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SOME EXPLORATORY EXPERIMENTS ON MEMORY FOR PHOTOGRAPHS OF FACES*

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Yin (1970) has revived Bodamer's (1947) contention that faces are processed separately from other visual objects. This was investigated in a series of exploratory experiments in which memory for photographs of the center of the face (eyes, nose and mouth) was compared with photographs showing only the periphery (hair, ears and chin). Because facial expression emanates from the center, it is argued that any specific mechanism may affect the center but not the periphery. Although the two types of stimuli were equally difficult to recognise, the center of the face was considerably harder when paired-associates were learned. In another experiment, whole faces were compared with geometric shapes, and the faces were superior on a recognition memory test but the shapes were superior on an associate learning test. The difficulty in learning paired-associates with faces may be linked to a difficulty in constructing good verbal descriptions of faces: compared to other visual stimuli, faces appear to have low association values. A face specific mechanism would predict this, but there are more parsimonious explanations, for example, in terms of the way the brain stores visual information.

There is a similarity between the way we perceive faces and printed words. Both are complex visual stimuli which we seem to process rapidly, often bypassing any perception of features and getting straight to the meaning. Although the meaning of a word is transmitted by the letters, and the strokes which make up those letters, our percept is of a sound or meaning. Similarly with faces, the features convey the information but our percept is of a person or an expression or a feeling of recognition, and the recall of details is poor. Another similarity is the

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fact that we are familiar with only a subset of both types of stimuli: Polish place names and black faces cause problems for the white English speaker. The analogy between words and faces is not a new one: Thomas Browne in *Religio Medici* (1643) attempted to explain 'How among so many millions of faces, there should be none alike' by a comparison with the vast number of words which have been assembled out of the letters of the alphabet, although he overlooked the fact that homographs are a lot more frequent than facial doubles.

Our quick extraction of meaning from printed words is easily attributable to the painstaking business of learning to read. But where does our comparable deftness with faces come from? We are not taught to process faces although there is no doubt we have plenty of practice. Do we simply learn the skill as we grow up, or do faces have some special advantage from birth? The smiling response (the apparently automatic response of a three to five month infant to a face or a face-like configuration, see Spitz and Wolf 1946) suggests faces are special objects from early in life.

For some time it has been known that brain damage in the right hemisphere sometimes has an unfortunate but interesting effect. The patient has great difficulty in recognising faces, but the ability to recognise other objects is relatively unimpaired (see, for example, Critchley 1953; Hecaen and Angelergues 1962). Yin (1970) has shown that patients with right posterior lesions are worse at face recognition than other lesion groups. But this is only true for upright faces. On a test using upside down faces the right posterior group was significantly better than other unilateral lesion patients.

This surprising result led Yin to propose that the brain may possess a specific mechanism for processing normally oriented faces, which does not handle other visual stimuli, including inverted faces. Although Bodamer (1947) has also proposed a specific mechanism, others oppose this view. For example, De Renzi and Spinnler (1966) have suggested that right lesion patients' difficulties with faces result from a more general impairment of 'subtle discrimination and integration of visuo-perceptive data'.

In what ways could face recognition be special? To take one possibility, we might possess an inbuilt mechanism for the recognition of faces which is not used to recognise other objects. It could be argued that this has evolved through the importance of identifying people, in particular, the importance of telling friend from enemy.

However, face recognition could be entirely the product of a learning process. But because faces are very difficult to discriminate, it is possible that, in learning this skill, we unconsciously develop techniques or strategies of a kind which we do not use for any other kind of recognition. If these tricks we learn for handling faces are sufficiently special, they should show up in appropriate memory experiments.

Whether learned or innate, specialised processes for recognising faces could take many forms. For example, there might be a specialisation of visual imagery, or there could be particularly sensitive ways of encoding the geometry of faces, such as the perception of curvatures and angles to a precision which is irrelevant in normal perception. The special mechanism might make a kind of statistical sampling of the population of faces to determine the distribution of features, and so improve the encoding of particular faces.

Clearly there are numerous ways in which face recognition could be special and no particular hypothesis is offered here. In these exploratory experiments using normal subjects, the purpose of comparing faces with other visual objects is to search for interactions, both the usual type within an experiment, and also by comparing scores of one experiment with another. For example, if a serial position curve for faces has a totally different shape from that for other objects, this would be a phenomenon which deserves further investigation. Similarly, if faces and control objects are remembered equally well in one experiment but quite differently in another, this would also merit investigation. Interactions across experiments need especially careful interpretation, particularly when different measuring scales have been used, but this approach is justified as long as more rigorous methods are applied to investigate any phenomenon that is found.

It is difficult to choose an appropriate class of objects to compare with faces. Objects which have been used previously such as inkblots, and pictures of houses and aircraft, seem to be less complex stimuli than faces, but are nevertheless harder to recognise. They also lack the social significance of faces. One possibility is to use the rest of the head when the face is masked out. It is easy to split photographs in the way illustrated in fig. 1. The *face* consists just of the mouth, the nose, the eyes and the eyebrows with surrounding shadow. The remainder, which is called the *head*, consists of the hair, the ears (when visible), the chin and the general shape of the face. It is suggested that *heads* are quite a good comparison for *faces*. *Heads* are looked at as often as *faces*. Like

faces, they are usually seen in only the upright orientation, they are three-dimensional, they are complex stimuli (perhaps not quite as complex as *faces*) and they have much the same social significance as faces.

Fig. 1. Full face photographs were cut into two parts: the *head* (left) and the *face* (right).

However, one could argue that the *head* is really part of the face and it is not appropriate to compare one against the other. But it is the center of the face which is the source of facial expression, and facial expression is frequently linked with any special phenomena associated with faces, for example, it is what is reported missing from an inverted or negative face (Kohler 1940; Galper 1970). It could also be argued that, by splitting the face in this way, one breaks the natural gestalt and produces two quite irrelevant stimuli. This is a rather subjective question but an inspection of fig. 1 does not appear to support it. In a pilot experiment using photographs of well known people, subjects correctly identified 41 per cent from the *head*, 42 per cent from the *face* and 74 per cent from the whole picture. Clearly, *heads* and *faces* are not exceptionally difficult to perceive.

The aim of these experiments is to look for evidence in normal sub-

jects for a specific mechanism for the recognition of faces. It is hypothesised that, if this mechanism exists, it will affect *faces* but not *heads*.

General procedure for Experiments 1 to 5

Material

The experiments made use of 20 full face black-and-white photographs of white male students who had attended a different university from any of the subjects. None of the men in the photographs had beards, moustaches, glasses or any other obtrusive features, and all the pictures were taken against a neutral background. Prints were made about 64 mm by 88 mm, and each was cut into two parts, the *head* and the *face*, as illustrated in fig. 1. The *face* was a trapezium shape cut to just enclose the eyebrows, eyes, nose and mouth. Ten *heads* and ten *faces* were selected at random for use in all five experiments. The other sets of ten were used as distractors for recognition tests.

Subjects

In all experiments university students acted as *S*s on a paid volunteer basis. Equal numbers of men and women were assigned to the *face* and *head* conditions, and no one took part in more than one experiment. All *S*s were tested individually.

Experiment 1

Method

This first experiment compared *heads* with *faces* using a recognition test. 32 *S*s were assigned to *heads* or *faces*, and were told to look at the ten photographs as they were presented and to try to remember them. The experimenter sat opposite the *S* turning the pictures at a four sec rate. After a 30 sec break the *S*s were given the test book, which had an old and a new picture on each page. *S*s were told to point to the old picture of each pair, guessing when uncertain.

Results

Using Shepard's (1967) convention, the score was the number of correct answers minus the number incorrect. The mean for *heads* was 8.75 and for *faces*, 8.00, and the difference is not significant ($F(1,28) = 1.27$, $p > 0.1$). The mean score for men was 8.63 and for women, 8.13 and this difference is also not significant, nor is the interaction between stimuli and sex of *S*.

Although the means suggest *heads* are slightly easier to recognise than *faces*, no

significant difference has been established. This experiment does no more than to set a baseline against which the following experiments can be compared.

Replication

It is possible that a ceiling effect caused similar scores for *heads* and *faces*. To check this, a further 40 *S*s were run using an identical procedure except that the recognition test was harder: the 20 pictures were shown separately and *S*s responded 'old' or 'new'. Mean d' for *heads* was 2.11 and for *faces*, 1.87. This difference is not significant ($F(1,36) = 1.26$, $p > 0.1$). Sex of *S* was also not significant, nor its interaction. Clearly, *heads* and *faces* are of similar difficulty in a recognition test.

Experiment 2

This experiment tested *S*s' memory for the order in which pictures were presented. To discourage any mnemonic or counting strategy, the *S*s were not warned that order would be tested.

Method

32 *S*s were instructed to try to remember ten pictures presented in the same way as Experiment 1. As soon as the last picture was shown, the photographs were shuffled and handed to the *S* who was asked to reconstruct the order in which the pictures had been shown, by laying them out on the table. *S*s had no warning that this was what they were required to do.

Results

The task was considered quite difficult by most of the *S*s. Spearman's rho was used as a measure of agreement between the order of presentation and the order as recalled by the *S*, and this ranged between −0.33 and 0.87. The mean rho for *heads* was 0.42 and for *faces*, 0.33, but this is not significant ($F(1,28) = 0.60$). The mean for men was 0.35 and for women, 0.39 and this is also not significant, nor is the interaction between stimuli and sex of subject.

Fig. 2 gives some idea of how accuracy varied as a function of the position in the sequence. The graph shows the probability that a photograph was put in its correct position or an adjacent position. The results for *heads* and *faces* follow each other closely, in particular the first two photographs on both conditions were positioned particularly accurately.

The results of this experiment are consistent with Experiment 1: *heads* have a larger mean score than *faces*, but there is no significant difference.

Experiment 3

The linking of a name with a face is a social skill of great importance. This

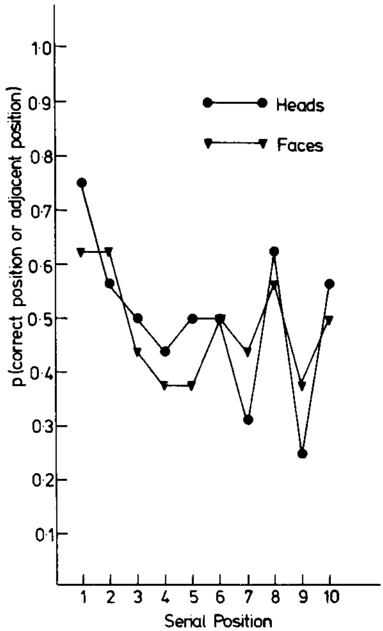

Fig. 2. Accuracy in recalling order of presentation in Experiment 2 is shown as a function of serial position, for *heads* and for *faces*.

experiment investigates a parallel task: paired-associate learning between *heads* or *faces* and letters of the alphabet. Two different sets of letters are used to reduce the effect of any unintentionally easy matches between letters and photographs.

Method

Either set of ten pictures could be displayed, one at a time, in an apparatus placed on a table between the *S* and the experimenter. A letter was clearly printed above each photograph, but could be hidden behind a flap.

16 men and 16 women were randomly divided into four groups: *faces* with letters A–J, *faces* with letters Q–Z, *heads* with letters A–J, and *heads* with letters Q–Z.

First the photographs were shown together with the letters for five sec each, and this was followed by a number of learning trials. On each trial the cards were first shuffled, and each one was shown to the *S* with the letter covered up. The letter was uncovered as soon as the *S* made a guess, or in any case after ten sec, and the letter and photograph were visible together for a further five sec. This procedure continued until all ten photographs had been shown. At the end of the trial the *S* was told how many correct guesses had been made. Trials continued until the *S*

reached the criterion of two consecutive trials without errors, or until a maximum of 15 trials were completed, whichever came sooner.

Results

The score is the number of trials to reach criterion. Three *S*s, all of whom were learning *faces*, still made errors in the 15th trial and were given a score of 17, which was the least number of trials in which they could have reached criterion, had the experiment continued. The fastest *S*, who learned *heads*, made no errors on her second and third trials, and so was given a score of three.

The mean score for *heads* was 7.25 and for *faces*, 11.06. This difference is significant ($F(1,24) = 8.24$, $p < 0.01$). Women, with a mean score of 7.56, learned significantly faster than men, with a mean of 10.75 ($F(1,24) = 5.75$, $p < 0.05$). However, the effect of the response letters was not significant, nor were any of the interactions.

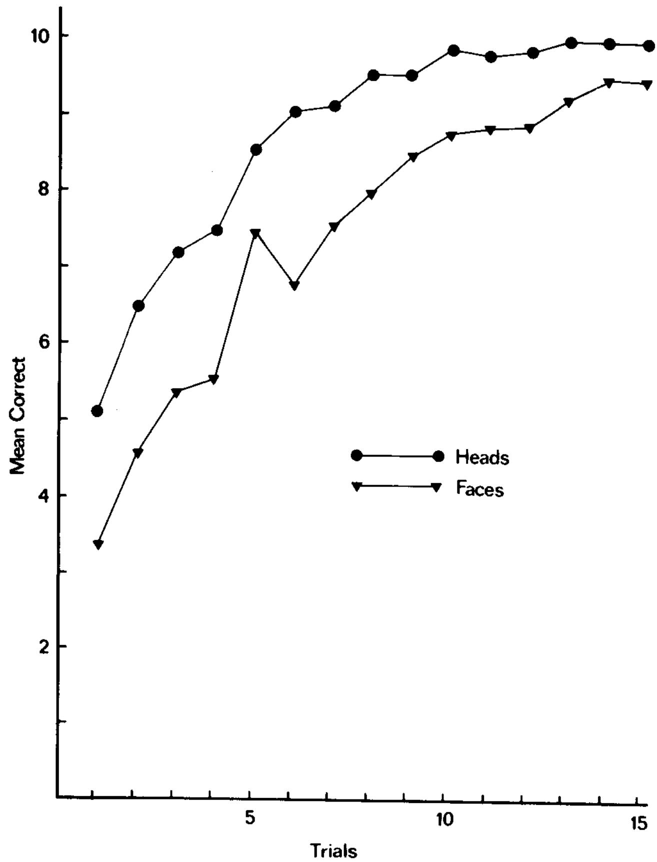

Fig. 3. The mean number of correct responses on each trial in Experiment 3 is plotted for *heads* and for *faces*.

Fig. 3 shows the mean number of correct responses on each trial for *heads* and for *faces*. *Heads* are better remembered than *faces* from the very first trial ($F(1,24) = 5.48, p < 0.05$).

*S*s were questioned carefully about the strategies they employed. As far as it was possible to tell, similar types of strategy were used for *heads* and *faces*. There was some evidence that women were more active in seeking mnemonics than men (see Phillips 1977, for more details).

Follow-up

In a follow-up to Experiment 3, the *S*s were contacted again several weeks after they had been tested to discover how well the material had been retained. All the *S*s had learned the material to a criterion of two consecutive errorless trials, or in three cases had just failed to reach the criterion in 15 trials, and so it can be reasonably assumed that the paired-associates for both *heads* and *faces* were fairly thoroughly learned.

A list of 16 people was drawn randomly from the original 32 *S*s and included eight men and eight women. 15 of the 16 were successfully contacted, but one person who could not be found was replaced by someone drawn from the other 16. *S*s were tested between 20 and 43 days after the first test. The mean was 29.6 days for *heads* and 29.4 days for *faces*.

*S*s were shown the photographs again and asked to recall the letters. The mean number correct was 7.63 for *heads* and 5.25 for *faces*, and this is statistically significant ($F(1,12) = 19.7$, $p < 0.001$). Sex of *S* was also significant ($F(1,12) = 9.2$, $p < 0.05$) with a mean of 5.63 for men and 7.25 for women. The interaction was not significant.

Discussion

Paired-associates for *heads* are learned faster than paired-associates for *faces*, and this difference cannot be explained in terms of *S*s' reported strategies. Although the difference was present on the first learning trial, this is not an exclusively short term effect, as retention of associates for *heads* was superior when tested about four weeks later.

This result is not consistent with Experiments 1 and 2, where *heads* and *faces* were of roughly equal difficulty.

Experiment 4

Yin (1969) has shown that inverting a picture of a face disrupts recognition more than inverting pictures of other objects such as houses or aircraft. It is interesting to ask whether the difficulty also occurs when *faces* are compared with *heads*. It could be argued that *heads* provide a more controlled comparison than the other objects which have been used, for example, *heads* are less geometric, and come closer to having the social importance of *faces*.

Method

32 *S*s were shown the ten inspection pictures (either *heads* or *faces*) presented upside-down at four sec intervals. After a 30 sec break the *S*s were given the test book, which had an old and a new picture on each page, and this was also presented upside-down. *S*s were told to point to the old picture on each page, guessing when uncertain.

Results

The score was the number of correct answers minus the number incorrect. The mean for *heads* was 7.38 and for *faces,* 5.25. This is statistically significant ($F(1,28) = 4.61, p < 0.05$), but sex of *S* was not significant, either as a main effect or as an interaction.

Experiment 5

There is no direct evidence that faces are any harder to recognise in photographic negative than other objects, although it is reasonable to suspect that a difference exists. This experiment compared recognition memory for *heads* and *faces* in photographic negative.

Method

The procedure is identical to Experiment 4, except that where photographs were presented upside-down, they were presented upright but in photographic negative. There were 32 *S*s.

Results

As before, the score was the number of correct answers minus the number incorrect. The mean for *heads* was 8.00 and for *faces,* 7.38, and there were no statistically significant effects.

Discussion of Experiments 1 to 5

The results of Experiments 1 to 5 are summarised in table 1. Each was a memory experiment comparing memory for *heads* with memory for *faces* and, as the same photographs were used throughout, a close comparison can be made between the five. In every case the mean for *heads* is larger than the mean for *faces* but from the significance levels it is clear that for Experiments 1, 2 and 5, the two types of material are of almost equal difficulty, but for Experiments 3 and 4, *heads* are considerably easier than *faces.* This is supported by the estimates of *omega squared* shown in the table (see Hays 1963, p. 381). For Experiments 1, 2 and 5 they are close to

Table 1
Summary of results for Experiments 1 to 5.

Experiment	Score	Means *Heads*	*Faces*	*F*-ratio	Estimated omega²
1. Recognition memory	(a) Correct minus incorrect	8.75	8.00	1.27	0.9 per cent
	(b) *d′*	2.11	1.87	1.26	0.7 per cent
2. Incidental memory for order	Spearman's rho	0.42	0.33	0.60	−1.3 per cent
3. Paired-associate learning	Trials to criterion	11.06	7.25	8.24 ($p < 0.01$)	17.6 per cent
4. Recognition of inverted pictures	Correct minus incorrect	7.38	5.25	4.61 ($p < 0.05$)	10.7 per cent
5. Recognition of negatives	Correct minus incorrect	8.00	7.38	0.76	−0.8 per cent

zero, but for Experiments 3 and 4 it is clear that the difference between *heads* and *faces* accounts for a substantial amount of variance in the scores.

Taking Experiment 1 as a baseline, it is worthwhile to consider the performance on each of the other experiments in turn.

Galper (1970) has shown that negative photographs of faces are harder to recognise than normal positive prints, and she attributes this to their lack of facial expression. As facial expression appears to emanate from the center of the face, this predicts that negative *heads* should be easier to recognise than negative *faces*. However, this was not found in Experiment 5 where the change to photographic negative appeared to disrupt the center and the periphery of the face equally. The difficulty may not be specific to faces but could affect a wider class of stimuli. Although an experiment by Phillips (1972) has failed to support a suggestion that the difficulty is due to the halftones (grays) in a photograph of a face, it is still probable that the phenomenon is not face specific.

There is considerable evidence that the recognition of faces is especially disrupted when they are turned upside-down (Hochberg and Galper 1967; Yin 1969; Scapinello and Yarmey 1970; Yarmey 1971; Rock 1973). Experiments 1 and 4 demonstrated that whereas *heads* and *faces* are equally difficult to recognise upright, *faces* are harder than *heads* when inverted. This suggests that inversion particularly disrupts the central part of the face, and this is consistent with a link between inversion and facial expression. However, Experiment 4 provides no clue as to why faces are so difficult upside-down, nor as to whether there is a specific mechanism for recognising faces.

Perhaps the most interesting result is the disparity between Experiment 1 and Experiment 3. Performance on a recognition memory test was equally good for *heads* and *faces*, but paired-associate learning was considerably easier with *heads*.

If this result is a consequence of some property of faces, it should also occur when whole photographs of faces are compared with other types of control stimuli. This is tested in Experiment 6.

Experiment 2 showed that incidental memory for order of presentation was equally good for *heads* and *faces*. This could be regarded as a type of paired-associate experiment where the subject must attach a temporal tag to the picture. However the results suggest that memory for order is closer to recognition memory than paired-associate learning. This is consistent with the views of Fozard and Yntema (1966) who suggest that the judged recency of a picture is partly determined by the strength of its memory trace.

Experiment 6

Experiments 1 and 3 demonstrated that whereas *heads* and *faces* are equally difficult to recognise, *heads* are considerably easier when learning paired-associates. Does this result hold when we generalise from a *face* to a normal photograph of a whole face, and from a *head* to other types of visual stimuli? It is predicted that if photographs of faces are compared with another set of visual stimuli of suitable difficulty, the faces should have a significantly higher score on a recognition test, and a significantly lower score on a paired-associate test.

Method

A large number of full face photographs of business men were cut from a newspaper advertisement and 32 were selected, removing those with glasses, beards, moustaches and other obtrusive features. The size of picture, lighting and background were similar in all the photographs. The photographs included the person's hair and ears, but they were cropped at the neck to eliminate clothing.

32 geometric designs were selected from those based on star shapes drawn by Hornung (1946). No shapes which were very similar were included. Examples are shown in fig. 4.

Both types of material measured roughly 30 mm square. For both types, the 32 pictures were mounted on a board in random order. Eight positions on the board were selected randomly and two monochrome slides were made for the pictures at these locations, one of which had a letter of the alphabet between S and Z printed above the picture.

The slides were presented in a Singer Caramate II SP projection unit and the pictures subtended a visual angle of about 12 degrees by 12 degrees at the *S*s' eyes.

24 university students acted as *S*s, with six men and six women assigned randomly to the two conditions – faces or geometric shapes.

*S*s, who were tested individually, were told they would see eight pictures of faces (or geometric shapes) with a letter of the alphabet (S to Z) above each one and they should try to remember which picture went with which letter. In the case of geometric shapes, *S*s were shown a card with five examples of the type of shape to be presented. The eight learning slides were seen for four sec each with a one sec gap

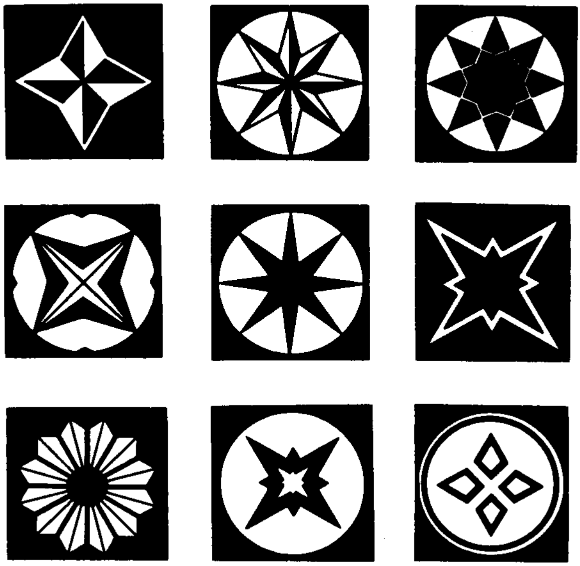

Fig. 4. Some examples of the geometric shapes used in Experiment 6, taken from Hornung (1946).

between slides. The test, following after a ten sec break, consisted of the same eight slides in a different order shown for nine sec each at ten sec intervals. *S*s wrote down their answers.

The recognition test followed without warning. *S*s were shown the board with 32 pictures and were asked to write down the numbers of the eight pictures they had just seen. There was no time limit.

Results

On both the paired-associate test and the recognition test, the score was simply the number of correct responses, and this could range from zero to eight. For the paired-associate test, the mean for geometric shapes was 4.5, and for faces it was 2.8, and this difference is significant ($F(1,20) = 5.24$, $p < 0.05$). There was also a significant effect of sex of subject ($F(1,20) = 9.99$, $p < 0.01$), with a mean of 4.8 for women and 2.4 for men. A similar sex difference was found in Experiment 3. For the recognition test, geometric shapes had a mean of 6.1 and faces had a mean of 7.2, and this was also significant ($F(1,20) = 4.94$, $p < 0.05$).

Fig. 5 summarises the results: as predicted, faces are better on the recognition test but worse on the paired-associate test. The experiment is a loose replication of Experiments 1 and 3, and supports the notion that faces are relatively easy stimuli to recognise but are relatively difficult to associate.

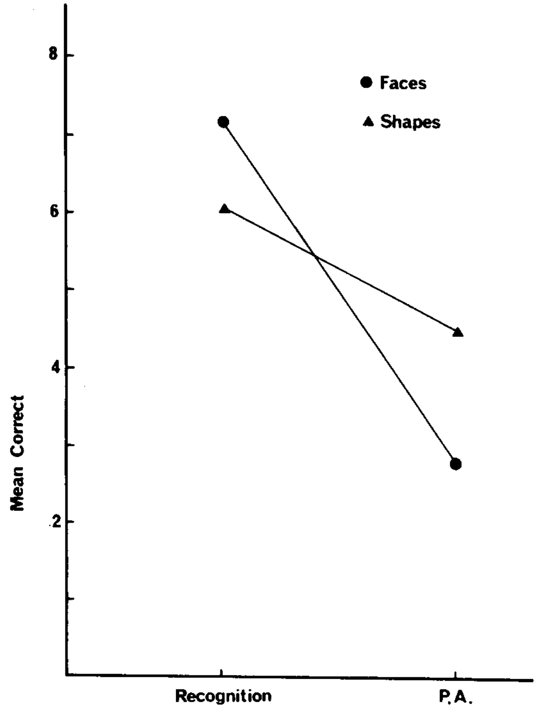

Fig. 5. Mean performance on recognition and paired-associate learning in Experiment 6, for faces and geometric shapes.

General discussion

'I find it easy to remember faces but I can't remember the names which go with them.' This frequent observation could be explained simply as the difference between recognition and recall: faces are recognised but names must be recalled. But Experiment 6 suggests that this explanation is not the whole story. Compared to another type of visual stimulus, faces were easier to recognise and harder to associate. If associating letters is like remembering names in real life, people may indeed have what seems a disproportionate difficulty in remembering names.

22 out of 32 subjects in Experiment 3 reported the frequent use of verbal strategies: they found words to describe the picture which could be linked to the response letter. Their introspections suggested that it

was difficult or impossible to link the letter directly to the memory trace of the picture. Faces may differ from other types of visual stimuli in that they have low association values. Just as Glaze (1928) observed that the association value of nonsense syllables affects their memorability, it may be hard to generate meaningful descriptions of faces and so it may be difficult to link them with other information. Experiment 3 suggests that the center of the face has a lower association value than the periphery, and additional evidence for this comes from an experiment where subjects matched photographs with descriptions written by another group of subjects. *Heads* were significantly better matched than *faces* (see Phillips 1977).

If there is a brain mechanism for processing faces, independent of other stimuli, this independence would make it difficult to associate facial information with information of other types. In particular, it would be difficult to learn paired-associates with faces. However, there are more parsimonious explanations.

One general characteristic of memory for faces seems to be the inaccessibility of the information. Although recognising faces is reasonably easy, it is difficult to recall the appearance of faces, whether by describing them in words or drawing them, and this poses a serious practical problem for police identification (e.g. Ellis et al. 1975).

Faces are certainly not the only type of stimuli which are difficult to recall (see Rock and Englestein 1969; Haber 1970), indeed visual memory seems to differ generally from verbal memory in that it is easier to get information in, but harder to get it out. A pertinent question is why should any memory system tend to be inaccessible? Why is it not possible to call up at will the large amount of information which we must use to recognise a face? There seems to be no good reason why brain evolution should deliberately create inaccessible memories, and so it is likely that poor access is a necessary consequence of the way information is stored.

As an example of the way storage can affect accessibility consider these two ways in which a square could be coded:

$$= {}_{w}H(X)_{e} = {}_{n}V(X)_{s} = {}_{e}H(X)_{w} = {}_{s}V(X)_{n} = \qquad (1)$$

(Height, Perimeter, Diameter of Circumscribed Circle)

$$= (1.00, 4.00, 1.41)\sqrt{\text{Area}} \qquad (2)$$

(1) is suggested by Sutherland (1968). H and V denote horizontal and vertical lines and n, s, e, w, points of the compass, show how they are joined. A similar but more elaborate notation has been suggested by Leeuwenberg (1971).

(2) is a code based on parameters. It could be matched to other shapes as well as a square, but as it is unlikely that one would encounter the other geometric shapes in real life it is, in effect, quite a good description of a square.

For the purposes of recognition, (1) and (2) are equally good, but as a basis for recall they are very different. (1) retains the basic structure of a square. From the coded description it is possible to discover that a square has four sides, or that it can be broken up into a U-shape with a bar on top. The code carries enough information to build up an image and to interrogate this image in various ways. In contrast, (2) is just a set of parameters which reveal nothing about the structure of a square.

Another difference is that (2) is a more economical description than (1). For complex, irregular patterns it is likely that descriptions similar to (1) would be very long and unwieldy (even when hierarchical coding is allowed), while descriptions similar to (2) could still be quite short.

It is not suggested that these are ways of storing visual information in the head, but they are examples of how it could be stored. The important difference is that codes of type (1) are possible to recall but uneconomical to store, whereas codes of type (2) are economical to store but cannot be recalled.

It is likely that visual memory uses codes of both types and that sometimes the same information is stored in both forms. Faces are complex stimuli and so for reasons of economy it is likely that type (2) storage would frequently be used: the parameters might bear some relationship to the dimensions found in studies of facial expression (e.g. Woodworth 1938; Schlosberg 1941).

If the brain stores faces as a series of parameters which carry a large amount of information but which lose much of the original pictorial detail, this would explain our efficiency in recognising faces and our poor performance in recalling them. It would also explain the difficulty in associating faces with other information, particularly names. Association seems to depend on finding mediating information to draw the two strands together. If faces are coded as abstract parameters, this mediating information may be difficult to find, whether it is verbal or visual.

Conclusions

The exploratory experiments which have been described offer little support for a special pattern recognition mechanism for faces. The design of these experiments has limited the type of specific mechanism which could be detected. For example, the comparison of *faces* with *heads* could not detect a mechanism which operates equally strongly on *heads* and *faces*. Studies of brain damaged patients offer some evidence for face recognition occurring at specific locations. If the only difference between the processing of faces and of other objects is one of locus within the right hemisphere, it is clear that this could not be demonstrated in a study of normal subjects, but if there are also differences in the type of processing, this should be demonstrable. It is possible that the disparity between recognition memory and associate learning results from a specific mechanism of this kind, but it is not difficult to find more parsimonious explanations.

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