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Author	日根, 恭子(Hine, Kyoko) 伊東, 裕司(Ito, Yuji)
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26 Availability and Accessibility of Holistic and Featural Information in Face Recognition: Effects of Retention Interval

Kyoko Hine[1,2] and Yuji Itoh[1]

[1] Department of Psychology, Keio University
[2] Center for Advanced Research on Logic and Sensibility (CARLS), Keio University

This study was designed to explore whether accessibility of holistic information decreased when facial memory was poor. In Experiment 1, forty-eight participants intentionally learned a set of 48 facial photos. After the learning phase, participants in the immediate group were immediately required to provide 'old/new' judgments, while there was a one-day delay between the learning and test phases for the delayed group. The faces used in the test phases included old faces, new faces, and conjoined faces, parts of which were from different learned faces. Comparison of differences in 'old' response rates showed that less holistic information was used in the delayed group. In Experiment 2, the procedure used was the same as for Experiment 1, except that the 'old/new' judgment test was replaced by an 'old/conjoined/new' judgment test requiring more holistic information. No reduction in holistic or featural information was found with the one-day delay. These findings suggest that accessibility of holistic information decreased when memory was weak without requiring holistic information processing.

I. Introduction

It is believed that two types of information are used in face recognition,

featural information and holistic information. Featural information is related to the parts of a face. The eyes, nose, and mouth are elements of featural information. Holistic information, on the other hand, is not decomposed into featural information, and is thus not easily summarized as featural information.

The face recognition literature suggests that holistic information plays the primary role in face recognition, while featural information is secondary (e.g., Diamond & Carey, 1977; Tanaka & Farah, 1993; Young, Hellawell, & Hay, 1987). Young, Hellawell, & Hay performed a study using composite face photos, in which composite faces were constructed from the top half of one face and the bottom half of another face. There were two types of composite faces, one in which the halves were aligned, and another in which they were misaligned. Participants in their study were asked to name the top halves or the bottom halves. When the halves were aligned, it was difficult to name the top or bottom halves. When the halves were misaligned, however, it was not difficult for the subjects to provide names. Naming of the halves required featural information processing. The aligned face makes us difficult to ignore to configural process. Therefore, the composite aligned face interfered with the process of featural information, and the subjects name the aligned face slowly. Holistic information is thus principally used in face recognition.

On the other hand, some studies have reported that featural information is as important as holistic information in face recognition (e.g., Cabeza & Kato, 2000). In such studies, two types of face prototypes, a configural prototype and featural prototype, were produced. The configural prototype was the average of the four original faces, while the featural prototype consisted of parts from the four different original faces. The participants saw the original faces in the study phase. Later, they underwent an old/new recognition test, in which original faces, prototypes, and non-studied faces were presented. The participants' recognition of both configural and featural prototypes was less accurate than that of non-studied faces. This finding suggested that both configural information and featural information are important in face recognition.

Though holistic information plays important roles in face recognition, face recognition does not always rely on holistic information more than featural information. Some findings suggest that that holistic information

processing is impaired. The verbal-overshadowing effect is one such phenomenon. Schooler and Engstler-Schooler (1990) report that describing a target face from memory impaired subsequent task performance involving identification of a target face in a line-up.

As a reason for the verbal-overshadowing effect, Schooler, Fiore, and Brandimonte (1997) have provided the theory of transfer inappropriate processing shift (TIPS). There are four assumptions in TIPS. (1) Verbalizing promotes application of a language process, and search of the verbal aspects of memory. (2) Selectively recollecting the verbal aspects of memory reduces the accessibility of the information which is not recollected. (3) Recollection of the verbal aspects of memory interferes with the processing of the nonverbal information which is not recollected. (4) Even if the accessibility of nonverbal knowledge and processing decreases, it will recover, if perceptual and nonverbal processing is appropriately performed. This theory suggests that we usually use more holistic information than featural information in face memory tasks, and in the encoding stage holistic information is encoded more than featural information. However, describing a face seen before induces a shift from nonverbal holistic information processing to verbal featural information processing. Hence, subsequent face recognition task performance falls because holistic information cannot be effectively used.

Although verbal-overshadowing effect has been observed, studies in which face recognition performance was improved by prior verbal description have also been reported (e.g., Schooler, Ryan, & Reder, 1996). To explain these contrary findings systematically, Itoh (2005) proposed the BEAS (Balance of the Effect by Attention Shift) model. The BEAS model has three assumptions. (1) When an unfamiliar face is remembered, featural information, which is easy to verbalize, and configural information, which cannot be verbalized or is difficult to verbalize, are encoded. (2) Verbal description before a recognition task shifts the direction of attention from holistic information, which is difficult to verbalize, to featural information, which is easy to verbalize. (3) Verbal description interferes with recognition that is based on holistic information, and promotes recognition based on featural information. It can thus be predicted that whether verbal description has an interruptive or facilitative effect depends on the availability of featural and holistic information

during face recognition.

Itoh (in preparation) makes an additional assumption. Under conditions in which memory of a face is good, whether duration of observation is long or retention interval is short, the availability of holistic and unverbalizable information is higher than that of featural and verbalizable information. On the other hand, when memory of a face is poor, whether duration of observation is short or retention interval is long, the availability of featural information is higher than that of holistic information. He conducted experiments to test this assumption. Verbal-overshadowing was observed only when memory was good, suggesting that verbal description exhibited an interference effect when availability of holistic information was higher than that of featural information.

The terms availability and accessibility were considered by Tulving & Pearlstone (1966). Availability concerns whether information or a trace can be searched, while accessibility refers to whether information that can be used is retrieved. It might be suspected that it is not sufficient to consider only the availability of holistic and featural information. Verbal-overshadowing effect was observed when memory was poor. It has been believed that reduction of availability of holistic information was responsible for this. However, decline of accessibility of holistic information could be a cause of it as well. The purpose of this study was to examine the possibility that accessibility of holistic information decreases more than that of featural information when memory is poor. In addition, we examined whether the results of Itoh's experiment (in preparation) could be accounted for by reduction of accessibility of holistic information.

II. Experiment 1

As noted above, the aim of this study was to examine the possibility that accessibility of holistic information decreases more than that of featural information when memory is poor. To control whether a memory state was rich or poor, we included a retention interval between an encoding phase and a retrieval phase. It was expected the longer the delay between the two was, the more memory would exhibit decay. In the delayed group, participants engaged in a face recognition task one day after a face

encoding phase. In the immediate group, on the other hand, they performed the task immediately after the face encoding phase. Comparing old response rates to target faces seen previously and some types of distracters between the immediate and delayed group, we could discuss about availability and accessibility of holistic and featural information.

1. Methods

1.1. Participants

A total of 48 participants ranging in age from 19 to 39 years took part in the present study. Participants were randomly assigned to either an immediate group or a delayed group.

1.2. Materials

Monochromatic face photos of 72 persons (36 men, 36 women) were prepared for this study. In addition, six photos of women were prepared to avoid the primacy and recency effects. All were full faces with neutral facial expressions, with the individual photographed wearing a white robe, and with the same background and lighting. Photo size was 128×128 pixels.

These photos were produced using Photoshop 5.0 (Adobe). All faces were divided into four parts: hair-outline, eyes-eyebrows, nose, and month. Reconstructed faces (original faces) consisted of four divided parts that had been picked from four different faces. Each original face consisted of hair-outline, eyes-eyebrows, nose, and month from four different faces of the same sex. Next, original faces were separated into three groups. Each group consisted of 24 original faces (12 female, 12 male). These original faces were again divided into four parts, and seventy-two conjoined faces were produced using facial parts of the original faces. Each conjoined face consisted of hair-outline, eyes-eyebrows, nose, and month from four different faces of the same sex in the same group. No conjoined faces shared the same parts from the same original face.

1.3. Procedure

This experiment was performed individually. The participant sat in front of a PC. The distance between the display and participant was approximately 45 cm. In the learning phase, participants viewed a set of 54 photos (24 men, 30 women) of original faces for a fixed period of three seconds each, and were instructed to intentionally learn them. The interstimulus interval (ISI) was 1.5 seconds. The six photos of women were placed in the first three and last three positions to avoid the primacy and recency effects. These six photos had thus never been presented in the later test.

After the learning phase, participants in the immediate group were immediately given the self-paced old-new recognition test. In the case of the delayed group, there was a one-day delay between the learning and test phases. The average delay was 23 hours 19 minutes (range, 18 to 29 hours). The experimenter and the experiment room for the second day were the same as for the first day in the case of the delayed group. In the old-new recognition test, 72 individual faces were presented in succession. Twenty-four of these faces were old faces that had been presented during the learning phase, 24 of them were conjoined faces that consisted of facial parts from four different faces seen during the learning phase, and 24 of them were new faces that had not been previously presented. The photos were presented in random order, though photos of the same type were not presented successively more than four times. The participants were told to respond that a face was old if they considered it to be the same as a face that they had seen during the learning phase. The same face recognition task was carried out under two conditions. The experiment with the immediate group took approximately 20 min to run. The experiment with the delayed group took 5 min for the first day and 15 min for the second day. After completing the experiments, the participants were thanked and debriefed.

2. Results

2.1. Old Response Rates

Figure 1 shows the old responses rates. Both immediate and delayed

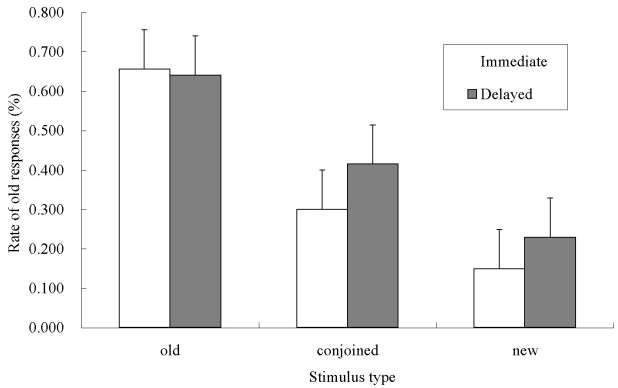

Figure 1. Rates of old responses (Experiment 1).

participants gave 'old' responses to old faces most often (0.656 for the immediate group and 0.641 for the delayed group) and more often to conjoined faces (0.300 and 0.415, respectively) than to new faces (0.149 and 0.229, respectively). A 3×2 analysis of variance (ANOVA) was conducted on the proportion of 'old' responses, with face type (old face, conjoined face, new face) and delay (immediate, delayed) as factors. The main effect of face type was significant ($F(2,92)=211.034$, $p<.001$). The main effect of delay was also significant ($F(1,46)=4.995$, $p<.05$). There was interaction between face type and delay ($F(2,92)=4.445$, $p<.05$). There was a significant simple main effect of delay for conjoined faces ($F(1,138)=9.424$, $p<.005$) and for delay for new face ($F(1,138)=4.578$, $p<.05$). There was no significant simple main effect of delay for old faces ($F(1,138)=0.175$, *n.s.*). There was a significant simple main effect of face type for both the immediate and delayed groups ($F(2,92)=132.462$, $p<.001$; $F(2,92)=4.445$, $p<.001$, respectively).

With use of multiple-comparison testing with the Ryan method (α = 0.05), for the immediate group there was a significant difference in 'old' responses between old faces and conjoined faces, old faces and new faces, and conjoined faces and new faces. For the delayed group, there was a significant difference in 'old' responses between old faces and conjoined faces, old faces and new faces, and conjoined faces and new faces.

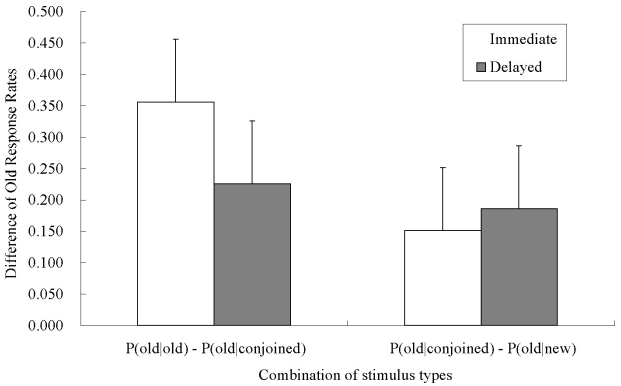

Figure 2. Differences of old response Rates (Experiment 1).

2.2. Differences in 'Old' Response Rates

In order to compare processing of holistic information and featural information more directly, we calculated differences in old response rates. We calculated two types of such differences. For one type, the difference was calculated as the rate of 'old' responses for old faces minus the rate of old responses for conjoined faces (P(old|old)-P(old|conjoined)). Both old faces and conjoined faces contained featural information that was presented previously. Thus, use of featural information alone was not sufficient to discriminate old from conjoined faces. Holistic information had to be used to discriminate such faces. This means that this difference between 'old' response rates to old faces and that to conjoined faces might reflect holistic information processing. The other type of differences was calculated as the rate of 'old' responses to conjoined faces minus the rate of 'old' responses to new faces (P(old|conjoined)-P(old|new)). When an 'old' response to a conjoined face was observed, it appeared that featural information was used but holistic information was not. If holistic information had been used effectively, a 'new' response to a conjoined face should have been observed. This discrimination score might reflect featural information processing.

Figure 2 shows differences in 'old' response rates. For both the immediate and delayed participants, P(old|old)-P(old|conjoined) (0.356 for immediate group and 0.226 for delayed group) were larger than

P(old|conjoined)-P(old|new) (0.151 and 0.186, respectively). A 2×2 ANOVA was conducted on the difference in 'old' response rate, with difference type (P(old|old)-P(old|conjoined), P(old|conjoined)-P(old|new)) and delay (immediate, delayed) as factors. The main effect of difference type was significant ($F(1,46)=9.354$, $p<.005$). The main effect of delay was also significant ($F(1,46)=4.661$, $p<.05$). There was interaction between difference type and delay ($F(1,46)=4.246$, $p<.05$). P(old|old)-P(old|conjoined) was larger in the immediate group than in the delayed group ($F(1.92)=8.110$, $p<.01$). There was no significant difference between the immediate and delayed groups in P(old|conjoined)-P(old|new) ($F(1.92)=0.577$, *n.s.*). Furthermore, in the immediate group, there was a significant main effect of difference type ($F(1,46)=13.103$), $p<.001$). In the delayed group, there was no significant main effect of difference type ($F(1,46)=0.498$, *n.s.*).

3. Discussion

The aim of this study was to examine the possibility that accessibility of holistic information is decreased more than that of featural information when memory is poor. At the task condition in which there was about one-day delay after the observed the faces, P(old|old)-P(old|conjoined), reflects the degree of holistic process, was significant lower than that at the task condition there was no delay after they observed the faces. On the other hand, the difference P(old|conjoined)-P(old|new) reflects the degree of featural processing, between the immediate condition and the delayed condition was not significant. From those results, the weight of holistic process at the condition there was one-day delay after they were exposed the faces was lower than at the condition there was no delay.

There are two possible explanations of these results. One is that the availability of holistic information decreased more rapidly than that of featural information. Another is that accessibility of holistic information was lower than that of featural information.

The results of Experiment 1 were therefore interpreted as follows. In the former case, availability of holistic information decayed more than availability of featural information during one-day delay. So it was not need to suppose the process was shifted from holistic information to

featural information at the recognition task. In the latter case, it might to be shifted from holistic information to featural information regardless there was difference between the amount of availability of holistic information and those of availability of featural information. In other words, holistic information, which was available, was not accessed because attention had shifted from holistic to featural processes. We conducted Experiment 2 to test these possibilities.

III. Experiment 2

The aim of Experiment 2 was to examine which of these possibilities accounted for the results of Experiment 1. One possibility was that availability of holistic information decreased more rapidly than that of featural information with a one-day delay. Another was that accessibility of holistic information decreased more than that of featural information during the delay.

In Experiment 2, we used a recognition task requiring more holistic information processing. Participants had to choose from among the recognition options ‘old’, ‘new’, and ‘conjoined’. They thus had to judge not only that the faces were seen during the study phase, but also whether the faces were recombined from faces seen during the study phase, in which case they were to provide the ‘conjoined’ response. Therefore, the recognition task in Experiment 2 required more holistic information processing than that in Experiment 1.

If the degree of holistic information used in the delayed condition decreased in Experiment 2, as in Experiment 1, this would not suggest that the reason that the degree of holistic information used in the delayed condition decreased in Experiment 1 was reduction of accessibility of holistic information. In this case, trying to use holistic information did not affect the boost of the degree of holistic information that was processed. If the degree of holistic information in the delayed condition was the same as that in the immediate condition in Experiment 2, this would not suggest reduction of availability of holistic information used in the delayed condition in Experiment 1. This would indicate that holistic information could be used with effort made to use it.

1. Methods

1.1. Participants

A total of 48 participants ranging in age from 19 to 31 years took part in the present study. Participants were randomly assigned to either an immediate group or a delayed group. Nobody participants in Experiment 2 participated in Experiment 1.

1.2. Materials

The stimuli used in Experiment 2 were the same as those in Experiment 1.

1.3 Procedure

The procedure was the same as in Experiment 1, except for the recognition task. The participants were told to respond that a face was old if they considered a face to be the same as one that they had seen during the learning phase. If they considered some components of a face to be same as components of faces seen during the learning phase, though the whole face had not been seen previously, they were to respond that the face was conjoined.

The average delay between learning and the test for the delayed group was 23 hours 11 minutes (range, 17 hours 45 minutes to 27 hours 5 minutes). The experiment with the immediate group took approximately 20 min to run. The experiment with the delayed group took 5 min for the first day and 15 min for the second day.

2. Results

2.1. ‘Old’ Responses

Figure 3 shows ‘old’ responses rates. Both immediate and delayed group participants gave ‘old’ responses to old faces most often (0.424 for the immediate group and 0.411 for the delayed group) and more often to

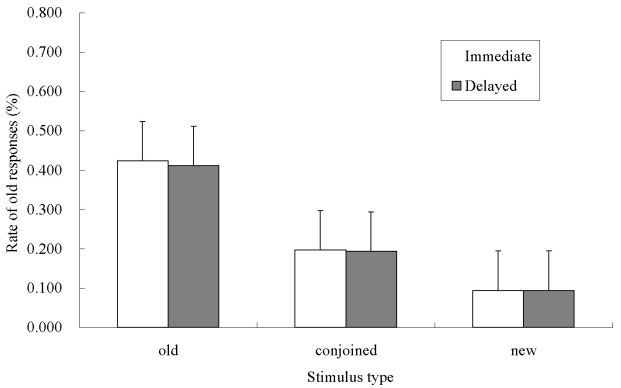

Figure 3. Rates of old responses (Experiment 2).

conjoined faces (0.196 and 0.193, respectively) than to new faces (0.094 and 0.094, respectively). A 3×2 analysis of variance (ANOVA) was conducted on the proportion of 'old' responses, with face type (old face, conjoined face, new face) and delay (immediate, delayed) as factors. The main effect of face type was significant ($F(2,92)=110.421$, $p<.001$). The main effect of delay was not significant ($F(1,46)=0.029$, *n.s.*). The results of multiple-comparison testing with the Ryan method indicated significant differences in 'old' responses between old faces and conjoined faces ($t(92)=10.004$, $p<.001$), old faces and for new faces ($t(92)=14.519$, $p<.001$), and conjoined faces and new faces ($t(92)=4.515$, $p<.001$). There was no interaction between face type and delay ($F(2,92)=0.039$, *n.s.*).

2.2. 'Conjoined' Responses

Figure 4 shows rates of 'conjoined' responses. Both immediate and delayed group participants gave 'conjoined' responses to conjoined faces most often (0.368 for the immediate group and 0.363 for the delayed group) and more often to old faces (0.352 and 0.326, respectively) than to new faces (0.321 and 0.287, respectively). A 3×2 analysis of variance (ANOVA) was conducted on the proportion of 'conjoined' responses, with face type (old face, conjoined face, new face) and delay (immediate, delayed) as factors. The main effect of face type was significant ($F(2,92)=4.034$, $p<.05$). The main effect of delay was not significant

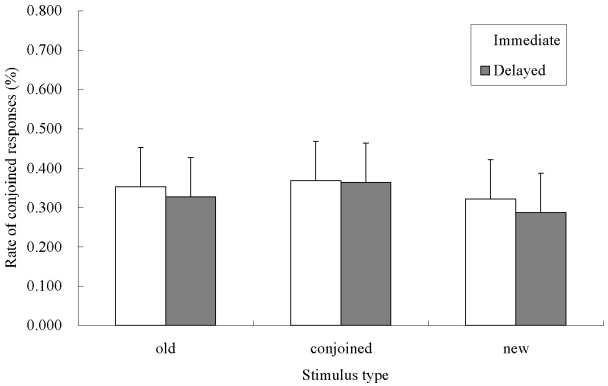

Figure 4. Rates of conjoined responses (Experiment 2).

(F(1,46)=0.364, *n.s.*). Multiple-comparison testing with the Ryan method revealed a significant difference in 'conjoined' response rate between new faces and conjoined faces (t(92)=2.830, p<.01). There was no significant difference in rate of this response between old faces and conjoined faces (t(92)=1.205, *n.s.*,) or between old faces and new faces (t(92)=1.625, *n.s.*). There was no interaction between face type and delay (F(2,92)=0.245, *n.s.*).

2.3. 'New' Responses

Figure 5 shows rates of 'new' responses. Both immediate and delayed group participants gave 'new' responses to new faces most often (0.585 for the immediate group and 0.637 for the delayed group) and more often to conjoined faces (0.436 and 0.448, respectively) than to old faces (0.224 and 0.257, respectively). A 3×2 analysis of variance (ANOVA) was conducted on the proportion of 'new' responses, with face type (old face, conjoined face, new face) and delay (immediate, delayed) as factors. The main effect of face type was significant (F(2,92)=111.648, p<0.001). The main effect of delay was not significant (F(1,46)=1.489, *n.s.*). Multiple-comparison testing with the Ryan method revealed a significant difference in rate of 'old' responses between old faces and new faces (t(92)=14.924, p<.001), conjoined faces and new faces (t(92)=6.816, p<.001) and old faces and conjoined faces (t(92)=8.109, p<.001). There was no interaction

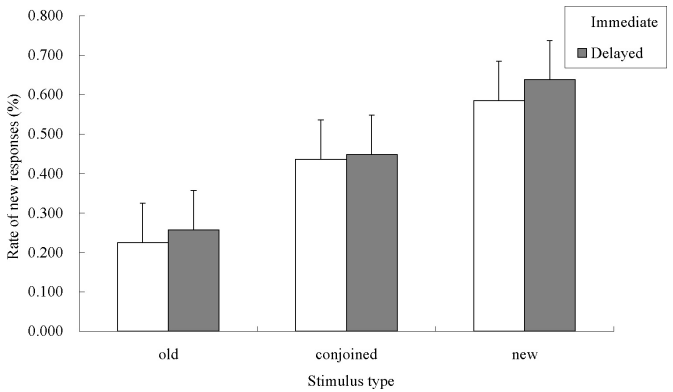

Figure 5. Rates of new responses (Experiment 2).

between face type and delay ($F(2,92)=0.323$, *n.s.*).

2.4. Differences in 'Old' Response Rates

As in Experiment 1, we calculated two types of differences in 'old' response rates. Figure 6 shows differences in 'old' response rates. For both immediate and delayed group participants, P(old|old)-P(old|conjoined) (0.227 for immediate group and 0.219 for delayed group) was greater than P(old|conjoined)-P(old|new) (0.102 and 0.099, respectively). A 2×2 ANOVA was conducted on difference in rate of 'old' responses, with

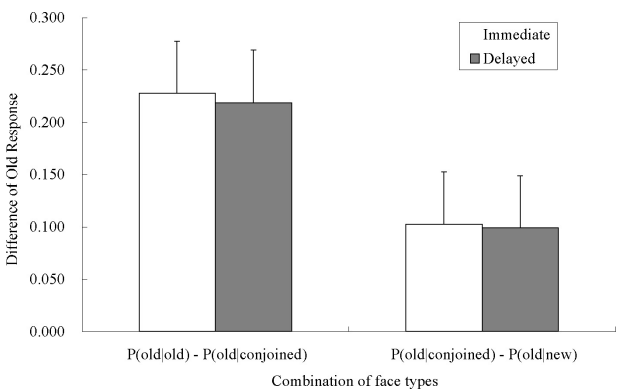

Figure 6. Differences in old response rates (Experiment 2).

difference type (P(old|old)-P(old|conjoined), P(old|conjoined)-P(old|new)) and delay (immediate, delayed) as factors. The main effect of difference type was significant ($F(1,46)=18.595$, $p<.001$). The main effect of delay was not significant ($F(1,46)=0.051$, *n.s.*). There was no interaction between difference type and delay ($F(1,46)=0.008$, *n.s.*).

3. Discussion

There are two possible explanations for the reduction in holistic processing in the delayed condition in Experiment 1. One is that there was greater reduction of availability of holistic information compared to that of featural information. Another is that there was greater reduction of accessibility of holistic information than that of accessibility of featural information. In the former case, it might be thought that the decay of available holistic information was faster than that of available featural information. Although the degree of holistic processing used in the delayed condition was the same as that in the immediate condition, the amount of holistic information decreased more than that of featural information with one-day delay. In the latter case, even if the decay of available holistic information was the same as that of available featural information, the rate of use of holistic information in the delayed condition was lower than that in the immediate condition. The shift in processing from holistic to featural information in the delayed condition was responsible for this result. Experiment 2 was conducted to determine which of these was the correct explanation.

In Experiment 2, there was no significant difference between the immediate and delayed conditions in either of two types of difference in ‘old’ response rates. This result suggested that reduction of accessibility of holistic information caused the decrease in rate of holistic information processing in the delayed condition in Experiment 1.

In Experiment 2, a ‘conjoined’ response option was available. This suggests that the criterion used by participants for ‘old’ responses differed from that in Experiment 1. When there was the effect of delay on conjoined responses or new responses, it might not be observed of the effect of delay on old judgment. However, the main effects of delay on ‘conjoined’ responses to conjoined and new faces were not significant. The main effects of delay on ‘new’ responses to conjoined and new faces were

also not significant. These findings do not support the conclusion that shift in criterion was responsible for the differences in results between Experiment 1 and Experiment 2.

These findings suggest that the degree of holistic information processing in the delayed condition in experiment 1 was decreased by reduction of accessibility of holistic information. This indicates that when memory is poor, as in the delayed condition in Experiment 1, accessibility of holistic information is decreased to a greater extent than that of featural information.

IV. General Discussion

The aim of this study was to examine whether accessibility of holistic information is decreased when face memory is poor. We set two conditions, an immediate condition and a delayed condition, and the recognition test performances in these two conditions were compared. The faces presented in the recognition test included old faces, new faces, and conjoined faces. In Experiment 1, in which participants were required to provide 'old/new' judgments, P(old|old)-P(old|conjoined), which reflected the degree of holistic processing, was significantly lower in the delayed condition than in the immediate condition. On the other hand, featural information was used in the delayed group as much as in the immediate group. In Experiment 2, in which participants were required to provide 'old/conjoined/new' judgments, which required more holistic information, holistic information was used in the delayed condition as much as in the immediate condition. In addition, featural information was used in the delayed condition as much as in the immediate condition. These findings suggested that accessibility of holistic information decreased when 'old/new' judgment was performed one day after observation of target faces, i. e. that face memory was poor.

Some studies have reported findings suggesting that availability of holistic information is decreased when memory is poor. The results of the present study suggested that not only availability of holistic information but also accessibility of holistic information decreased where memory was poor.

Itoh (in preparation) examined whether verbalizing of a target face interferes with subsequent face recognition when memory is poor, by manipulating accessibility of face memory. In his study, the retention interval between the learning and test phases was varied, with no interval or a one-week interval after participants observed faces. He assumed that when face memory is poor, the availability of featural information is greater than that of holistic information. Verbal-overshadowing effect was found only in the immediate condition in his study. It thus appeared that availability of holistic information decreased during a one-week period after observation of target faces. The present study yielded no evidence that availability of holistic information decreased during a one-day retention interval. These differences in findings need to be addressed.

In Itoh's study (in preparation), the retention interval between the observation of target faces and recognition testing was one week. In the present study, the retention interval was only one day. A one-day delay was thus not sufficient to reduce availability of holistic information. If the delayed group in Experiment 2 had taken the recognition test one week after facial observation, we might have found reduction of holistic information even when holistic information was strongly required.

A new explanation of the reduction of holistic information during the retention interval might be suggested. To confirm the validity of the BEAS model as an explanation of the verbal overshadowing effect, Itoh set the assumptions that availability of holistic information decreases when memory is poor. However, this assumption could itself support the BEAS model. In the present study, we obtained no findings suggesting the interpretation that availability of holistic information decreased with retention interval. In addition, our findings do not suggest that availability of holistic information was not decreased during one-day delay. Further research is thus needed to clarify the availability and accessibility of holistic and featural information in face recognition.

When featural information is altered, holistic information is as well. This means that holistic information and featural information are not independent in face recognition. Availability and accessibility are not independent factors in it, either. When availability is altered, accessibility is as well. It is thus difficult to clarify the separate effects of availability and accessibility of holistic and featural information. What our findings do

clearly indicate is that accessibility of holistic information decreased when face memory was weak. Further research on face recognition focusing on holistic and featural information is thus clearly needed.

References

Cabeza, R., & Kato, T. (2000). Features are also Important: Contributions of Featural and Configural Processing to Face Recognition. *Psychological Science*, **11(5)**, 429-433.

Diamond, R., & Carey, S. (1977). Developmental Changes in the Representation of Faces. *Journal of Experimental Child Psychology*, **23**, 1-22.

Itoh, Y. (2005). The Facilitating Effect of Verbalization on the Recognition Memory of Incidentally Learned Faces. *Applied Cognitive Psychology*, **19**, 421-433.

Itoh, Y. (in preparation). Facilitating and interfering effects of the verbalization of targets on the recognition of faces.

Schooler, J. W., & Engstler-Schooler, T. Y. (1990). Verbal Overshadowing of Visual Memories: Some Things Are Better Left Unsaid. *Cognitive Psychology*, **22**, 36-71.

Schooler, J. W., Fiore, S. M., & Brandimonte, M. A. (1997). At a Loss from Words: Verbal Overshadowing of Perceptual Memories. *The Psychology of Learning and Motivation*, **37**, 291-340.

Schooler, J. W., Ryan, R. S., & Reder, L. (1996). The Costs and Benefits of Verbally Rehearsing Memory for Faces. In D. J. Herrmann, C. McEvoy, C. Hertzog, P. Hertel, & M. K. Johnson (Eds.), *Basic and Applied Memory Research: Practical Applications* (Vol.2, pp.51-65). Mahwah, N.J.: Lawrence Erlbaum Associates.

Tanaka, J. W., & Farah, M. J. (1993). Parts and Wholes in Face Recognition. *The Quarterly Journal of Experimental Psychology*. **46A(2)**, 225-245.

Young, A. W., Hellawell, D., & Hay, D. C. (1987). Configurational information in face perception. *Perception*, **16**, 747-759.

Tulving, E., & Pearlstone, Z. (1966). Availability Versus Accessibility of Information in Memory for Words. *Journal of Verbal Learning and Verbal Behavior*, **5**, 381-391.