Perception, 1988, volume 17, number 4, pages 475-481

Feature saliency in judging the sex and familiarity of faces

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Received 7 December 1987, in revised form 20 July 1988

Abstract. Two experiments are reported on the effect of feature masking on judgements of the sex and familiarity of faces. In experiment 1 the effect of masking the eyes, nose, or mouth of famous and nonfamous, male and female faces on response times in two tasks was investigated. In the first, recognition, task only masking of the eyes had a significant effect on response times. In the second, sex-judgement, task masking of the nose gave rise to a significant and large increase in response times. In experiment 2 it was found that when facial features were presented in isolation in a sex-judgement task, responses to noses were at chance level, unlike those for eyes or mouths. It appears that visual information available from the nose in isolation from the rest of the face is not sufficient for sex judgement, yet masking of the nose may disrupt the extraction of information about the overall topography of the face, information that may be more useful for sex judgement than for identification of a face.

1 Introduction

Psychologists interested in the study of face processing are concerned with the ways in which information about faces might be represented, and the nature and organization of the processes by which such representations are created and manipulated. Our current understanding of this organization is expressed in functional models of face perception (eg Hay and Young 1982; Bruce and Young 1986; Ellis 1986), which deal with the functional and temporal relationships between the processing modules involved in face perception. The models describe distinct stages of processing which can occur on viewing a face. Certain aspects of face processing are represented in all functional models as being sequentially organized. For example, all models agree on the general progression from recognition of a familiar face as familiar, to access of semantic information about the person, and then finally to their name, held in a separate store from that holding semantic information. Evidence for this sequence has been drawn from laboratory experiments, studies of everyday errors, and studies of the effects of different types of brain injury (see Bruce and Young 1986 for a summary). All the models also argue that expression judgement proceeds in parallel with recognition. Bruce (1986) found that subjects were no quicker at judging the expressions of familiar faces than those of unfamiliar faces, suggesting that these processes take independent routes. This independence is also supported by neurological dissociations, where cerebral damage can affect the identification of faces and not impair analysis of expression or vice versa (Cicone et al 1980; Etcoff 1984; Bowers et al 1985).

The different models of face recognition are not identical, however. For example, Ellis (1986) has suggested that recognition of familiar faces comes at the end of a hierarchical sequence of processes that includes perception of the sex of its owner. In this model the first stage of processing establishes that what is seen is a face, rather than some other pattern. A subsequent process yields information about more detailed physical aspects of the face, such as its age and sex. Much of the evidence for this sequence is neurophysiological, drawn from studies of prosopagnosic people who, for example, are unable to tell the sex of a face (Bornstein 1963; Cole and Perez-Cruet 1964), the age, or the skin colour (Whiteley and Warrington 1977). No patients, however, have been reported as being unable to establish that a face is a face rather than some other object, suggesting that physical analysis of the age and sex of a face is subsequent to establishing its 'facedness'. Finally, a description suitable for the recognition of familiarity emerges, and we are able to identify the face. Bruce and Young (1986), in contrast, leave open the possibility that faces may be classified as faces, and classified in terms of age and sex in parallel with recognition of their identity.

The theory proposed by Ellis in which the assessment of the sex of a face is functionally prior to identification leads to a number of further predictions about the performance of subjects in experimental settings, and researchers have not been slow to test them. Bruce et al (1987) tested the prediction that identification of a face should be delayed by making the allegedly prior judgement of sex more difficult and thus more time consuming. Yet they found that faces whose sex was difficult to judge could be recognized as quickly as faces whose sex was relatively easy to judge. Even when the familiarity judgement was made contingent upon the sex judgement (where the subjects' task was to respond when a face was male and familiar) there was no effect of masculinity on response times. Bruce et al argue that their results are more readily interpreted by a model of face recognition in which judgements of sex and familiarity proceed with some degree of independence, rather than in a hierarchical sequence. Yet, unlike some other aspects of the Bruce and Young (1986) model of face recognition, no clinical dissociations have been presented in support of the independence of these processes.

Clinical dissociations can provide the clearest evidence for the independence of two processes which may nevertheless share the same input. A good example of this was shown by Campbell et al (1986), who demonstrated dissociable impairments of lipreading and expression analysis. The first of two cases they describe was a prosopagnosic woman who could not judge the familiarity, sex, or expression of a face, yet could judge what phonemes were being mouthed in photographs. A second woman had no difficulty identifying faces or judging expression, yet experienced difficulty making phonetic judgements. These patterns of deficit were shown even when the women were presented with information from the lower half of the face (ie the mouth) alone.

The absence of similar clinical evidence for the independence of sex and familiarity is perhaps not surprising when thought is given to the kind of deficit that could arise. Only the ability to recognize faces yet *not* to judge their sex could do so, and it is unlikely that such a case would ever present itself. Much of the semantic information we hold for each person we know is bound to the sex of the person, eg "...*he* is called *Tim* and *he* plays *football* for Watford ...", so the sex of a familiar face could always be known via semantic routes. Moreover, cues such as hairstyle, clothing, and body shape are available for both familiar and unfamiliar faces. Patients have been reported who cannot judge the sex of faces, yet, severely prosopagnosic, they are also unable to recognize faces (Bornstein 1963; Cole and Perez-Cruet 1964). Thus our sources of evidence for or against any interpretation of these aspects of face processing are necessarily limited to experimental studies.

One clear source of experimental evidence for the functional independence of different processes or representations is the demonstration of their differential sensitivity to interference or disruption by some experimental treatment. In the two experiments reported here we aimed to investigate whether masking of certain facial features, ie the eyes, nose, or mouth, would have a different effect on speed of sex judgement than on speed of recognition, thereby suggesting the independence of the two processes.

Our second aim was to obtain information about which internal features are most salient for making sex and identity decisions, and, for sex judgement, whether the information they carry is sufficient in isolation. It has been suggested that the size and shape of the nose are critical for sex judgement (Enlow 1982). According to Enlow, male noses are generally larger than female ones, owing to the greater capacity of the lungs, and this increase in size is accompanied by a protuberant bridge of the nose and immediately adjacent brow region in the male. This makes male eyes appear more deeply set and the cheekbones less prominent than in the female. The prototypical female face in contrast has a smaller nose and thereby apparently larger eyes and more prominent cheekbones. In addition, Enlow (page 6) suggests that male and female nose shapes differ: "The tip of the male nose is often more pointed and has a greater tendency to turn downward, and the somewhat more rounded female nose often tips upward". For familiarity judgements, in contrast, there is evidence to suggest that, of the internal features, the eye region provides the most useful information (Shepherd et al 1981; Haig 1986). In order to test these claims, and thus test for the possible independence of sex and familiarity judgements, in experiment 1 we used familiar and unfamiliar male and female faces with either the eyes, nose, mouth, or no features masked; first as stimuli in a familiarity judgement task, and second in a sex-judgement task. In experiment 2 we used features from the same faces in isolation as stimuli in a sex-judgement task.

2 Experiment 1

2.1 *Method*

2.1.1 *Subjects.* Forty-eight students (twenty-three male, twenty-five female) from the Department of Psychology at Nottingham University were subjects.

2.1.2 *Apparatus and stimuli.* Sixty-four faces formed the stimulus set, the familiar faces (half of which were male and half female) were television celebrities such as newscasters, comedians and athletes. None of the faces had glasses, beards, or moustaches, and the monochrome prints from which the slides were derived had been trimmed to minimize the possible influence of external cues and to make hairstyles more uniform in length. Masking of the features was achieved by sticking appropriately sized rectangles of completely opaque black crepe tape onto the surface of the glass-bound slides. The tape could then be removed and replaced to cover a different feature so that each face served in all levels of the masking factor. The resulting slides were back-projected onto a 20 cm $\times$ 30 cm screen at a distance of 90 cm from the seated subject. A Rockwell AIM 65 microcomputer was used to control the projector (Kodak Carousel S-RA2000), and its attached electronic shutter, to present the stimuli. Faces subtended approximately 8 deg by 7 deg visual angle (vertical by horizontal). Subjects responded to the stimuli by pressing one of two buttons. Response times were recorded by the computer and printed out for analysis.

2.1.3 *Design.* A $2 \times 4 \times 2 \times 2 \times 4$ factorial design was used. The first factor was the task (recognition or sex judgement) and was between subjects. Thus twenty-four subjects performed a recognition task and twenty-four performed a sex-judgement task. The second factor was subgroup so that all stimuli could appear at each level of the masking factor, between subgroups of six subjects. The remaining three within-subjects factors were familiarity (famous and not famous), sex (male or female), and feature masked (eyes, nose, mouth, or no mask).

2.1.4 *Procedure.* Subjects were seated in a research cubicle and the general procedure was explained to them. Subjects performing the recognition task were asked to decide as quickly as possible whether the faces appearing on the screen were familiar or not, and to indicate their decision by pressing one of two buttons nominated. Subjects performing the sex-judgement task were asked to decide upon the sex of the face appearing, and to indicate their decision as above. All subjects were told that some of the faces were famous, and some not, some were male, some female.

After a warning tone and a 500 ms delay, each slide was presented for a duration considered adequate for accurate responses to be made. As recognition takes longer on average than sex judgement, the times used were 1500 ms for the sex-judgement task, and 2300 ms for the recognition task. A 300 ms intertrial interval followed each stimulus, making the interstimulus interval 800 ms. Total trial duration was thus 2300 ms or 3100 ms, and the task took each subject around 5 min.

2.2 *Results*

The average response times under different task, mask, and familiarity conditions are given in table 1. Errors were low in the sex-judgement task, and higher for the recognition task. Analysis of the errors revealed that although some individuals were recognized less often than others there was no significant effect of the feature masked on these errors.

A split-plot analysis of variance (ANOVA) was conducted on subject mean correct response times per cell. This analysis revealed a significant main effect of familiarity ($F_{1,40} = 26.8$, $p < 0.001$), and a significant familiarity × task interaction ($F_{1,40} = 6.2$, $p < 0.05$). Analysis of the simple main effects showed that the effect of familiarity was restricted to the recognition task ($F_{1,40} = 29.3$, $p < 0.001$), the "yes" responses for familiar faces being an average of 72 ms faster than the "no" responses to unfamiliar faces.

There was a significant main effect of the mask factor ($F_{3,120} = 13.4$, $p < 0.001$), and a significant mask × task interaction ($F_{3,120} = 19.2$, $p < 0.001$). Thus, different masks affected response times differently according to the task. To investigate the nature of these differences further, and to avoid problems of interpretation resulting from some items requiring a positive response in one task and a negative response in the other, separate ANOVAs (factors: subgroup, sex, and feature masked) were conducted for each level of the task factor.

Analysis of the data from the recognition task revealed a significant main effect of subgroup ($F_{3,20} = 3.2$, $p < 0.05$) because of differences in the overall speed of the groups. There was a significant main effect of familiarity ($F_{1,20} = 31.4$, $p < 0.01$) as unfamiliar faces gave rise to responses around 70 ms slower overall. There was a significant main effect of feature masked ($F_{3,60} = 5.5$, $p < 0.05$) and an unplanned comparison with higher-order contrasts revealed that responses when the eyes were masked were significantly longer than those at any other level of this factor ($F_{3,20} = 4.7, p < 0.01$).

Table 1. Mean response times (in ms) in the recognition and sex-judgement tasks, with familiar and unfamiliar faces, under different masking conditions.

	Feature masked			
	none	eyes	nose	mouth
Recognition task				
Familiar	768	798	746	762
Unfamiliar	817	874	814	858
Mean	793	836	780	810
% Error	10.3	12.2	10.6	9.8
Sex-judgement task				
Familiar	637	710	924	724
Unfamiliar	666	743	977	709
Mean	652	727	951	717
% Error	4.9	7.0	6.2	7.0

Analysis of the data from the sex-judgement task revealed a significant main effect of feature masked ($F_{3,60} = 17.5$, $p < 0.001$), and a significant subgroup × familiarity × feature masked interaction ($F_{9,60} = 2.3$, $p < 0.05$). This interaction was seen because the third subgroup was especially slow in judging the sex of the unfamiliar nose-masked faces. Regarding the main effect, masking of the nose had a dramatic effect. An unplanned comparison with higher-order contrasts revealed a significant difference between the nose condition and the other three conditions ($F_{3,20} = 5.9$, $p < 0.01$).

2.3 *Discussion*

It is clear from these results that masking of different facial features has different effects on judgements of sex or familiarity. Obscuring the nose region has the greatest effect on sex judgements, whilst obscuring the eye region does most to hinder recognition. These findings relate well to Enlow's claims for sexual dimorphisms based on the shape and size of the nose and concomitant differences in facial topography, yet leave us uncertain as to the true effect in these terms of obscuring the nose. To test whether it is the shape of the nose per se that is used to determine a person's sex from their face, or whether it is the size of the nose in relation to the other features, the features masked in experiment 1 were presented in isolation to subjects who were asked to judge their sex.

3 Experiment 2

3.1 *Method*

3.1.1 *Subjects.* Twelve students (six male, six female) from the Department of Psychology at Nottingham University served as subjects.

3.1.2 *Apparatus and stimuli.* The apparatus was the same as in experiment 1. For the stimuli, thirty of the nonfamous faces were masked leaving only one of three features, eyes, nose, or mouth, exposed, this area being equivalent to the area masked in experiment 1.

3.1.3 *Design.* A 3 × 2 × 3 factorial design was used, with subgroup being the first factor, so that all three features from all faces were used. Sex was the second factor, and feature exposed (either eyes, nose, or mouth) the third. Four subjects (two male and two female) formed each subgroup.

3.1.4 *Procedure.* The procedure was the same as for experiment 1. The exposure duration was set at 2300 ms and subjects were asked to judge the sex of the individual features, responding as quickly as possible whilst trying to judge accurately.

3.2 *Results*

As this task was difficult the error rates were much higher than those in experiment 1 and form the basis of our analysis. 22% of responses to eyes were incorrect, 41% to noses, and 33% to mouths. One-sample *t*-tests revealed that responses to noses were not significantly above chance ($t_{11} = 1.8$, $p = 0.095$). Responses to eyes were above chance ($t_{11} = 8.2, p < 0.01$) as were those to mouths ($t_{11} = 4, p < 0.01$).

A single-factor ANOVA on the errors per feature exposed condition revealed a significant main effect of this factor ($F_{2,22} = 6.2$, $p < 0.05$), and a posteriori comparisons revealed only the eyes to be significantly different from the nose ($t_{11} = 3.5$, $p < 0.01$). An unplanned contrast of the eyes with both other conditions was significant ($F_{2,11} = 5.7$, $p < 0.05$). To summarize, when features are presented individually, the eyes provide the most reliable information for sex judgement in this task, and the nose provides the least.

3.3 *Discussion*

The results of this experiment show that it is not the shape of the nose per se that is important in determining the sex of a face. Thus the effect of masking the nose in experiment 1 was not seen because information about the shape of the nose was lost, but because of a disruption of the relationship between the nose and the rest of the face. This is discussed in more detail in the next section.

There are general implications here for the interpretation of studies in which facial features are artifically obscured or otherwise manipulated to study the information they might yield. Our results suggest that great care should be exercised before concluding that the obscured feature itself was important in the decision being made by subjects.

4 General conclusions

These results support Enlow's general claim that the nose region differs between male and female faces. Furthermore they have implications for the way in which we encode these differences. Enlow (1982, page 6) points out that some configural aspects of the nose, in particular "larger and more flaring nostrils", are characteristically male. Whilst this may be true, our results suggest that the effect of masking the nose is to disrupt perception of the configural relationship between the nose and the rest of the face. When the nose was masked the size of the nostrils was not visible, yet the size in relation to that of the nose was visible in experiment 2 and was of little use in judging the sex. Similarly, when masked, the shape of the nose per se was not apparent, but, when presented in isolation, 'noses as shapes' gave no clue as to the sex of the face. Enlow points out that the size of the nose "leads to collateral differences in other topographic structures of the face" (page 6). We argue that subjects performing sex judgements in this experiment were relying on perception of these topographical differences, and that these differences are less apparent when the relief of the face is obscured by masking the nose.

The effect of feature masking was quite different when the task was to judge familiarity, the eyes giving rise to greatest disruption when masked. In itself this result is less surprising, first because it is in keeping with previous research (eg Haig 1986), and second because the eyes condition required masking of a greater proportion of the face. Though it is unlikely that information about the relief of the face is redundant in other circumstances, it appears to be easily forsaken by subjects judging the familiarity of partially masked faces. Subjects claimed to "see through" the mask to the familiar faces, and this is consistent with the Bruce and Young (1986) model, in which the recognition unit for a face could be activated discretely by an incomplete view. What is clear from these results overall is that different regions of the face are more or less useful in making judgements of different kinds. This, then, yields a further kind of evidence for the independence of the two judgemental processes.

Two further points must be made about the implications of these experimental results. First, if familiarity judgement were contingent upon sex judgement, one would not expect familiarity judgements to faces with the nose masked (average response time 780 ms) to be quicker than sex judgements to the same faces (average 951 ms). Instead one would expect a 'knock-on' effect whereby any treatment that slowed sex judgement would in turn slow recognition. Thus the results obtained from these experiments are consistent with theories of face perception in which processing of the sex and familiarity of faces proceeds in parallel (see Bruce et al 1987), and inconsistent with theories that emphasize the elaboration of a single description.

Second, the fact that sex judgements of faces with the nose masked gave rise to such long reaction times (951 ms) is itself worth further comment. If subjects can tell that these same faces are familiar so much more quickly (780 ms), why cannot they use the semantic information thereby derived to inform them of the sex much more quickly?

One possibility is that the strong emphasis within the task upon structural aspects of the face, and the inclusion of a high proportion of unfamiliar faces (for which semantic information would not be available), leads subjects to ignore this potentially informative route to task solution. A second possibility is that the very long response times in the nose-masked condition results from disruption of the looking strategies of subjects rather than conceptual strategies. Subjects may learn to look at the nose (informative about sex in 75% of trials), but may have to redirect their attention in the minority of trials where it is absent.

Acknowledgements. Preparation of this paper was supported in part by a grant from the Science and Engineering Research Council to Vicki Bruce and Mike Burton (GR/D 8698.0). We thank Andy Young for helpful comments on this work and on an earlier version of the paper.

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