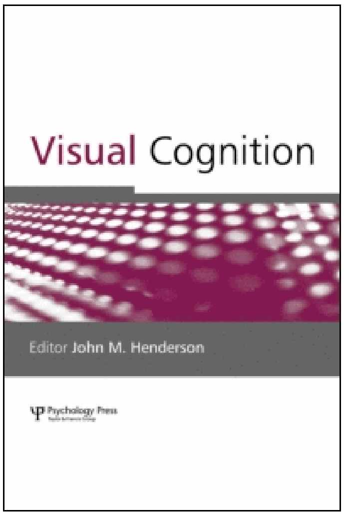

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Processing style and person recognition: Exploring the face inversion effect

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Processing style and person recognition: Exploring the face inversion effect

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It has frequently been reported that recognition performance is impaired when faces are presented in an inverted rather than upright orientation, a phenomenon termed the face inversion effect (FIE). Extending previous work on this topic, the current investigation explored whether individual differences in global precedence—the propensity to process nonfacial stimuli in a configural manner—impacts memory for faces. Based on performance on the Navon letter-classification task, two experimental groups were created that differed in relative global precedence (i.e., strong global precedence [SGP] and weak global precedence [WGP]). In a subsequent face-recognition task, results revealed that while both groups demonstrated a reliable FIE, this effect was attenuated among participants displaying WGP. These findings suggest that individual differences in general processing style modulate face recognition.

Keywords: Social cognition; Face processing; Individual differences; Person perception; Face perception.

It is 40 years since Yin's (1969) seminal demonstration that face recognition is impaired when stimuli are presented in an inverted (i.e., rotated through 180°) rather than upright (i.e., canonical) orientation, the so-called *face inversion effect* (FIE). Replicated on numerous occasions (for reviews, see Searcy & Bartlett, 1996), this effect has been traced to impairments in the extraction of configural information from disoriented faces (Farah, Tanaka, & Drain, 1995; Tanaka & Farah, 1993). Compared with other classes of object, face

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recognition is a complex task that demands the fine-grained perceptual discrimination of homogeneous stimuli (Kanwisher, McDermott, & Chun, 1997). The extraction of configural (i.e., holistic) rather than featural (i.e., isolated features) information is acknowledged to support this ability (Tanaka & Farah, 1993; Young, Hellawell, & Hay, 1987), particularly when faces are presented in an upright orientation (Maurer, Le Grand, & Mondloch, 2002; Robbins & McKone, 2003). When faces are inverted and the extraction of configural information is compromised, reliance on available feature-based cues impedes person recognition (e.g., Rhodes, Brake, & Atkinson, 1993; Robbins & McKone, 2003).

Although an extensive literature corroborates the importance of configural information to face recognition, it is unclear if there are systematic differences in people's sensitivity to this information, hence their face recognition performance. Recent research examining the face processing abilities of individuals with autistic spectrum disorders (ASD), however, suggests that a reliance on configural information to recognize others is by no means universal (Behrmann et al., 2006; Lahaie et al., 2006). Specifically, accumulating evidence suggests that some individuals with ASD display a propensity to process complex stimuli, including faces, at a feature-based level (Joseph & Tanaka, 2003; Lahaie et al., 2006). One consequence of this feature-driven approach to person perception is that while some individuals with high-functioning autism display impaired face recognition skills, they do not necessarily exhibit the costs commonly associated with facial inversion (e.g., Dawson, Webb, & McPartland, 2005). Indeed, some studies with ASD populations have reported an inverse FIE, such that individuals with ASD are better at recognizing inverted than upright faces (Hobson, Ouston, & Lee, 1988). It must be noted, however, that there are considerable inconsistencies in the literature concerning the perceptual abilities associated with ASD, particularly with respect to the emergence of the FIE (e.g., Nishimura, Rutherford, & Maurer, 2008; Teunisse & de Gelder, 2003).

Intriguingly, there is also evidence to suggest that, at least for nonfacial stimuli, certain members of the general population display a reliance on feature-based information. Happé, Briskman, and Frith (2001), for example, reported that normal-functioning parents of children with ASD demonstrate facilitated performance on tasks in which detail-oriented (i.e., feature-based) processing is advantageous, such as the embedded figures test (Witkin, Oilman, Raskin, & Karp, 1971). There is also evidence of broad individual differences in the natural human tendency to process information at a global rather than local level (Frith & Happé, 1994). It has been suggested that individuals who show high levels of performance on activities such as the Embedded Figures Test (Witkin et al., 1971), the Rod and Frame Test (Witkin & Asch, 1948), and the Block Design Tasks that are commonly included in intelligence test batteries (e.g., Wechsler Adult Intelligence Scale

III; Wechsler, 1997) do so because they display *weak central coherence*, the tendency not to focus on the global aspects of visual stimuli (Frith & Happé, 1994; Happé & Frith, 2006).

But what of face recognition abilities in the general population, might people differ in their reliance on configural information when processing faces? A couple of lines of research suggest that this may be the case. First, in the nonfacial domain, researchers have identified individual differences in what has been termed *global precedence*, the propensity to process complex visual stimuli in a holistic (i.e., configural) manner (i.e., as a single gestalt; Happé et al., 2001; Navon, 1977; Witkin et al., 1971). Is it possible, therefore, that this basic processing difference may also extend to face recognition. Second, the costs and benefits of processing faces at a global or local level have been identified in studies exploring the malleability of person recognition (see Macrae & Lewis, 2002; Perfect, 2003; Weston & Perfect, 2005). What this work suggests is that different processing strategies (i.e., global vs. local) can be primed, with predictable effects on face recognition performance. Specifically, whereas the adoption of a global processing strategy enhances face recognition, triggering a local processing orientation impairs person identification (Macrae & Lewis, 2002).

There is, then, evidence to suggest that face recognition is impacted by an individual's orientation to global or local facial features during stimulus encoding (Macrae & Lewis, 2003; Perfect, 2003). In addition, it is apparent that individuals differ in their propensity to perceive complex visual stimuli in a global or local manner (e.g., Happé et al., 2001; Witkin et al., 1971). Taken together, these findings suggest that there may be systematic individual differences in people's basic face processing abilities. In particular, the strength of people's propensity to process faces in a configural manner may moderate the magnitude of the FIE. To explore this possibility, we created two experimental groups (i.e., strong global precedence, SGP, and weak global precedence, WGP) based on performance on the Navon letter-classification task (Navon, 1977). In a subsequent recognition task, we then measured memory for upright and inverted faces in each of these groups.

METHOD

Participants and design

Forty-eight undergraduates (30 female) from the University of Aberdeen completed the experiment for course credit. The experiment had a 2 (Global precedence: SGP or WGP) $\times$ 2 (Face orientation: upright or inverted) mixed design with repeated measures on the second factor.

Stimulus materials and procedure

Participants arrived at the laboratory individually, were greeted by a male experimenter, and seated facing a computer screen at a standard viewing distance of 57 cm. In the letter-identification task, participants were required to report the global or local identity of a series of Navon (1977) letters as quickly and accurately as possible via a keypress. Each trial comprised the presentation of a fixation cross for 500 ms, followed by a global or local precedence cue for 1000 ms (the word "global" or "local" respectively). 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) then appeared for 100 ms, before being replaced by a complex mask (i.e., random pattern) for 1000 ms. Participants were asked to make their response by pressing a key corresponding to the letter to which their attention had been directed. There was a 1500 ms intertrial interval. The global stimuli covered an area of approximately 150 mm × 130 mm, with local stimuli presented in 12-point Times New Roman font. Participants completed 192 experimental trials, 96 with a global orientation and 96 with a local orientation. Critically, half of the trials in each orientation were consistent and half were conflicting. The order of trials was randomized for each participant.

Two experimental groups (i.e., SGP and WGP) were formed based on relative global processing precedence, as evidenced by reaction time performance during the Navon task. Trials on which errors were committed were excluded from the process of creating the groups. An index of relative global precedence was created by subtracting the interference effect on local trials from the corresponding effect on global trials [i.e., global precedence index = (global consistent − global conflicting) − (local consistent − local conflicting)]. A median split was then performed on these data. As the majority of participants showed greater interference from global than local forms, we use the terms "strong" and "weak" global precedence in a purely relative sense to distinguish between those individuals who were both poor at ignoring the global form on local trials and good at attending to the global form on global trials, and those people who were good at ignoring the global form on local trials and poor at attending to the global form on global trials. Thus, those individuals who scored above the median (i.e., high global interference during the local processing task relative to low local interference during the global processing task) were assigned to the SGP group (14 females) and those individuals who scored below the median (i.e., high local interference during the global processing task relative to low global interference during the local processing task) were assigned to the WGP group (16 females).

To establish if the groups differed in their performance on the Navon task, response latency and error data (i.e., difference scores; conflicting trials

– consistent trials) were analysed using separate 2 (Global precedence: SGP or WGP) × 2 (Direction of attention: global or local) mixed model analyses of variance (ANOVAs). The treatment means are listed in Table 1. Analysis of the response latencies revealed a main effect of Direction of attention, $F(1, 46) = 47.75$, $p < .001$, such that interference was greater when attention was directed to the local rather than global aspects of the stimuli (respective *M*s: 110 ms vs. 21 ms). The analysis also yielded a Global precedence × Direction of attention interaction, $F(1, 46) = 62.12$, $p < .001$. Simple effects analyses revealed that while the SGP group showed significantly more interference on local than global trials, $F(1, 23) = 67.78$, $p < .001$ (respective *M*s: 170 ms vs. –21 ms), this effect was not reliable for the WGP group, $F(1, 23) < 2$, *ns* (respective *M*s: 50 ms vs. 63 ms).

Analysis of the error data revealed only a main effect of Direction of attention, $F(1, 46) = 18.83$, $p < .001$, indicating that more errors were committed when attention was directed to the local rather than global aspects of the stimuli (respective *M*s: 9% vs. 3%).

Several weeks after completing the Navon task (i.e., on average 6 weeks later), the same participants completed a standard face-recognition experiment. Participants viewed 64 greyscale images of upright unfamiliar faces depicted in frontal pose displaying neutral facial expressions (32 male and 32 female). The test stimuli comprised 128 unfamiliar faces (64 old and 64 new), half of which were upright and half of which were inverted. Each trial comprised the presentation of a central fixation cross which remained on screen for 500 ms; this was followed by a display containing the target face which remained on screen for 5000 ms. There was a 1500 ms intertrial interval. The order of presentation of the faces was randomized and the orientation of the test items (upright or inverted) was counterbalanced across the sample. In the test phase, participants reported the status of the faces (i.e., old or new) by means of a keypress.

TABLE 1
Navon task performance as a function of global precedence group

	Direction of attention			
	Globally directed		*Locally directed*	
Trial type	*Consistent*	*Conflicting*	*Consistent*	*Conflicting*
Reaction time (ms)				
Strong precedence	491	470	528	698
Weak precedence	366	429	451	501
Error rate (%)				
Strong precedence	3	4	1	11
Weak precedence	1	6	2	11

RESULTS

Measures of recognition sensitivity (d') and response bias (C) were computed for each participant and the resulting data were submitted to separate 2 (Global precedence: SGP or WGP) × 2 (Face orientation: upright or inverted) mixed model ANOVAs. Analysis of d' yielded a main effect of Face orientation, such that upright faces were recognized more accurately than inverted faces, $F(1, 46) = 91.85$, $p < .001$ (respective *M*s: 3.02 vs. 1.47). Importantly, a Global precedence × Face orientation interaction also emerged, $F(1, 46) = 4.38$, $p < .05$ (see Figure 1). Simple effects analyses revealed that both groups displayed a significant FIE: SGP, $F(1, 23) = 48.65$, $p < .001$; WGP, $F(1, 23) = 46.85$, $p < .001$. As expected, however, the magnitude of this effect (i.e., upright > inverted) was greater for the SGP than the WGP group, $t(46) = 2.09$, $p < .05$ (respective *M*s: 1.89 vs. 1.21). This difference in the magnitude of the FIE was driven by performance on the upright faces. When the stimuli were upright, participants in the WGP group outperformed their counterparts in the SGP group, $F(1, 46) = 7.04$, $p < .05$. When however the faces were inverted, performance across the groups did not differ, $F(1, 46) < 1$, *ns.*

Analysis of C yielded a Global precedence × Face orientation interaction, $F(1, 46) = 4.25$, $p < .05$. Simple effects analysis revealed that participants in the SGP group adopted a more liberal response bias to inverted than upright faces (respective *M*s: -0.074 vs. 0.093). No such effect emerged for participants in the WGP group, $F(1, 23) < 1$, *ns* (respective *M*s: 0.066 vs. 0.058).

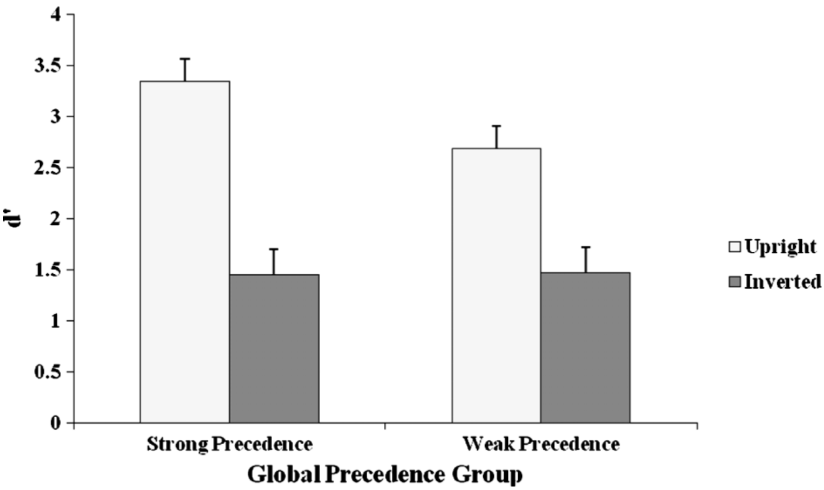

Figure 1. Recognition memory performance as a function of face orientation and global precedence group. Error bars denote standard error of the mean.

GENERAL DISCUSSION

Yin's (1969) demonstration of the FIE was a milestone in face processing research as it indicated that the manner in which human faces are processed may be different from other classes of visual stimuli. Although the general idea that face processing is in some way "special" remains a topic of considerable debate (Gauthier & Tarr, 1997; Kanwisher et al., 1997), there is greater consensus among researchers about the critical role played by configural information in supporting face recognition (Gauthier & Tarr, 1997; Kanwisher et al., 1997; Tanaka & Farah, 2003). The current findings support and extend previous research on this topic in a number of potentially interesting ways. First, the results provide further evidence for the FIE. Compared to upright faces, inverted faces are recognized more poorly (Yin, 1969). Second, and more importantly, our findings suggest that the magnitude of the FIE is moderated by individual differences in people's basic perceptual processing styles. In particular, the propensity to perceive stimuli (i.e., Navon letters) at a less global level is associated with an attenuated FIE.

Several recent studies have demonstrated that the implementation of specific processing orientations impacts face recognition performance (Macrae & Lewis, 2003; Perfect, 2003). The explanation that has been advanced for these effects is that employing a global or local orientation respectively enhances or interferes with the configural processing operations that support face recognition (Macrae & Lewis, 2003). Building on these findings, the current results suggest that individual differences in the tendency to process complex visual information at a global level also impacts recognition performance. Specifically, relative global precedence modulates the magnitude of the FIE. In so doing, the current results extend Behrmann et al.'s (2006) work exploring the visuoperceptual processing abilities of adults with autism. Also using the Navon letter-classification task, Behrmann et al. reported a relationship between letter naming and performance on tasks that rely on configural processing—face and Greeble recognition. In particular, the larger the local processing bias displayed during the letter-classification task, the greater the observed deficits in both face and Greeble discrimination. Complementing Behrmann et al.'s research, the current findings reveal how basic processing differences (i.e., relative global precedence) in the general population can also impact face recognition.

Configural processing is the oft-used umbrella term to describe the perception of relations among facial features and can be divided into three types: sensitivity to first-order relations (i.e., faces have a standard arrangement of features); sensitivity to second-order relations (i.e., perceiving the distances among features); and holistic processing (i.e., viewing the entire face as a single perceptual unit or gestalt; Maurer et al., 2002). But which of these aspects of face processing is implicated in the current findings? As first-order relations do not provide a useful indicator of individual identity they are an unlikely source of individual differences in the FIE (Maurer et al., 2002). Similarly, although second-order relations are believed to be important for discriminating the identity of upright faces (Diamond & Carey, 1986), there is little evidence of an overlap between processing second-order relations and performance on the Navon task (Tanaka & Farah, 1991). Whereas the former task relies on detecting very subtle spatial differences among multiple features (Kanwisher et al., 1997), the latter activity demands crude categorical distinctions based on the basic configuration of letters (Navon, 1977). Instead, as there is considerable evidence to suggest that holistic processing is the aspect of face perception that is impacted most by stimulus inversion (Farah et al., 1995; Robbins & McKone, 2003; Tanaka & Farah, 1991) and that it is also implicated in global processing (Navon, 1977), we suggest the current findings are evidence of an overlap between global processing propensity and holistic face perception.

While the current findings may be indicative of individual differences in relative global precedence, it is worth noting that a modified explanation can be offered for the reported pattern of results. Recent research using Navon stimuli that possess global or local precedence has suggested that differences in face recognition performance may reflect the ease of switching between automatic and analytic processing modes rather than the costs or benefits associated with the adoption of a specific perceptual processing orientation (i.e., global or local; see Perfect, Weston, Dennis, & Snell, 2008). In the current task context this suggests that face recognition performance may have been influenced by the ease with which participants could switch between automatic (i.e., configural) and analytic (i.e., feature-based) processing modes when to-be-encoded faces were encountered in upright and inverted orientations, respectively. Specifically, if certain individuals experienced particular difficulty switching between processing modes following facial inversion, then one would expect these participants to produce the largest FIE. Given the potential theoretical significance of Perfect et al.'s (2008) viewpoint, future research should attempt to elucidate if the efficiency of switching between different processing modes modulates face recognition performance both in the general population and among individuals with ASDs.

The current results demonstrate that ability in a particular task context—classifying Navon letters—is related to performance in a seemingly disparate activity: Face recognition (see Behrmann et al., 2006; Macrae & Lewis, 2002; Weston & Perfect, 2005). It is possible, however, that the effects reported herein may extend beyond person recognition. Indeed, it is likely that individual differences in global precedence may impact any task that is supported by holistic processing (i.e., the extraction of configural information). For example, recent research suggests that holistic processing plays a critical role in the discrimination of emotional expressions (Calder & Jansen, 2005). As such, it is possible that individual differences in global precedence may moderate the accuracy with which people can recognize emotions. Indeed, there is little reason to suspect that the influence of global processing precedence need be confined to facial stimuli (Gauthier & Tarr, 1997; Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999). It is increasingly evident that, among experts, many other classes of stimuli are recognized following the extraction of configural information (e.g., birds, dogs, Greebles). Thus, not only do the current findings provide a novel demonstration of the relationship between face recognition and an apparently unrelated perceptual task, they may also provide a tantalizing glimpse of deep-seated and pervasive differences in the manner in which people perceive the world.

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