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When the smile is a cue to familiarity

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The question discussed in the two following experiments concerns the effect of facial expressions on face recognition. Famous and unknown faces with neutral or smiling expression were presented for different inspection durations (15 ms vs 1000 ms). Subjects had to categorise these faces as famous or unknown (Experiment 1), or estimate their degree of familiarity on a rating scale (Experiment 2). Results showed that the smile increased ratings of familiarity for unfamiliar faces (Experiments 1 and 2) and for famous faces (Experiment 2). These data are discussed in the framework of current face-recognition models and are interpreted in terms of social value of the smile. It is proposed that the smiling bias found here acts at the level of the decision process.

INTRODUCTION

A face is a stimulus that allows the viewer to extract a lot of information about a person. First, we are able to identify someone by retrieving semantic information such as his or her job or name. We are also able to infer a great deal of semantic information about unfamiliar people, for example, their gender, age, or ethnic group. Finally a face gives many cues to infer feelings and moods. Some people have characteristic expressions but usually the detection of these facial expressions is not a very efficient cue for recognition.

There are two different hypotheses with regard to the question of the relationship between identity recognition and expression recognition. According to the independence hypothesis, face recognition and expression recognition involve independent processes which may be experimentally and neuropsychologically dissociated (Bruce, 1983; Bruce & Young, 1986; Campbell, Brooks, De Haan, & Roberts, 1996; Ellis, 1983, 1986; Parry, Young, Saul, & Moss, 1991). According to the interactive hypothesis, facial expression may influence the retrieval of identity (Endo, Endo, Kirita, & Maruyama, 1992; Sansone & Tiberghien, 1994; Yin, 1970).

The independence hypothesis: Face recognition is not modified by expression analysis

Bruce and Young's model of face processing defines independent and specific processing stages for identification and expression processing (Bruce & Young, 1986; see also Young & Bruce,

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1991). The memory trace of a familiar face is a set of related structural codes for different orientations of the head ("Face Recognition Units" or FRUs). These memory traces may be global (configurational codes) or local (distinctive features) but they are extracted from a pictorial code (dependent on the viewpoint and expression), and from a structural code (independent from the expression). In a test of face recognition, this last representation is compared with the memory set of FRUs. A familiar face is recognised when there is a match between the structural code of the perceptual input and a specific FRU in memory. Then semantic information and name are activated by a person identity node (PIN). There are two main predictions from this theory: first, the representations used in the expression judgement are less abstract than the representations matched with the FRUs; second, the judgement of facial expressions should be faster than the familiarity judgement.

Bruce and Young's (1986) model is mainly supported by neuropsychological evidence. Some studies have shown that several prosopagnosic patients can interpret facial expressions correctly while being unable to identify familiar faces (Bruyer et al., 1983; Hornak, Rolls, & Wade, 1996; Humphreys, Donnelly, & Riddoch, 1993; Parry et al., 1991; Shuttleworth, Syring, & Allen, 1982; Tranel, Damasio, & Damasio, 1988). The opposite dissociation was also observed: some cerebral diffuse or local lesions caused an inability to discriminate or to name facial expressions without preventing correct identification (Bornstein, 1963; Hornak et al., 1996; Humphreys et al., 1993; Kurucz & Feldmar, 1979; Kurucz, Feldmar, & Werner, 1979; Parry et al., 1991).

There is also some neurophysiological evidence showing that some neurons in the temporal cortex of the monkey have selective responses to identity and not to facial expression; on the other hand, some other neurons selectively respond to facial expression and are not sensitive to facial identity (Hasselmo, Rolls, & Baylis, 1986, 1989; Perrett et al., 1984). Moreover, neurons sensitive to identity and neurons sensitive to expression are localised in different cortical regions (Hasselmo et al., 1986, 1989). In humans, when the brains of patients undergoing surgery for epilepsy have been electrically stimulated, the stimulation of different sites disturbed recognition of faces and of facial expression, who no overlap between the areas mediating the two processes (Fried et al., 1982). Lastly, blood flow increased in distinct cortical regions when subjects had to do identification or expression tasks (Sergent, Shinsuke, MacDonald, & Zuck, 1994), with the former being performed predominantly in the ventro-medial region of the right hemisphere including the limbic system, whereas the latter is carried out predominantly in the latter part of the right hemisphere and in the dorsal region of the limbic system.

Finally, chronometric studies are consistent with these results. For instance, Young, McWeeny, Hay, and Ellis (1986) showed that the latencies for identity matching are shorter for familiar than unfamiliar faces, but there was no difference between the latencies for familiar and unfamiliar faces when the task involved expression matching. In the same way, Bruce (1986) did not observe any effect of familiarity when participants were asked to decide whether a face was smiling or not.

The interactive hypothesis: Expression processing modifies face recognition

It could seem that there is sufficient evidence to conclude that the processing of information about identity-familiarity and expression is achieved by components that work independently. However, there are some experimental findings that cast the assumed independence between face recognition and expression processing into doubt. While Bruce (1982) did not observe any effect in the changing of expression between study and test for familiar faces but did for unfamiliar faces, Davies and Milne (1982) showed that a different expression increased the latencies of responses for both familiar and unfamiliar faces. But these two studies used different familiar faces: Bruce (1982) used faces of relatives whereas Davies and Milne (1982) used famous faces. Other studies have shown an effect of expression, essentially a smiling expression, on familiar face recognition. Kottoor (1989) found better recognition when faces were smiling than when they were neutral. Endo et al. (1992) showed effects of expression on familiar face recognition that depended on the type of familiarity. The famous faces in their experiment were more easily recognised with a smiling expression than with a neutral one. The opposite pattern of results was observed for faces that were personally known to the participants. Sansone and Tiberghien (1994) observed that experimental familiarisation with unknown smiling faces increased further recognition compared to experimental familiarisation with unknown neutral faces.

Another finding comes from Etcoff's study (1984). Using Garner's procedure (1974, 1976) which allows the study of independent or correlational processing of different dimensions in a class of stimuli, Etcoff showed that normal adult and left-brain-damaged patients could differentially pay attention to identity and expression in a categorisation task, without interference from the other dimension. She concluded that these two types of information were independently processed. However this capacity of selective attention was impaired for right-brain-damaged patients who had difficulties in separating the two dimensions. This finding goes against her conclusion. More recently, Schweinberger and Soukup (1998) also investigated the effect of variation of identity or expression on classification according to the selective paradigm described by Garner (1974, 1976). All participants were healthy people. They observed that whereas variations in facial expression did not influence response times when faces were classified for identity, speeded classification of faces for expressions could not be performed irrespective of identity. According to their conclusions, there is an asymmetric dependence in the processing of facial identity and facial expression. Another interesting case is the patient with a partial bilateral amygdalotomy described by Young et al. (Young, Hellawell, Van De Wal, & Johnson, 1996). This patient was poor at recognising emotional facial expressions. Nevertheless she showed relatively good performance on identity tasks and was able to match faces when they were wearing different disguises. However, she failed on an identity-matching task when the expression was manipulated, notably by mistaking the same person with two different expressions for two different persons. The authors suggested that a deficit in interpreting facial expressions could have led her to confuse differences in facial expression with differences in identity (cf Etcoff, 1984). The same failure on identity matching when the expressions were different was observed with Capgras syndrome patients (Sansone, Luauté, Bidault, & Tiberghien, 1998).

Correlational studies are also consistent with the interactive hypothesis. Weddell (1989) observed that deficits for identity recognition and expression recognition were correlated for right-brain-damaged subjects but not for normal and left-brain-damaged subjects. Braun, Denault, Cohen, and Rouleau (1994) report the same observation with right lobectomised patients. Salem, Kring, and Kerr (1996) found similar results with schizophrenic patients.

There is also some neurophysiological evidence against complete independence. Perrett et al. (1984) recorded neurons whose response to expression generalised to identity. Hasselmo et al. (1986, 1989) found neurons that respond significantly either to both types of information or with a significant interaction between both. Finally Sergent et al.'s (1994) study of humans showed that, even if distinct cerebral regions were activated by identity and expression tasks, some other regions were activated in both cases, to different degrees. So, some experimental, neurophysiological and neuroanatomical findings are consistent with the hypothesis that face recognition and emotional expression processing are not always so clearly dissociable and can sometimes interact.

The aim of the experiments reported here is to explore further the relationship between the identification of a face and the perception of its facial expression, by examining whether an expression affects the subject's ability to make judgements of familiarity. Earlier studies have shown that smiling expressions can have a significant effect on face recognition, mainly by improving it (Endo et al., 1992; Kottoor, 1989; Sansone & Tiberghien, 1994). We designed a first experiment where subjects had to decide whether faces were familiar or not. Faces belonged to famous or unknown people, displaying neutral or smiling expressions. It is possible that some studies did not observe effects of expression because of the nature of the experimental design. Indeed the long presentation times and the absence of processing constraints may have allowed subjects to efficiently disregard information about expression as being not pertinent for face recognition. In order to check this possibility we presented faces for 15 ms or 1000 ms, studying the role of a temporal constraint on processing. It has been observed that false alarms increased when the presentation time was short rather than long (Shepherd, Gibling, & Ellis, 1991). Moreover a presentation time of 15 ms prohibits all eye movements to explore the face. Bloom and Mudd (1991) observed a relationship between the number of eye movements and the level of processing. Consequently a short presentation time of 15 ms would favour the emergence of false alarms and disrupt the access to high-order semantic and/or verbal information to evaluate the familiarity of the faces in this experiment. The second experiment was mainly a replication of the first with a more sensitive measure: subjects had to evaluate the familiarity of smiling and neutral faces belonging to famous and unknown people using a 7-point scale.

EXPERIMENT 1

Method

Participants. A total of 48 psychology students from the University of Grenoble participated in this experiment. All had normal or corrected eyesight.

Design. The design for the experiment was $2 \times 2 \times 2$ mixed factorial. Inspection duration (15 ms vs 1000 ms) was manipulated between subjects. Face familiarity (famous vs unknown) and facial expression (smiling vs neutral) were manipulated within subject.

Materials. Photographs of 20 famous faces and 20 unknown faces were used in this study. In a previous experiment, which used the same materials, a group of 105 subjects had to say if the famous faces were familiar or not. All famous faces were judged familiar (80.77–100% of subjects according to the faces, mean = 96.88%, SD = 4.97). For each person two black and white photographs were chosen: one with a neutral expression and one with a smiling expression. The photographs were digitised and presented on a computer screen. A control group of 32 subjects had to say which expression these faces displayed (either neutral or smiling). Neutral faces were judged neutral in 91.3% (SD = 15.9%) of cases, and smiling faces were judged smiling in 93.9% (SD = 13.9%) of cases. There was no significant difference between these two means, $F(1, 31) = 0.28$, $p > .10$. Moreover face familiarity did not interact with expression, $F(1, 31) = 2.28$, $p > .10$.

Procedure. Each subject was presented with the 80 items (40 persons with two different expressions) either for 15 ms or 1000 ms. Each face was preceded by the presentation of a black point in the middle of the screen for 300 ms. Participants were assigned to conditions using a counterbalancing procedure: half the subjects in each condition (15 ms or 1000 ms) saw half of the faces first with a neutral expression then with a smile (with the opposite order for the other half of the faces). This order was reversed for the other half of the subjects. The presentation order within the two sets of 40 faces was randomised.

Subjects were instructed to decide as quickly as possible if the face was familiar (by pressing a key with a finger of a given hand) or unfamiliar (by pressing a key with a finger of the other hand). Speed and accuracy were stressed in the instructions. The position of the response keys was counterbalanced between subjects. Trials were separated by a delay of 4 seconds. At the beginning of the experiment a set of 20 trials (10 famous faces and 10 unknown faces, half neutral and half smiling) was used for training.

Results

An analysis of variance was performed on the percentage and the latencies of correct decisions. Table 1 sets forth the proportion of correct responses and standard deviations by condition.

The effect of familiarity was significant for both accuracy and latencies. Famous faces were

TABLE 1
Experiment 1

	Famous		*Unknown*	
Presentation time	*Neutral*	*Smiling*	*Neutral*	*Smiling*
15 ms: % (SD)	58.7 (10.5)	62.3 (13.9)	70.4 (16.9)	64.4 (19.2)
ms (SD)	894 (207)	903 (182)	1049 (285)	1053 (281)
1000 ms: % (SD)	85.4 (12.7)	84.4 (12.9)	90.8 (8.3)	87.7 (9.6)
ms (SD)	677 (90)	676 (95)	755 (116)	752 (97)

Mean percentages and reaction times of correct decisions by face familiarity, face expression, and presentation time.

recognised less often but faster than unknown faces were rejected: 72.7% vs 78.3%, $F(1, 46) = 4.17$, $p < .05$, and 788 ms vs 902 ms, $F(1, 46) = 36.65$, $p < .001$. There was an effect of the presentation time for both accuracy and latencies. Subjects were more accurate and faster for the 1000 ms condition than for the 15 ms condition: 87.1% vs 64.0%, $F(1, 46) = 120.43$, $p < .001$, and 715 ms vs 975 ms, $F(1, 46) = 30.59$, $p < .001$.

The interaction between familiarity and expression was significant for accuracy, $F(1, 46) = 4.45$, $p < .05$, but not for latencies, $F(1, 46) = 0.01$. For accuracy, it indicated that while there was no effect of expression for famous faces, 72.1% for neutral famous faces vs 73.3% for smiling famous faces, $F(1, 46) = .41$, unknown faces were rejected more often with a neutral expression than with a smiling one: 80.6% vs 76%, $F(1, 46) = 5.49$, $p < .05$. None of the other interactions were significant: (main effect of expression: $F(1, 46) = 2.47$ for accuracy and $F(1, 46) = 0.06$ for latencies; interaction between familiarity, expression and presentation time: $F(1, 46) = 1.84$ for accuracy and $F(1, 46) = 0.004$ for latencies).

Discussion

Results of this experiment show that familiarity decisions may be influenced by expression. The proportion of familiar responses rose when faces were not familiar but smiling. For familiar faces (i.e., famous faces), no influence of the smile emerged. A possible explanation of the absence of a smile effect for familiar faces may be derived from the observation of a fast processing of familiar faces: correct decisions for famous faces were faster than for unknown faces. Familiar face processing is interrupted when there is enough information accumulated to decide that the face belongs to a famous person. Evidence for this hypothesis comes from studies indicating that familiar faces are processed faster than unfamiliar faces (Young et al., 1986). So when the face is unknown to the system, it is processed until the subject is able to choose the unfamiliar response. At this point of choice, a smiling expression can be mistaken for information of familiarity.

In order to explore more precisely the possibility of a smiling bias in familiarity decisions, we planned a second experiment where subjects had to evaluate face familiarity with a rating scale (from unknown to very famous). As in Experiment 1, the subjects were shown the faces of famous and unknown persons, smiling or not, for 15 or 1000 ms. We expected that the use of a 7-point rating scale would increase the sensitivity of familiarity decisions to a smiling bias by comparison with the binary responses (famous or not famous) used in Experiment 1. With a rating procedure, subjects had to decide if the face was familiar or not and to modulate their responses according to the degree of confidence about familiarity or unfamiliarity. We had two hypotheses: first that the smiling bias would be enhanced by a short presentation time and second that the smiling bias would also emerge for famous faces, at least with a short presentation time.

EXPERIMENT 2

Method

Participants. A total of 48 psychology students from the University of Grenoble participated in this experiment. All had normal or corrected eyesight.

Design. As Experiment 1.

Materials. As Experiment 1.

Procedure. Participants were asked to rate the familiarity of neutral or smiling faces on a scale from 1 (totally unknown) to 7 (very famous). Famous and unknown faces were presented for 15 ms or 1000 ms. In Experiment 1 subjects were asked to give their answer as quickly as possible. Here they answered with no time constraint. The general procedure was as described for Experiment 1.

Results

The results were again analysed with an analysis of variance. Table 2 sets forth the mean degree of estimated familiarity and standard deviations by conditions. There was a main significant effect of familiarity. Famous faces were judged more familiar than unknown faces: 5.2 vs 2.6, $F(1, 46) = 417.91$, $p < .001$. Presentation time also had a significant effect. Faces were judged less familiar for a 15 ms than for a 1000 ms presentation time: 3.7 vs 4.1, $F(1, 46) = 7.72$, $p < .01$. There was a significant interaction between these two factors, $F(1, 46) = 117.28$, $p < .001$. This interaction occurred because increasing the presentation time

TABLE 2
Experiment 2

	Famous		Unknown	
Presentation time	*Neutral*	*Smiling*	*Neutral*	*Smiling*
15 ms (SD)	4.2 (0.7)	4.4 (0.8)	2.9 (0.9)	3.2 (1.0)
1000 ms (SD)	6.2 (0.7)	6.2 (0.8)	2.0 (0.5)	2.2 (0.6)

Mean ratings of familiarity (from 1 = totally unknown to 7 = very famous) by face familiarity, face expression and presentation time.

for famous faces strengthened the familiarity feeling from 4.3 to 6.2, $F(1, 46) = 86.13$, $p < .001$. For unfamiliar faces, increasing the presentation time reduced the familiarity feeling from 3.0 to 2.0, $F(1, 46) = 20.80$, $p < .001$.

Facial expression also had a significant effect on the judgement of familiarity. Smiling faces were judged more familiar than neutral faces: 4.0 vs 3.8, $F(1, 46) = 7.73$, $p < .01$. No other significant effect was observed.

Discussion

These data confirm and extend the results and conclusions of Experiment 1: a smile increased the feeling of familiarity induced by a face. Moreover, the use of a rating scale was a more sensitive measure of this smiling bias. Unlike Experiment 1, this expression bias was observed for both famous and unknown faces. Subjects had not only to say "yes" or "no", but also to evaluate face familiarity. Perhaps this different decision led them to process more precisely the intensity or amount of familiarity. Under these conditions, smiling could have been mistaken for an indicator of familiarity. The presentation time had no significant influence on the smiling bias, i.e. the smiling bias was not stronger for a short presentation time than for a longer one.

GENERAL DISCUSSION

In summary, a small smiling bias can be observed in decisions of familiarity whatever the initial familiarity of the faces. The smile increased the feeling of familiarity for unfamiliar (Experiments 1 and 2) and for familiar faces (Experiment 2). These results agree with previous findings that familiar face recognition is easier with a smiling expression (Endo et al., 1992; Kottoor, 1989; Sansone & Tiberghien, 1994) and extend them to unfamiliar faces. In these two experiments, the emergence of a smiling bias required either previous unfamiliarity of the face (Experiment 1) or a precise evaluation by the subjects of the face's familiarity (Experiment 2). Contrary to our predictions, presentation time had no significant influence on the smiling bias in either Experiment 1 or 2.

The fact that a smiling expression increases the feeling of familiarity implies an association between face recognition and expression processing. What is the level of this interaction? The smiling bias observed in these two experiments cannot be attributed to a structural effect at the matching level between the visual input and the representation of the face in long-term memory. Indeed it affects familiar faces and unknown faces, and therefore the cognitive locus is at a common level for both types of faces. It is more likely that the bias occurs at the decision stage. Even if the cognitive system can identify faces without interference from expression, some information about emotional facial expression can, under some conditions, influence a decision about familiarity.

How can these results be interpreted according to current models of face processing? According to Bruce and Young's (1986) model, familiarity recognition depends on the Face Recognition Units stage (FRU). These authors provide no connection between this last stage and Facial Expression Analysis (FEA) that could explain the findings reported here. Nevertheless, the FRUs only generate a graded resemblance signal, the actual decision of familiarity being made by the cognitive system. Therefore, the cognitive system receives two inputs, an input about the familiarity of the face and another about its expression. A later modification of Bruce and Young's (1986) model (Burton, Bruce, & Johnston, 1990) proposed that familiarity decisions are made from the Person Identity Nodes stage rather than at the

FRUs stage, but this model does not contain an expression analysis module. The findings reported here indicate that a smiling input from the FEA tips the balance towards the cognitive system making a ''familiar'' response for unknown faces (Experiment 1) or making a ''more familiar'' response for unknown and famous faces (Experiment 2). Therefore there is some ''weak'' interaction between face recognition and facial expression analysis at a decisional level, observable when a strong smiling input is concurrent with a weak familiar input, or when subjects are instructed to balance their responses about their familiarity feelings.

A smiling bias consisting of an increase of the familiarity for smiling faces is not such a surprising phenomenon considering everyday life. The smile has a particular social status and is certainly the most frequent expression that we confront. It is less often mixed up with other expressions. It is the most easily recognised expression for both normal subjects and brain-damaged patients (see for example, Braun et al., 1994; Etcoff & Magee, 1992). Moreover we smile more often at people we known than at unknown persons. So when we perceive a smiling person who looks at us, our first feeling may be to believe that we know this person, even if we are not able to reach identification. Further investigations would be useful to determine if this bias is specific to the smiling expression or if it can be observed with negative expressions. Indeed the smiling bias could occur because of the positive valence of this expression. If so, negative expressions like sadness or anger would not increase the feeling of familiarity, and might even decrease it. Perhaps it is the expressiveness of the smile relative to the neutral expression that induces the smiling bias. People may feel more inclined to express their emotional state to familiar persons than to unknown people. If so, then all emotional expressions may increase the feeling of familiarity relative to neutral expression. These would be interesting questions for future research to address.

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