Psychonomic Bulletin & Review
2006, 13 (2), 223-228

Do the upright eyes have it?

ATSUSHI SENJU and TOSHIKAZU HASEGAWA
University of Tokyo, Tokyo, Japan

Eye contact is crucial for social communication. A perceived direct gaze facilitates detection, whereas face inversion diminishes this facilitative effect (Senju, Hasegawa, & Tojo, 2005). In the present study, we adopted a visual search paradigm to investigate why a direct gaze facilitates detection in an upright face, but not in an upside-down face. Upright eyes were found to facilitate detection even when other parts of the face were inverted or absent, whereas inverted eyes had no effect on search performance. A critical role for the morphological information of upright eyes, which can be distorted by "eye inversion," in direct gaze processing is suggested.

Another person's direct gaze, or perceived eye contact, signals that person's intention toward the perceiver, and this represents crucial information for social interaction and communication (Gibson & Pick, 1963; Kleinke, 1986). Sensitivity to such a direct gaze enables the perceiver to swiftly detect the other person's intention and make use of the "language of the eyes" (Baron-Cohen, 1995; Baron-Cohen, Wheelwright, & Jolliffe, 1997) in social interaction and communication. Previous studies have revealed that even neonates prefer faces with a direct gaze over faces with closed or averted eyes (Batki, Baron-Cohen, Wheelwright, Connellan, & Ahluwalia, 2000; Farroni, Csibra, Simion, & Johnson, 2002), suggesting an inborn preference for a direct gaze. In adults, a direct gaze facilitates detection (Senju, Hasegawa, & Tojo, 2005; Senju, Yaguchi, Tojo, & Hasegawa, 2003; von Grünau & Anston, 1995), enhances facial memory (Macrae, Hood, Milne, Rowe, & Mason, 2002), captures visuospatial attention (Senju & Hasegawa, 2005), and modulates brain activity related to the processing of facial attractiveness (Kampe, Frith, Dolan, & Frith, 2001) and facial expression of emotion (Sato, Yoshikawa, Kochiyama, & Matsumura, 2004; Wicker, Perrett, Baron-Cohen, & Decety, 2003). However, little is known about the mechanism underlying direct gaze processing.

In a previous study (Senju et al., 2005), we adopted a visual search paradigm and found that a perceived direct gaze accelerates detection latency (i.e., the *stare-in-the-crowd effect*; von Grünau & Anston, 1995). This facilitative effect was, however, diminished when facial stimuli were presented upside down. Face inversion is also known to interfere with direct gaze processing in infants (Farroni, Johnson, & Csibra, 2004). There are at least two possible explanations for the absence of effect of a direct gaze in an upside-down face. The first is the *face inversion effect* (Valentine, 1988; Yin, 1969). Face inversion, which is known to distort configural facial processing, would interfere with direct gaze processing if it was dependent on the configural information of the face. The second is the *eye inversion effect* (Jenkins & Langton, 2003). Since morphological information, such as contrast polarity between the iris and sclera, is reportedly required for direct gaze processing (Ricciardelli, Baylis, & Driver, 2000; Senju & Hasegawa, 2005), it is possible that another morphology of the eyes, or their shape, is also necessary for the facilitative effect of a direct gaze.

In the present study, we investigated whether face and eye orientation contribute to the facilitative effect of a direct gaze, or perceived eye contact. To examine this issue, we adopted the same visual search paradigm used in Senju et al. (2005), but facial context was either upside down with reference to the eye orientation (Experiment 1, Figure 1A) or absent (Experiment 2, Figure 1B). If the facial context is critical for the stare-in-the-crowd effect, it is predicted that direct gaze would be detected faster, but only when it is presented in the context of an upright face. On the other hand, if the eye orientation is critical, direct gaze should be detected faster when eyes are upright, regardless of the facial context.

EXPERIMENT 1

In Experiment 1, we investigated the effect of eye orientation and configural facial processing (i.e., the presence of an upright face) on the faster detection of a perceived direct gaze in the visual search paradigm described in Senju et al. (2005).

The stimuli used were laterally averted faces with varying degrees of eye direction, and the targets were either faces with direct gaze or those with averted gaze. In these stimuli, only the eye regions were inverted within each upright and upside-down face, such that upright faces had upside-down eyes, and vice versa (Figure 1A). If the facial configuration is critical for the facilitative effect of a perceived di-

The authors gratefully acknowledge Kuniyoshi Sakai, Kazuo Shigemasu, Yoshihiko Tanno, and Jun'ichi Nagai for their helpful discussions. Correspondence should be addressed to A. Senju, who is now at RISTEX, Japan Science and Technology Agency, 705 Kyushu University Station II for Collaborative Research, 3-1-1 Maidashi, Higashi-ku, Fukuoka 812-8582, Japan (e-mail: senju@mrg.biglobe.ne.jp).

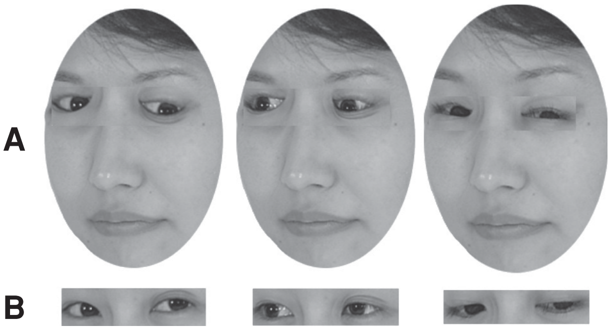

Figure 1. Facial stimuli presented in (A) Experiment 1 and (B) Experiment 2. Left: direct gaze. Center: averted gaze. Right: downward gaze. (Note that the facial stimuli were presented in full color.)

rect gaze, this effect was predicted to occur in upright faces with upside-down eyes, but not in upside-down faces with upright eyes. On the other hand, if the orientation of eyes is important, the opposite result was predicted.

Method

Participants. Ten students attending the University of Tokyo (6 females, 4 males; 19–31 years old, average age = 25.8 years) participated. All were right-handed and naive to the hypothesis and had normal or corrected-to-normal visual acuity.

Apparatus and Stimuli. The experiment was conducted on a laptop PC with a 12-in. color LCD monitor, using the Cedrus SuperLab Pro software. The participants were seated approximately 67 cm from the monitor. The monitor was angled on the desk so that the view of each participant was oriented correctly to the screen. Their reaction times (RTs) and accuracy were measured from their keyboard responses.

A central cross that subtended 1º appeared on the screen, and the participants were instructed to fixate on this cross before the experiment started. Each stimulus display consisted of five or nine female faces with varying eye directions. The faces were presented in an imaginary circle, which was centered on the central fixation cross and subtended approximately 12.5º (Figure 2). Color photographs of the faces were cut into ovals (2.5º wide and 3.5º high) to produce the stimulus elements in the eye direction condition. All the faces were laterally averted (i.e., 30º from the center of the viewer) in order to control for the bilateral symmetry inherent in a direct gaze from the front view, which can make a direct gaze perceptually salient. The stimuli consisted of a face with a direct gaze, a face with an averted gaze, and a downward-looking face. These three stimuli were produced from the same basic image, on which the same person's eyes were superimposed from other photographs according to the stimulus type, using the Adobe Photoshop 7.0 software. This process resulted in three face types that were exactly the same, except for the eye direction.

Most important, the eye regions of the facial stimuli were cut into a square (2.0º wide and 0.5º high), reversed vertically (i.e., upside down), and superimposed on the same position on the face (Figure 1A). The target in each condition was a face (with either a direct or an averted gaze), and the remaining two kinds of facial stimuli served as distractors.

Design and Procedure. The experiment consisted of five factors: eye direction of the target face (target gaze: direct or averted), eye orientation (upright or inverted), facial direction (left or right), number of presented faces (array size: five or nine items), and presence of the target (present or absent). One of the eight possible combinations of the target condition (target gaze, eye orientation, and facial direction) served as a target in each block, yielding eight blocks in total. Within each block, the distractors were always the same as the targets with respect to the eye orientation and facial direction but had a different gaze direction from that of the targets. Each block consisted of 32 test trials and was preceded by 8 practice trials. Accordingly, each participant underwent a total of 320 trials. Within each block, the target was present in 50% of the test trials and was absent in the other 50% (i.e., 16 trials each). Each array size also appeared an

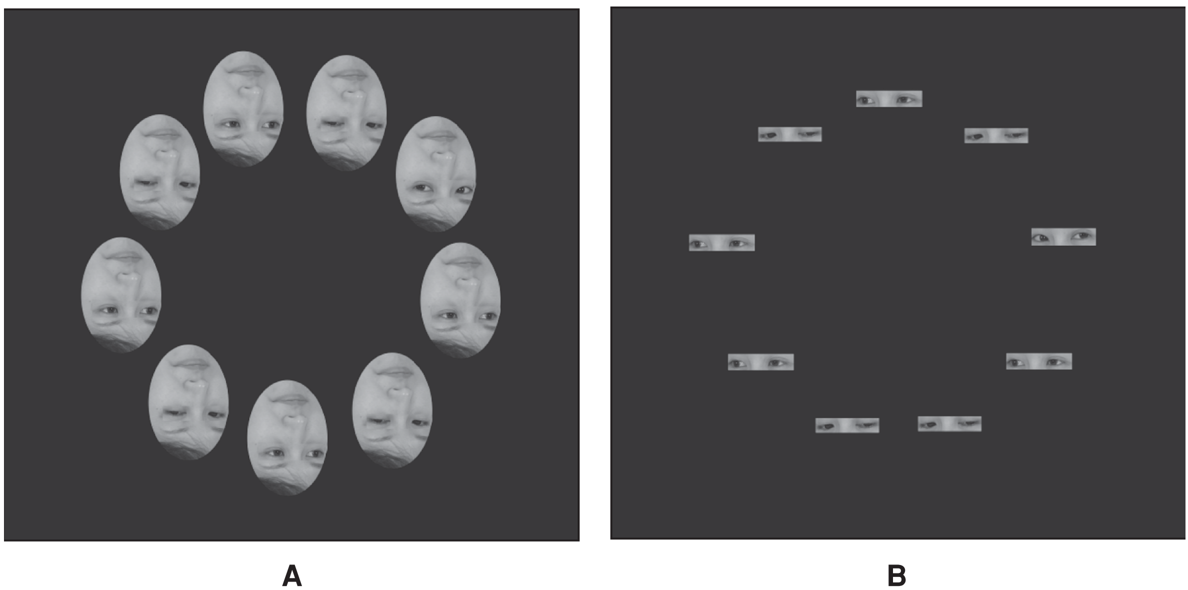

Figure 2. Examples of a stimulus display with a display size of nine for (A) Experiment 1 and (B) Experiment 2. (A) The upright eye condition with a target (direct gaze, appearing in the upper right of the stimulus array) present among distractors (rightward gaze and downward gaze). (B) The upright eye condition with a target (direct gaze, appearing on the right of the stimulus array) present among distractors (leftward gaze and downward gaze).

Table 1
Mean Reaction Times With Standard Errors (*SE*s) and error rates (%E) for Experiment 1

		Target Present				Target Absent			
		Eyes upright (Face Inverted)		Eyes Inverted (Face Upright)		Eyes Upright (Face Inverted)		Eyes Inverted (Face Upright)	
Array Size		Direct	Averted	Direct	Averted	Direct	Averted	Direct	Averted
Five items	*M*	1,248.4	1,469.8	1,432.3	1,568.7	1,786.9	1,902.4	1,837.8	1,954.3
	SE	90.4	92.0	115.4	141.9	159.3	140.9	120.2	200.0
	%E	6.1	6.1	3.3	8.3	2.2	0.0	1.7	0.0
Nine items	*M*	1,620.8	2,013.4	1,988.5	2,044.1	2,485.4	2,790.8	2,728.0	2,863.8
	SE	105.1	138.1	202.2	188.7	190.7	178.7	170.2	211.0
	%E	8.9	9.4	7.8	14.4	1.1	0.6	0.0	2.8

Note—"Direct" and "Averted" refer to gaze directions. Data for the left and right face orientations were pooled, since orientation had no significant effect.

equal number of times. The presentation order of each trial and the order of the blocks were randomized across participants.

At the beginning of each block, the target stimulus was presented at the center of the screen, and the participants were instructed to memorize the target and find it throughout the following trials. Then, the participants were instructed to fixate on the central cross before each trial and to press the "H" key on the computer keyboard when the target was present and press the space bar when the target was absent as fast as possible, using the preferred hand. Eight practice trials preceded the test trials for each block, in order to familiarize the participants with the task and the target stimuli. Each trial started with the presentation of the central fixation cross for 500 msec, and this was then replaced with the stimulus array. The stimulus array remained on the display until the participant responded. Immediately after the participant's response, feedback was presented on the center of the screen for 500 msec. The next trial started after a 1,000-msec interstimulus interval. The participants were allowed to take a brief rest between experimental blocks, and a 5-min rest was inserted between the fourth and fifth blocks.

Results and Discussion

The average RTs for correct responses and average error rates (Table 1) were subjected to five-way ANOVAs, with the target gaze (direct or averted), eye orientation (upright or inverted), facial direction (left or right), array size (five or nine items), and presence of the target (present or absent) as independent variables. Trials with RTs of less than 100 msec were regarded as anticipatory responses and excluded from the analysis. This resulted in the elimination of less than 1% of the trials.

For the RTs, the ANOVA yielded significant main effects of the array size [$F(1,9) = 305.31$, $p < .01$, $\eta_p^2 = .97$], the presence of the target [$F(1,9) = 218.43$, $p < .01$, $\eta_p^2 = .96$], and their interaction [$F(1,9) = 32.01$, $p < .01$, $\eta_p^2 = .78$], indicating that search was dependent on the number of distractors and that visual search was more exhaustive when the target was absent.

Most important, a significant main effect of the target gaze [$F(1,9) = 13.08$, $p < .01$, $\eta_p^2 = .59$] and a significant interaction between the target gaze and eye orientation [$F(1,9) = 7.21$, $p < .05$, $\eta_p^2 = .44$] were found (Figure 3A). Simple effect analyses revealed that the detection of a direct gaze was significantly faster than that of an averted gaze in the upright eye condition [$F(1,9) = 9.93$, $p < .01$, $\eta_p^2 = .52$], but this effect was not significant when the eyes were inverted [$F(1,9) = 1.83$, n.s., $\eta_p^2 = .17$]. No other main effects or interactions approached significance. In addition, RTs were converted to inverse and subjected to an ANOVA to confirm the possible effect of outliers (Ratcliff, 1993), which also revealed the significant interaction between target gaze and eye orientation [$F(1,9) = 20.26$, $p < .01$, $\eta_p^2 = .69$]. A main effect of the target gaze was significant in the upright eye condition

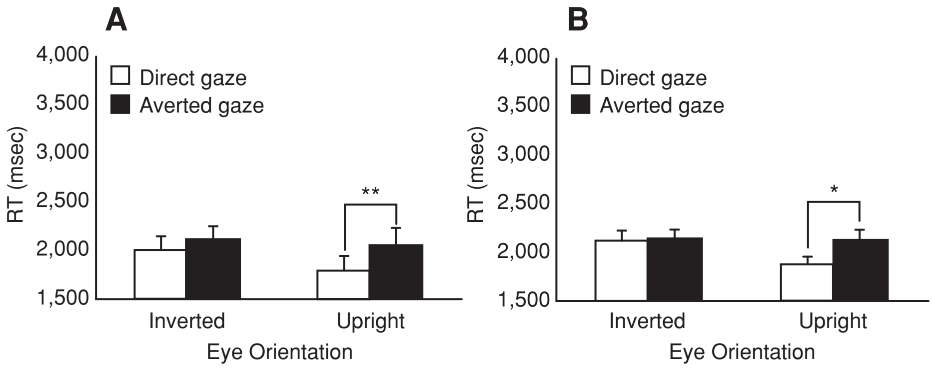

Figure 3. Mean reaction times (RTs, in milliseconds) as a function of the target gaze direction and eye orientations in Experiment 1 (A) and Experiment 2 (B). The white bars represent the RTs for targets with a direct gaze, and the black bars represent the RTs for targets with an averted gaze. The error bars represent the standard error. **$p < .01$. *$p < .05$.

[F(1,9) = 13.74, $p < .01$, $\eta^2_p = .60$] but not in the inverted eye condition [F(1,9) = 0.71, n.s., $\eta^2_p = .07$].

For the error rates, the main effects of the array size [F(1,9) = 5.66, $p < .05$, $\eta^2_p = .39$], the presence of the target [F(1,9) = 34.14, $p < .01$, $\eta^2_p = .79$], and their interaction [F(1,9) = 6.26, $p < .05$, $\eta^2_p = .41$] were significant. Error rates were also subjected to Kruskal–Wallis tests, but the target gaze had no significant effect.

These results clearly suggest a critical role for the orientation of the eyes in the facilitative effect of a perceived direct gaze in a visual search. A significant effect of the gaze direction was found in the upright eyes in the inverted face, which distorts configural facial processing but preserves the natural orientation of the eye region. In contrast, the effect of the gaze direction was distorted in the upright face when the eye region was presented upside down. These observations support the importance of the eye region and contradict a possible effect of configural facial processing.

EXPERIMENT 2

In experiment 2, we adopted virtually the same design as that in Experiment 1, except only the eye regions of each face were presented (Figure 1B). If normally oriented eyes are enough to facilitate detection of the perceived direct gaze, faster detection of a direct gaze was predicted when upright eyes, but not upside-down eyes, are presented. On the other hand, if facial context is necessary, the gaze directions should not affect search latency.

Method

Another 10 students attending the University of Tokyo (4 females, 6 males; 19–30 years old, average age = 24.7 years), who were right-handed, naive to the hypothesis, and had normal or corrected-to-normal visual acuity, participated.

The apparatus, experimental design, and procedure were identical to those in Experiment 1 (Figure 1B). In Experiment 2, only the eye regions of the facial stimuli were cut into squares (2.0º wide and 0.5º high) and presented to the participants.

Results and Discussion

The average RTs for correct trials and average error rates (Table 2) were subjected to five-way ANOVAs, with the target gaze (direct or averted), eye orientation (upright or inverted), facial direction (left or right), array size (five or nine items), and presence of the target (present or absent) as independent variables. Trials with RTs of less than 100 msec, which represented less than 1% of the trials, were excluded from the analysis.

For the RTs, the ANOVA yielded significant main effects of the array size [F(1,9) = 244.57, $p < .01$, η^2_p = .96], the presence of the target [F(1,9) = 182.71, $p < .01$, η^2_p = .95], and their interaction [F(1,9) = 148.81, $p < .01$, $\eta^2_p = .94$], as found in Experiment 1.

Interestingly, there was a significant interaction between the eye orientation and the target gaze [F(1,9) = 6.90, $p < .05$, $\eta^2_p = .43$]. Simple effect analyses revealed that detection of a direct gaze was significantly faster than that of an averted gaze when the eyes were upright [F(1,9) = 5.55, $p < .05$, $\eta^2_p = .38$], but this effect was not significant when the eyes were inverted [F(1,9) = 0.04, n.s., $\eta^2_p < .01$] (Figure 3B). The main effect of the target gaze was marginally significant [F(1,9) = 4.92, p = .054, $\eta^2_p = .35$]. The interaction between the target gaze and the array size failed to reach significance [F(1,9) = 0.04, n.s., $\eta^2_p < .01$]. No other main effects or interactions approached significance. As in Experiment 1, RTs were converted to inverse and subjected to the same analysis, which also revealed the significant interaction between target gaze and eye orientation [F(1,9) = 5.13, $p < .05$, $\eta^2_p = .36$], a significant main effect of the target gaze in the upright [F(1,9) = 6.86, $p < .05$, $\eta^2_p = .43$] but not in the inverted [F(1,9) = 0.32, n.s., $\eta^2_p = .60$] eye condition.

For the error rates, the main effects of the array size [F(1,9] = 17.60, $p < .01$, $\eta^2_p = .66$], the presence of the target [F(1,9) = 13.96, $p < .01$, $\eta^2_p = .61$], and their interaction [F(1,9) = 15.78, $p < .01$, $\eta^2_p = .04$] were significant, as found in Experiment 1. No other main effects or interactions were significant. Error rates were also subjected to Kruskal–Wallis tests, but target gaze had no significant effect.

The results showed that a direct gaze was detected more rapidly than was an averted gaze, even when the stimuli were the eye regions alone, and not the whole face, provided that the eyes were upright. Again, these results clearly support a critical role for eye orientation in the facilitative effect of a direct gaze.

Table 2
Mean Reaction Times With Standard Errors (*SE*s) and Error Rates (%E) for Experiment 2

		Target Present				Target Absent			
		Eyes Upright		Eyes Inverted		Eyes Upright		Eyes Inverted	
Array Size		Direct	Averted	Direct	Averted	Direct	Averted	Direct	Averted
Five items	*M*	1,241.4	1,441.6	1,471.1	1,481.1	1,751.5	2,021.9	1,981.5	2,005.5
	SE	56.6	86.9	89.8	73.3	58.0	128.5	73.1	69.0
	%E	2.2	2.2	5.6	2.2	0.0	0.6	1.1	0.0
Nine items	*M*	1,724.2	2,010.1	1,995.2	2,008.9	2,774.0	2,981.8	2,997.2	3,029.3
	SE	50.6	142.0	137.3	97.4	139.5	181.1	122.4	164.5
	%E	5.6	5.6	9.4	6.1	1.7	0.0	2.2	0.0

Note—"Direct" and "Averted" refer to the gaze directions. Data for the left and right face orientations were pooled, since orientation had no significant effect.

GENERAL DISCUSSION

The present study is the first to report that the shape of the eyes, or at least their natural orientation, is necessary to facilitate direct gaze detection. The results reveal that upright eyes facilitate detection latency, even when the facial context is incongruent to eye orientation (Experiment 1) or absent (Experiment 2). On the other hand, upside-down eyes have no effect on the search latency.[1]

When all the data from the present two experiments and our previous study (Senju et al., 2005, Experiment 1) were subjected to an ANOVA with facial context (congruent, incongruent, or absent) as a between-subjects factor, facial context had no significant main effect or interaction, including the interactions with target gaze or eye orientation (all Fs < 2.51, all ps $> .1$), which would suggest that eye orientation affects the effect of target gaze direction independent of facial context. However, since Jenkins and Langton (2003) found that facial context modulates the effect of eye inversion on explicit gaze discrimination, further studies will be required to test whether facial context modulates the eye inversion effect in general.

The present findings are consistent with the findings of other studies investigating direct gaze perception. In previous studies, stimuli were real faces (Batki et al., 2000; Gibson & Pick, 1963), photographs of real faces (Farroni et al., 2002; Farroni et al., 2004; Macrae et al., 2002; Senju et al., 2005; Senju et al., 2003), or depictions of eyes (von Grünau & Anston, 1995). It should be noted that all these "eyes" were not merely pairs of concentric circles but had realistic eye shapes, including asymmetry to the vertical axis. In addition, von Grünau and Anston also reported that a "straight gaze," or bilaterally symmetrical shape with a dark center surrounded by a light area, did not facilitate detection when a less eye-like shape (square) was used. Moreover, distortion of another aspect of eye morphology—namely, contrast polarity—is known to interfere with direct gaze processing (Ricciardelli et al., 2000; Senju & Hasegawa, 2005).

Jenkins and Langton (2003) also reported the important role of eye orientation in gaze discrimination. In their experiments, participants were shown a sequence of images in which the eyes either were straight ahead or were turned to one side or the other at varying degrees of eccentricity, and participants were required to judge whether the gaze was to the right or to the left. Larger degrees of deviations were necessary for correct responses when upside-down eyes were used as stimuli than when upright eyes were presented. The authors concluded that eye inversion had a detrimental effect on gaze perception. Although their findings closely relate to the present results, they cannot fully explain our results for two reasons. First, in our averted gaze stimuli, the degree of deviation (20º) was much larger than the gaze-discrimination thresholds reported by Jenkins and Langton (5.78º–6.79º); hence, it should have been easy enough for the participants to discriminate direct gaze from averted gaze in our present study. Second, it is unlikely that our upside-down direct gaze stimuli were perceived as averted, because it is known that ambiguous gaze is more likely to be perceived as a direct gaze (Martin & Jones, 1982). Since the task used by Jenkins and Langton was left/right judgment and did not include "direct" as a choice, it is unknown whether eye inversion increases the frequency of direct gaze responses. It is more likely, however, that eye inversion biases participants to judge them as "direct gaze," due to the increased ambiguity. The present results thus suggest that eye inversion eliminates, or at least reduces the saliency of, direct gaze, rather than interferes with discrimination between direct gaze and averted gaze.

The present results suggest that some form of configural processing around the eye region is involved in the perceived saliency of direct gaze, which is eliminated by the inversion. We do not have detailed data to discriminate between different kinds of configural processing, such as holistic processing (Tanaka & Farah, 1993) or processing based on second-order relations (Diamond & Carey, 1986) among the features (i.e., eyes or parts of eyes). Further research is needed to find out what kind of configural processing is involved in the eye inversion effect.

Ganel, Goshen-Gottstein, and Goodale (2005) claimed that explicit judgment of gaze direction is processed in a part-based manner, on the basis of their findings that facial expression affects the speed of gaze discrimination even when a face or eyes are inverted. Our results, however, do not support that perceived salience of direct gaze, or the stare-in-the-crowd effect, is subserved by the same part-based process. It may suggest that the stare-in-the-crowd effect is based partly on different processes from explicit gaze judgment, which requires further investigation.

It is not clear whether or not these results apply specifically to the eyes. Since it is also claimed that the mouth is processed holistically (Martelli, Majaj, & Pelli, 2005), similar findings might be obtained for the mouth or any other facial parts—which is a subject of future research.

To summarize, the present findings may indicate that perceived saliency of direct gaze, as well as discriminative accuracy of gaze direction (Jenkins & Langton, 2003), is heavily dependent on the external morphology of realistic human eyes or their configuration, and this can be distorted by eye inversion.

REFERENCES

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press.

Baron-Cohen, S., Wheelwright, S., & Jolliffe, T. (1997). Is there a "language of the eyes"? Evidence from normal adults and adults with autism or Asperger syndrome. *Visual Cognition*, **4**, 311-331.

Batki, A., Baron-Cohen, S., Wheelwright, S., Connellan, J., & Ahluwalia, J. (2000). Is there an innate gaze module? Evidence from human neonates. *Infant Behavior & Development*, **23**, 223-229.

Diamond, R., & Carey, S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experimental Psychology: General*, **115**, 107-117.

Farroni, T., Csibra, G., Simion, F., & Johnson, M. H. (2002). Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences*, **99**, 9602-9605.

Farroni, T., Johnson, M. H., & Csibra, G. (2004). Mechanisms of eye gaze perception during infancy. *Journal of Cognitive Neuroscience*, **16**, 1320-1326.

Ganel, T., Goshen-Gottstein, Y., & Goodale, M. (2005). Interactions between the processing of gaze direction and facial expression. *Vision Research*, **45**, 1191-1200.

Gibson, J. J., & Pick, A. D. (1963). Perception of another person's looking behavior. *American Journal of Psychology*, **76**, 386-394.

Jenkins, J., & Langton, S. R. H. (2003). Configural processing in the perception of eye-gaze direction. *Perception*, **32**, 1181-1188.

Kampe, K. K. W., Frith, C. D., Dolan, R. J., & Frith, U. (2001). Reward value of attractiveness and gaze. *Nature*, **413**, 589-590.

Kleinke, C. L. (1986). Gaze and eye contact: A research review. *Psychological Bulletin*, **100**, 78-100.

Macrae, C. N., Hood, B. M., Milne, A. B., Rowe, A. C., & Mason, M. F. (2002). Are you looking at me? Eye gaze and person perception. *Psychological Science*, **13**, 460-464.

Martelli, M., Majaj, N. J., & Pelli, D. G. (2005). Are faces processed like words? A diagnostic test for recognition by parts. *Journal of Vision*, **5**, 58-70.

Martin, W. W., & Jones, R. F. (1982). The accuracy of eye-gaze judgement: A signal detection approach. *British Journal of Social Psychology*, **21**, 293-299.

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin*, **114**, 510-532.

Ricciardelli, P., Baylis, G., & Driver, J. (2000). The positive and negative of human expertise in gaze perception. *Cognition*, **77**, B1-B14.

Sato, W., Yoshikawa, S., Kochiyama, T., & Matsumura, M. (2004). The amygdala processes the emotional significance of facial expressions: An fMRI investigation using the interaction between expression and face direction. *NeuroImage*, **22**, 1006-1013.

Senju, A., & Hasegawa, T. (2005). Direct gaze captures visuospatial attention. *Visual Cognition*, **12**, 127-144.

Senju, A., Hasegawa, T., & Tojo, Y. (2005). Does perceived direct gaze boost detection in adults and children with and without autism? The stare-in-the-crowd effect revisited. *Visual Cognition*, **12**, 1474-1496.

Senju, A., Yaguchi, K., Tojo, Y., & Hasegawa, T. (2003). Eye contact does not facilitate detection in children with autism. *Cognition*, **89**, B43-B51.

Tanaka, J. W., & Farah, M. J. (1993). Parts and wholes in face recognition. *Quarterly Journal of Experimental Psychology*, **46A**, 225-245.

Valentine, T. (1988). Upside-down faces: A review of the effect of inversion upon face recognition. *British Journal of Psychology*, **79**, 471-491.

von Grünau, M., & Anston, C. (1995). The detection of gaze direction: A stare-in-the-crowd effect. *Perception*, **24**, 1297-1313.

Wicker, B., Perrett, D. I., Baron-Cohen, S., & Decety, J. (2003). Being the target of another's emotion: A PET study. *Neuropsychologia*, **41**, 139-146.

Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology*, **81**, 141-145.

NOTE

1.The search mechanism underlying the present results is somewhat unclear, since the gaze direction did not affect the search slope (i.e., the search speed per item); therefore, this mechanism requires further investigation. However, such uncertainty does not undermine the main finding that gaze direction has an effect on the search latency.

(Manuscript received May 26, 2005;
revision accepted for publication September 12, 2005.)