

The inherently contextualized nature of facial emotion perception

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According to mainstream views of emotion perception, facial expressions are powerful signals conveying specific emotional states. This approach, which endorsed the use of stereotypical-posed faces as stimuli, has typically ignored the role of context in emotion perception. We argue that this methodological tradition is flawed. Real-life facial expressions are often highly ambiguous, heavily relying on contextual information. We review recent work suggesting that context is an inherent part of real-life emotion perception, often leading to radical categorical changes. Contextual effects are not an obscurity at the fringe of facial emotion perception, rather, they are part of emotion perception itself.

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In the successful TV series ‘Lie to me’, Tim Roth plays the brilliant Dr. Cal Lightman, an expert who advises the police in their investigations. By astutely analyzing the facial movements of the crime suspects, he penetrates their true feelings and emotions, succeeding where the police fail. As the show’s slogan reads: ‘He sees the truth. It’s written all over our faces’. The notion that facial expressions convey diagnostic information about the emotional state of the expresser is deeply ingrained in lay intuition, popular culture and scientific thought. According to this view, facial expressions are like barcodes in the supermarket, designed to be decoded in a manner that is largely independent of contextual information. Here, we challenge this view and argue that real-life facial expressions are highly ambiguous cues that rely heavily on contextual information.

The modal approach: faces tell the whole story

According to the Basic Emotion view, humans express a small set of emotions with highly recognizable facial configurations. These expressions are assumed to be

universal [1–4], genetically prewired [5–8] and well recognized by specialized perceptual and neural processing [9–19]. For example, in an influential paper Smith *et al.* [10] argue that ‘the face, as a transmitter, evolved to send expression signals that have low correlations with one another’. Thus, an entire body of knowledge has been obtained using isolated decontextualized facial expressions.

Ignoring contextual information may be a legitimate experimental approach. When we stub our toe we feel a stabbing pain. This sensation can be studied by one group of scientists in an isolated manner, without ever referring to contextual factors. At the same time, a second group of scientists may take a keen interest in the factors that modulate the experience of pain (e.g., perhaps injuring one’s toe hurts more after failing a test). Both approaches seem legitimate and even compatible — but can the same be said about emotion perception? Unfortunately, we believe that the answer is a resounding, ‘no’.

Real-life faces do not tell the whole story

Although the basic emotion approach has been successful in yielding much data on emotion perception, this body of work has relied nearly exclusively on artificially-standardized sets of stereotypical, lab-created and highly recognizable portrayals of facial expressions, for example [20,21]. These stimuli are often created by instructing actors to configure their facial muscles in a particular way, creating systematic, standardized, and nearly caricature-like facial displays.

While methodologically convenient, the evidence for such stereotypical faces occurring in everyday life is scant at best. Current evidence suggests that real-life facial expressions are *inherently* ambiguous and often non-diagnostic of the situation in which they occurred [22,23–27,28**]. It is perhaps not surprising that a recent review of naturalistic studies bluntly described the link between emotion and naturalistic facial expressions as ‘very weak, nonexistent, or unpredicted’ [29*].

The fact that real-life facial expressions are extremely different from the stereotypical standardized stimuli used in most experiments has far reaching implications. Most research on the impact of context on emotion perception has utilized such stereotypical posed facial expressions. Consequently, the stereotypical faces are modulated by context (e.g., agreement about of the posed emotion category is reduced, RT is increased) but the perceived facial expression is often not dramatically altered [30].

However, if real-life facial expressions are inherently ambiguous they may be *naturally susceptible* to far more radical, category-shifting contextual influence. Context may not merely modulate the categorization of diagnostic signals, rather, it may shape and mold the very perception of highly ambiguous signals. This would imply that contextual effects on real-life faces may be the rule, not a perceptual obscurity at the fringe of normal perception.

Context effects in emotion perception

Recent reviews have outlined the wide range of contextual impact on facial emotion perception [31,32,33*, 34*,35]. Our aim here is not to provide an additional comprehensive list. Instead, we selectively review recent work illustrating that context does not merely modulate, but rather, triggers a radical categorical change in the perception of everyday emotional faces.

Following Wieser and Brosch [33*] we conceptualize three main sources of contextual influence on facial expression perception: (a) *effects within the expresser*, which refers to any contextual cue arising from within the target who's facial expression is being judged (e.g., the target's tone of voice); (b) *effects external to the expresser*, which refers to any cue from the surroundings of the target (e.g., other people, scene information, and so on); and (c) *effects within the perceiver*, which refers to any factors that arise from within the perceiver of the target (e.g., social biases, psychiatric illness, and so on). While these distinctions rarely occur neatly in real life, they are useful for taxonomical purposes.

Contextual effects within the expresser — a new body of evidence

Some of the most powerful contextual influences on the perception of facial expressions arise from within the expressing target. These can include the tone of voice [36], chemo signals in sweat [37,38], or body language to which we turn in more detail. Recent work has examined real-life affective displays of tennis players during professional matches [28**]. In that study, different groups of participants rated the affective valence of images portraying tennis players winning or losing a critical point in a tennis match. Importantly, the images were presented in one of three formats: face alone, body alone, or face with body (see Figure 1a,b).

Strikingly, when rating the facial valence alone, participants utterly failed in differentiating the winners from losers — an illustration of the ambiguity of real-life emotional facial expressions. By contrast, when the faces were presented with the diagnostic contextualizing bodies, viewers easily differentiated winners from losers (see Figure 1c).

The contextualizing effect of the body on the face is not limited to competitive sports. For example, Abramson

et al. [39] examined real-life emotional fearful expressions evoked during extremely scary pranks and intense haunted house tours. Isolated faces were poorly classified, yet when the faces appeared together with a contextualizing body, viewers successfully perceived the emotion of the situation. Importantly, this study provides evidence that during real-life situations, facial expressions are both highly ambiguous and strongly contextualized.

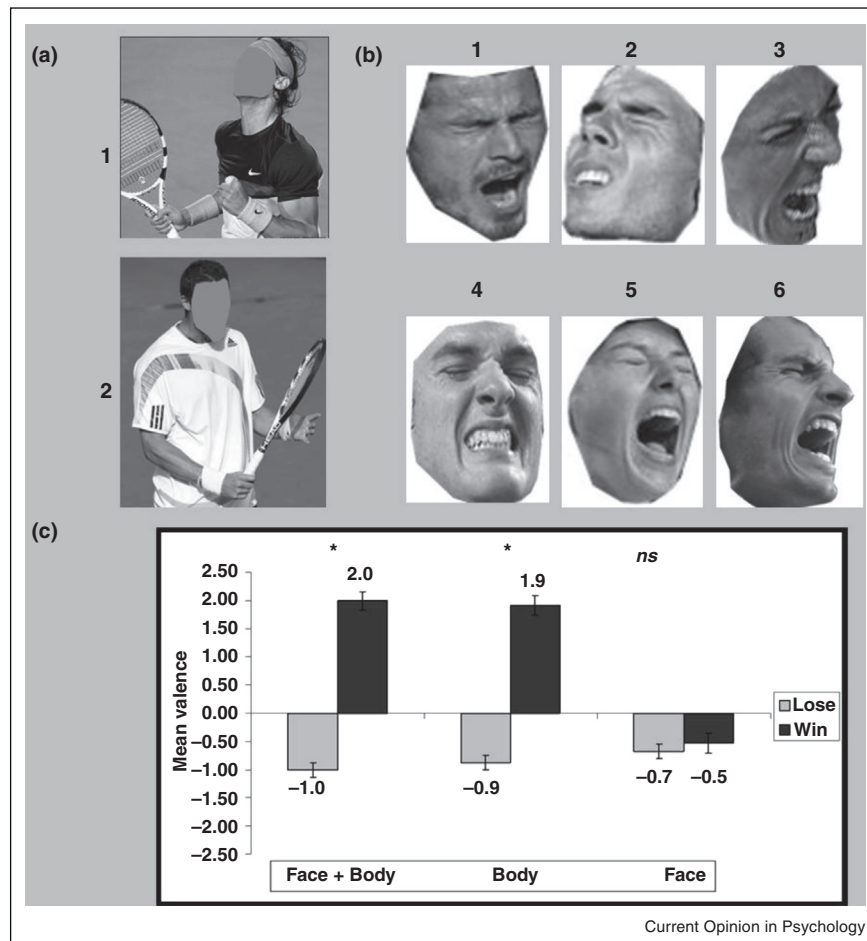
Although our review so far implies that stereotypical posed faces are less susceptible to contextual influence, they are not totally immune. Rather, the perceived similarity between facial configurations is an important determinant of context effects. To take an example, the categorization of a smiling face is unlikely to be strongly affected by a disgust context, because the two stereotypical facial-expressions (happiness, disgust) are very dissimilar. An angry face, however, is more likely to be affected by disgust context because the stereotypical facial expressions of anger and disgust are perceptually similar [40,41].

This similarity hypothesis was examined by planting stereotypical disgust faces on bodily postures that in isolation are consensually categorized as conveying other emotions and asking participants to judge which emotion is conveyed by *the face* [42*,43] (see Figure 2). The results indicated powerful, yet selective effects of context on the emotional categorization of facial expressions. For example, the categorization of stereotypical 'disgust facial expressions' as disgust-expressing dropped from 91% in the congruent condition (i.e. when disgust faces appeared with disgust bodies), to mere 11% in the high-similarity incongruent condition (i.e. when disgust faces appeared with anger bodies). However, the same disgust faces were minimally influenced by a fearful body, even though the body was no less strong and clear a context [42*,43]. Thus, the magnitude of contextual influence was strongly correlated with the degree of perceptual similarity [43]. Although perceptual similarity is important, contextual effects are often asymmetrical (e.g., stereotypical disgust faces are more influenced by anger bodies than *vice versa*) suggesting that additional factors are also at play [44].

Recent evidence highlights the importance of the body as a face-contextualizing agent at both the phylogenetic and ontogenetic levels. Phylogenetically, rhesus macaques encountering a conspecific looked for longest, most frequently, and first at conspecifics' bodies rather than their heads [45]. Furthermore, functional imaging of the macaque brain shows that the face patch system exhibits a response to faces with bodies above and beyond its responses to individually presented faces and bodies [46].

Ontogenetically, by the age of 6.5 months, infants can differentiate between happy and angry affective displays conveyed in bodies [47] and by the age of 8 months,

Figure 1



(a) Characteristic body language of (1) winners and (2) losers. (b) Isolated facial expressions of winners and losers in tennis (1, 4, 6 = losing point; 2, 3, 5 = winning point). (c) Mean valence ratings as a function of stimuli format. All photos in this figure credited to a.s.a.p. Creative/Reuters. Source: Adapted from Science with permission.

infants show neural sensitivity to the affective congruency between the face and body. Specifically, ERP data demonstrate that viewing conflicting body expressions hampers the neural discrimination of facial expressions in infants [48]. Interestingly, when stereotypical posed faces are paired with incongruent bodies, children integrate the emotional information from both sources at roughly the same time as they acquire sensitivity to each cue in isolation [49].

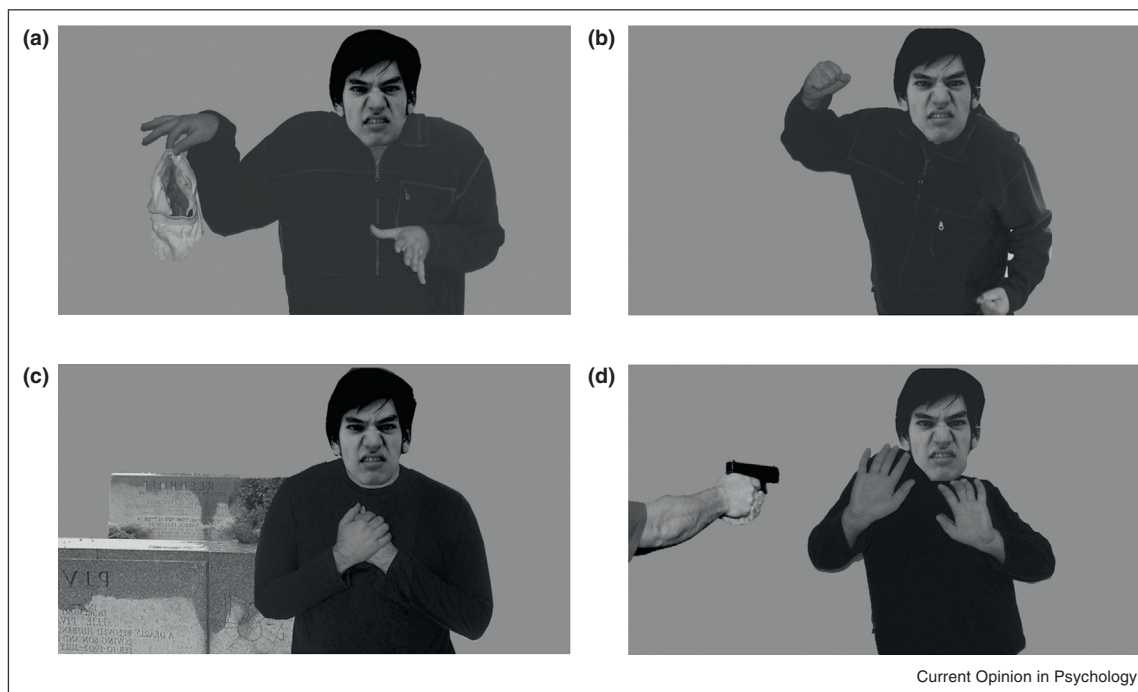
Finally, we note that body context fundamentally changes the very processing of the face. For example, in a pioneering study Meeren *et al.* [50**] measured ERPs to stereotypical fearful and angry faces with incongruent vs congruent bodies while participants classified the emotion of the faces (bodies were task irrelevant). Their results showed an enhancement of the occipital P1 component as early as 115 ms after presentation onset, suggesting a rapid neural integration

of the information from faces and bodies. In another example, characteristic eye movements to stereotypical facial expressions changed systematically as a function of the body context with which they were paired [42*]. Specifically, the very initial fixations on the face were shifted in context-congruent ways. Thus, the attentional and neural processing of facial expressions is altered by contextual information.

Contextual effects external to the expresser

In addition to the cues originating from within (e.g., body language, vocalizations), a rich array of external contextual cues may impact the perceivers impression. To start with, knowledge of the situation may strongly impact one's perception of facial configurations. Experimentally, knowledge can be manipulated by visual scenes [51,52], short vignettes [53*], or even semantic-linguistic labels [54–57] — all of which have been shown to influence facial expression perception.

Figure 2



Stereotypical disgust faces planted in different body context, (a) Disgust, (b) Anger, (c) Sadness, and (d) Fear. Note that the disgust face is most influenced by the anger context (b) and least influenced by the fear context (d). The facial expression in the figure has been adapted from Van Der Schalk et al. [21] and is part of the ADFES set.

Consider the recent study by Kayyal *et al.* [58] in which viewers were presented with pictures of emotional reactions of Olympic athletes to winning and losing. Critically, observers were given either correct, incorrect, or no information about the situation (i.e., winning or losing). Remarkably, contextual information consistently overrode facial information, regardless of the actual original situation in which the emotional facial reaction was evoked.

As social beings, one important contextual cue is the behavior of other individuals interacting with the target [59,60]. For example, using synthetic dynamics stereotypical expressions Mumenthaler and Sander [61] showed that a target face was judged as more fearful when an angry face was gazing at its direction than when a fearful face was gazing at its direction. In fact, this finding, held strong even when the gazing face was presented subliminally [62]. Importantly, this work shows that strength of social context is not merely a matter of emotional congruity, rather, it may operate through the specific functional relations expected between emotional targets.

An important aspect of contextual effects is that they themselves are dependent on the contextual requirements of the task. Barrett and Kensinger [63^{••}] presented

participants with stereotypical facial expressions overlaid on images of neutral contexts. Participants were asked to either categorize the emotion or make an affective judgment concerning the face (whether to approach or avoid it). Contextual encoding was measured by recall of the neutral, task irrelevant contextual scenes. If indeed emotion categorization inherently involves contextual encoding whereas valence judgments can be determined based on the configuration of the face, then this should impact the learning of contextual background scenes. As predicted, participants remembered contextual information better when they were required to categorize the emotion seen in a face than when they were asked to make an affective judgment about the face. These results indicate that emotion perception inherently involves contextualization.

Contextual effects within the perceiver

Different people may perceive identical facial configurations very differently. Comprehensive reviews have described the impact of age [64], personality [65], and psychiatric and neurological disorders [66,67[•],68,69] on emotion perception.

For example, studies in contextualized emotion perception among older adults (ages 61–92) suggest that the

impact of context changes across the lifetime [64]. Stereotypical facial expressions in neutral body context were equally perceived among older and young adults, however, when placed in incongruent body context, older adults showed stronger contextual influence than younger adults.

One recent study of particular interest examined the influence of semantic emotional labels on emotion perception by examining the unique within-perceiver condition of semantic dementia, a neurodegenerative disease that impairs the use of concept knowledge [67*]. As predicted, semantic labels were critical for constructing the perception of emotion categories in stereotypical expressions, and consequently semantic dementia perceivers were impaired at emotion categorization, even when the task did not involve emotion words. By contrast, they succeeded in a valence judgment, presumably because this basic affective dimension can be directly read-out from the face.

Culture is a within-perceiver contextual factor that may drastically alter the perceptual processing of emotion from faces. Although a comprehensive discussion is beyond our scope, we highlight recent studies demonstrating how context may fundamentally alter emotion perception. For example, eye tracking studies have demonstrated that compared to Westerners, East Asians tend to extensively scan the eye region while paying less visual attention to the mouth region [70]. In fact, this systematic scanning difference is already evident in 7 months old East Asians [71]. These findings are in good accordance with work showing that the internal representations of emotional facial configurations differ across cultures, with East Asians entertaining more extensive action representations in the upper facial regions while Caucasians represent more facial action in the lower facial regions [72**].

Recent work has illustrated that cultural context may impose radical differences in emotion perception. For example, a study examining emotion perception of stereotypical facial expressions in the remote culture of West-Trobrianders of Papua New Guinea revealed striking differences in the emotional meaning attributed to such faces. Specifically, the presumably universal fearful face expression was perceived as a threatening-angry display, a finding replicated across two experiments with different methods and participants [73*].

One particularly intriguing demonstration of within perceiver context is the susceptibility to contextual influence. For example, Masuda *et al.* [74*] demonstrated that when a target face is surrounded by other faces, the influence of the context on recognizing the emotion of the target face was evident for Japanese, but not Western perceivers. Thus, the impact of contextual effects may be modulated by contextual effects within the perceiver.

Individual differences

Virtually all prior work on body context examined context effects at the group level, ironing out any creases in the susceptibility of individual participants to contextual cues. But, could the overall mean results be hiding striking individual differences in contextualization?

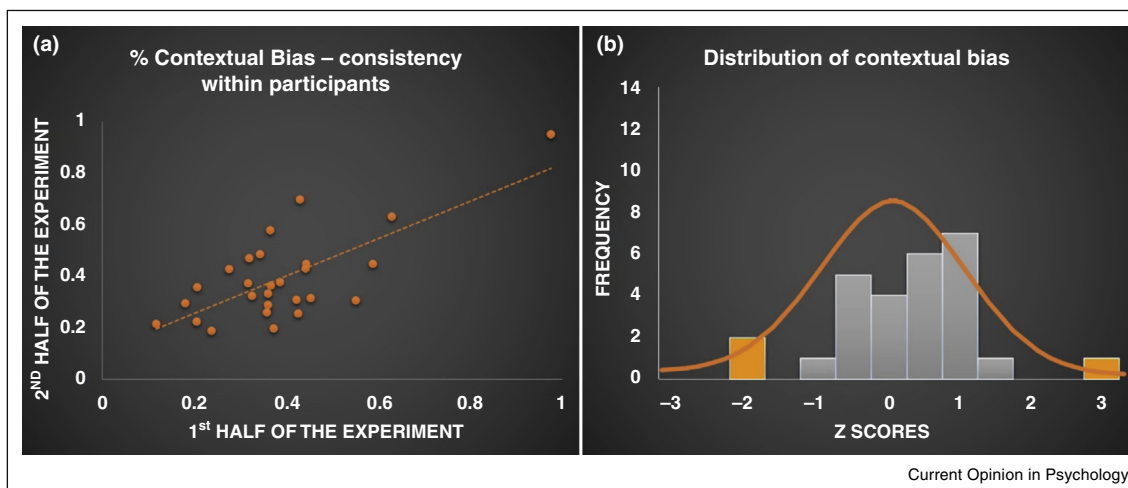
In order to examine this question Ensenberg *et al.* [75] re-analyzed studies in which participants were asked to perceive stereotypical facial expressions while those were combined with congruent and incongruent body language [76,77]. For example, to examine whether the tendency to use context is a relatively reliable individual characteristic, we compared the performance on the first and last halves of one experiment. Each participant received a score reflecting the extent to which she relied on the context — obtained by examining the tendency to (mis-)classify the stereotypical emotional face as conveying the body emotion in incongruent trials. Indeed, performance in the first and last halves of the experiment revealed a strikingly high correlation within individuals, $r(25) = .832$, $p < .01$, suggesting consistent behavior within each subject during the experiment (see Figure 3a).

Next, one can ask about specific profiles in contextualization. Research on facial identity perception has defined impaired recognition (i.e., prosopagnosia) [78] and super-recognition [79] as performance below and above 2SD of the mean, respectively. Using a similar approach, we examined the contextualization distribution in our data (i.e., the tendency of each participant to be influenced by incongruent body context when classifying stereotypical facial expressions).

Figure 3b illustrates two distinct profiles in contextualizing emotions (highlighted in orange). On the extreme left-hand side of the graph, 2 participants can be classified as under-contextualizers. These participants display facial expression categorization that is seemingly unaffected by even the most compelling incongruent body language. Conversely, the extreme right-hand side of the graph displays the opposite pattern of an over-contextualizer. This participant was strongly swayed by virtually every contextual body with which the face appeared. Interestingly, these participants' contextualizing tendencies were unrelated to their perception of the isolated stereotypical faces and bodies which were average and unremarkable.

This, of course, is only a tentative, first stab, at a fascinating set of questions that our labs are currently addressing: Is the tendency to use context in emotion perception a trait? And if so, what does it mean and how does it work? What are the cognitive, behavioral, and neural mechanisms? And what are its implications? Additionally, more work is ongoing aiming to delineate the unique characteristics of both under-contextualizers and over-contextualizers.

Figure 3



(a) Consistency of the contextual bias within participants across the first and second part of the experiment. Although individual differences were seen across participants, participants were highly stable in their behavior during the experiment. (b) The distribution of high and low contextualizing individuals. High scores reflect a tendency to classify the face as the body-context and low scores represent an immunity to the contextualizing body.

Coda

The current review illustrates that the role of context on real-life emotion perception is immense. Perhaps it is time to move forward from the view that ‘contextual cues modulate emotion perception’ to the view that ‘contextual cues are essential to emotion perception’. Decades of research have studied emotion perception in artificial decontextualized conditions while attempting to obtain maximal experimental control. In biology, the tension between *in vitro* and *in vivo* approaches is well documented. As psychological scientists we echo the advice of Lipinski and Hopkins [80]: ‘Whether the aim is to discover drugs or to gain knowledge of biological systems, the nature and properties of a chemical tool cannot be considered independently of the system it is to be tested in’.

Conflict of interest statement

Nothing declared.

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