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Contributed Paper

Reverse Hierarchy in Vision

Tomohiro Ishizu*

Recently, a model termed *Reverse Hierarchy Theory* (RHT) offers a new perspective on human visual perception, where global and local information are assumed to be processed, respectively, by feed-forward and feedback systems. (Ahissar & Hochstein, 2000; see also Hochstein & Ahissar, 2002). We examined a temporal dissociation between global and local feature to assess the role of feedback connections as proposed in RHT in Experiment 1. Next, we investigated the brain responses that might reflect the feedback processing during the recognition of various contours of faces using electroencephalography in Experiment 2.

Experiment 1

Global and local recognition

Recognizing objects such as bodies, scenes and words depends upon identification of both global and local features of these objects. Currently, the processing of global versus local features of visual objects constitutes one of the major topics in human vision research. Most objects in our environment are organized hierarchically; that is, lower level parts (e.g., hands, arms, legs) are “nested within” higher-level objects (e.g., bodies). One aspect of these hierarchies involves the relationship between the whole and its parts and how this relationship is perceived. Using psychophysical techniques, several studies have investigated how this hierarchical relationship medi-

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ates visual perception of that integrates local features into global shapes (Barlow & Reeves, 1979; Smits et al., 1985; Beck et al., 1989; Field, Hayes, & Hess, 1993; Hess, Dakin, & Field, 1998; Saarinen & Levi, 2001). Nevertheless, it remains unclear whether global or local features are perceived first in processing visual information. It can be argued that historically Structuralists assumed that the visual system processed lower level units first and then constructed higher level units (e.g. Wundt, 1874), whereas Gestalt psychologists assumed that the global shape of an object has perceptual priority, with recognition of local components following (e.g. Wertheimer, 1922,1923). This problem continues to be disputed today (e.g., Sanocki, 2001; Hübner & Volberg, 2005).

Reverse Hierarchy Theory

Reverse Hierarchy Theory (RHT) offers a new perspective on this old problem (Ahissar & Hochstein, 2000; see also Hochstein & Ahissar, 2002). According to this theory, visual processing consists of both a feed-forward system, which transfers information from lower (V1 area of visual cortex) to higher levels of the visual cortex (e.g. Inferior temporal area), and a feedback system, which transfers information in the reverse direction, namely from the higher (IT area) to the lower visual cortex (V1). A simple and complete image of objects is expressed using feed-forward information that is managed in a higher visual cortex; this area of visual cortex, because it has relatively large receptive fields, can support a broader attention span and generalization across the visual field with feed-forward processing. By contrast, theoretically lower levels of the visual cortex (e.g., V1), then, are responsible for processing more detailed and complex visual information and this is expressed in V1 through feedback. Consequently, local information (i.e., as opposed to global information) receives thorough processing mainly at this later stage when it re-enters V1 for a second time. Thus, all perception initially follows a

bottom-up pathway, i.e., by entry to V1. However, if we assume that conscious awareness begins upon entry to higher cortical areas and proceeds in a top-down (IT to V1) fashion, then not all visual perceptual processes will be immediately available to consciousness. Instead, explicit and conscious perception emerges only later in a feed-forward process, namely when information reaches higher cortical areas; in addition, conscious awareness of low-level details occurs only following their incorporation into this top-down pathway. In sum, the RHT of perception distinguishes between two visual modes: “vision at a glance”, a high-level, rapid generalized visual mode, and a “vision with scrutiny” mode which is guided in a later stage by the “vision at a glance” mode (Hershler & Hochstein, 2005). The “vision with scrutiny” mode entails slower processing based on focused attention and provides detailed information for explicit perception. Therefore, the primary visual cortex must be activated when participants pay attention to detailed features.

Taken together, global perception comes faster and appears to take place in higher cortical areas, whereas local perception develops more slowly and is processed within the lower visual cortex by a feedback stream. Assuming this is the case, then it is possible to hypothesize that presentation of another stimulus immediately following the presentation of a target stimulus should create interference with the feedback processing of a target stimulus in the primary visual cortex. If the subsequent stimulus is presented at the time when the feedback signal is scheduled to arrive at primary visual cortex from a higher cortical area, then it should disrupt the visibility of detailed features of the target. This is because activities induced by subsequent stimulus should interfere the feedback stream at the primary visual cortex. On the other hand, visibility of global features of configurations processed via feed-forward mechanisms could be maintained, given the time parameters of this scenario.

Psychophysical studies that involve the *visual backward masking*

paradigm are relevant here (for review, Breitmeyer & Ogmen, 2000). In the present research, the first stimulus is referred to as a target stimulus and the second functions as a mask. We predicted that when a target stimulus was presented with a short SOA (e.g., 40 ms), participants would perceive the global configuration (for example, an object's contour) but not detailed local features embedded within it (for example, a small bar). However, when a target stimulus was presented with a long SOA e.g., exceeding 100 ms), participants would perceive both overall configuration and detailed features correctly.

To summarize, our goal in this study was to evaluate predictions of temporal dissociation of global and local features, given the RHT, using a visual masking paradigm and variable SOAs. The rationale is that a selective disruption of visual perception of local, but not global, features should occur when a visual mask follows a target stimulus by a short, but not a long, SOA.

METHODS

Subjects

Twenty healthy volunteers (eight men, twelve women $M = 22.4$ year old) participated in this study. All participants were right-handed as assessed by the Edinburgh Inventory (Oldfield, 1971). None reported a previous history of neurological or visual disorder. Participants gave their informed consent before participating in the study.

Materials

Presentation of all stimuli was controlled by an AV tachistoscope (Iwatsu IS-703). Four pictures were used as target stimuli; target stimulus color was grey. Globally, these stimuli consisted of two different contours (vertical versus horizontal ellipses), and locally there

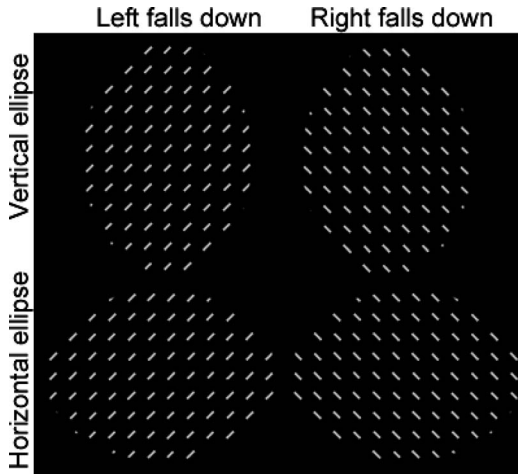


Figure 1. Four configurations for target stimuli. In the upper two vertical ellipses, the bars slope left or right; in the lower two horizontal ellipses, the bars slope left or right.

were two bar orientations (the left slopes down versus the right slopes down) in each of the four configurations. Thus each of the four configurations consisted of small bars, with either the left bar or the right bar falling down, and could be seen as one whole configuration (see Figure 1). Therefore, the target stimuli contained both global (vertical/horizontal contour) and local (left/right bar orientation) information. All target stimuli lasted were presented 35 ms. The mask consisted of random-dot noise as used by Turvey (1973) (see also Kinsbourne & Warrington, 1962a, 1962b). All masks lasted 300 ms.

Experimental design and procedure

The design was a $2 \times 2 \times 3$ repeated measures design with two levels of mask condition (mask present, mask absent), two levels of stimulus structure (global, local) and three levels of stimulus onset asynchrony (SOA) between target and mask (40, 80, 120 ms).

A session began with approximately 10–15 minutes of darkness adaptation. During this time, a description of the masking task and detailed procedural instructions were read aloud to a participant. The masking task was self-paced, and participants had a short rest after each block. Participants were instructed to focus on a fixation point at the center of the display. Each of the four stimuli described above was presented an equal number of times, randomly throughout a block of trials. The experiment consisted of two sessions, a contour recognition session (focus upon global structure) and an orientation recognition session (focus upon local structure). Each session consisted of four blocks, with each block containing 40 stimuli of each of the four types (a total of 160 trials per block). The global recognition and the local recognition task order were counter-balanced.

In a two-response category identification task procedure (MacMillan & Creelman, 2004) participants had to decide which of the two contours appeared in the contour recognition session, and which of the two orientations appeared in the orientation recognition session. Responses were made by pressing the left or right button on a button box by right index finger or middle finger. Participants were instructed to make their best guess when they were not sure which contour or orientation they had seen.

RESULTS

Data were analyzed using a repeated measures analysis of variance (ANOVA) with two levels of mask condition (mask present, mask absent), two levels of stimulus structure (global, local) and three levels of stimulus onset asynchrony (SOA) between target and mask (40, 80, 120 ms).

The proportions of correct responses for judging overall contour (global) and bar orientation (local) features were transformed to per-

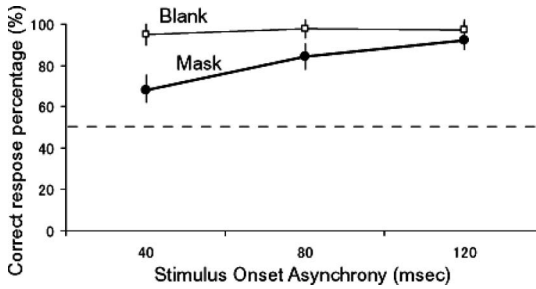


Figure 2. The percentage of correct responses for contour recognition with and without (control) mask. Broken line indicates the chance level (50%).

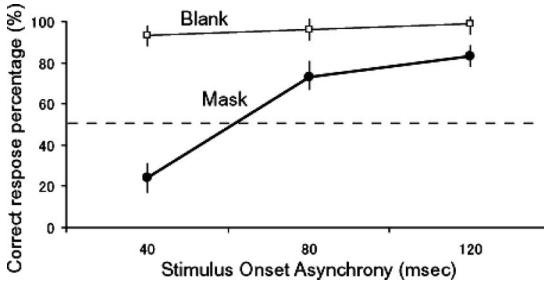


Figure 3. The percentage of correct responses for orientation with mask and without (control) mask. Broken line indicates the chance level (50%).

centages and then averaged (see Figures 2 and 3). In contour recognition with a mask, the correct percentages were 68% for SOA 40 ms, 84% for SOA 80 ms, and 92% for SOA 120 ms. In the control condition, with a mask absent, correct percentages were 95% for SOA 40 ms, 98% for SOA 80 ms, and 97% for SOA 120 ms. Thus, accuracies for all SOA conditions were above chance levels (50%) in the contour recognition session. These data are shown in Figure 2 for experimental and control conditions as a function of SOA.

Significant main effects were observed for mask condition ($F = 547.00, p < .0001$), for stimulus structure ($F = 582.00, p < .0001$) and for SOA ($F = 237.20, p < .0001$). Performance without a mask (i.e.

only a grey blank) was better than performance with the mask. Follow-up analysis of the main effect of SOA using multiple comparisons revealed that higher accuracy occurred in the SOA 80 and 120 ms conditions, relative to the 40 ms condition ($t(19), p < .001$). Also there was a significant interaction between stimulus condition and SOA on orientation recognition session ($F = 603.69, p < .0001$) due to the less accuracy responses produced in response to the shorter SOA (40 ms) compared to the longer SOAs (80 and 120 ms) in mask present condition, whereas performance of no mask condition was flat and high across all SOAs ($t(19), p < .01$).

In the orientation session, the correct percentages were 24% for SOA 40 ms, 73% for SOA 80 ms, and 83% for SOA 120 ms with the mask. For the control (mask absent) condition, correct percentages were 93% for SOA 40 ms, 96% for SOA 80 ms, and 99% for SOA 120 ms. These data are plotted in Figure 3 as a function of mask condition and SOA.

Statistical analyses of percent correct scores in this session revealed that in 40 ms SOA condition accuracy levels were below chance. Significant main effects were observed for the masking condition ($F(1, 228) = 193.42, p < .0001$) and for SOA ($F = 87.38, p < .0001$). Again, as with contour recognition, performance without a mask was better than with the mask. Further analysis of the main effect of SOA by multiple comparisons revealed that higher accuracy occurred in the SOA 80 and 120 ms conditions, relative to the SOA 40 ms condition ($t(19), p < .001$). And then we conducted a paired t -test with stimulus structure as dependent variables to compare with the performances of the SOA 40 ms in the contour session and in the orientation session. There was a significant effect of stimulus structure ($t(19), p < .0001$). The performance accuracy was higher for contour than orientation. There was also a significant interaction between stimulus condition and SOA on contour recognition session ($F = 100.72, p < .0001$) due to the less accuracy responses produced in

response to the shorter SOA (40 ms) compared to the longer SOAs (80 and 120 ms) in mask present condition, whereas performance of no mask condition was flat and high across all SOAs ($t(19), p < .01$).

DISCUSSION

In the contour recognition session, performance was significantly reduced when the target was presented with a mask having a short SOA (40 ms) versus with longer SOAs. Nevertheless, even with the short SOA contour recognition performance was still above chance levels (50%), indicating that at all SOAs in this session the recognition of global contour was reliably maintained. On the other hand, in the orientation recognition session, performance was dramatically reduced when the target was followed by a mask after a short SOA, and it was considerably under chance levels. In addition, good visibility of orientation targets with SOAs of 80 and 120 ms was maintained. In this session, target visibility was critically disrupted only when the target was presented with a short SOA. To sum up, then, recognition of orientation, a local feature, is disrupted selectively at the short SOA, whereas recognition of contour, a global feature, is maintained at all SOAs. Both contour and orientation recognition were maintained at long SOAs.

These findings, when considered in light of RHT, suggest that the temporal dissociation of global and local features observed here may result from differences between feed-forward processing, which is a high-level, rapid generalized visual mode, and feedback processing, which is a slower process based on focused attention and that provides detailed information for explicit perception (Ahissar & Hochstein, 2000). While global information is processed in the feed-forward system, local information is processed in the feedback system, and is interfered by activities induced by a subsequent (immediate) presentation of the mask at V1. That is, local information re-

garding orientation is disrupted selectively by the mask, and it may require at least 40 ms to re-enter the primary visual cortex for recognition of local features. That an SOA of 40 ms was the most diagnostic SOA in this experiment, with respect to this disruption, is consistent with a previous TMS study (Pascual-Leone & Walsh, 2001), which showed fast reverse projection from the V5/MT to the primary visual cortex. However, latencies obtained here for feedback processing were generally faster than those reported in previous studies concerned with RHT (e.g. Juan, Campana & Walsh, 2004). Those TMS studies used a visual search task which demanded more active attention than required for the present task; such differences may have affected the results of latency. Several studies have reported that active and passive attention is processed in different neural mechanisms respectively (e.g. Buschman & Miller, 2007). Further research is needed to address this possibility. Although our data do not totally clarify the processes of visual perception, our results suggest that the dissociation between global and local feature perception and its temporal hierarchy in human visual system.

Experiment 2

Face inversion effect

In Experiment 1, we showed that the dissociation of global and local perception with relatively simple stimuli, however, things that we see in daily life have more complicated structures, such as face. Many previous studies about face recognition have claimed the importance of global-local features, so-called configurational information (e.g. Yin, 1969; Faraf *et al.*, 1995; Coharel *et al.*, 2006). The importance of configurational information in face recognition is supported by findings of impairment after inversion that is more severe than that seen for objects; the so-called “face inversion effect” (Yin, 1969). Thus, we take longer and are less accurate in recognizing an in-

verted face relative to an upright face. A previous study suggested that faces are recognized in a more holistic fashion than other objects by using whole faces and isolated face parts (Faraf *et al.*, 1995). Similarly, a recent study proposed that inverted faces disrupt holistic face processing, and induce processing on the basis of individual features (Coharel *et al.*, 2006). Consistent with these behavioral measures, event-related potential (ERP) studies found that the N170, that is face-specific ERP, was larger and occurred later in response to inverted faces as compared to upright faces (Eimer, 2000; Itier & Taylor, 2002).

Configuration and face perception

Aside from inversion, other unusual facial configurations also disrupt holistic processing. For example, it is easier to recognize detailed facial features when the face is split and the upper and lower halves are misaligned (Young, Hellawell & Hay, 1987). Because facial recognition is dominated by global processing of the whole configuration rather than local processing of detailed features (Farah, 1996), when viewing an unusual configuration, the global processing is diminished and the local processing is automatically facilitated, thereby improving recognition of detailed features (Young, Hellawell & Hay, 1987). Although these findings demonstrate the importance of configurational information in face perception, few studies have directly related brain activity to this type of facial processing. Indeed, studies examining the relationship between processing unusual facial configurations and brain activity are an important step in furthering our understanding of the mechanisms underlying face recognition. Reverse hierarchy theory suggests that a simple and complete image of objects is expressed using the information managed at higher visual cortex with feed-forward processing, whereas complicated and detailed visual information is expressed at V1 via feedback processing. Therefore, primary visual cortex must be ac-

tivated when participants pay attention to detailed features, for example, during observing unusual faces.

Using electroencephalography (EEG) we investigated brain responses during the recognition of neutral, inverted, and split faces, and compared this to the activity produced by a non-facial object (clock). We focused on the face-specific-component N170, and the P300 component. The P300 is an ERP of which peaks around 300 ms after stimulus onset. It is the most prominent ERP component sensitive to cognitive processing and is commonly elicited when participants attend to a stimulus and are required to discriminate the stimulus features (Hermann & Knight, 2001). Because of these properties, we expected the P300 to be affected by inverted and split face stimuli.

When considered together, RHT and data on face recognition suggest that it would be more difficult to recognize detailed features on a normal face configuration because of the feed-forward system of holistic facial processing. An unusual facial configuration would result in disrupting the holistic processing similar to face inversion effect and occurring higher order feedback to V1, making it easier to be aware of detailed features and also producing larger amplitude of N170. We predicted that when a neutral face was presented, brain activity would reflect feed-forward processing, and when an unusual facial configuration (split face) was presented, brain activity would reflect feedback activity and the N170 component would be larger than when a neutral face was presented.

METHODS

Subjects

Twelve healthy volunteers, aged 18–25 years ($M = 20.3$ years old), participated in this study. All participants were right-handed as assessed by the Edinburgh Inventory (Oldfield, 1971). None of the partici-

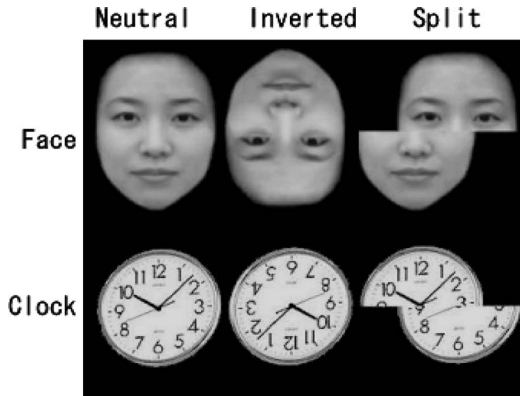


Figure 4. Stimuli for (upper) neutral, inverted, and split face, (lower) neutral, inverted, and split clock.

pants had a previous history of neurological or visual disorder. Participants gave their informed consent before participating in the study.

Stimuli and Procedure

Six pictures were presented to participants in a random order. These consisted of a face and a clock in three different presentations: neutral, inverted, and split horizontally and misaligned (see Fig. 4). To create the neutral face, we averaged 20 Japanese female faces using FACE TOOL (Information-technology Promotion Agency (IPA), Japan). The split face was created by dividing the neutral face into two parts; the upper part included the eyes and the lower part included the nose and mouth, with one part shifted horizontally. Because a large shift of more than one-half the distance from the center strongly directs attention to the eyes and leads to large amplitude N170 components (Juan, Campana, & Walsh, 2004), we shifted the halves one-third from the center of the face.

Each of the above six stimuli described above was presented an equal number of times. The duration of presentation of each picture was 500 ms, with an inter-stimulus interval of 1.5 s (range:

1.35–1.65 s). Participants were instructed to focus on the fixation point and silently observe the presented images presented. Three blocks of stimuli were presented with each block consisting of approximately 30 of each stimulus type. The stimulus pictures were projected onto a monitor placed 50 cm in front of the participants. The visual angle of stimulus was $2.5^\circ \times 3^\circ$.

EEG recordings and analysis

Presentation of stimuli was controlled by an AV Tachistoscope (Iwatsu, IS-703). EEG (Nihon Kohden, Neurofax) was recorded continuously from a 25-channel electrode net throughout the stimulus presentation. The impedance of each electrode was kept below 10 k Ω . The electrooculogram (EOG) was recorded to monitor eye movements. The recording bandpass filter was 0.03–100 Hz. The sampling rate was 601 Hz.

After discarding artifactitious data, the remaining trials were averaged for each participant and the averaged data were filtered using a 0.1-Hz high-pass and 30-Hz low-pass filter. Our analysis focused on both the right and the left occipital-temporal electrodes (T5, T6) for the N170 component, and on the parietal electrode (Cz) for the P300 component because these waves are known to be most prominent over these sites (Hermann & Knight, 2001). Peak latency was calculated for the N170 and the P300, and peak amplitude was calculated by measuring the peak voltage of each component.

Data were analyzed using a repeated measures analysis of variance (ANOVA) with factors Configuration, Condition, and Hemisphere (factor hemisphere was only for the N170 component).

RESULTS

EEG data

The amplitude and latency data within each time window (N170

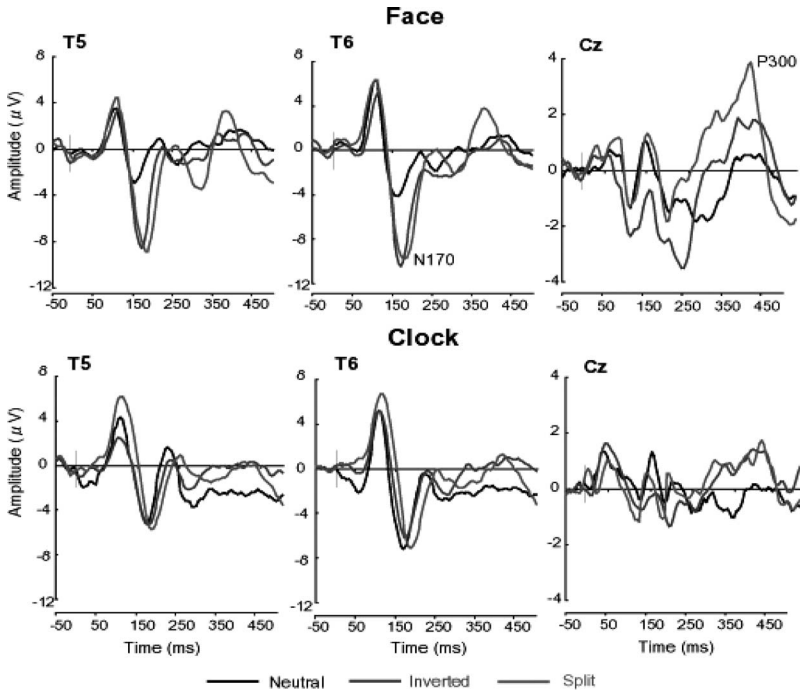


Figure 5. Grand-averaged waveforms for (upper) Face, (lower) Clock from T5, T6 and Cz.

and P300) were analyzed using a repeated measures analysis of variance. Averaged waveforms are illustrated in Figure 5 and averaged amplitude and latency values are illustrated in Figure 6 for each component of interest.

The N170 component

Significant main effects were observed for configuration ($F(3, 160) = 22.17, p < .0001$), condition ($F(1, 160) = 13.10, p = 0.0004$), and hemisphere ($F(1, 160) = 22, p = < .0001$). There was also a significant interaction between configuration and condition ($F(3, 160) = 9.15, p < .0001$) due to the larger N170 amplitudes produced in response to the face

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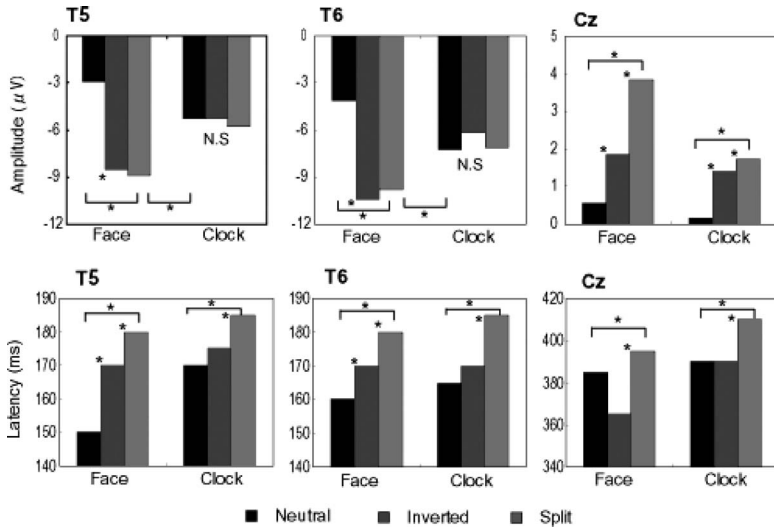


Figure 6. Mean N170 and P300 amplitude from T5, T6 and Cz (upper). Mean N170 latency from T5, T6 and Cz (lower). Significant differences at the .05 level are denoted with an asterisk.

as compared to the clock in the split configuration ($t(11), p < .05$). Further analysis of the interaction between configuration and condition revealed that larger N170 amplitudes occurred in the inverted and split configurations relative to the neutral configuration, but only for the face condition. In the clock condition there were no significant difference in N170 amplitude between the neutral, inverted, and split configurations. Finally, a significant main effect of hemisphere was seen in N170 amplitude ($F(1, 160) = 22, p < .0001$). N170 amplitudes were larger in the right than in the left hemisphere.

When N170 latency was examined, the significant finding was the main effect of configuration ($F(1, 160) = 9.35, p < .0001$). There was also a significant interaction between configuration and condition ($F(3, 360) = 9.05, p < .0001$). Then we conducted ANOVA analysis for each condition separately. For face condition, significant main

effect was observed for configuration ($F(3, 160)=4.17, p<.0001$), and further analysis of this effect by multiple comparisons revealed that delayed N170 latencies in the split configuration relative to inverted configuration, and in the inverted configuration relative to neutral configuration in face. Whereas, for clock condition, significant main effect was observed for configuration ($F(3, 160)=4.48, p<.0001$), and further analysis of this by multiple comparisons revealed that delayed N170 latencies in the split configuration relative to inverted and neutral configuration.

The P300 component

The repeated measures ANOVA with configuration and condition as the dependent variables for P300 amplitude revealed only a significant main effect of configuration ($F(1, 360) = 22.35, p < .0001$). Further analysis of this effect by multiple comparisons showed larger P300 amplitudes in response to split as compared to inverted stimuli, as well as larger amplitudes in response to inverted as compared to neutral stimuli.

Consistent with the amplitude data, analysis of P300 latency revealed only a significant main effect of configuration ($F(1, 80) = 22.8, p < .0001$). Delayed P300 latencies were seen in response to split configuration relative to the inverted and neutral configurations by multiple comparisons.

DISCUSSION

Overall, participants exhibited larger N 170 amplitude to faces than clocks, as has been demonstrated in previous studies (Schweiberger, & Sommer, 1991; Deouell, Bentin & Soroker, 2000). This finding is consistent with the proposed specialization of the N170 component in the processing underlying face recognition (Watanabe, Miki & Kakigi, 2005; de Gelder *et al.*, 2006). The primary objec-

tive of the present study was to investigate whether the N170 and P300 components were sensitive to the configuration of face and clock stimuli that were inverted or split and misaligned along the horizontal plane. Configuration significantly impacted N170 amplitude for faces but not for clocks, though the N170 latencies were affected by configuration in both types of stimuli. In contrast to the N170, amplitude and latency for the P300 component were affected by configurational manipulations of both the face stimuli and the clock stimuli.

These results show that N170 amplitude is sensitive to the configuration of faces but not clocks. Responses to inverted and split faces produced larger N170 amplitudes as compared to a neutral face. In contrast, the inverted and split clock produced N170 amplitudes that were essentially equivalent to the neutral clock. The N170 response may reflect facilitation of the local processing involved in face recognition. According to reverse hierarchy theory, paying attention to local features leads to feedback processing. Thus, there is a possibility that the N170 response is closely related to feedback processes. Consistent with this contention, the latencies of the N170 component seen here were similar to the latency of re-activation seen in a previous study (Di Russo, Martinez, & Hillyard, 2003).

We also found that N170 amplitudes were larger in the right electrode than in the left one, even in the split face configuration which directs attention to local features. Previous work has identified a right hemisphere superiority in global processing and a left hemisphere superiority in local processing for Navon-type hierarchical letters (Navon, 1987). However, many investigations of lateralized perception in healthy participants have not found such asymmetry (Yovel, Levy, & Yovel, 2001). Because face recognition is strongly lateralized to the right hemisphere (Rossion *et al.*, 2003), even conditions directing attention to local features may be affected superseded by this laterality.

Based on the results for facial stimuli, it appears that an unusual image (e.g., a split configuration) can be detected at the earlier stage of visual processing; that is, the N170. In contrast to the N170, the P300 was sensitive to configuration for either stimulus type. The responses to inverted and split configurations of either the face or the clock produced larger amplitudes of the P300 relative to the corresponding neutral stimuli. Thus, for recognition of a non-facial object, an unusual configuration is not detected in the early stage, but instead at the late stage of processing such as the P300. The differential early processing described above supports the unique processing underlying face recognition, and it may also reflect facilitation of the local processing of facial information.

An effect of inverted and split configuration on P300 amplitudes was seen for both the faces and clocks stimuli. This result may reflect responses to non-prototypical stimuli, as we rarely encounter split or inverted images. Moreover, consistent with many previous studies (Rossion et al., 2000; Eimer, 2000), the effect of inversion in N170 component was not seen in clock condition, however the N170 latency was sensitive to both faces and clocks in split configuration. Previous studies have reported that global processing occurs faster than local processing in latency (Proverbio, Minniti, & Zani, 1998; Han, He, Yund, & Woods, 2001). So split images might lead much attention to local features than inverted images do, then the latency was delayed. Further research is needed to confirm this possibility.

In summary, despite the importance of configurational information in face perception, the brain activity underlying this processing remains unclear. In the present study we demonstrated that unusual face configurations are detected at earlier stages of visual information processing (such as the N170) as compared to non-facial objects, which are detected at later stages (such as the P300). However, to better understand the processing underlying face recognition, further research is needed to establish the function and generator of

the N170.

CONCLUSION

In present study, we examined the temporal dissociation in global-local feature in Experiment 1. Consistent with RHT, it is suggested that local information is processed in a feedback system; this processing is then interrupted by the mask stimulus presented later at the primary visual area. Global information, by contrast, is transferred via a feed-forward system, and is not disrupted by the mask. In Experiment 2, we investigated brain responses with facial stimuli using EEG. We suggested the possibility that N170 component is closely related to feedback processes which is mentioned in RHT.

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