANS DECODE EMOTIONS?

There are two principal strategies for decoding emotion displays (*7*). First, in the absence of any contextual information, the sender's expressions can be used to draw inferences regarding his or her presumed emotional state using a pattern-matching approach (*8*). Thus, people see the upturned corners of the mouth and wrinkles around the eyes and conclude that the other is happy. This is also largely the approach used in computer sensing. And this approach seems to make perfect sense, since after all humans are really good at detecting emotions from 'naked' stimuli presented without context. Yet, this approach works only well when clear patterns are present, such as is the case when prototypical emotion expressions are presented. In fact, humans are not nearly as good when it comes to the decoding of spontaneous expressions, such as those shown in everyday interactions. For example, in a recent study in our laboratory using still pictures of spontaneous expressions from an interaction with friends, decoding accuracies ranged from .32 (sadness) to .73 (happiness) with anger .48 and disgust .57 in between. That is, except for smiling in happiness, people tended to be wrong rather than right. Interestingly, test retest correlations over more than 2 years were quite high (happy .44, anger .54, sadness .57, disgust .60), suggesting that whatever these decoders did, they did it again. And dynamic spontaneous expressions from single individuals are not recognized any better (*9*).

However, humans also have other means for deucing the likely emotions of others and this is where context plays a primary role. Specifically, the knowledge that the perceiver possesses regarding both the sender and the social situation in which the interaction takes place can be used to triangulate likely emotional states. The perceiver can take the context information to assume the perspective of the encoder and to then correctly infer the emotional state that the sender is most likely experiencing.

III. TYPES OF SITUATIONAL CONTEXT

Matsumoto and Hwang (*10*) distinguish between four different types of face context combinations: a) Face-trigger linkage, where the face is shown together with the emotion elicitor; b) Response coherence, where the face is shown together with other, coherent or incoherent, expressive channels; c) Face contrast, where the face is shown following other expressions by the same expresser, and, d) face imbedding, where the face is shown as part of a larger image which contains other objects including the faces of others. Wieser and Brosch (*11*) also add eye gaze and dynamic movement as context, but these them to us more properly features of the expression per se. But this list is not exhaustive as it only focuses on the external information in the scene presented to the perceiver. But the second means of decoding emotions we outlined above, perspective taking, uses another source of context information as well – the perceiver, or more specifically, the perceiver's knowledge about the world. Finally, the very medium by which (facial) expressions are delivered can be considered as context as well. In what follows we will outline different forms of context and their implications.

A. The (emotion-eliciting) situation (Face-trigger linkage)

Situational context can been provided by a variety of means such as combining facial expressive stimuli with pictures or stories describing the purported emotion elicitor (*12-14*). This type of research can suffer from a marked lack of realism, such as when faces are simply pasted into a scene.

Fig. 1. Example of a face in a scene.

Yet, human observers, especially psychology students, are nothing if not adaptable and will try to make sense even out of stimuli like this. Yet, when pasting faces into different scenes differences in ratings between stimuli can well be due to perceptual influences (even distraction) from the scene, rather than to an informative influence of the context. While stories that accompany faces also lack ecological validity, they at least avoid that problem. In general, however, situational context is very informative, because of the existence of naïve emotion theories regarding typical emotion eliciting events. These can take the form of simple rules such as 'people who receive good news are happy.' Alternatively they can take the form of "core relational themes" (*15*), which describe appraisals, such as sadness results from an appraisal of irrevocable loss. Conversely, if the situation suggests such a loss, then sadness is a likely reaction. This approach also requires some knowledge of the emoter – for example, for a toddler an ice cream that fell to the ground may be indeed irrevocably lost, whereas an adult is likely aware of the option to get another ice cream to replace the lost one. In fact, such rules are useful for computer sensing as well. When my application is designed to track a learner's emotions, it is certainly important that I can track interest, boredom or frustration and even anxiety, but reactions such as nostalgia or awe may not occur frequently enough to warrant extra effort. In short, knowing the situational context in which an emotion has been elicited helps to restrict the search space for likely emotions.

B. Response coherence

In this line of research, information from the face has been contrasted with information from another nonverbal channel – for example the body (*16, see also, 17*) or the voice (*18*). This type of "context" can only be considered context in emotion research. In everyday interactions the whole person is usually perceived. Yet, it is noteworthy that even when information from both visual and auditory channels are presented, there is still a trend to attend predominately to facial information (*18*).

C. Face contrast

Another factor that impacts on emotion perception is what happened before, the facial expressions shown prior to the current one (e.g., *19*) or transitions from one to the other (*20*). Without additional situational context, these expressions themselves serve as a social reference. Yet, additional situational information about why the emotion changed may annul this effect.

D. Face imbedding

In this case other faces are the context. A classic study on the effect of this type of context was conducted by Masuda and colleagues, who showed Asian and US Americans cartoons (*21*) and photos (*22*) of a group of people and asked them to decode the central person's emotions. They found that Asian but not Western participants' judgment of a central character's emotional state was affected by the emotions expressed by the surrounding group. The impact of incongruent expressions of a surrounding group on perceptions of a central character's emotion expressions, was presumed to be mediated by the holistic perceptive style associated with an interdependent self-construal (*23*). Specifically, individuals from a collectivistic culture who have an interdependent self-construal not only scan emotional faces differently (*24*), but also tend to focus more on aspects of the background of scenes (*25*).

Yet, these studies presented emotional faces surrounded by other emotional faces, but without an situational context that justifies the differences in the expressions shown by the different individuals in the group. In a recent study in our laboratory, we provided participants with a reason for the divergent emotions shown in two people's faces. In this case, even though the study was conducted in an individualistic country, the ratings of one person's emotion expression where strongly influenced by the expression of the other person. For example, when both a supporter of a player in a ball game and an opponent showed a positive emotional expression, the supporter's expression was rated less positively. This, because the fact that the opponent is happy suggests an advantage for their team and hence whatever the player did could not have been that wonderful after all, even though the more biased supporter may put on a good show for the benefit of the player. Thus, other people and their expressions can serve as a useful guide for what happened and which emotion should be expected.

So far, we have only considered context elements that are "visible" (or sometimes audible), that is, that are part of the situation and that can be perceived by a human or a machine. Importantly, all those forms of contexts can be approached with variants of pattern matching. At most, we need to add patterns of core relational themes, or typical emotion elicitors. However, when humans take the perspective of someone else, they can and do add other elements, which we will discuss now.

IV. THE PERCEIVER AS CONTEXT

A. The perceiver's knowledge

Most emotions occur in interactions with others and these interpersonal situations are highly rule-governed (*26*). These rules are perceived as normative for interactions and even correct in a moral sense (*27*). Hence, for many situations there are social norms that guide the appropriate expression of emotions. These are usually referred to as display rules (*28*). Given that such pervasive rules are shaping the interaction, knowing these rules allows the prediction of the likely emotions experienced in the interaction.

Display rules and their associated expectations vary with the gender and status of the expresser (e.g., *29, 30*) and from culture to culture. But there are also rules for different social contexts within a culture. For example, anger expression is more acceptable for office staff than for service agents (*31, 32*). Also, rules to suppress antagonistic affect are more strongly normative for women than for men, whereas rules to suppress positive emotions are more commonly applied to men (*33*). For example, lets assume we know that a person's car was vandalized and we now see their emotion expression? What does the person show? It turns out, women are normatively expected to show sadness rather than anger in such a situation unless they were explicitly described as very dominant (*34*).

As noted above, display rules vary with culture, in fact, the very term display rule was used by Ekman and Friesen (35) to explain cultural differences in overt emotional reactions. These differences can in part be related to differences in cultural values such as individualism and collectivism (36). Importantly, display rules have a converse side in decoding rules (8), such that perceivers tend to be less good at decoding expressions that are proscribed by a pertinent display rule. In this vein, Greek participants rated anger expressions less intensely and sad and disgust expressions more intensely than participants in Germany – a difference that disappeared when interdependence was controlled for (37). These findings are congruent with an understanding that in an interdependent cultural context antagonistic negative emotion displays in groups are undesirable - in keeping with norms of interpersonal harmony (1, 38), whereas affiliative negative emotions such as sadness are more desirable. Accordingly, negative emotions in a relational context were found to have different meanings for German and Greek participants, which also were mediated by their level of interdependence (39). Thus, emotional display rules, which vary as a function of the cultural and social values that people subscribe to, affect our perception of emotions.

This was shown in yet another recent study in our laboratory. In this study, we assessed how the emotions of bystanders to an event are used to infer that a norm violation had occurred (norm violation appraisal) and what the violated norm was (norm learning) in a cross-cultural context. Because anger expressions are based in an appraisal of norm violation, we had predicted that when the bystanders react with anger to the action of another person, observers should find it easier to conclude that a norm was violated and to learn the norm.

Yet, if the perception of anger varies according to social norms and rules, then the usefulness of this emotion for norm violation appraisals and norm learning should also vary. This is exactly, what we found when comparing individuals from Germany, Israel, and the US.

Specifically, German participants were especially prone to perceive anger, whereas Greek participants were more likely to perceive sadness and participants from the US more likely to perceive the expressers as indifferent. Israeli participants overall differentiated best between these three types of expressions. Importantly, these cultural differences in emotion perception were related to cultural differences in norm learning accuracy and appraisals of norm violation. Specifically, across all emotion expression conditions, ratings of anger were positively and ratings of indifference were negatively related to both norm learning accuracy and appraisals of norm violation. Consequently, in cultures in which social norms are more lenient with regard to the expression of anger (Germany and Israel) participants were more likely to describe a norm accurately and appraise the situation as likely to involve a norm violation when the group reacted with anger to the norm violation.

This study nicely demonstrates the importance of socio-cultural norms for not only the perception of emotions but also for how these emotions are used for inferences about the situation. It also implies that in order to fully understand how a given observer will evaluate a given expression one has to know the rules and norms that this observer will use. Unfortunately, there is very little research on this topic. Most of the time, display rules are inferred post-hoc from the very fact that people reacted differentially to a given emotional situation, as in the classic study by Ekman and Friesen (28). Yet, this approach is tautological. On the other hand, most social rules are implicit and hence people can not readily report on them. This makes it difficult to establish a comprehensive set of display rules.

B. The perceiver's goals, needs, expertise, and own emotional state

Emotional display rules, even though they vary across cultures and subcultures, still have a certain stability and where known (as is often the a case for the more explicit organizational displays rule – "Service with a smile" is an example, can be modeled. But the situation is made more complex by the fact that more fleeting characteristics, especially the perceivers' goals, needs, expertise and even their own emotional state (40), affect emotion perception. For example, a highly motivated perceiver may pay more attention to the cues emitted by the target, that is, engage in more effective pattern matching or more elaborate perspective taking. Thus, Thibault and colleagues (41) found that perceivers who strongly identified with members of a group were better at labeling emotion expressions from members of that group. In a similar vein, research on gender differences in emotion recognition shows that motivational factors may explain why in many studies women are found to have higher decoding accuracy (42).

Further, the emotional state of the perceiver tends to influence the processing of (social) information. Specifically, according to Forgas' "affect infusion model" (43), perceivers' information processing strategies differ in the extent to which a full search of information occurs and how open or closed this search is. At one extreme of this process, the perceiver may directly and automatically retrieve a preexisting label when encountering a stimulus. At the other extreme, the perceiver may engage in an extensive and open search of information. This latter strategy involves substantive processing using preexisting knowledge in a relatively unbiased manner (44).

In addition, there are reciprocal relations between the perceiver's information about the situation and the effects of goals and needs on processing. For example, the smile of another person is usually perceived positively as happiness. But when perceivers know the other person to be in competition with them, the perceivers' own goal to achieve success becomes salient, and the same smile may become a smirk and the happiness becomes glee in their mind.

To render the issue more complex – the perceiver's emotional state may in addition be partially determined by an automatic reaction to the emotion of the expresser through emotional contagion (cf. 45). This process could conceivably precede the conscious identification of the other's emotional state. For example, the fear of a target may cause fear in the perceiver. This fear, in turn, may affect decoding by making the perceiver less attentive to the details of the target's emotion - or give preferential status to the elements of the expression

consistent with the perceiver's own fear. Thus, even if the perceiver correctly identifies the emotion as fear, the fear may be attributed to the wrong cause or associated with the wrong object or be perceived as more intense than it actually is.

These characteristics of the perceiver are changeable across situation and mostly, but as the example above shows not exclusively, impact on perspective taking. But some characteristics of the perceiver are more stable and extend to pattern matching. This applies in particular to the perceiver's competence in decoding others' emotions (e.g., *46, 47*). Emotional intelligence encompasses both the ability to apply pattern matching in emotion recognition and knowledge about what types of situations typically result in which emotions (*48*). And people also vary in the degree to which they are generally observant of situational cues.

Finally, individual differences in personality also can affect identification. Thus, traits such as hostility (*49*) and aggression (*50*) can bias emotion perception, such, for example, that a person may be predisposed to see generally more anger in others.

To summarize, the perceiver influences emotion decoding in two principal ways. First, by rendering certain types of cues more accessible (*51*), and second by engaging in a more or less purposeful strategy and actively choosing the information on which judgments are based (*40*). In this sense the perceiver is not a passive recipient of information but contributes actively to the decoding process.

V. THE FACE AS CONTEXT

So far we have discussed a number of elements of context for emotion perception, which are more or less closely associated with the emotion-eliciting situation. The last element of context that we would like to discuss, however, is different in that is specific to the expresser -- the morphology of the face. This term refers to both the bone structure of the face as well as to other stable facial features such as eyebrow and lip shape and the wrinkles and folds of the face as we age.

In recent years, research has accrued showing that these stable features interact with facial expressions both in regard to the identification of emotions and when it comes to drawing inferences from facial expressions (*52*). Thus, fear is better recognized in immature than in mature faces, whereas anger is better recognized in mature and male faces (*53, 54*). Also smiles shown by women are perceived as more appetitive than smiles shown by men, whereas angry frowns shown by men are perceived as more threatening than angry frowns shown by women (*55*). In fact, it can be shown that anger, dominance and male sex markers on the one hand and happiness, affiliation and female sex markers on the other overlap perceptually in face space and are functionally equivalent. That is, anger, dominance and male sex all look sufficiently similar that they can and do convey the same meaning with the converse for happiness, affiliation and female sex markers (*52, 54*).

This relation between emotion expression, dominance and affiliation, and gender is so strong that it can produce the reverse bias, that is, the facial expression shown by an androgynous face can bias the assignation of gender to this face. Thus, an avatar who shows a happy or fearful expression is perceived as more likely to represent a woman and an avatar who looks angry is considered to be less likely to represent a woman and in a sex detection task participants are slower to decide that a women is indeed a women when she shows anger (*56*).

Interestingly, these morphology based associations are also in line with stereotype beliefs about men and women's emotions. In fact, facial morphology and beliefs drive the inferences drawn from faces to an about equal degree (*57*). Thus, the face is not an empty canvas on which emotions appear and disappear but rather provides its own context to the expression.

VI. THE IMPACT OF CONTEXT – WHEN, HOW MUCH AND ON WHAT?

In the preceding, we have outlined different types of context and their impact on emotion perception. But context does not always exert the same degree of influence. Rather, context influences on emotion perception depend on the ambiguity of the cues from which the emotion is to be identified. Strong prototypical emotion expressions such as those used in classic emotion recognition studies tend to be less susceptible to these influences. By contrast, the weak and often ambiguous expressions more commonly shown in everyday life (e.g., *58*) often require additional knowledge to be interpreted at all (*7, 59*). The same is true when there is more than a single emotion cue and the different cues are suggestive of different emotions (*16*). At the extreme end, where cues are entirely uninformative of a specific emotion such as when a facial expression reflects neutrality, context will be the sole determinant of the identification (*14, 60*). Conversely, some emotions may be very powerful signals that are interpreted quite independent of context. For example, in a recent study we (*61*) found that, unlike happiness and neutrality, awe was not susceptible to context. As awe is a reaction to an absolute judgment – that something is indeed outstanding and vast – context information does not readily qualify this perception.

In sum, emotions occur in contexts and these contexts carry with them information that is sometimes just useful and at other times even indispensible for emotion communication. In this process the decoder has to be understood as an active element who brings their own goals, motivations or preconceptions into the situation. As such, emotion communication among humans can be very complex indeed.

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