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Emotion – in press

Processing Orientation and Emotion Recognition

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Brief Report

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Abstract

There is evidence that some emotional expressions are characterised by diagnostic cues from individual face features. For example, an upturned mouth is indicative of happiness, while a furrowed brow is associated with anger. The current investigation explored whether motivating people to perceive stimuli in a *local* (i.e., feature-based) rather than *global* (i.e., holistic) processing orientation was advantageous for recognising emotional facial expressions. Participants classified emotional faces while primed with local and global processing orientations, via a Navon-letters task. Contrary to previous findings for identity recognition, the current findings are indicative of a modest advantage for face emotion recognition under conditions of *local* processing orientation. When primed with a local processing orientation, participants performed both significantly faster and more accurately on an emotion recognition task than when they were primed with a global processing orientation. The impacts of this finding for theories of emotion recognition and face processing are considered.

Processing Orientation and Emotion Recognition

Processing facial cues can provide perceivers with socially relevant information regarding the identity, age, gender and current emotional state of others. There is evidence that performance on one aspect of face processing – recognising identity – is not necessarily constant and can be influenced by implementing different perceptual processing strategies (Macrae & Lewis, 2002; Perfect, 2003; Weston & Perfect, 2005). Specifically, face identification performance is better when adopting a global (i.e., holistic) rather than a local (i.e., feature-based) processing orientation (Macrae & Lewis, 2002). It has been suggested that employing a global perceptual orientation might enhance the configural processing operations that dominate face recognition (Macrae & Lewis, 2002; see Perfect, Weston, Dennis, & Snell, 2008 for an equally plausible account of the same phenomenon). At the same time, however, there is also evidence that configural face processing strategies are not always optimal. For example, making categorical face judgements (e.g., sex, race) is optimised through the extraction of individual category-specifying face features (Cloutier, Mason, & Macrae, 2005; Macrae & Martin, 2007; Martin & Macrae, 2007)

Making categorical decisions about the current emotional state of others may well be another example of a face processing task that benefits from a feature-based perceptual strategy. There is certainly evidence that individual face features can be strongly diagnostic of specific emotions (e.g., an upturned mouth is indicative of happiness, while a furrowed brow signals anger; Ellison & Massaro, 1997). Is it possible that employing a local rather than global processing strategy may result in an advantage for emotion recognition? To explore this possibility we examined whether adopting a local relative to global processing orientation improved performance in an emotion recognition task.

While the relative dominance of configural over feature-based face information for identity recognition has been widely documented (Tanaka & Farah, 1993; Young, Hellawell,

& Hay, 1987), there have been comparatively few examinations of the perceptual determinants of emotion recognition. What little evidence there is regarding the role of configural/featural face cues is somewhat mixed (Bassili, 1979; Calder, Young, Keane, & Dean, 2000; Ellison & Massaro, 1997; White, 2000). One commonly cited example of a configural bias for emotion processing comes from research by Calder and colleagues (2000), who found that emotion recognition was superior for misaligned composite face stimuli in which the top half represented one emotion and the bottom half another than for aligned versions of the same stimuli, and that this effect was attenuated when stimuli were inverted. This mirrors similar findings for identity discrimination and suggests our overwhelming drive to perceive faces as holistic perceptual units (Tanaka & Farah, 1993) impacts the manner in which we extract signals of emotion. At the same time, however, Experiment 1 of the investigation by Calder and colleagues highlighted the utility of individual face features as emotional cues. It was found that emotion recognition accuracy was no better for whole face images than half face images (either the top or bottom sections of a face) for all six basic emotions (i.e., anger, disgust, fear, happiness, sadness, surprise). It seems that there are individual feature-based cues that may be diagnostic of specific expressions; for example, viewing only the mouth tends to result in greater accuracy for judgements of happiness and disgust than viewing only the eye region, whereas viewing the eyes is a much better indicator of anger, sadness and fear than is viewing the mouth (Calder et al., 2000; Sullivan, Ruffman & Hutton, 2007).

Other research has examined more directly the possibility that individual face features have differential diagnostic power when categorising emotional expressions (Ellison & Massaro, 1997). Ellison and Massaro suggest that rather than processing emotional expressions holistically, we simultaneously extract information independently from multiple individual face features. The information from these sources is then integrated and used to make an emotion categorisation. They demonstrated that although emotion categorisations occur most efficiently when multiple face features convey consistent emotional signals, the presence of single unambiguous diagnostic features (e.g., an upturned mouth) is sufficient for accurate categorisations independent of whether an additional feature (e.g., eyebrow position) was indicative of the same emotion. This suggests that when basic emotions are unambiguously signalled, individual face features may dominate the process of emotion categorisation.

Visual scanning studies provide further evidence for the importance of individual features in the recognition of facial expressions of emotion (Adolphs et al., 2005; Sullivan et al., 2007). Sullivan et al. (2007) found that those who fixated more on the mouth region of happy and disgusted facial expressions demonstrated superior recognition of these emotions, whereas increased fixation of the eye-region was associated with better recognition of fear, anger and sadness. Impairments in emotion recognition after amygdala damage have also been associated with difficulties in extracting information from specific facial features. For example, instructing a patient with amygdala damage to focus on the eye-region of certain emotion faces (e.g., fear) improved her ability to recognise fearful facial expressions to that of the same level as control participants (Adolphs et al., 2005). Taken together, these findings highlight the importance of focusing on specific features of emotional faces when attempting to successfully decode emotional state.

The possibility that individual face features may influence emotion recognition is one that also has some support in neuroscience examinations of the topic (Adolphs, 2002). There is evidence that very early in the face processing stream sub-cortical structures (e.g., superior colliculus, pulvinar thalamus, amygdala) are involved in extracting coarse feature-based information from the visual array (Morris, de Gelder, Weiskrantz, & Dolan, 2001; Vuilleumier, Armony, Driver, & Dolan, 2003; Whalen et al., 1998; although see Johnson, 2005). This sub-cortical activity, coupled with early cortical analysis in V1 and V2, has been suggested as a route for processing highly salient facial expressions, such as those for fear and anger (Adolphs, 2002). It has been suggested that the advantage for identifying such expressions is reliant on the early detection of highly salient individual diagnostic features (e.g., Adolphs, 2002).

Building on the weight of evidence suggesting that some face features are better diagnostic indicators of specific emotions than others (Bassili, 1979; Calder et al., 2000; Ellison & Massaro, 1997, Sullivan et al., 2007), and that processing orientation modulates configural and featural face processing (Macrae & Lewis, 2002), the current research examined whether adopting a local relative to global perceptual processing orientation results in an advantage for emotion recognition. The accuracy and response latency with which participants reported six basic emotional expressions of briefly presented faces was assessed across two experimental conditions: one priming a local processing orientation and one priming a global processing orientation. Processing orientation was primed using a Navon-letters task (Macrae & Lewis, 2002; Navon, 1977). It was hypothesised that employing a local processing orientation would benefit emotion recognition by improving sensitivity to diagnostic feature-based cues (Ellison & Massaro, 1997).

Method

Participants and Design

One hundred and twenty participants (93 female) from the University of Aberdeen completed the experiment for course credit. Ten participants were excluded due to excessively high error rates (> 3 S.D. above the median). The experiment had a 2 (Processing Orientation: local or global) X 6 (Emotion: Anger, Disgust, Fear, Happiness, Sadness, Surprise) repeated measures design.

Stimulus Materials and Procedure

Participants arrived at the laboratory in groups of 20 to 30, were greeted by a male experimenter and were each seated facing a computer screen. Participants were informed that they would complete 4 blocks: a global processing task (priming block), a global/emotion task (critical block), a local processing task (priming block), and a local/emotion task (critical block).

Priming task (blocks 1 & 3) - To ensure that participants were engaged in the primed processing orientation from the beginning of the critical trials, prior to each global/emotion and local/emotion block participants completed a respective block of either global processing or local processing Navon trials (48 trials in each block). Each Navon trial comprised the presentation of: a fixation cross for 500ms, a Navon figure that was either consistent (e.g., an *S* composed of *S*s) or conflicting (e.g., an *S* composed of *T*s) for 100ms, a complex mask (i.e., random pattern) for 1000ms, and a response screen that remained until a response was made (Hübner & Volberg, 2005; Martin & Macrae, 2010). At the start of each block participants were instructed to direct their attention to either the global or local form of letters and asked to make their response in each trial by pressing a key corresponding to the appropriate letter. The Navon stimuli had global precedence (i.e., the large global letter was dominant; Martin & Macrae, 2010), with the global stimuli covering an area of approximately 150 mm X 130 mm, and local stimuli presented in 12-point Times New Roman font.

Emotion perception task (Blocks 2 & 4) - To try and ensure the primed processing orientation remained throughout the critical block, trials alternated between a Navon task and an emotion recognition task on a trial by trial basis (i.e., Navon trial – emotion trial – Navon trial – emotion trial; see Figure 1). Faces were presented briefly in an attempt to avoid ceiling effects associated with recognition of happiness (e.g., Martinez & Du, 2010). The inter-trial interval was 1500ms. Navon trials were identical to those from the priming task (above).

Each trial of the emotion recognition task comprised the presentation of: a fixation cross for 500ms, an emotional face for 125ms, a complex mask (i.e., random pattern) for 100ms, followed by a response screen which remained until a response was made. Participants reported the emotion they thought each face was expressing by pressing one of 6 buttons each corresponding to one of the 6 emotions. The emotional face stimuli consisted of 96 grayscale images, comprising 16 different identities of unfamiliar individuals (8 female), each depicting 6 different emotional expressions (i.e., anger, disgust, fear, happiness, sadness, surprise; Nim Stim; Tottenham et al., 2009). The accuracy and latency of responses was recorded by the computer.

In each emotion perception block there were 48 Navon trials (24 consistent and 24 conflicting) and 48 critical emotion trials (i.e., each of the 6 emotional expressions appearing in 8 trials). The order of blocks (i.e., whether the global or local blocks appeared first), the face stimuli used in each block, and the meaning of response keys were counterbalanced across participants. The order of trials within each block was randomised.

Results

The proportion of correct responses were analysed using a 2 (Processing Orientation: local or global) X 6 (Emotion: Anger, Disgust, Fear, Happiness, Sadness, Surprise) repeated measures analysis of variance (ANOVA). The analysis revealed a main effect of Processing Orientation, [$F(1, 109) = 11.48$, $p < .01$; $\eta p^2 = .095$], with participants better at recognising emotional expressions in the local processing condition than in the global processing condition (Respective *M*s: .74 vs. .72; respective *S.E.s*: .006 vs. .006 – the effect size of this difference equates to Cohen’s $d = .45$; a ‘small effect’). There was also a main effect of Emotion [$F(5, 545) = 199.07$, $p < .001$; $\eta p^2 = .646$]; the proportion of correct response to all emotions differed from one another ($p < .001$) with the exception of anger and disgust, and sadness and surprise, which did not differ (Table 1). There was no evidence of an interaction between Processing Orientation and Emotion [$F(5, 545) = 1.31$, $p = .26$; $\eta p^2 = .012$; Table 1].

Median correct response times were also analysed using a 2 (Processing Orientation: local or global) X 6 (Emotion: Anger, Disgust, Fear, Happiness, Sadness, Surprise) repeated measures (ANOVA). The analysis revealed a main effect of Processing Orientation [$F(1, 109) = 9.69$, $p < .01$; $\eta p^2 = .082$] with participants faster to respond in the local processing condition than in the global processing condition (respective *M*s: 1263ms vs. 1377ms; respective *S.E.s*: 31ms vs. 33ms – the effect size of this difference equates to Cohen's $d = .42$; a 'small effect'). There was also a main effect of Emotion [$F(5, 545) = 187.42$, $p < .001$; $\eta p^2 = .632$]; the response times to all emotions differed from one another ($p < .001$) with the exception of anger and disgust, and disgust and surprise, which did not differ (Table 1). There was no evidence of an interaction between Processing Orientation and Emotion [$F(5, 545) = .394$, $p = .85$; $\eta p^2 = .004$; Table 1].

Discussion

The current research examined the relationship between global and local processing orientation and a key aspect of face processing – emotion recognition. When primed with a local processing orientation, participants performed significantly better on an emotion recognition task, both in accuracy and speed of responses, than when they were primed with a global processing orientation. These findings are indicative of an advantage for recognition of emotional facial expressions under conditions of *local* processing orientation. The current results are contrary to those of previous research that demonstrated that another aspect of face processing – discriminating identity – can be enhanced by engaging in a global processing orientation (Macrae & Lewis, 2003; Perfect, 2003). At the same time, these results compliment previous findings indicating that engaging in a local, relative to global, perceptual style improves performance when a feature-based face processing strategy is optimal (Weston & Perfect, 2005).

Why is there an advantage for emotion recognition accuracy when a local, relative to global, processing orientation is primed? One possibility is that performing a locally oriented Navon task and identifying emotions are both tasks that are optimised when attention is directed towards extracting individual features of a more complex visual scene. Just as performing a locally oriented Navon task requires identifying the component letters of a larger image, so under certain circumstances recognising emotional expressions may be improved by directing attention towards useful individual face features (Ellison & Massaro, 1997). Thus, similarly to instructing participants to look at specific regions of emotional faces (Adolphs et al., 2005), a local processing orientation may improve the efficiency of emotion recognition by facilitating the extraction of diagnostic feature-based face cues (Ellison & Massaro, 1997; Joyce, Schyns, Gosselin, Cottrell, & Rossion, 2006).

An alternative explanation of the current findings is that rather than representing an overlap between emotion recognition and local processing, they might instead reflect an association between emotion recognition and analytical processing of visual stimuli (Perfect et al., 2008). Perfect and colleagues found that focusing on featural face information was easier under conditions of controlled/analytical processing style, relative to automatic processing style, irrespective of whether this was driven by global or local precedence stimuli. Specifically, recognition of composite faces (Young et al., 1987) was improved when a priming task required a non-automatic, controlled/analytic processing style (i.e., either local responses to global precedence stimuli or global responses to local precedence stimuli). By this logic, in the current task context, where global precedence Navon letters were used, emotion recognition performance might be advantaged because participants were primed with an analytic (i.e., feature-based) rather than automatic (i.e., configural) processing mode.

With this in mind, future research should attempt to elucidate whether global responses to local precedence Navon stimuli produce similar findings to those reported here.

There are consistent theoretical (e.g., Bruce & Young, 1986; Haxby, Hoffman, & Gobbini, 2000), behavioural (for a review, see Palermo & Rhodes, 2007) and neuroscience reports (e.g., Vuilleumier et al., 2003) that recognising the identity of a face and discriminating the emotion that it is expressing are quite distinct cognitive operations (although see Calder & Young, 2005). Given this suggestion of relative functional independence of identity and emotion processing, are the current findings evidence of a feature-based rather than a configural/holistic-based explanation of facial emotion recognition? We suspect not. Evidence from social psychological explorations of categorical face processing (e.g., sex categorisation), suggest that under circumstances when processing conditions are challenging (e.g., brief presentation duration, degraded image quality) there is an advantage for the extraction of coarse feature-based cues (e.g., Macrae & Martin, 2007; Martin & Macrae, 2007). When, however, processing conditions are improved, configural face processing dominates the person perception experience (Macrae & Martin, 2007). The advantage for emotion recognition under locally oriented attention may be a consequence of faces being presented for relatively brief durations (i.e., 125ms). If participants were given longer to view face images any local advantage may be attenuated or extinguished; similarly, making the task more difficult (e.g., shorter presentation duration) may increase the benefits associated with a local processing orientation. Indeed, given the relatively moderate advantage for emotion recognition accuracy afforded under local processing conditions reported here (i.e., 2% more correct responses in the local condition) replicating this effect should be a priority.

The current findings that participants were most accurate at perceiving happy facial expressions and least accurate recognising fear provides further evidence that some emotional expressions are easier to categorise than others (Young et al., 2002). Ceiling effects are consistently found for the recognition of happy facial expressions as due to the nature of the task smiling faces are rarely mistaken for the other predominately negative emotion labels. In contrast, fear is often confused with a number of the other emotional expressions; most commonly surprise but also anger and disgust (Burgoon & Bacue, 2003). There was not, however, a significant interaction between emotional expression and processing orientation, suggesting that the local advantage is relatively consistent across the six emotional expressions used in this study.

The current study is the first we are aware of to demonstrate the influence of perceptual style on a task of online face processing rather than one of face memory (Macrae & Lewis, 2002; Perfect, 2003). This is a notable distinction as it suggests global/local processing orientation might impact other socially relevant online face processing tasks, such as identifications of sex, race and age. If this were the case, in addition to the specific implications for emotion recognition alone, the relationship between processing orientation and the manner in which we extract categorical information from faces may have wider social-cognitive ramifications that impact the way we integrate multiple competing feature-based cues (e.g., a smiling mouth and averted gaze).

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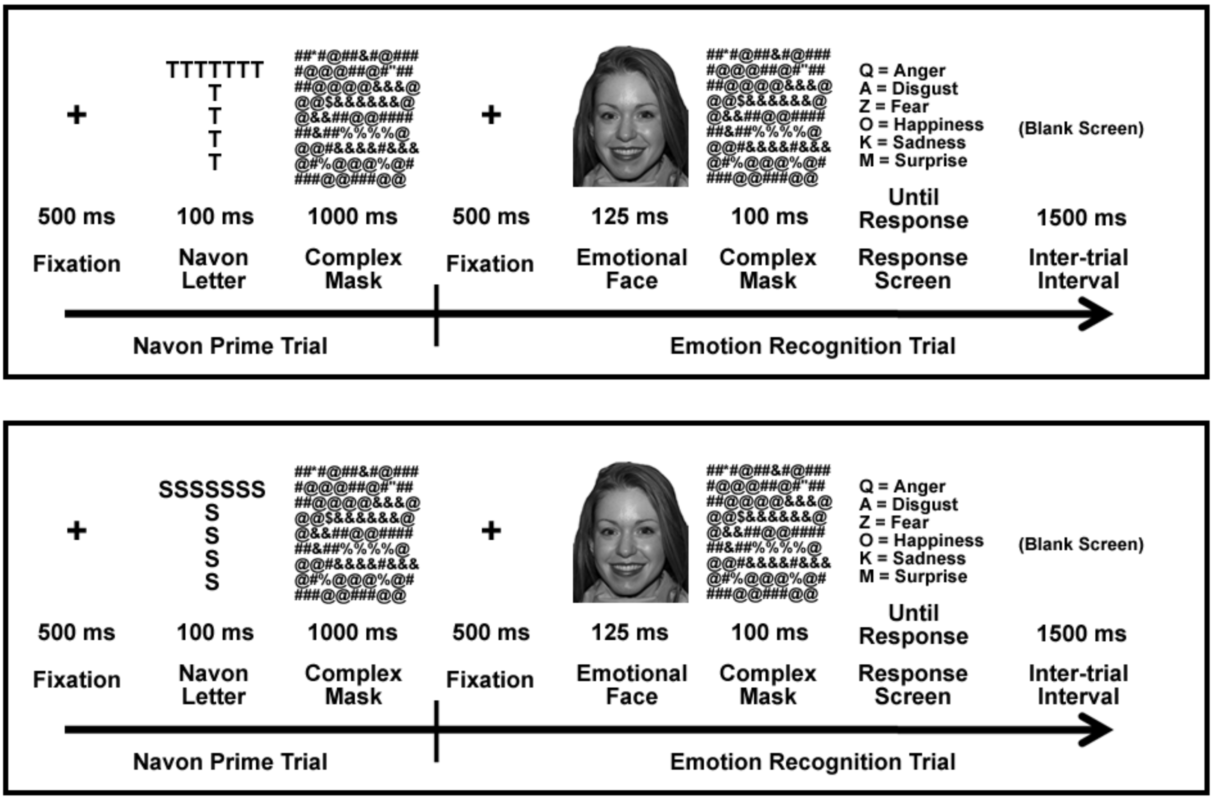

Figure 1. Examples of trial structure in primed emotion recognition task (Top panel: consistent Navon letter trial; Bottom panel: inconsistent Navon letter trial)

Table 1. Task Performance by Emotion & Processing Orientation

		Anger	Disgust	Fear	Happy	Sad	Surprise
Local Orientation	Proportion Correct	0.69	0.65	0.50	0.97	0.83	0.81
	S.E.	*0.014*	*0.014*	*0.019*	*0.005*	*0.013*	*0.014*
	Response Latency (ms)	1407	1323	1656	822	1112	1257
	S.E.	*47*	*41*	*48*	*24*	*36*	*36*
Global Orientation	Proportion Correct	0.65	0.64	0.49	0.96	0.79	0.79
	S.E.	*0.016*	*0.013*	*0.018*	*0.006*	*0.015*	*0.014*
	Response Latency (ms)	1493	1440	1778	922	1258	1374
	S.E.	*47*	*43*	*49*	*23*	*41*	*43*
Total	Proportion Correct	0.67	0.64	0.50	0.96	0.81	0.8
	S.E.	*0.013*	*0.012*	*0.016*	*0.004*	*0.01*	*0.013*
	Response Latency (ms)	1450	1381	1717	872	1185	1316
	S.E.	*36*	*36*	*38*	*20*	*29*	*34*