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THE EFFECTS OF EXPRESSION ON FACE RECOGNITION

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In the face recognition model proposed by Bruce and Young (1986), they claimed that the information used to recognize a face does not depend on the facial expression. The results of the present study was incongruent with their view. In experiment 1, 48 subjects were shown the faces of familiar staffs from Tohoku University and the faces of unfamiliar staffs from another college. Each face was shown with 3 different expressions (i.e. neutral, happy, and angry). The subjects' task was to decide whether or not each face was familiar. It was found that the personally familiar people were recognized faster with a 'neutral' face than with a 'happy' or 'angry' face. In experiment 2, 'neutral' and 'happy' faces of well-known people were used as familiar faces. Twenty subjects performed the same tasks as in experiment 1. The results showed that well-known people were recognized faster with a 'happy' face than with a 'neutral' face. These results indicate that the expression on the stimulus face has an effect on the processing of identity.

Key words: face recognition, facial expression, familiarity.

INTRODUCTION

Recently many theoretical models of face recognition have been proposed, among which the functional model presented by Bruce and Young (1986) is regarded as the most accurate. According to this model, the process of identifying a familiar face involves serial stages. First, structural encoding processes produce descriptions of the encountered face. Second, these descriptions are matched with representations of familiar faces stored within face recognition units in order to determine whether the presented face is familiar or not. Third, identity-specific information is accessed from person identity nodes, so that we can specify who the person is. Finally, names are retrieved. This view of the serial processing of identity has been supported by evidence from the results of laboratory experiments (e.g., Young, Ellis, & Flude, 1988; Young et al., 1986a, 1986b), studies of everyday errors (Young, Hay, & Ellis, 1985), and from neuropsychological studies (de Haan, Young, & Newcombe, 1991; Flude, Ellis, & Kay, 1989).

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However, it has been suggested that there are several problems with the detailed mechanisms in Bruce and Young's model, and some modifications have been proposed. One of the problems is the nature of the representation stored in face recognition units. Bruce and Young assumed that face recognition units might contain abstract structural codes similar to logogens in a word recognition model proposed by Morton (1969, 1979). A. Ellis et al. (1987) have presented findings which are incompatible with the concept of the logogen-type recognition units. They investigated the repetition priming of the recognition of familiar faces when similarities of priming and target faces were varied. It was found that maximum repetition priming was obtained when the priming and target photographs were the same, less when they were similar, and least, but still present, when they were dissimilar. The effects of repetition priming are explained as a consequence of changes within the face recognition units (Bruce & Valentine, 1985; Ellis, Young, & Flude, 1990). The logogen-type recognition units, however, could not account for the graded-similarity effects in repetition priming, because these types of units should not be sensitive to the particular view of a familiar face. Ellis et al. (1987) argued that the results could be best explained by some forms of instance-based models (e.g., McClelland & Rumelhart, 1985).

Hay, Young, and Ellis (1991) have also suggested that instance information is maintained in the recognition system. They analyzed the difficulties and errors in recognizing people which occurred under laboratory conditions rather than in everyday life. They found that in 42% of the failures to determine a face was familiar, the subjects made comments such as "I've never seen him like that". Such explanations are more consistent with an instance-based model.

When we apply an instance-based account to Bruce and Young's model, there is an additional problem to be solved. This is the problem of the structural encoding processes. Bruce and Young have claimed that expression-independent descriptions are derived from encountered faces for the analysis of identity. Their claim is incongruent with the view that individual instances are directly stored.

The aim of the present study was to investigate the effects of facial expressions on the analysis of facial identity, in order to examine whether information about the expressions on the encountered faces is involved in representations of familiar faces. In experiment 1, familiarity decision times were measured when personally familiar faces were presented with the three types of facial expressions, i.e., neutral, happy, and angry. In experiment 2, well-known persons' faces were presented with a 'neutral' or 'happy' expression and the recognition times were compared.

EXPERIMENT 1

METHOD

Subjects: Forty-eight volunteers (24 male, 24 female) participated in this experiment. They were Psychology students from Tohoku University.

Materials and Apparatus: The test stimuli for all conditions were 48 black-and-white

photographs of faces. They consisted of the faces of 16 males displaying three types of expression (neutral, happy, and angry). Half of these people were staff members from the Psychology department of Tohoku University, who were familiar to the subjects. The other half were staff members from another college, who would be unfamiliar to the subjects. The filler stimuli were 24 black-and-white photographs of male faces collected from magazines. Half of the fillers were famous faces (politicians, TV personalities, and sportsmen) consisting of 3 'neutral' faces, 3 'happy' faces, 3 'angry' faces, and 3 'sad' faces. The other half were unfamiliar faces, which showed 4 types of facial expression in the same manner as the famous faces.

The stimuli were presented by a Gerbrands tachistoscope. They subtended a visual angle of approximately 5 deg. A personal computer (SHARP Inc. X1) was used for controlling the stimulus presentation and recording the subjects' responses and response latencies.

Design and procedure: The subjects were assigned into the three expression conditions of the test faces. The subject's task was to decide whether or not each face was familiar as quickly but as accurately as possible. The response was made by pressing one of two keys with index figures of the left and right hands. Response-hand assignment was counterbalanced across subjects in each expression condition. A warning tone, which sounded for 500 msec, proceeded each trial by 750 msec. The stimulus was turned off as soon as the subject responded. If the subject did not respond by the time the exposure reached 2 sec, the response was recorded as an error.

After four practice trials with additional faces, the subjects were presented a random series of 34 faces. These faces consisted of 16 test faces, which had one of the three expressions, and 18 filler faces which had expressions differing from the 16 test faces. The filler faces were included so that the subjects would not anticipate a certain type of facial expression or a specific familiar face used as the test faces.

Results

After the experiment, a reliability study of the expressions on the test faces was undertaken with 10 of the 48 subjects. They selected the most suitable emotion for each test face from 12 emotional words (i.e., neutral, happy, surprised, frightened, fearful, sad, angry, disgusted, expectant, thinking, doubtful and ashamed). There were 3 faces whose expressions were not regarded as the target expression by more than 7 *Ss* (70%). Both the data for these faces and those for the same person's face wearing other expressions were excluded: the data for 2 familiar persons and the data for one unfamiliar person.

Mean reaction times for correct responses and error rates in each condition were calculated for each subject. Overall means for each condition are given in Table 1.

Table 1. Mean correct reaction times (in msec) and error rates (in percentages) to different expression types of faces in experiment 1.

	neutral	happy	angry
familiar	759(5)	875(20)	874(17)
unfamiliar	876(3)	891(2)	898(3)

Reaction times

After transforming the data for the correct reactions into reciprocals, a two-way split-plot ANOVA was carried out to determine the effects of familiarity (within-subjects factor) and expression (between-subjects factor). A main effect of familiarity (familiar or unfamiliar) was significant ($F(1,45)=12.05$, $p<.01$). And an expression X familiarity interaction was also significant ($F(2,45)=4.43$, $p<.05$). A simple main effect of expression for familiar faces was significant ($F(2,45)=3.58$, $p<.05$), but not for unfamiliar faces. Further comparisons by LSD tests with each other expression condition for familiar faces revealed that the reaction times for 'neutral' faces were faster than those for the other expression conditions ($p<.05$), and that there was no significant difference in reaction times between 'happy' faces and 'angry' faces. A simple main effect of familiarity for 'neutral' faces was also found ($F(1,45)=19.67$, $p<.01$), but not for 'happy' faces or 'angry' faces; only for 'neutral' faces the subjects were faster to accept familiar faces than to reject unfamiliar ones.

Error rates

After transforming the error rate data into inverse sines, a two-way split-plot ANOVA was carried out to determine the effects of familiarity (within-subjects factor) and expression (between-subjects factor). A main effect of familiarity was significant ($F(1,45)=21.97$, $p<.01$). A main effect of expression was marginally significant ($F(2,45)=2.97$, $.05<p<.10$). And an expression X familiarity interaction was also marginally significant ($F(2,45)=3.5$, $.05<p<.10$). A simple main effect of expression for familiar faces was significant ($F(2,45)=3.42$, $p<.05$), but not for unfamiliar faces. Further comparisons by LSD tests with each other expression condition for familiar faces revealed that there was only a significant difference of error rates between 'neutral' faces and 'happy' faces ($p<.05$); error rates for 'happy' faces were significantly higher than those for 'neutral' faces. Analyses of the simple main effects of familiarity revealed that more errors were made with familiar faces than with unfamiliar ones for 'happy' and 'angry' faces ('happy' faces; $F(1,45)=16.72$, $p<.01$; 'angry' faces; $F(1,45)=10.81$, $p<.01$), but the effect of familiarity was not significant for 'neutral' faces.

Discussion

The main finding of experiment 1 was that familiar faces with a 'neutral' expression were recognized as familiar faster than the same face with a 'happy' or 'angry' expression. This finding cannot be explained in terms of diferences in speed-accuracy tradeoffs, because the

error rates for 'neutral' faces were significantly lower than for 'happy' or 'angry' faces in familiar people.

As mentioned above, Bruce and Young(1986) claimed that face recognition was mediated by expression-independent representations. The findings of this experiment are not consistent with their view, because it predicts that facial expressions should have no effect on the processes of identity. In experiment 2, we examined whether the findings of experiment 1 were replicated when famous faces rather than personally familiar ones were used as the stimuli of familiar faces.

EXPERIMENT 2

METHOD

Subjects: Twenty volunteers (10 male, 10 female) participated in this experiment. They were Psychology students from Tohoku University.

Materials and Apparatus: The stimuli were black-and-white photographs of 20 male faces collected from magazines. Half of them were well-known faces(i.e., politicians, TV personalities, and sportsmen) consisting of 5 'neutral' faces and 5 'happy' faces. The other half were unfamiliar faces consisting of 5 'neutral' faces and 5 'happy' faces. The apparatus was the same as used in experiment 1.

Design and procedure: There were two within-subjects factors: expression (neutral and happy) and familiarity. Each subject was shown all 20 faces. The other aspects of procedure were the same as in experiment 1.

RESULTS

After the experiment, we tested the reliability of the facial expression. Ten of the 20 subjects judged which emotion each stimulus displayed using the same procedure as in experiment 1. There were 3 faces whose expressions were not regarded as the intended expressions by more than 7 *Ss*(70%): one 'neutral' face of a well-known person and 2 'happy' faces of well-known people. The data for these stimuli were excluded.

Mean reaction times for correct responses and error rates in each condition were calculated for each subject. Overall means for each condition are given in Table 2.

Table 2. Mean correct reaction times(in msec) and error rates (in percentages) to different expression types of faces in experiment 2.

	neutral	happy
familiar	754(15)	702(17)
unfamiliar	829(3)	878(3)

Reaction times

After transforming the data for correct reactions into reciprocals, a two-factor ANOVA was carried out to determine the effects of familiarity (within-subjects factor) and expression (within-subjects factor). A main effect of familiarity (familiar or unfamiliar) was significant ($F(1,19)=45.48$, $p<.01$). An expression X familiarity interaction was also significant ($F(1,19)=19.99$, $p<.01$).

Analyses of the simple effects of expression revealed that the reaction times for 'happy' faces were faster than for 'neutral' faces in famous people ($F(1,19)=5.99$, $p<.05$), but that RTs for 'happy' faces were slower than for 'neutral' faces in unfamiliar people ($F(1,19)=11.08$, $p<.01$). All the simple effects of familiarity for each expression condition were also significant (neutral faces; $F(1,19)=13.60$, $p<.01$; happy faces; $F(1,19)=51.78$, $p<.01$). The reaction times were faster for familiar faces than for unfamiliar faces in all the expression conditions.

Error rates

After transforming the error rate data into inverse sines, a two-factor ANOVA was carried out to determine the effects of familiarity (within-subjects factor) and expression (within-subjects factor). Only a main effect of familiarity was significant ($F(1,19)=9.36$, $p<.01$); more errors were made with familiar faces than with unfamiliar ones.

Discussion

The results of experiment 2 were that 'happy' faces of well-known people were recognized as familiar faster than their 'neutral' faces, and that 'happy' faces of unfamiliar people were rejected more slowly than their 'neutral' faces. These results were not contaminated by differences in speed-accuracy tradeoffs, because there was no difference between error rates for 'happy' faces and those for 'neutral' faces.

In experiment 2, the faces of different people were used for the two facial expressions. This differed from the method used in experiment 1. It shows that distinctive familiar faces are recognized as familiar faster than typical familiar faces (Valentine & Bruce, 1986a, 1986b). There is a possibility that the results of experiment 2 are contaminated by the effect of distinctiveness. In order to examine this possibility, an additional study was conducted. Ten subjects were required to rate each face used as the stimulus for distinctiveness on 0-6 scale. Mean ratings were calculated for each face that was not excluded from analyses of the results. Table 3 shows overall means for each condition. An analysis of ANOVA revealed that there was no significant difference between the two expression conditions. Thus, it can be said that the effects of distinctiveness do not contaminate the results of the present experiment.

Different expressions affect the time it takes to recognize famous faces. This is consistent with the findings obtained in experiment 1. However, the pattern of this effect using famous faces is different from that found by using personally familiar faces. We shall consider this aspect in our general discussion.

Table 3. Mean distinctiveness and ratings of faces used in experiment 2.

	neutral	happy
familiar	5.32	5.03
unfamiliar	3.60	3.98

General Discussion

We examined whether facial expressions could influence the reaction time for recognizing a familiar face. In experiment 1, we found that personally familiar faces with a 'neutral' expression were recognized faster than the same face with a 'happy' or 'angry' expression. In expresiment 2, we found that famous people were recognized faster with a 'happy' face than with a 'neutral' face.

Our findings that facial expressions affect the time taken to recognize familiar faces are incongruent with Bruce and Young's model (1986). According to their model, expression-independent descriptions are derived from encountered faces, and are used for analyses of identity. This leads to the prediction that facial expressions should have no effect on the processes of identification.

One might argue that the time taken to derive an expression-independent description differs with facial expressions, thus influencing the results of the present study. For example, if expression-independent descriptions are derived faster from faces displaying neutral expressions than from faces displaying other expressions, then a 'neutral' face will be determined faster whether it is familiar or not. However, such a hypothesis predicts that any face should show the same pattern of the effect of facial expression on the process of identification. It thus cannot accommodate the findings that personally familiar and well-known faces show different patterns of the effect of facial expression on the time taken to recognize as famiiar.

Alternatively, it is more plausible to assume that information about the facial expression of encountered faces is maintained in the representations of familiar faces. Therefore, some types of instance-based models (e.g., McClelland & Rumelhart, 1985) might be able to explain the results of the present study. In such models, after training with several instances of a particular concept, the recognition system responds strongly to the prototype pattern of the concept as well as particular recent instances. We seem to have seen the various facial expressions of a particular familiar person with different frequencies; one of his or her expressions may be observed more frequently than other expressions. In this case, the instance-based model predicts that the face which shows the expression observed more frequently will be recognized as familiar faster than other faces, because the facial expression observed more frequently seems to be more similar to the prototype expression of that particular person than other facial expressions. The instance-based account might also be compatible with the findings that personally familiar and well-known faces are recognized faster with different expressions, if it is assumed that the prototype expression or the most frequently observed expression of personally

familiar people is different from that of well-known people.

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