THE PSYCHOLOGY OF FACE RECOGNITION: A BRIEF INTRODUCTION

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Contents

	Page Number
INTRODUCTION	3
CONFIGURAL PROCESSING OF FACE	3
Evidence For Problems With	3 4

Applying Theories of Pattern Recognition to Face Recognition	4
FEATURE DETECTION THEORIES	6
Evidence For Evidence Against	6 6
INFORMATION PROCESSING MODEL	7
Evidence For Problems With	7 12

REFERENCES

13

Introduction

Face recognition is the situation of using the face to identify a familiar individual. It is different to face perception, which includes the perception of emotions from facial expressions, and the perception of unfamiliar faces (Roth and Bruce 1995).

There is also face identification (naming the person) and face recall (describing the face from memory) (Cohen 1989).

The main question is whether faces are recognised by features (eg: hair, nose) or in a configural (whole) way.

There are three main theoretical approaches to recognition of familiar faces:

i) Configural processing of faces

ii) Feature Detection Theories

iii) Information Processing Model.

Configural Processing of Faces

This approach argues that faces are recognised as a whole configuration (holistically), and features are not analysed separately.

A configural way can include the spatial relationship between features on the face, or how the features interact (eg: the shape of the mouth affects the perception of the shape of the nose) (Rakover 2002).

EVIDENCE FOR CONFIGURAL PROCESSING OF FACES

1. Recognition of upside-down faces

Researchers have found that faces are harder to recognise upside-down than other objects, so it cannot be the features only that are important (Yin 1969).

Also when a "grotesque" face is presented, the unusual features are not noticed upside-down (eg: "Thatcher illusion"; Thompson 1980).

The "Thatcher illusion" is a picture of Margaret Thatcher where the mouth and eyes have been turned upside-down. Normally this looks "grotesque", but upsidedown there appears to be nothing wrong.

The relationship between the eyes, nose and mouth (ie: configuration) is harder to perceive in the upsidedown face, and the "grotesque" features are not seen (Roth and Bruce 1995).

Yin (1970) argued that the inverted face is also

harder to recognise because it is more difficult to recognise the facial expression of such a face.

2. Composite faces

Young et al (1987) combined the top and bottom halves of two famous faces of the time of the experiment (politicians - Margaret Thatcher and Shirley Williams). Participants were asked to name the face by the top half, and they were unable to do this. If face recognition was based on features, then this should not be the case. The researchers argued that the newly-combined face is a new configuration.

PROBLEMS WITH CONFIGURAL PROCESSING OF FACES

i) Some facial features are more important than others. For unfamiliar faces, recognition depends on external features of the face (eg: face outline, hairstyle), but internal features are more important for familiar faces. The most important internal feature is the area around the eyes, and the area around the nose is the least important (Roberts and Bruce 1988).

ii) Most of the research is based around recognition of faces in photographs (ie: 2D stimuli), when, in real life, face recognition is of a 3D stimuli (Eysenck and Keane 1995).

APPLYING THE THEORIES OF PATTERN RECOGNITION TO FACE RECOGNITION

The configural processing of faces is similar to how patterns and objects are recognised by the Template Matching Hypothesis and Prototype Theories.

Template Matching Hypothesis

One possibility is that individuals store a fixed set of views of faces they have learnt.

EVIDENCE FOR:

EVIDENCE AGAINST:

It is difficult to recognise the same that has changed (eg: with/without beard). A change in wig reduced face recognition to 50%, while a wig and beard change reduced accuracy to 30% (Patterson and Baddeley 1997 quoted in Brewer 2000) There would need to be a template for each view of face face: front and side, and this would require a massive memory capacity

Prototype Theories

Prototypes are not individual faces, but a summary of the main features of faces. General prototypes of the face are stored in the memory, and individual faces are linked to them.

The process works in two ways - typical faces are quicker to recognise as faces compared to other objects, but distinctive faces (ie: those different to the typical face) are easier to recognise for individual faces.

Valentine and Bruce (1986) have shown these processes experimentally. Participants were asked to rate the familiarity of a famous person, and the reaction time to answer was measured. The average time taken was 661 msecs for distinctive faces as compared to 707 msecs for typical ones. When participants were shown jumbled faces and asked if it was a face or a non-face, recognition for typical faces took 561 msecs on average and distinctive faces 608 msecs.

Valentine (1991) sees distinctive faces as stored in "face space" where few others are stored. Known faces are stored on dimensions of the space which represent the dimensions used to distinguish between the faces, and typical faces are clustered close together at the average. Distinctive faces are at the extremes of the dimensions. Thus identification is much easier with less competing information in the memory store.

While Bruce et al (1994) found that distinct faces are different in measurements of features, like nose width, than faces rated as typical. Also caricatures of famous faces, which exaggerate the person's face, make them more distinctive, and easier to recognise (Valentine 1996).

The problem with this approach is the inability to explain the exact nature of prototypes.

Feature Detection Theories

Individuals focus upon features (eg: hair, eyes) of the face, and build up a picture of the whole face to recognise.

EVIDENCE FOR FEATURE DETECTION THEORIES

Participants asked to describe unfamiliar faces used particular features. Hair was mentioned most often, then eyes, nose and mouth (Shepherd et al 1981).

Bradshaw and Wallace (1971) argue that facial features are processed independently, and in a particular sequence. Using Identikit faces, the researchers showed participants pairs of faces that differed by features (either on 2,4 or 7 features), and asked them to say if it was the same person.

The more features that were different, the quicker were participants to answer as not familiar. With many differences, the participants would encounter this quicker in their comparison of the features.

EVIDENCE AGAINST FEATURE DETECTION THEORIES

Sergent (1984) showed that faces with the same features but combined in different ways will not be recognised. In other words, the whole of the face must be taken into account.

This research combined in eight faces, two different chins, two different eye colours, and two different arrangements of space on the face.

Further evidence against Feature Detection Theories comes from Tanaka and Farah (1993). Their aim was to test the recall for specific features of the face. Participants were asked to recognise a particular feature (Larry's nose) when presented in different faces, scrambled faces or in isolation.

The Feature Detection Theories predict recognition of the feature irrelevant of the context. The results of the research were that recognition was poorer in isolation or in a different context to learning, and better in the original context learnt (around 70% accuracy). Thus face recognition is more than just the features separately ¹.

¹ Police forces are now using with witnesses face reconstruction systems that computer generate whole face images (eg: EvoFIT; Lander 2002) rather than the individual features of Photofit systems.

Information Processing Model

Bruce and Young (1986) argued that face recognition can be seen as involving three stages:

i) The face is compared with a set of stored descriptions called "face recognition units" (FRU), and this produces a feeling of familiarity or not;

ii) The memory is activated to recall facts about the person if familiar;

iii) The retrieval of the name.

This model of face recognition is based upon stages that progress in a particular order (known as serial processing). The order of the stages cannot be changed. This model makes use of different modules in the brain visual recognition (ie: FRUs) and semantic memory (figure 1).

FACE \downarrow Stage 1 VISUAL ENCODING (ie: seeing face - structurally encoding) \downarrow Stage 2 MATCHING PROCESS (to Face Recognition Units - produces feeling of familiarity) \downarrow Stage 3 SEMANTIC INFORMATION (recall facts about person - person identity nodes) \downarrow Stage 4 NAME RETRIEVAL (recall memory - name generation) Figure 1 - Information Processing Model of face

recognition.

EVIDENCE FOR INFORMATION PROCESSING MODEL

1. Face recognition error studies

This type of study focuses upon situations when face recognition fails. These are occasions when individuals cannot recognise a familiar face, or they recognise the face but cannot recall information about the face (like the person's name).

Young, Hay and Ellis (1985) asked twenty-two

volunteers (11 male, 11 female) at Lancaster University to keep a eight-week self-reported diary (table 1) of the times they could not recognise a famous or familiar face, or could not remember information or the name of the person (face recognition errors).

The participants were asked to record the face recognition error incident briefly, including what information was unavailable, and whether they recalled the information or recognised the individual at a later date. The first week of the study was a training week, and the data from seven weeks were used.

An example of diary event was this error:

I just thought the person looked familiar, as she waved, and I thought it was at me. I waved back, then realised I didn't know her. She was waving at someone else (quoted in Banyard and Grayson 2000).

ADVANTAGES	DISADVANTAGES
- Rich data about experience	- Bias in what is recorded eg: forgetting events
- Record at time overcomes memory problems	- Reaction to knowing someone will read it
- Study of areas that would be difficult by researcher	- Dependent on level of detail provided by participants
- Useful to study infrequent behaviours	- No independent way of verify self-reports

Table 1 - Advantages and disadvantages of self-reported diary studies.

The study produced 1008 such incidents (922 completed records), which were analysed for the type of face recognition error.

Table 2 lists the categories of face recognition errors found by the researchers.

The types of errors can be divided into five groups (three were evident and two were not found) to support the Information Processing Model:

i) A failure to recognise familiar faces because, for example, the appearance has changed (eg: walking past a person and not recognising them, but told about it later). This was due to a failure at point A in figure 2. This could include "highly familiar" faces (42% of these errors).

ii) Recognition of the face leading to a feeling of

1. Person Unrecognised

2. Person Mis-Identified a. Unfamiliar person mis-identified as familiar person (usually viewing conditions poor) b. One familiar person mis-identified as another (usually celebrities) 3. Person seemed familiar only a. Familiar person successfully identified (eg: acquaintance seen in unfamiliar context) b. Familiar person not identified c. Person found to be unfamiliar (viewing conditions poor) 4. Difficulty of Retrieving Full Details of Person a. Difficulty successfully resolved b. Difficulty not resolved

Table 1 - Types of face recognition errors categorised by Young et al (1985).

FACE \downarrow VISUAL ENCODING \downarrow Α MATCHING PROCESS \downarrow В SEMANTIC INFORMATION \downarrow С NAME RETRIEVAL

Figure 2 - Blockages or errors in the Information Processing Model of face recognition.

familiarity only (eg: couldn't remember where met before). This can be seen as problem at point B in figure 2.

iii) Recognition of the face, feeling of familiarity, and only information about the person recalled, not their name (eg: famous person on television). This is a blockage at point C in figure 2.

iv) There were no cases of recognition and name retrieval without semantic information. This supports the model because individuals cannot go to stage 4 without passing through stage 3 in figure 1. It is not possible to recall the name without any information about the

person.

v) There were no cases of name recall without feelings of familiarity or semantic information about the person. Again this supports the model.

2. Recognition reaction time studies

This type of study measures the reaction time of participants answering questions about famous faces. Three types of questions are asked:

- a) Do you recognise the face?
- b) What information can you recall about them?
- c) What is their name?

Each question will take slightly longer to answer because of the stages involved in finding the information. Question (a) involves stages 1 and 2 in figure 1, question (b) stages 1, 2 and 3, and (c) all 4 stages.

Young et al (1986) found the following average reaction times to answer the three questions: question (a) 775 msecs, (b) 931 msecs, and (c) 1255 msecs 2 .

3. Case studies of brain-injured patients

Situations will occur where individuals have some kind of injury (eg: accident or stroke) which leads to minor brain damage. The abilities that the individuals lose can help psychologists to understand how the brain works. However, these are individual cases, and generalisation of the findings is not possible (table 3).

Brain-injured patients are often studied through the forced-choice test. The task is to say which one of the pair of photographs is familiar. One photograph is a famous face or an individual known to the participant, and the other photograph is a complete stranger.

Evidence from Case Studies:

a) Damage to FRUs (point A on figure 2)

"PH" (De Haan et al 1987), injured in a car

² Interestingly, recall of names of celebrities is more accurate if the celebrities were associated with a particular role (eg: James Bond; Roger Moore) (Bredart 1993).

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ADVANTAGES

- The loss of brain functions show how the brain works, and which areas involved

- Better than deliberately damaging brain of animals, in terms of ethics, applicability of animal models to humans, and the participants can talk about their problems

- Easier to test than with animals

- Modern brain-scanning techniques can pinpoint exact area of brain damaged - Only unusual individual cases and results may not be generalisable

DISADVANTAGES

- Usually no record of behaviour pre-injury for comparison

- Only shows correlation between damaged area of brain and problems

Table 3 - Advantages and disadvantages of using braininjured patients in research.

accident, was able to recognise familiar names, but not familiar faces. The inability to recognise faces is known as prosopagnosia ³.

"PH" was presented with pairs of names (one familiar, one not) and was asked which was familiar: "PH" achieved 118 of 128 correct. Thus there was no damage to the semantic memory. When presented with pairs of faces, "PH" got 51% correct (this is the same as guessing).

b) Problems with semantic information retrieval (point B on figure 2)

"KS" (Ellis et al 1989) sustained damage to his right temporal lobe during an operation on the brain to deal with epilepsy. Only the long-term memory for information about people was impaired, not the general long-term memory for number and words.

c) Problems with name retrieval (point C on figure

"EST" (Flude et al 1989) was able to recognise familiar faces and recall semantic information about the person, but was poor at name retrieval. "EST" was also poor at naming objects, but had no problems with

³ The sufferer is unable to recognise familiar famous faces, individuals known to them, or even themselves in photographs or in the mirror. However, other object and pattern recognition abilities are not affected. This suggests that there are different processes in recognising faces and non-faces.

familiar name recognition. This suggests that name recognition is different to name retrieval for faces.

PROBLEMS WITH INFORMATION PROCESSING MODEL

1. The sequences of familiar face recognition are too rigid.

A direct challenge to the sequences comes from "ME" (De Haan et al 1991), an amnesiac, who could match faces and names for famous people to 90% accuracy, but would recall no semantic information about them. In figure 1, this is going from stage 2 to 4 and missing out 3.

2. The Information Processing Model is also challenged by "covert recognition". This is the correct recognition of faces without any conscious awareness of the recognition process. Individuals with brain-injury which leads to prosopagnosia are presented with photographs of faces. One face is familiar and the other is not. The task is to say which is the familiar face.

Researchers found that individuals will choose correctly even though they claim to have no conscious recognition. In other words, they say that they are guessing, but they guess right nearly every time. Getting half right would be predicted by chance.

Some researchers have argued that there are two routes to face recognition: primary and secondary routes. The former route is conscious, while the latter is at an emotional or unconscious level. Secondary processing links to the idea of the feeling of familiarity. Normally these two routes match (Hayden Ellis 1997).

3. Recognition of a face is linked to where the face was encoded. In other words, a person met in one situation/context is easier to recall in that situation/context (eg: at school), but harder to recall in another context (eg: in the street).

4. Face recognition can also be affected by differences in the situation between the encoding and the recall situations. For example, research shows that different lighting can influence face recognition. Participants had to match the photographs of ten men with video clips in different lighting. There was a 79% accuracy for the full-face, and 70% for the head with a 30 degree angle change (Bruce et al 1999).

5. The exact function and processes of the model are too vaguely specified (Eysenck and Flanagan 2001).

Burton et al (1990) adapted the Information Processing Model to accept that the process is bidirectional between the semantic information store (which now contains the name of the individual) and the Face Recognition Units (FRU) (figure 3). The feeling of familiarity now takes place at the person identity nodes (PIN); ie: the person is recognised rather than the face.

The new model is called an interactive activation and competition model (Burton and Bruce 1993).

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FACE
↓
VISUAL ENCODING
↓
MATCHING PROCESS (FRUS)
↑
↓
SEMANTIC INFORMATION/NAME GENERATION (PINS)
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Figure 3 - Adapted Information Processing Model by Burton et al (1990).

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