FACIAL RECOGNITION

A Senior Honors Thesis

Presented to

the Faculty of the Department of Psychology

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

By

Debra Parish

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ABSTRACT

Two experiments investigated the possible properties involved in facial recognition. In the first experiment, the overall ratings of faces were compared to the ratings of their component features. Certain features were found predictive thus indicating the use of features in facial recognition. It was suggested that the nature of the task could have dictated the strategy used.
In the second experiment, similarity ratings were compared for faces seen in upright and inverted presentations with two time variations (5 and 8 seconds). There appeared some characteristics common to all conditions, but not enough across the two variables to produce significant correlations when both time and presentation mode changed.

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Chapter I

Introduction

The topic of facial recognition has gained increased attention in recent years. Despite this fact, the evidence is inconclusive as to what properties are involved in the recognition of faces.

This study will attempt to cover the various theories currently held on facial recognition with the intention of eliminating some of the explanations and developing the remainder into a workable explanation of the cognitive strategy involved.

Current Theories

Feature analysis. The use of features in facial perception can be viewed as occuring in one of two ways, either through serial analysis or parallel processing. "Serial models are characterized by the assumption that in determining whether two simultaneously presented multidimensional stimuli are the same or different the two stimuli are compared dimension,by dimension, one comparison after another. Parallel models are characterized by the assumption that several com-

parisons may be made simultaneously" (Egeth, 1966, p. 245). Further dichotomies exist within each model but will not be covered within the scope of this paper.

Bradshaw and Wallace (1971) showed the perception of faces to be a serial process involving a rapid sequential self terminating scan of features, although they allowed that the nature of the task might have imposed a serial strategy.

The literature on laterality differences can be interpreted as supportive of the alternative model--parallel processing. The left hemisphere, which employs a serial procedure, has been found to be superior in recognition of non-verbal shapes, patterns, and nonsense figures, and processes these visual stimuli in an holistic, gestalt or parallel fashion (White, 1969). Numerous studies can be quoted showing that verbally mediated matching must be serial, while parallel processing is limited to the matching of physical characteristics (Neisser & Beller, 1965; Smith & Nielsen, 1970).

But as Garner (1970) points out, before one can determine whether information is being processed serially or parallel, it must be known that there is more than one informative stimulus dimension. If only one stimulus dimension is involved in facial perception, as supported by Simpson and Crandel's (1972) results, then only one feature

(the eyes, nose, mouth, etc.) is attended or the face is seen wholistically as a gestalt.

Gestalt representations. This theory involves comparing unitary representations of multidimensional objects without regard to their component dimensions. The previously cited results of laterality differences would equally support this interpretation of facial recognition. Levy, Trevarthen, and Sperry (1972) propose that facial recognition appears to be gestalt-like and resistant to analytical verbal description. Witnesses encounter this difficulty of verbally depicting a face in describing criminals.

More conclusive evidence was presented by Harmon (1973) in his finding that degradation of the face pattern did not prevent its identification even after individual facial features had been blurred. While Harmon's findings can be explained in terms of pure pattern recognition, there are additional studies in which the results cannot be accounted for by simple pattern storage and recognition.

Hochberg and Galper (1967) discovered that recognition accuracy for faces seen in photographs was higher when faces were first seen and then later recognized in the usual upright orientation than when faces were:

(1) viewed and recognized in an inverted orientation, or

(2) viewed in inverted and recognized in upright.

Hochberg and Galper interpret the above as suggesting faces

are not coded and stored on their pattern characteristics alone. Yin's (1969) findings and conclusions were similar. Galper (1970) repeated the study but used positive and negative photographs in place of upright and inverted presentations and found significantly lower recognition accuracy for the photographs of faces seen in negative. These results further support an alternative explanation to pattern recognition since the positive-to-negative transformation leaves the pattern unchanged. They also negate the possibility that Hochberg and Galper's earlier results were attributable to the effect of the inversion transformation used in that study.

Thus when the evidence from a number of sources is juxtaposed, it suggests that facial recognition may be a unique process involving more than feature analysis or pure pattern recognition.

A unique process. Yin compared the outstanding characteristics of face recognition with the recognition of other visual objects. He contended that if face recognition involves a unique skill, it should differ from object recognition under the following conditions:

(1) there should be a predisposition in infants for attending to and recognizing faces.

(2) above a certain age in normal adults and children, one should find a disparity between the ability

to remember faces and the ability to remember other visual objects.

(3) certain brain injuries should affect face recognition without affecting recognition of other visual objects.

Adequate support cannot be established for Yin's criteria in all three areas.

(1) Infant perception studies yield positive, although still inconclusive evidence for a unique facial recognition ability (Fagan, 1972).

(2) Studies comparing object and face recognition show that the two may indeed involve different recognition strategies. A special strategy was used for dealing with normally presented faces that was not used for remembering other visual objects. It was difficult to use in dealing with "distorted" facial configurations. Carey and Gendzier (1974) conducted an experiment showing that as a child approached age ten, his or her memory for normally presented faces increased sharply while memory for other objects and inverted faces improved only slightly. In a subsequent experiment, the investigators were able to trace this improvement in face recognition performance to the older child's increased attention

to the whole face.

(3) Presently, the studies on abnormal deficits in face perception do not provide support for a face-specific deficit. Although the less severe cases involve only a face deficit, this may be symptomatic only of a more general deficit since in the more severe cases the face deficit always is accompanied by some other visual recognition problem.

In addition to empirical evidence, our day to day experiences in dealing with the human face suggest that it may be a special visual object. For instance, the ability to remember hundreds of faces despite their slight differences is remarkable in comparison to the ability to remember great numbers of other highly similar objects. This special ability to discriminate between same and different is resistant in many cases to assessories such as beards, glasses, effects of age and cosmetics. Furthermore, numerous inferences are made about personality, moods, and individual traits from a person's face. For example, "shifty eyes" are commonly equated with dishonesty. "In short, the potential uniqueness of face perception involves people's ability to derive a great deal of information from the face on the basis of very slight physical differences" (Yin, Note 1).

Approach to the Problem

One approach to exploring the question of the properties involved in facial recognition is to obtain some measure of facial recognition and compare it to individual ratings on the features of the face. In this manner, it can be determined which features if any are most predictive of the overall ratings. In the absence of any such predictive feature(s) one can look for something other than, or in addition to, feature analysis to account for the facial recognition process. To obtain these two measurements a similarity rating task was utilized for both whole faces and their individual features. The features were isolated and presented in such a way as to insure the sum of the parts of the face shown in the five feature presentations to be equal to the whole face as seen in the overall condition. So actually five cross sections of the face were used, which each included a particular feature.

The question of facial recognition involving pure pattern recognition, as opposed to being a unique process, can be explored further within the task being used to obtain measurements of overall facial perception. Using Yin's paradigm as a basic model, faces were presented upright and inverted. The differing presentations should yield high correlations if the same strategies are used. As pointed out earlier, this should be the case if only pattern recognition is involved

since nothing has been altered in the pattern by simple inversion. Whereas, low correlations would imply when the face is not viewed in the upright or normal orientation, perception is affected (inversion does not affect object recognition). An additional variation of time was included to determine whether subjects would rotate the face to its normal orientation if given ample time. Two pilot studies were run to determine; (a) whether rotation would take place, and (b) what times did and did not allow for rotation and then subsequent similarity judgments. The decision to use 5 and 8 seconds as the discriminative times was based on the second pilot study in which the correlation between the upright 5 second condition (U5) and inverted 5 second condition (I5) was significantly different from the correlation between the upright 8 second condition (U8) and inverted 8 second condition (I8).

The following section presents the results of the two experiments. The Methods section will be presented separately for each, whereas they will share a Results and Discussion section. This integration is necessary due to the nature of the analysis of the data.

Chapter II

Experiment 1

Methods

Subjects

The subjects consisted of 24 male and female volunteers ranging in age 18 through 50. Six subjects were randomly assigned to each of four experimental conditions. Most subjects gained extra credit in lower level Psychology courses at the University of Houston for participation in the study. The remainder received no benefits.

Apparatus

The experiment was carried out in a university laboratory darkened to insure good vision. Twenty 35mm black and white slides of photographs of Caucasian, male faces and twenty were used for the basic test series. Selection of slides for the test series was based on two criteria, lack of excessive facial hair (viz., beards, moustaches) and the absence of glasses, in order to eliminate accessories which might affect the subject's approach to the task. Although the

drawings were portraits, many did not evoke the feeling of "looking at a face." In most cases, the poor representations stemmed primarily from the artist's tendency to caricature certain features, such as exaggeration of the eyes. The elimination of these slides resulted in 25 usable pairs, 5 of which were employed as a practice set.

Procedure

The subjects were told to rate on the basis of similarity, each pair of slides shown. The subjects were to respond by checking a blank representing a rating of one through six on an answer sheet consisting of 23 sets of 6 blanks each. From left to right, the first column of blanks was labelled as "most similar" (equivalent to a rating of one) and the sixth column as "least similar" (equivalent to a rating of six). Subjects were instructed not to mark their rating sheets during the slide exposures. During this time, they were only to look at the faces and form an opinion as to similarity. Subsequent to each presentation, they were given time (indicated by white projected light) to mark their judgments.

They were then shown five practice pairs which were to be marked on a sample sheet. This was done not only to familiarize the subjects with the task, but also to prepare them for the pace at which the slide presentation would progress. Questions were answered before proceeding.

The subjects were randomly divided into groups of six with each group participating in one condition which varied as to length of presentation (5 seconds or 8 seconds) and mode of presentation (upright or inverted). Thus, the slides were shown upright for 5 seconds in Condition 1, upright for 8 seconds in Condition 2, inverted for 5 seconds in Condition 3, and inverted for 8 seconds in Condition 4. The intervals of white projected light between slide exposures remained constant at 5 seconds for all conditions.

Subjects 1-3 in each condition saw slides 1-20; subjects 4-6 viewed slides 20-1.

Chapter III

Experiment 2

Methods

Subjects

The subjects were 15 male and female volunteers ranging in age 18 through 50. One subject was disqualified and replaced due to his participation in the former experiment. Participation was rewarded with extra credit for those volunteers enrolled in lower level Psychology courses at the University of Houston.

Apparatus

The location and apparatus were identical to Experiment 1 with the exception of the stimulus material. Five duplicates were made of each slide in the previous test series, five of each photograph and five of each drawing. For each of the 10 duplicates per face, all of the slide was blocked out except one feature, resulting in a test series comprised of 20 pairs of noses, 20 pairs of mouths, 20 pairs of eyes, 20 pairs of chins, and 20 pairs of hairlines. As before, two Kodak Carousel projectors projected

the pairs of slides simultaneously side by side on a screen located in the front center of the room.

Procedure

The instructions were the same as in Experiment 1 with two exceptions:

(1) Subjects were told they would be rating the similarity of pairs of features (as opposed to faces).

(2) Subjects were given five answer sheets which each had 23 sets of 6 blanks and were instructed to progress to a new page after four consecutive white light intervals.

Before proceeding with the test series, five practice pairs consisting of one pair representing each of the five features were viewed and rated by the subjects. Any questions were answered at this time.

Counterbalancing was accomplished by varying the starting point of presentation. Three people were randomly assigned to each of five starting positions. The difference in starting positions was the order in which subjects viewed and rated the trays of features.

The features were presented only in the upright mode with a constant stimulus duration of 5 seconds and a 5 second interval of white light between each exposure. All

other variables remained the same as in Experiment 1.

Chapter IV

Results

The author first considered the results pertinent to the question of whether feature ratings were predictive of ratings obtained on the overall face, next considered the effects of mode of presentation (upright vs. inverted) and finally examined the effects of length of presentation (5 seconds vs. 8 seconds).

The data on the feature and overall ratings were subjected to a stepwise multiple regression. The primary data is shown in Table 1 with each column reporting the predictive features in correlations of features with overall ratings in the four conditions. The hairline alone is a significant predictor in the 5 second upright condition, t (18) = 2.45, p-.05. In the 5 second inverted condition, three predictors are found to be significant. Eyes accounted for most of the variance, t (16) = 3.87, p-.001; then the mouth, t (16) = 3.87, p.-05; and next the hairline, t (16) = 2.26, p.-05.

Table 2 presents the correlation matrix for the ratings

in the four conditions involving the whole face. Collapsing across times a significant correlation of .666 was obtained for the upright and inverted ratings, t (22) = 4.19, p-.001. Collapsing across modes of presentation a significant correlation of .718 was obtained for the 5 and 8 second presentation, t (22) = 4.84, p-.001.

Table 1

Basic Regression Coefficients

	U5	U8	I5	[a]I8
Constant	1.63	2.56	1.57	
Features				
Mouth			-.47	
Nose				
Eyes			.68	
Chin				
Hairline	.51	.51	.26	
F Ratio	6.97	5.98	9.77	
df	1/18	1/18	3/16	

[a]No independent variable could be included in the I8 model.

*p-.05

**p-.01

Table 2

Correlation Matrix

of Overall Facial Ratings

	U5	U8	I5	I8
U5	-			
U8	*.824	-		
I5	*.706	.531	-	
I8	.552	.526	*.612	

*p-.01

Chapter V

Discussion

The individual features seem to play an important role in facial recognition. In the normal mode of presentation (upright), only one informative stimulus dimension was found, the hairline. But in the inverted condition, three features became important predictors of the five second judgment (the eyes, mouth, and hairline). The inversion seemingly forces the subject into either a serial or parallel analysis of features. It is impossible to distinguish which on the basis of the data. An alternative explanation for this finding can be foud in Yin's warning that the use of schematic or artificial reproduction of faces forces subjects to rely on a feature analysis. The stimulus, in this case, is inadequate for relating to the subject's social experience. Yin suggests the potential uniqueness of face recognition is attributable to the whole face being attended and coded to some social experience. If this is the case, then indeed the overall ratings would be predicted by the feature ratings.

While the manipulation of exposure time seems to have no effect on the process involved in similarity ratings when the features are upright (as evidenced by similarity of regression equations), this is not the case when the faces are shown inverted. Exposure time does have an affect on the strategy used by the subjects in the longer inverted time (it is not evidenced by the linear regression equations), presumably becoming more varied across trays, across subjects, or within subjects. There are some characteristics upright and inverted ratings share, such as hairline as a predictor. There are some which are common to exposure time. But there are not sufficient commonalities across both time and exposure conditions to produce significant correlations when considering comparisons in which both have been changed (e.g., I5 x U8, I8 x U5).

The results of the present study offer inconclusive evidence as to the properties involved in facial recognition. To rule out possible explanations for these findings, future research should be conducted using different stimulus materials, as well as different tasks.

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