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Research Article

Angry, Disgusted, or Afraid?

Studies on the Malleability of Emotion Perception

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ABSTRACT—***Current theories of emotion perception posit that basic facial expressions signal categorically discrete emotions or affective dimensions of valence and arousal. In both cases, the information is thought to be directly "read out" from the face in a way that is largely immune to context. In contrast, the three studies reported here demonstrated that identical facial configurations convey strikingly different emotions and dimensional values depending on the affective context in which they are embedded. This effect is modulated by the similarity between the target facial expression and the facial expression typically associated with the context. Moreover, by monitoring eye movements, we demonstrated that characteristic fixation patterns previously thought to be determined solely by the facial expression are systematically modulated by emotional context already at very early stages of visual processing, even by the first time the face is fixated. Our results indicate that the perception of basic facial expressions is not context invariant and can be categorically altered by context at early perceptual levels.***

Whether on a first date, in a fight at the local pub, or in a poker game, humans continuously attempt to decipher social and emotional cues from each other. A particularly important source of information for decoding such cues is the face and its expressions (Adolphs, 2002, 2003; Darwin, 1872/1965; Ekman, 1992, 1993; Russell, 1997). Consequently, extensive research has investigated how facial expressions are processed and perceived. Two major views have evolved. According to the *discrete-category* view (Ekman, 1992), basic facial expressions convey discrete and specific emotions. For example, Buck (1994) stated that "the receiver has, literally, direct access to the motivational-emotional state of the sender" (p. 104). In the extreme formulation of this view, the readout of specific emotions from facial expressions is largely unaffected by their context (e.g., Ekman & O'Sullivan, 1988; Nakamura, Buck, & Kenny, 1990).

According to the second, *dimensional* view (Russell, 1980, 1997), facial expressions are not categorized directly into specific emotion categories, but rather convey values on the dimensions of valence and arousal. These values are read out from the facial expression and are subsequently used to attribute a specific emotion to the face. Although the final attribution of a specific emotion to the face entails the integration of the aforementioned dimensions and situational information, the initial reading out of affective dimensions from the facial expression is assumed to be unaffected by context (Carroll & Russell, 1996; Russell, 1997; Russell & Bullock, 1986).

Hence, although the discrete-category and dimensional frameworks hold different views about the information conveyed by facial expressions, they share the notion that affective information (specific emotions or affective dimensions, respectively) is read out from the face by a process that is relatively immune to context.

Yet, in real life, faces are rarely encountered in isolation, and the context in which they appear is often very informative. Therefore, regardless of which of these two frameworks one accepts, there is reason to believe that the interplay between facial expressions and their context may prove to be an important determinant of emotion perception (e.g., Trope, 1986). Early studies examined this topic by pairing facial expressions with verbal vignettes that conveyed emotional information. Participants then judged what emotion was felt by the target person. Unfortunately, results proved inconsistent: Some studies demonstrated negligible contextual effects (e.g., Nakamura et al., 1990), others demonstrated strong contextual effects (e.g., Carroll & Russell, 1996), and still others failed to show dominance for either contextual or facial information (e.g., Fernandez-Dols, Sierra, & Ruiz-Belda, 1993; Goodenough & Tinker, 1931). Furthermore, the relevance of those studies to the

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perception of facial expressions is indirect at best, because participants were asked not to describe the emotion expressed in the face, but rather to attribute emotion to the target person.

More recently Meeren, van Heijnsbergen, and de Gelder (2005) have shown that incongruence between body language and facial expressions (e.g., a picture incorporating an angry face on a fearful body) may cause Stroop-like interference effects when participants engage in speeded categorization of briefly presented faces. Interestingly, although participants in that study were slower and less accurate in the incongruent than in the congruent condition, they were still much more likely to categorize the faces correctly and ignore the context than to incorporate it into their face categorizations. Hence, in line with previous studies (e.g., Ekman, Friesen, & Ellsworth, 1982; Ekman & O'Sullivan, 1988), the study by Meeren et al. suggests that although the perception of basic facial expressions might be modulated by context, the emotional categorization of facial expressions is largely unaffected by it.

As we noted, however, there are reasons to suspect that facial expressions might be more sensitive to context than previous studies suggest. Specifically, prior studies might have resulted in equivocal results because they did not take into account the perceptual similarity among facial expressions. One goal of the present study was to address this factor and unveil rules that govern contextual effects on the perceptual processing of facial expressions and on the mapping of facial expressions into emotion categories.

In the first two experiments, we investigated the malleability of emotion perception by systematically manipulating the similarity between the target face (i.e., the face to be judged) and the face that would typically be associated with the emotional context. In Experiment 1, we took a discrete-category view, asking participants to categorize the emotion expressed by faces. In Experiment 2, we took a dimensional stand, asking participants to rate the valence and the arousal expressed by faces. Finally, in Experiment 3, we monitored eye movements to determine if context can modulate early stages of face processing, or only later processes that influence categorization.

EXPERIMENT 1

Facial expressions vary in how similar they are to each other. For example, the facial expression of disgust bears a strong similarity to that of anger, but little similarity to that of fear (Dailey, Cottrell, Padgett, & Adolphs, 2002; C.A. Smith & Scott, 1997; Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007). Consequently, the average confusability is considerably higher for isolated disgusted and angry faces than it is for isolated disgusted and fearful faces (Ekman & Friesen, 1976). In Experiment 1, we examined if the perceptual similarity between facial expressions affects viewers' susceptibility to contextual influences in categorizing the expressions. We hypothesized that contextual effects might rely on the similarity between the target facial expression and the facial expression typically associated with the affective context. For example, because the facial expression of disgust is highly similar to that of anger but not that of fear, compelling contextual effects should be expected when a disgust facial expression appears in the context of anger, but not when it appears in the context of fear.

To explore this hypothesis, we took advantage of a recently developed computational network model that successfully classifies facial expressions to their respective emotion categories and indicates the relative perceptual similarity between expressions (for details, see Susskind et al., 2007). Using the model's output, we established that facial expressions of disgust share a decreasing degree of similarity with expressions of anger, sadness, and fear, in that order. Consequently, we predicted that contextual effects on the likelihood of miscategorizing facial expressions of disgust would be greatest in an anger context, intermediate in a sadness context, and smallest in a fear context.

Method

Participants

Sixteen undergraduate students (9 females, 7 males) from the University of Toronto (18–23 years old, $M = 21.2$) participated.

Stimuli and Design

Portraits of 10 individuals (5 females, 5 males) posing the basic facial expression of disgust were taken from Ekman and Friesen's (1976) set. These faces were placed on images of models in emotional contexts that formed four levels of perceptual similarity between the disgusted face and the facial expression typically associated with the context: (a) fear (low similarity), (b) sadness (medium similarity), (c) anger (high similarity), and (d) disgust (full similarity; see Fig. 1). One female and one male body were used to convey each of the four emotional contexts. The context bodies subtended an overall visual angle of $13^\circ \times 6^\circ$; body language, gestures, and object manipulations in the images contributed to the manifestation of a specific emotional context. Isolated facial expressions and isolated emotional contexts (with blank ellipses covering the faces) served as control stimuli and were presented in separate blocks.

Procedure

Face-context composites were presented on a computer monitor one at a time. Participants were instructed that on each trial they should press a button indicating the category that "best describes the facial expression." Their choice was to be made from a list of six basic-emotion labels (sadness, anger, fear, disgust, happiness, and surprise) that was presented under the image. Participants were allowed to freely explore the entire stimulus display, without time limits. The experiment was approved by the ethics board at the University of Toronto.

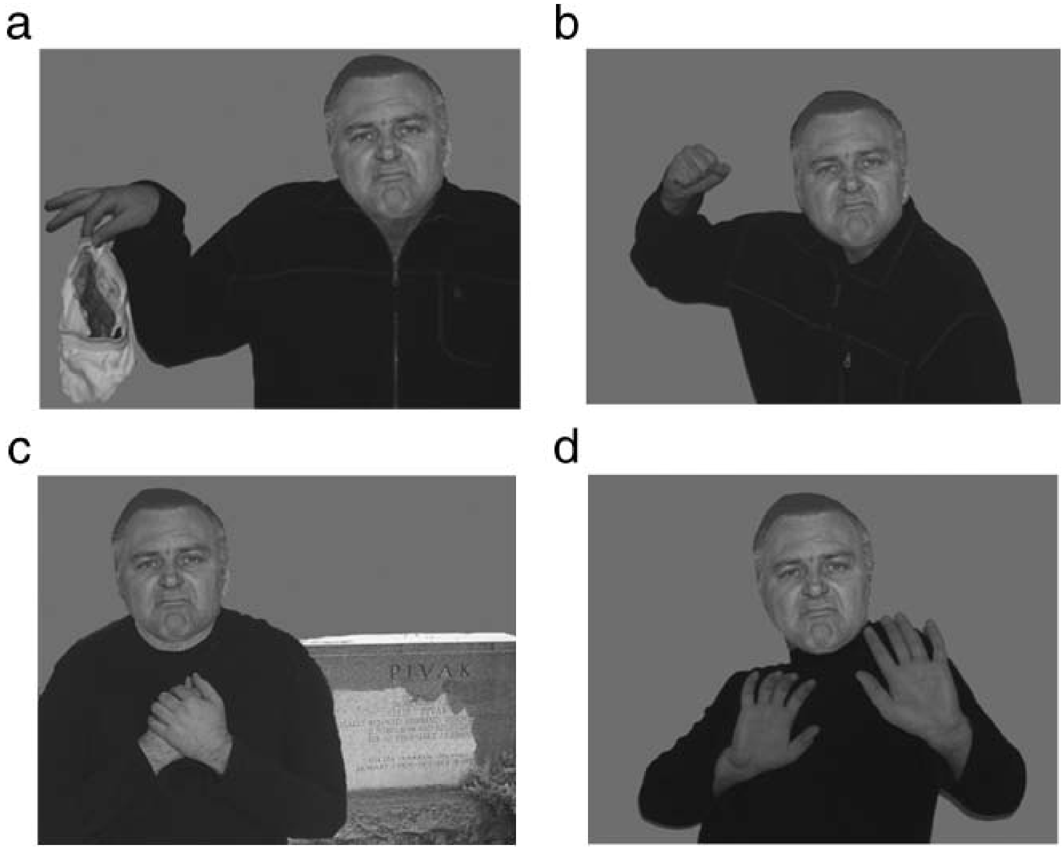

Fig. 1. Examples of stimuli exhibiting four levels of perceptual similarity between the target face and the facial expression typically associated with the context. In Experiment 1, identical disgusted faces appeared in contexts of (a) disgust (full similarity), (b) anger (high similarity), (c) sadness (medium similarity), and (d) fear (low similarity). All facial expressions are reproduced with permission from the Paul Ekman Group.

Results

The different emotions portrayed by the isolated-context images were categorized with comparable accuracy (disgust: 92%, anger: 94%, sadness: 96%, and fear: 92%). Repeated measures analysis of variance (ANOVA) and all pair-wise comparisons confirmed that accuracy did not differ significantly between contexts (all ps $>$ .26). The isolated faces were categorized as "disgust" with an accuracy of 65.6% (chance performance = 16.7%), which is within the normal performance range (Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002).

Two measures were used to assess the effects of context on categorization of the facial expressions: (a) accuracy, the percentage of times the face was categorized as "disgust," and (b) contextual influence, the percentage of times the face was categorized as expressing the context emotion (rather than any other emotion). Accuracy was inversely related to the perceptual similarity between the facial expression of disgust and the facial expression typically associated with the emotional context (Fig. 2a). Repeated measures ANOVA showed a significant main effect of similarity (full, high, medium, low), $F(3, 45) = 43.7$, $p <$ .0001, $p_{rep} = .996$. Bonferroni-corrected pair-wise comparisons between all context conditions confirmed that the decline in accuracy was significant across all levels (all ps $<$ .005, $p_{rep} =$ .96). The systematic decline in accuracy indicates that participants did not simply ignore the faces, as that would have resulted in equal effects of context for all conditions.

The percentage of responses that corresponded to the context category was positively related to the perceptual similarity between the facial expression of disgust and the facial expression associated with the emotional context (Fig. 2b). Repeated measures ANOVA demonstrated the reliability of this effect, $F(3, 45) = 93.8$, $p < .0001$, $p_{rep} = .996$. Bonferroni-corrected pair-wise comparisons between the anger-, sadness-, and fear-context conditions confirmed that in every case, decreasing similarity was associated with a decrease in the tendency to miscategorize the facial expression as representing the context's emotion (rather than disgust; all ps $<$ .01, $p_{rep} = .95$). Furthermore, disgusted faces were equally likely to be categorized as expressing the context emotion when they appeared in the anger context and when they appeared in the disgust context, $p > .7$.

EXPERIMENT 2

Experiment 1 tested whether reading out of discrete emotions is affected by the similarity between the objective facial expres-

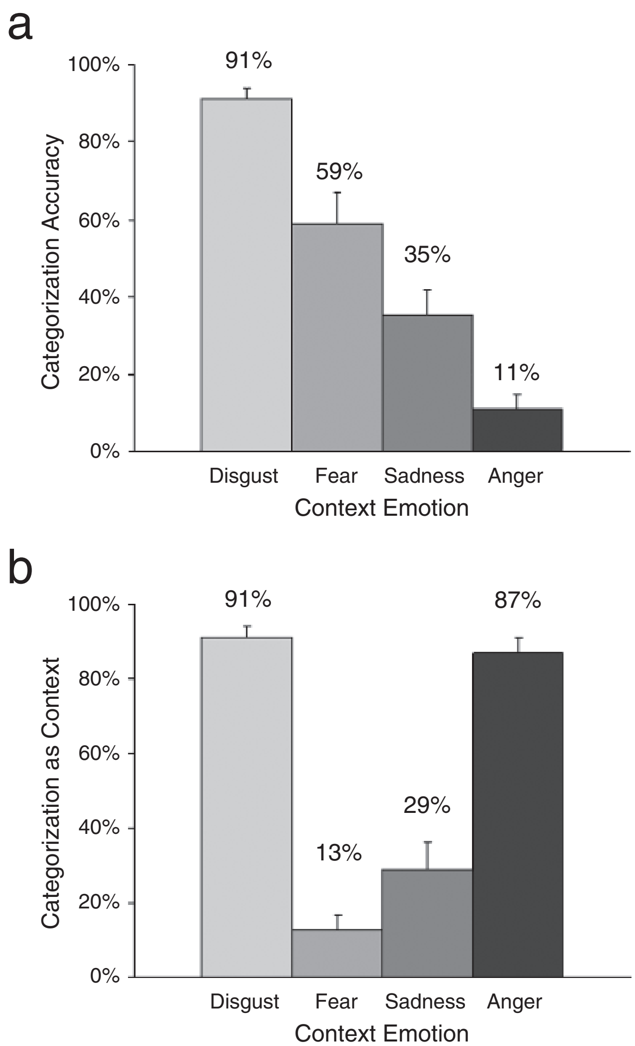

Fig. 2. Results from Experiment 1: percentage of (a) accurate categorization of the faces as showing disgust and (b) miscategorization of the faces as showing the emotion corresponding to the context, as a function of the emotional context. Error bars indicate standard errors of the means.

sion and the facial expression typically associated with the context. Experiment 2 tested the dimensional view, according to which reading out of valence and arousal from facial expressions should not be affected by context (e.g., Carroll & Russell, 1996). In contrast, we predicted that participants' ratings of the dimensions of facial expressions would be affected by context as long as the target face was perceptually similar to the facial expression associated with the context (e.g., a sad, low-arousal face would be rated as showing higher arousal when embedded in a high-arousal fearful context than when embedded in a low-arousal sadness context). Building on the outcome of Experiment 1, we examined (a) whether a high-arousal emotional context could increase ratings of the arousal in sad, low-arousal facial expressions, and (b) whether a positively valenced emotional context could increase ratings of positive affect in disgusted, negatively valenced facial expressions.

Method

Participants

Sixteen undergraduate students (7 females, 9 males) from the Hebrew University (18–24 years old, M = 20.1) participated.

Stimuli and Design

Sad and fearful facial expressions differ in their degree of arousal (e.g., Russell & Bullock, 1985), yet they are perceptually similar (Susskind et al., 2007) and, hence, are likely candidates for demonstrating contextual effects on ratings of arousal. Likewise, despite their difference in valence, faces expressing disgust and pride share perceptual features (Scherer & Ellgring, 2007) and, hence, are likely candidates for demonstrating contextual effects on ratings of valence. For Experiment 2, we selected four different sad faces and four different disgusted faces from Ekman and Friesen's (1976) set. The sad faces were combined with two low-arousal sadness contexts and with two high-arousal fear contexts (see Fig. 3a). The disgusted faces were combined with two different positive-valence contexts of pride (see Fig. 4a) and two different negative-valence contexts of disgust. The stimuli were presented randomly in a within-participants design.

Procedure

Participants were first instructed to rate the valence and arousal of the facial expressions (embedded in context) using a computerized version of the Affect Grid, which enables simultaneous rating of valence and arousal on scales from 1 (*negative/low*) to 9 (*positive/high*; see Russell, Weiss, & Mendelsohn, 1989). In a subsequent stage, participants categorized the same facial expressions as conveying anger, fear, pride, sadness, disgust, surprise, or happiness. This block was always second, to prevent the valence and arousal ratings from being contaminated by the specific semantic category assigned to each face. The experiment was approved by the ethics board at the Hebrew University.

Results

Arousal Ratings of Sad Faces

The average arousal rating of sad faces was strongly influenced by the context. Sad faces in a fear context were rated as conveying higher arousal than the same faces appearing in a sadness context, $t(15) = 4.7$, $p < .001$, $p_{rep} = .986$ (Fig. 3b). As in Experiment 1, context also induced a categorical shift in the categorization of the faces. Participants were less accurate at categorizing sad faces in fearful than in sad contexts, $t(15) = 7.8$, $p < .0001$, $p_{rep} = .996$. Similarly, participants were more likely to categorize sad faces as fearful when the faces appeared

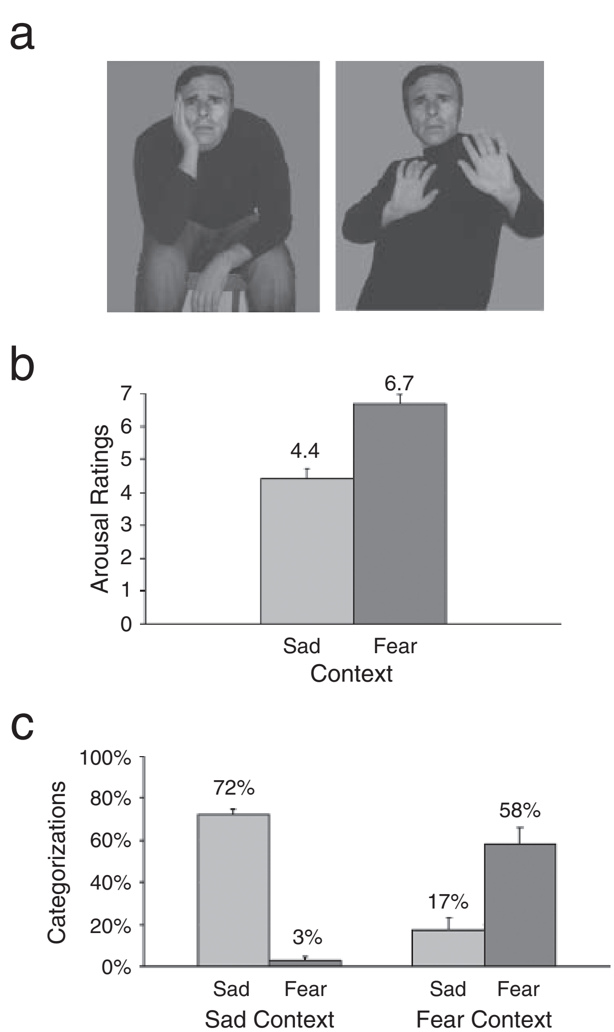

Fig. 3. Test of the effects of context on arousal ratings and categorizations of sad faces in Experiment 2. The illustrations in (a) show an example of a low-arousal facial expression of sadness paired with a low-arousal sadness context (left) and an example of the same face paired with a high-arousal fearful context (right). The graphs present (b) mean ratings of arousal as a function of the context and (c) emotional categorization of the facial expressions as a function of their context. Error bars indicate standard errors of the means.

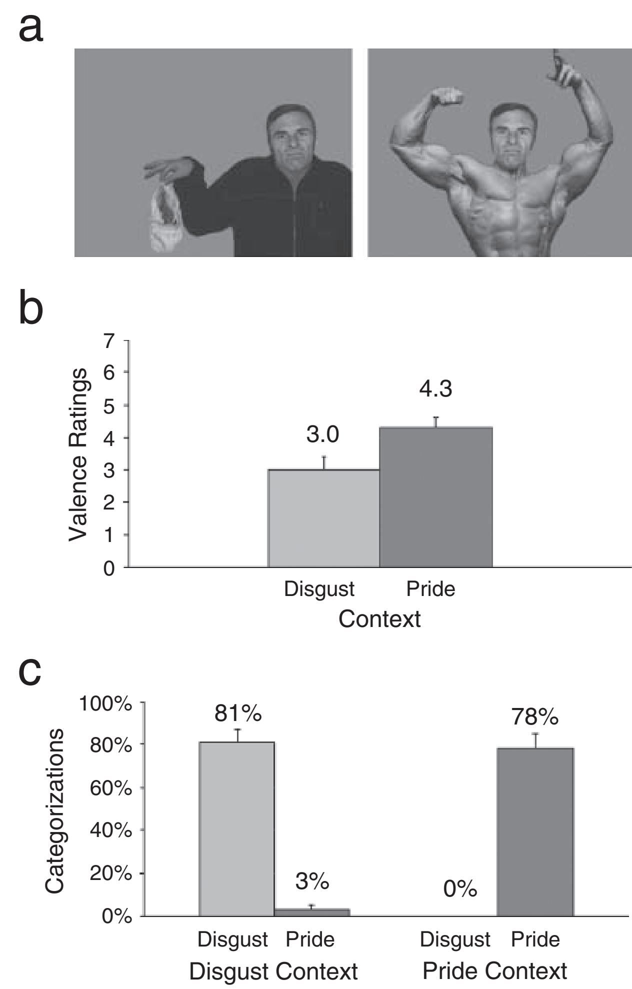

Fig. 4. Test of the effects of context on valence ratings and categorizations of disgusted faces in Experiment 2. The illustrations in (a) show an example of a negative-valence facial expression of disgust paired with a negative-valence disgust context (left) and an example of the same face paired with a positive-valence pride context (right). The graphs present (b) mean ratings of valence as a function of the context and (c) emotional categorization of the facial expressions as a function of their context. Error bars indicate standard errors of the means.

in a fearful context than when they appeared in a sad context, $t(15) = 6.1$, $p < .0001$, $p_{rep} = .996$ (Fig. 3c).

Valence Ratings of Disgusted Faces

The average valence rating of disgusted faces was also significantly influenced by the context. Faces expressing disgust in a pride context were rated as more positive than the same faces in the context of disgust, $t(15) = 3.3$, $p < .005$, $p_{rep} = .966$ (Fig. 4b). The context also exerted a categorical shift in the categorization of discrete emotions. Although the majority of the faces were categorized as expressing disgust when placed in a disgust context, none were categorized as expressing disgust when they appeared in the pride context, $t(15) = 13.9$, $p < .0001$, $p_{rep} = .996$ (Fig. 4c).

EXPERIMENT 3

Experiments 1 and 2 demonstrated that the categorization of facial expressions to discrete emotion categories and the rating of facial expressions' affective dimensions can be altered by the context in which the expressions are embedded. It was unclear, however, if these contextual effects involve changes to the actual processing of faces or are based on postperceptual interpretation. To address this question, we monitored eye movements while participants scanned expressive faces embedded in differing contexts.

Different facial regions are utilized during processing of expressions of disgust and anger. Whereas recognition of disgust requires focusing on the mouth and nose, anger requires focusing on the eyes and eyebrows (Calder, Young, Keane, & Dean, 2000; M.L. Smith, Cottrell, Gosselin, & Schyns, 2005). Eye-tracking studies have shown that when participants view isolated angry faces, they indeed make more fixations to the eye region than to the mouth region, whereas when they view disgusted faces, they fixate the eyes and mouth equivalently (Wong, Cronin-Golomb, & Neargarder, 2005). We hypothesized that when the context-induced emotion and the facial expression are incongruent, the scanning of the face should be affected by the context, rather than by the configuration of the face alone.

Method

Participants

Twenty-six young volunteers (13 females, 13 males) from the Toronto area (21–35 years old, $M = 24.7$) participated.

Stimuli and Design

From Ekman and Friesen's (1976) set, we selected 10 different faces expressing anger and 10 faces of the same 10 models expressing disgust. There were six context images, two that posed anger, two that posed disgust, and two that were neutral. Faces and context images were combined so that each facial expression appeared in one of three contextual conditions: congruent (e.g., angry face in an anger context), incongruent (e.g., angry face in a disgust context), or neutral (e.g., angry face in a neutral context).

Procedure

Stimuli were presented on a 19-in. monitor. Each face-context composite was presented for 5,000 ms and followed by a central fixation cross. The composites subtended a visual angle of 13°. Participants were asked to categorize each face according to which one of six basic emotions it expressed. Eye movements were monitored with an EyeLink II eyetracker. Two custom-built ultraminiature high-speed head-mount cameras took simultaneous images (500-Hz sampling rate) of both eyes to provide binocular pupil tracking, with resolution below 0.5° of visual angle. Eye movements were calibrated using a 9-point calibration-accuracy test. The experiment was approved by the ethics board at Baycrest Rehabilitation Centre, Toronto.

Data Analysis and Dependent Variables

A saccade was defined as a movement of more than 0.5° with acceleration of at least 8000°/s and velocity of at least 30°/s. Saccade offset (fixation onset) was defined as four continuous samples in which the velocity and acceleration were below these values. Each face stimulus was divided into two regions of interest (ROIs): The *upper face*, which included the eyes and eyebrows, and the *lower face*, which comprised the lower nose and mouth area (Wong et al., 2005). Fixations in both predefined ROIs were recorded for every trial.

Results

Facial-Expression Categorization

Angry and disgusted faces in a neutral context were categorized with comparable percentages of accuracy (anger: $M = 56.9\%$, $SD = 20$; disgust: $M = 58.9\%$, $SD = 23$; $p > .7$). When faces appeared in an emotional context, both accuracy (i.e., categorizing the face as expressing the originally intended emotion) and contextual influence (i.e., categorizing the face as expressing the context emotion) showed a significant interaction between the facial expression and the context emotion (both ps $< .0001$, $p_{rep} = .996$). As in Experiments 1 and 2, although face categorization was highly accurate in a congruent context (anger: $M = 86.1\%$, $SD = 3.3$; disgust: $M = 86.9\%$, $SD = 2.7$), accuracy dropped when the same faces appeared in an incongruent context (anger: $M = 34.2\%$, $SD = 3.3$; disgust: $M = 12.6\%$, $SD = 2.9$), as participants were highly prone to perceive the faces as conveying the contextually induced emotion.

Eye Scanning of Faces in a Neutral Context

The number of fixations in the two ROIs was submitted to a 2 (facial expression: anger, disgust) × 2 (ROI: upper face, lower face) repeated measures ANOVA. Replicating previous findings (Wong et al., 2005), a significant interaction indicated that for angry faces, the upper face received more fixations ($M = 5.6$, $SD = 0.5$) than the lower face ($M = 4.6$, $SD = 0.3$), whereas for disgusted faces the pattern of fixations was equal (upper face: $M = 4.8$, $SD = 0.5$; lower face: $M = 4.9$, $SD = 0.3$), $F(1, 25) = 5.13$, $p < .05$, $p_{rep} = .878$. Post hoc comparisons confirmed that more fixations were allocated to the eye region in the angry faces than in the disgusted faces, $t(25) = 2.19$, $p < .05$, $p_{rep} = .878$, and that the number of fixations to the mouth and nose region did not differ significantly between the angry and disgusted faces, $p > .1$. The pattern of results was highly similar for other eye-movement measures, such as average fixation duration, fixation proportion, and saccade count.

Eye Scanning of Faces in an Emotional Context

A 2 (facial expression: anger, disgust) × 2 (context emotion: anger, disgust) × 2 (ROI: upper face, lower face) repeated measures ANOVA on the number of fixations revealed a three-way interaction, $F(1, 25) = 46.3$, $p < .0001$, $p_{rep} = .996$, indicating that scanning changed systematically as a function of context and facial expression (see Fig. 5a). When angry faces appeared in a congruent (anger) context, more fixations were made to the eye region than to the mouth region, $t(25) = 3.13$, $p < .005$, $p_{rep} = .966$. However, when the same faces appeared in a disgust context, the two regions received approximately equal numbers of fixations, $t < .1$. Conversely, when disgusted faces appeared in a disgust context, the mouth and eye regions received approximately equal numbers of fixations, $t < .1$, but when the same faces appeared in an anger context, significantly

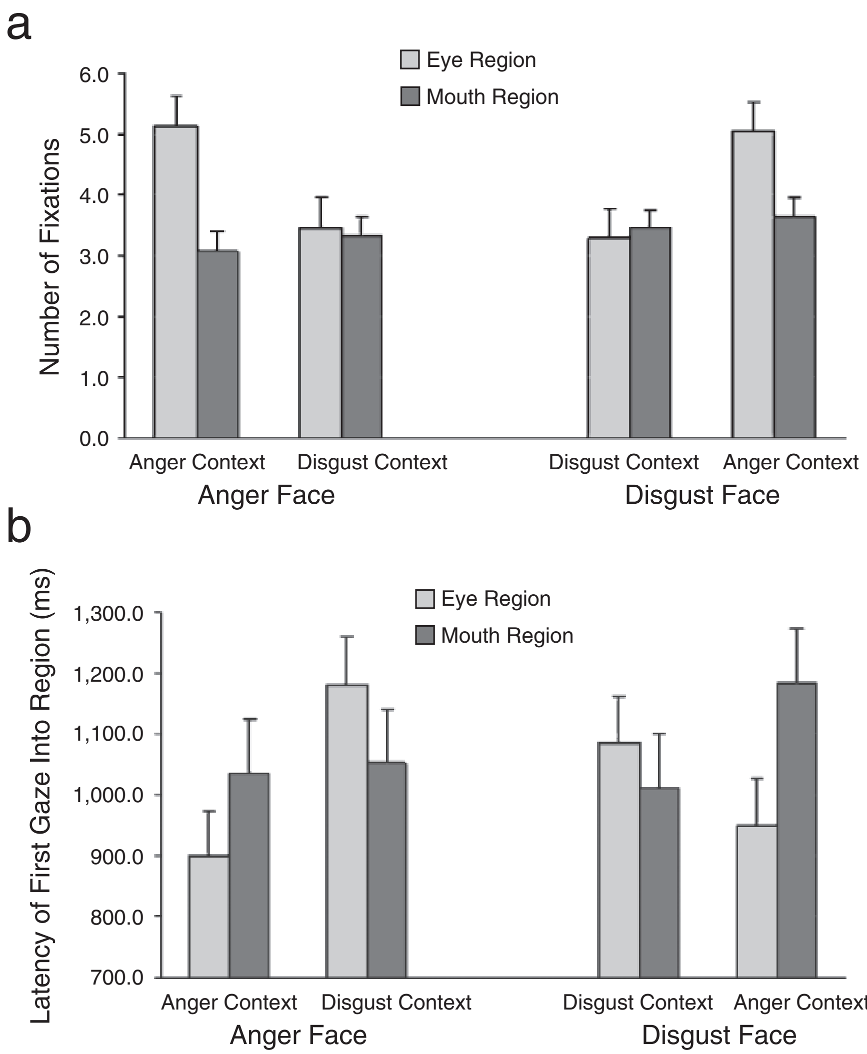

Fig. 5. Results from Experiment 3: effects of context on eye scanning of facial expressions. The graphs present (a) the number of fixations in the eye and mouth regions and (b) the latency of the first eye movement into the eye and mouth regions, as a function of the combination of emotional expression and emotional context. Error bars indicate standard errors of the means.

more fixations were made to the eye region than to the mouth region, $t(25) = 2.2$, $p < .05$, $p_{rep} = .878$.

To determine if context changes the scanning priority of different face regions, we examined how long after stimulus onset each ROI was entered for the first time (i.e., the first gaze). The Face × Context Emotion × ROI interaction was significant, $F(1, 25) = 5.5$, $p < .03$, $p_{rep} = .908$ (see Fig. 5b). Participants were faster to enter the eye region when they viewed angry faces in an anger context than when they viewed the same faces in a disgust context, $t(25) = 2.8$, $p < .008$, $p_{rep} = .956$. Conversely, participants were faster to enter the mouth region when they viewed disgusted faces in a disgust context than when they viewed the same faces in an anger context, $t(25) = 2.6$, $p < .01$, $p_{rep} = .950$.

Thus, facial expressions of disgust and anger are scanned differently when placed in a neutral or congruent context as opposed to an incongruent context. Moreover, an incongruent context changes characteristic eye-scanning patterns from an early stage, resulting in a fixation pattern that reflects the normal scanning of a facial expression that would typically be associated with the emotion expressed by the context.

GENERAL DISCUSSION

The present data challenge an important postulate of the two leading views of how emotions are perceived from facial expressions. Whereas the discrete-category and dimensional theories both postulate that affective information (whether specific emotions or values on the dimensions of valence and arousal) is read solely off the face's physiognomy and, therefore, is immune to contextual influence, we found that the mapping of facial expressions to emotion categories can be influenced strongly by bodily and scene context, even at early stages of perception.

Our results contrast with the discrete-category view in that we found that facial expressions can be perceived as conveying strikingly different emotions depending on the bodily context in which they appear. Unlike the Kuleshov effect, in which context changes the emotion read from neutral faces (Pudovkin, 1929/1970), the effect we demonstrated in the experiments reported here involves categorical changes in the perception of prototypical basic expressions. Our results also contrast with the dimensional view, as context also modulated ratings of the valence and arousal of presented faces. A critical finding is that these effects depended on the similarity between the presented facial expression and the facial expression typically associated with the context emotion. The greater the perceptual similarity between the target face and the context-associated face, the easier it was to perceive the context emotion in the target face.

A useful way to conceptualize these context effects and the influence of the similarity between expressions is by using the metaphor of "emotion seeds." Emotion seeds may be thought of as expressing the perceptual information shared by different facial expressions. Although these seeds lie dormant in isolated faces, they can be activated by appropriate context. If the context activates a facial expression that shares many emotion seeds with the expression displayed by the target face, these seeds "sprout" and may override the original expression of the target face. In contrast, an equally powerful context will have little impact if its associated facial expression shares few emotion seeds with the expression of the target face. According to this model, the absence of context-induced cross-category shifts in previous studies using prototypical faces (e.g., Meeren et al., 2005; Van den Stock, Righart, & de Gelder, 2007) can be explained by the fact that the facial expressions contrasted in those investigations were fairly dissimilar (e.g., fear and anger; Susskind et al., 2007), sharing few emotion seeds.

Examining the pattern of fixations during face scanning, we found that the characteristic eye movements to facial regions, even at very early stages of processing, changed systematically as a function of the affective context in which facial expressions appeared. These data imply that contextual effects do not just reflect late, high-level, interpretive processes. Rather, context induces changes at the most basic levels of visual processing. Recently, Adolphs et al. (2005) showed that eye movements to specific facial features had a crucial role in determining emotion perception. Our results are in line with this observation; the facial regions that are initially attended are determined by context, and which regions are attended first might affect the perceived emotion.

In conclusion, our study indicates that the affective information read out from the face is influenced both by the actual expression exhibited by the face and by the facial expression typically associated with the context in which the face appears. This account is valid regardless of whether the information in question identifies specific emotion categories or concerns the values of affective dimensions. In both cases, contextual effects are strongly governed by the emotion seeds shared by the target and context-associated facial expressions.

For decades, researchers investigating emotion perception have taken measures to control for any confounding effects of context, and hence its importance has been underemphasized. In contrast, our results suggest that context plays a key role in the readout of emotion from facial configuration. Consequently, we propose that basic models of perception of facial expressions must be modified to include face-context interactions. A beginning is provided by the current characterization of the rules and potential mechanisms that govern these interactions.

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