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FORENSIC APPLICATIONS OF FACIAL MEMORY RESEARCH

Kenneth R. Laughery and Michael S. Wogalter

Rice University, Houston, Texas

INTRODUCTION

Scenario of a Crime

A phone call came into the police station from a woman reporting she is a clerk at a 7-11 convenience store and had just been robbed by a man with a gun. It was 1:30 a.m. and the store is a few blocks from the station. Two policemen were dispatched to the store and arrived within a few minutes. One policeman interviewed the clerk and got the following descriptive information about the robbery event. A man came into the store alone about 20 minutes earlier. The clerk was finishing waiting on another customer, a young woman, and did not pay any attention to the man. After the woman left the store, the man walked over to the counter and pulled out a gun from inside his jacket and pointed it at the clerk. The clerk reported that he said, "Open the cash register and give me the money". The clerk said that she was "frightened to death of the gun" and was "afraid he was going to do something bad to me." She opened the register and gave him all of the bills (paper money currency), after which he told her to lie down on the floor behind the counter. She then heard him hurry to the door and out of the store. The woman then got up and called the police within a few minutes. The policeman asked if she heard a car start and drive away and she reported no.

When asked about details of the robbery the clerk said he was a black man. "He was kind of skinny and tall, maybe about 6 feet tall." She said she was not very sure of his age but "he wasn't too old, probably in his 20's." She did not think he had a beard, but he did have some hair on his face, like stubble, and needed a shave. She could not describe his hair, and after a pause said she thought he was wearing a baseball hat. She thought he had on a black nylon jacket where the gun had been hidden inside. She could not remember what kind of pants he had on.

When asked about the gun she said it was black and had a short barrel, not more than three inches long. The part that held the bullets was round. The handle on the gun was brown and had some marking, like engraving, on it. When asked, she said he held the gun in his right hand and took the money in his left hand.

The clerk, a 22 year old white woman, had been working at the 7-11 store for three months. This was the first time anything like this had happened while she was on duty at the store.

The following afternoon the woman went to the police station and worked with an Identi-kit operator to make a composite of the man who robbed the store. The procedure took about 30 minutes. At the end the woman described the composite as "not looking exactly like him, but about the best I can do." The composite face had no beard or moustache and included a baseball type hat.

Two days later the woman was again brought to the police station voluntarily to review a photospread. The photospread consisted of 10 photos of black males with an age range of 20 to 35. The black and white photos were front bust views. Three of the faces had modest beards, three had moustaches, and the remaining four were shaved. The photos were from a larger mug file and consisted of men who had been booked for robbery crimes within the past two years and were known to be living currently in the city. The woman was instructed to examine the photos carefully and report if she thought any looked like the man who robbed the store. The photos were laid out on a table in two rows of five. After a few minutes, the woman reported she was not sure but one of the faces (without a beard or moustache) looked something like him. She said a second face also had "some resemblance", but she thought he was "not so likely" as the first. The face in the second photograph had a small moustache. The first man identified was subsequently found to have a solid alibi.

Two months later the man in the second photograph was positively identified as having robbed another convenience store on the previous night. He was arrested and two days later a lineup was arranged to be viewed by the female clerk from the earlier 7-11 robbery. The lineup consisted of six black men with a height range of 5'9" to 6'3" and an age range of 24 to 36. The suspect was 6'2" and 31 years old. The suspect still had a small moustache. Two other men in the lineup had moustaches, one had a modest beard, and the remaining three were clean shaven. Upon viewing the lineup the woman paused for a few minutes and then said she was "pretty sure" the suspect had committed the crime. When asked to look at the six men closely to determine if she was positive, she again viewed them carefully and reported she was "positive". Several months later in court the woman positively identified the accused and said under oath that she was "absolutely certain" he was the person who had robbed the store.

Facial Memory and the Crime

In this chapter we are concerned with forensic applications of facial memory reseach. The scenario described above represents a reasonably common type of crime in the United States - a convenience store robbery. Our purpose for describing it here is that it includes several elements that involve human memory; that is, the memory of the female clerk in the 7-11 store. We will refer to the scenario in identifying some of the facial memory issues associated with eyewitness identification. These forensic issues to which facial memory research may be applied could be classified or organized in several different ways. We have chosen to organize them on the basis of the memory processes and/or procedures involved. Roughly speaking, these processes can be characterized as recognition and recall. It should be noted, however, that the emphasis in this paper is on forensic applications as opposed to the basic nature of facial memory. Forensic procedures will be described. Facial memory research will then be discussed in terms of its implications for the forensic tasks.

There are several forensic tasks used in eyewitness identification situations that resemble the types of recognition procedures employed in research on facial memory. In the scenario these tasks include the examination of the 10 item photospread, the review of the six person lineup, and the identification of the accused in the courtroom. Other recognition procedures often employed in law enforcement are a mugfile search and a showup (a one-person lineup where the expected response is yes or no). The key element of all of these procedures is that a witness is attempting to find a match between the information he/she has in memory about a face and external faces (photo or live) with which the memory is being compared.

There is another category of recognition or matching tasks that takes place in the forensic setting. Often a photograph of the criminal, such as obtained by a hidden camera in a bank robbery, or a facial representation obtained from a witness, such as a sketch or Identi-Kit composite, is available. Such photographs and representations are made available to police or published in newspapers for the purpose of identifying the person.

Forensic efforts that involve recall-like activities generally are aimed at producing one or both of two types of products: a verbal description of a face and/or a hard-copy representation of a face. More precisely, the aim is to get a description or representation of the facial information in an eyewitness' memory. Here, the emphasis is on getting an accurate product. The scenario included at least two examples of recall. The first occurred when the female clerk described the robber to the police officer shortly after the crime. The second recall example was the production of the Identi-kit composite. There are numerous other recall techniques employed in law enforcement for generating hard copy facial images. The sketch artist and the Photofit are two that are reasonably well known and used. Others will be mentioned later.

In actual forensic practice, of course, the recognition-recall distinction is not always so clear cut. For example, most of the techniques for generating hard-copy images involve getting some sort of face representation fairly early in the procedure and then refining the image by making changes. This refining process clearly involves noticing mismatches between the image and memory - a recognition-like task. Another concern is the extent to which the two types of memory procedures influence each other. For example, does the Identi-kit procedure in the scenario influence the subsequent matching process in the photospread and lineup? From the general memory literature one might very well expect such effects. Nevertheless, for the purpose of this paper, the organization around recognition (matching) and recall (production) is useful for analyzing forensic tasks and the applications of facial memory research.

Another topic that has received attention in the facial memory research literature is training. Here the objective is to improve the facial memory of the potential eyewitness so as to be more competent in the matching and/or production tasks. Two recent papers (Baddeley & Woodhead, 1983; Malpass, 1981) have provided reviews and analyses of work in this area. Generally, training efforts have resulted in very little improvement in face recognition performance. One exception to this conclusion concerns cross-racial identification, which will be discussed in a later section.

The above tasks, matching and production, represent areas for applying facial memory research to law enforcement. The objective is to apprehend criminals on the basis of facial information from the memory of an eyewitness. The concern is to make the most effective use of that memory. There has also been research on topics associated with facial memory that are more closely associated with judicial procedures. For example, the effects on a jury of the eyewitness' confidence in the accuracy of his/her memory. In this paper we will not deal with applications of facial memory research to judicial procedures. Two recent collections, Lloyd-Bostock and Clifford (1983) and Wells and Loftus (1984) contain several papers that address these issues. Also, because of the availability of the two recent papers on training, that topic will not be covered here. Rather, the analysis and discussion will be limited to law enforcement procedures that involve memory in matching and production tasks.

Recent years have witnessed a major increase in research activity on facial memory. Several very good books have been published reviewing and summarizing the work and its implications (Davies, Ellis & Shepherd, 1981; Ellis, Shepherd & Davies, 1982; Ellis, Jeeves, Newcombe & Young, 1986; Lloyd-Bostock & Clifford, 1983; Wells & Loftus, 1984). Journal articles and book chapters have appeared that provide an excellent analysis of many of the issues of interest here. In some cases where such works exist, we will forego duplicating the effort and simply call attention to the reference. One such reference (Ellis, 1984) deserves particular mention at the outset. Ellis' purpose in that paper was essentially the same as ours is here; namely, to explore the practical applications of face memory research. We have tried to complement rather than duplicate his efforts. While some overlap is inevitable, anyone interested in this topic will find the Ellis paper of great value.

Methodological Issues and Concerns

Before beginning our discussion of the forensic tasks and facial memory research, it is appropriate to note certain methodological issues and concerns associated with facial memory research as it applies to forensic problems. First, there is virtually a complete absence of field research on the memory performance of actual eyewitnesses. Some observations have been made, but for the most part these have bordered on being anecdotal. There are, of course, difficulties in carrying out field studies. Generally such efforts are limited to descriptive outcomes, since control of potential influential factors cannot be achieved. In addition, the number of such factors or variables is likely to be large, making cause-effect relationships even more difficult to determine. Another important concern in such research efforts is the potentially intrusive nature of the research activity. For example, assessing memory is likely to affect that memory, and in matters as sensitive and important as eyewitness identification, such effects would not be tolerable.

A second point regarding methodology concerns the issue of generalization. Recent years have witnessed a tremendous spurt in the amount of facial memory research. Generally, the research efforts can be characterized as falling into two categories. The categorization is essentially based on the purposes or goals of the research. One category consists of studies oriented towards understanding the performance of the eyewitness to a crime and the factors that influence that performance. These efforts are usually referred to as forensic studies and employ research pardigms intended to parallel or simulate circumstances that occur in actual forensic settings. The second category of studies is those directed towards achieving a better understanding of human information processing in general or facial processing in particular. Most, but not all, such studies are done in the context of an information processing approach. These studies often employ paradigms that bear little resemblance to forensic settings, and they are not intended to. To what extent can the results of basic research on facial memory be applied to forensic issues? For that matter, one may also ask to what extent can the results of laboratory studies using forensic paradigms be generalized to actual law enforcement proceedings? These are not new questions, of course, and they are encountered in virtually every effort to apply research findings to solving real problems. Furthermore, we do not have answers to offer here. A fundamental issue in applying the results of face research to forensic settings is generality/specificity, and such applications should be carried out with full awareness of the limitations.

A third methodological point associated with doing research in this area concerns ethics. Here we are concerned with the limits on what one can and cannot do in research activities of this type. An example will make the point. One of the variables often raised and discussed in this context is the fear or stress associated with being a victim or a witness to a crime and how this fear influences facial memory. In our opening scenario the store clerk reported being "frightened to death." Clearly there are limits on the extent to which one can induce and manipulate fear or stress in a research activity. While such limits are both necessary and appropriate, they do constrain the questions asked and answers obtained in this type of forensic research.

The above methodological issues and concerns are, of course, interrelated. Furthermore, they identify fundamental problems in applying the results of face research to forensic problems. Laboratory efforts are necessarily constrained by ethical considerations, and the research results may or may not be directly applicable to the forensic setting. There are no simple solutions to this problem. Obviously, it is important to be aware that the constraints exist. In addition, however, there is a need to devote more effort to field research in actual forensic settings. We will return to this latter point in the final section.

FORENSIC MEMORY TASKS

In this section we will describe the forensic tasks that involve human memory. As noted earlier, these tasks can be characterized as matching (recognition) or production (recall). As also noted, these categories are often overlapping and unclear. Nevertheless, they serve as a convenient and useful way of organizing and describing the tasks.

Field Matching or Recognition

Facial recognition is an exceptional ability, as evidenced by the number of faces we are able to recognize and the apparent ease with which we do it. The recognition tasks involve matching an internal representation to external records. In forensics, recognition is often called identification.

As noted earlier, the forensic context provides several tasks in which face recognition or matching is involved. These tasks include searching a mugfile, reviewing a lineup, examining a photospread, and identifying (positively or negatively) an individual in a showup or in a courtroom. The mugfile and photospread tasks are essentially the same, differing primarily on the basis of the number of photographs in the set and the manner in which they are presented - sequentially or simultaneously.

Mugfiles and Photospreads

It is a common practice for law enforcement agencies to obtain facial photographs of people when they are arrested for a crime. Often these photographs consist of front and side views. Mugfiles containing such photographs are accumulated over time, and in some circumstances, such as in cities, may become quite large numbering in the thousands. Crime victims and witnesses are frequently asked to search through these files, or at least a subset, in an effort to identify the person who committed the crime. The criminal, of course, may or may not be in the file.

In law enforcement, preliminary verbal descriptions are usually obtained from a witness. The clerk in our scenario initially provided a verbal description of the robber to the police officer. This descriptive information may be used to limit the size of the mugfile in various ways. For example, many files are organized on the basis of race and sex. If the target person is a white female, only the subfile will be searched. Generally, the search task will be much more constrained than this example implies. Other information such as type of crime, perhaps a sexual offence, may serve to organize the file and thus limit the search. In the scenario the photos in the photospread were from a larger mugfile and consisted of men who had been booked for robbery crimes in the past two years and were known to be living currently in the city.

The actual search procedure may vary. The witness may look through a stack of photographs one at a time in a linear search. The photographs may be presented in a booklet or album with several to a page. The photospread procedure involves presenting the set simultaneously, perhaps laying them out together on a table to be scanned and compared. The clerk in the scenario examined a 10 item photospread. Specific equipment has also been developed and is in use in some law enforcement agencies enabling faces to be presented on a viewing screen and accessed directly or sequentially. All of these mugfile/photospread procedures are recognition tasks, where the witness is attempting to find a photograph in which the face matches the face in his/her memory.

Lineups

The lineup or identity parade is a live simultaneous presentation of some number of people, typically about six, that may or may not contain the target person. The witness views the lineup members in an effort to determine whether any of them match his/her memory for the target face - a recognition task. In this procedure information other than the face may also be used, such as physical characteristics (height) or perhaps even voice. The clerk in the robbery scenario participated in the lineup task two months after the event. It should be noted that this particular recognition or matching task was not the first such effort, as she had earlier done the photospread task. Such procedures are common in law enforcement, but they raise serious questions about the effects of the first task on performance in the second. We will discuss this issue further in a later section.

Two papers by Malpass and Devine (1983, 1984) and a book by Shepherd, Ellis and Davies (1982) provide very good reviews of photospread and lineup procedures and factors that influence the outcome of such procedures. The 1984 paper by Malpass and Devine also explores some of the methodological issues associated with doing research that is applicable to these forensic tasks.

Individual Identifications - The Showup and the Courtroom

Another common recognition procedure is the situation where a suspect is presented alone; no decoys (distractors) are present. The witness makes a yes or no decision. The showup is such a procedure, as is the courtroom identification. Invariably, the identification in court has been preceded by one of the other identification tasks, and is subject to concerns about the effect of one memory task on another.

In the scenario the clerk had participated in both photospread and lineup procedures prior to the courtroom identification. Such circumstances are not uncommon in actual practice.

FACIAL PRODUCTION OR RECALL

While facial recognition would seem to be a quite good human ability, facial production or recall appears to be quite the opposite. By most criteria we seem to be rather incompetent when it comes to generating verbal descriptions or hard-copy representations of faces. It is not clear, however, to what extent the limits on the quality of representations are the result of limited competence in people or limitations in the techniques.

We have categorized the face production or recall tasks that take place in forensic settings into verbal description and generating hard-copy representations. This distinction breaks down in one important respect; namely, most of the techniques for generating a facial image of a target person also involve verbal description of the face. Nevertheless, the categories are useful for organizing the forensic tasks and considering the effects of various research findings.

Verbal Description

The first memory task performed by the 7-11 clerk in the scenario was to describe to the police officer the characteristics of the robber. This description included some facial information. It is probably a relatively rare exception that a victim of or witness to a crime is not asked to describe what he/she remembers about the criminal's face. Indeed, it is likely that such descriptions will be repeated on more than one occasion in the course of a criminal investigation, including shortly after the crime has occurred when there is still a good deal of stress being experienced. Research on verbal description of faces has been reviewed by Davies (1983) and Laughery, Duval and Wogalter (1986).

Generating Hard-Copy Representations

There are a variety of techniques employed by law enforcement agencies for obtaining a visual representation of a target person's face. Several good reviews by Davies (1981, 1983, 1986) have addressed performance in such tasks. The three most widely employed and researched procedures are the sketch artist, Photofit and Identi-Kit. Each of these procedures involves the witness working with another person, an artist or technician/operator, to construct the face. The witness' task includes an ongoing verbal interaction with the artist or technician during which the face or parts of the face are being described. The Photofit and Identi-Kit involve the selection of individual facial features which are put together to form a composite face. Feature exchanges are then made to improve the match between the composite and the face in memory.

There are other less commonly used devices that have been developed for constructing facial images from memory. The Minolta Montage Synthesizer (Duncan & Laughery, 1977) was developed and used in Japan for creating facial images from photographic features. Davies (1986) describes a new device, the Magnaface, that is used to produce a composite in colour. While we are not certain about the Magnaface procedure, it is our understanding that both of these techniques involve verbal description and working with a technician to create the composite. The Field Identification System (Laughery, Smith & Yount, 1980) is a procedure that enables a witness to construct an image without the involvement of a second person. It consists of a book-like device with four sets of horizontal page strips, each strip set containing examples of facial features. The witness selects an appropriate strip from each set resulting in a composite face. No verbal description is involved in this procedure.

As noted earlier, the distinction between recognition and recall is not nearly so clearcut in the facial construction tasks. Virtually all the techniques except perhaps the sketch artist entail initially producing a full face composite and then making feature changes to achieve a better representation. This refinement process clearly includes a process of matching the current composite version to the face representation in memory.

FACIAL MEMORY RESEARCH: IMPLICATIONS FOR FORENSIC PROCEDURES

In this section we will discuss some of the research on facial memory and its implications for forensic procedures. We will be selective in at least two respects. First, the focus will be on research that has implications for the issues encountered in the forensic setting. Obviously there is a great deal of judgement in deciding what is most relevant, and others would undoubtedly cite studies that we do not cite and vice versa. Secondly, as we have already pointed out, there are a number of recent publications that deal with specific questions or issues of this sort, and in most instances we will not attempt to duplicate those efforts.

The analysis is organized around some major components of the forensic tasks. Specifically, three sections will address the exposure and forensic task situations, post-exposure processing, and person (target/ witness) factors. We have chosen this organization rather than specific tasks such as lineups, mug file searches or composite productions because the specific forensic tasks have various components in common and this organization is more efficient.

Exposure and Forensic Task Situations

The circumstances of viewing a target at the scene of a crime are invariably different from the conditions when the witness again confronts the target in the forensic matching task. These differences may be in the witness, such as stress level, in the actual physical appearance of the target person, or in some other aspect of the situations. Similarly, there may be differences between the target face in the photographs or composites shown to police or to the public and the actual target face when encountered later. What are the effects of these differences? In this section we will discuss the implications of existing facial memory research in regard to these issues.

Target face changes

What happens to identification accuracy when the target undergoes some change, transformation, or disguise (e.g. changes in expression, orientation and pose, hair-style, and presence or absence of accessories)?

<u>Formats at exposure and test:</u> Typically, the witness encounters the criminal live. In subsequent matching tasks the suspect and decoys may

appear live, as in lineups, showups and courtrooms, or in static photographic form, as in mugfiles or photospreads. The clerk in the robbery scenario encountered the suspect and decoys in both live and photographic form. A few law enforcement agencies have experimented with dynamic representations such as brief video recordings for their files and used these in the identification task. A static-to-live procedure is where the police and the public are shown a photograph or composite for the purpose of identifying the live críminal. In the composite production task the witness attempts to create a static representation of the target face. A number of research efforts have addressed the effects of these format differences on performance in the identification tasks.

Shepherd, Ellis and Davies (1982) exposed subjets to target faces that were presented either live, in colour video, in multiple colour photographs, or in multiple black-and-white (B&W) photographs. Subjects were told their task was to listen to a 2-minute life story and to judge its truthfulness. Subjects were tested two weeks later with lineups of live, video, colour photographs or B&W photographs. Live presentation exposure was found to lead to significantly better identification performance than the other modes. Lowest performance came from those subjects who were initially exposed tothe target in the photographic form.

Egan, Pittner and Goldstein (1977) found that after several retention intervals (2, 21 or 56 days) live faces are better recognized than photographs at test when subjects had seen live faces at study. In addition, Davies, Ellis and Shepherd (1978b) found that line drawings are not so recognizable as photographs.

Since colour photographs may provide a dimension of information nonexistent in B&W, Laughery, Alexander and Lane (1971) and Laughery (1972) examined whether recognition performance would be enhanced by the use of colour compared to B&W photographs at test. The results showed that not only was the hypothesis of colour photographs over B&W unconfirmed, there was almost the exact same performance in both conditions.

Sussman, Sugarman and Zavala (1972) tested a similar hypothesis. Subjects were initially shown a film depicting an event in a department store, and upon its completion were asked to remember one of the characters. One hour later subjects were tested with the target embedded either in B&W video tape sequences,in colour slide pairs, or in B&W slide pairs. The results showed that the B&W video sequences provided better identification performance than the colour slides, and the difference between colour and B&W slides was marginal ($p < .1$ with a two- tailed test). From these results, Sussman et al. (1972) suggested that adding information at test (such as accompanies movement) aids identification.

If greater amounts of information lead to better recognition performance, then in general, photographs should be better recognized when presented in colour than in B&W. On the other hand, the theoretical notion of encoding specificity would make a somewhat different prediction: B&W portraits will be better recognized at test when pictures are studied in B&W than if they were studied in colour. Wogalter and Laughery (in press) examined facial recognition with presentation of B&W versus colour photographs at study and at test. Performance was highest when photographs remained in the same mode from study to test than if the mode was changed. These results provide some support for encoding specificity.

However, encoding specificity does not have any prediction regarding a difference between 'changed' conditions; that is, when a colour photograph at study is changed to B&W at test, vs when a B&W photograph at study is changed to colour at test. Is there an asymmetry? The results indicated that faces studied in B&W and then tested in colour reduced recognition performance more than study in colour and test in B&W. These results seem to indicate that greater information at test can hurt recognition in some circumstances.

Pose: The standard mugfile consists of two poses, a front view and a side view. How is matching performance affected by the pose position? Are there other views that would lead to better performance, such as a three-quarter pose? Several research efforts have addressed these questions.

Davies, Ellis and Shepherd (1978b) presented full and three-quarter face views of targets and then either presented the faces in the same or the other pose in the recognition task. They found no difference in whether the poses were switched or maintained. Laughery, Alexander and Lane (1971) also found no effect of changing pose from frontal full-face to three-quarter or vice versa compared to no transformation. Krouse (1981) has suggested that the lack of measures that correct for false alarm rates may have promoted the null finding in the above studies. Other research has yielded pose-change effects. Baddeley and Woodhead (1983) presented two or three views of faces and tested for recognition with full, three-quarter, or profile views. They found that reinstating the poses at test that were presented at study provided the best performance. Transformations of 45 degrees (frontal to three-quarter, profile to three-quarter, or vice versa) were the next best. Changes of 90 degrees (full to profile, and vice versa) yielded the poorest performance. Baddeley and Woodhead (1983) suggest that the three-quarter pose allows one to gain more information about the face. This study as well as other research suggests that the three-quarter pose contains more information than the frontal pose, and the profile contains less than the frontal (Patterson & Baddeley, 1977; Krouse, 1981).

Accessories: There may be differences in the appearance of a target person between the time of the crime and the time of the matching task. These differences may be of the type referred to as accessories, which include glasses, hair-styles, beards, moustaches, a hat, etc. These may be intentional, such as disguises, or they may be less planned and simply occur with time. The time lapse between the crime and a subsequent identification may be quite long, several months is not uncommon. In the robbery scenario the clerk did not encounter the lineup until two months after the crime, and the courtroom identification occurred several months after that. Time differences in the mugfile and photospread tasks may be much longer in a reverse sense; namely, the photographs may have been taken well before the crime, perhaps several years. In such cases differences due to age, weight changes, and so forth may even become relevant.

Several studies have examined the effect of changing accessories between exposure and test (e.g. glasses, facial hair). Baker (1967) found that the addition of glasses to an Identi-Kit composite hurt recognition more than the addition of a moustache. Laughery and Fowler (1977) reported that regardless of the direction of change, wigs and beards decreased recognition more than glasses. Patterson and Baddeley (1977) found that the addition of glasses alone had little effect on recognition accuracy, but the addition of glasses plus a change in orientation hurt recognition.

Other factors and other research: Other research has examined the effects of other face-change factors on recognition. Galper and Hochberg (1971) did not find an effect of expression change from study to test. Performance was fairly high regardless of expression changes. However, Bruce (1982) has shown that changing from a smiling to an unsmilling face decreased recognition accuracy. In addition, expression and pose interacted showing a large decrease in accuracy when both changes were made.

Often experiments on face memory use just a single view (a picture) of the target. Viewing the target in multiple orientations allows generalization to other variations of the target's face, which leads to better recognition when the target is shown in a new pose (Dukes & Bevan, 1967). Familiar faces are easier to recognize despite transformations, presumably because familiar faces are well represented in memory - needing a less informative view at test to trigger recognition (Ellis, Shepherd & Davies, 1979; Ellis, 1981).

Context differences

The effect of change in context at exposure and at identification is related to the effects of face changes. We have seen that face changes between exposure and identification reduce recognition performance. A similar effect has been found for context changes.

Bower and Karlin (1974) attempted to examine the effect of context on recognition memory for faces. Pairs of faces were presented. At test pairs of faces were either the same, one face of the pair was deleted, or there was a different face paired with the target face. No context effect was found regardless of whether the faces were tested together, alone, or paired with a different face. On the other hand, Watkins, Ho and Tulving (1976) and Winograd and Rivers-Bulkeley (1977) have found support for contextual effects. Watkins, Ho and Tulving (1976) showed that reinstatement of a paired face or a descriptive phrase at test increased recognition. Winograd and Rivers-Bulkeley (1977) showed that recognition was enhanced following compatibility ratings of male-female pairs when the target face was accompanied by its study partner at test. In addition, a change of room from study to test has been shown to reduce recognition (Brown, Deffenbacher & Sturgill, 1977).

In another approach to reinstatement of context, Malpass and Devine (1981b) exposed subjects to a staged act of vandalism, and after an interval of five months, witnesses were recalled for a photo lineup. One group of witnesses were given guided recollection instructions to recall the setting they were in at the time of the incident, to visualize the room, their neighbours and the act and appearance of the vandal. Another group did not receive guided recollection instructions. The hit rate was greater for the group that mentally reinstated the context of the original incident. A similar effect has also been shown using hypnosis (Timm, 1981). Davies and Milne (1985) examined the effects of physical reinstatement (same vs different room) and mental reinstatement of context (instructed guidance vs spontaneous recall) on Photofit likenesses. They found that guidance increased the quality of likeness and to a lesser extent physical reinstatement of context (room) did also.

Although some of the effects reported here may be more related to shifts in response criterion than to memory sensitivity, the effect of context change appears to be an important factor in face memory. Ellis (1984) in his review of the face context literature suggests that more research needs to be done when there is a substantial change of context, such as the change from incident to police lineup. We strongly agree that such research would be useful in assessing context effects and in suggesting ways that forensic procedures might take them into account.

Processing factors

What the victim or witness does in the way of processing information about the criminal's face at the time the crime is committed is obviously going to be a factor in subsequent memory performance for that face. The issue here is not simply whether or not the witness ever looks at the face, but also how he/she thinks about or deals with that facial information.

Research and theory dealing with some aspects of encoding processes have employed the concept of depth of processing. Though most of this work has dealt with verbal materials, some of the techniques and ideas have been applied to faces. Problems that have been cited in the verbal learning literature regarding the explanatory and metaphorical nature of the phenomenon are also applicable to research with facial stimuli (e.g. Baddeley, 1978). In this paper we will not address the issues of depth of processing reasoning; rather, the results of experiments using the methodology will be presented in terms of what effects the variables have on face memory.

Much of the depth of processing work examined the effects of making orienting judgements of faces that direct subjects towards the face as a person vs the face as a visual stimulus. Most of the research indicates that making abstract facial judgements leads to better recognition performance than physical judgements. This effect has been examined in many experiments with a variety of orienting tasks. Warrington and Ackroyd (1975) reported that judgements of pleasantness led to better performance than judgements of facial height. Winograd (1976) found that personality trait and occupational stereotype judgements led to better face recognition than judgements of physical characteristics, with the exception of the heaviness judgements. Patterson and Baddeley (1977) reported that trait judgements led to slightly better recognition performance than facial feature judgements. Bower and Karlin (1974) and Strand and Mueller (1977) found that recognition memory was better if faces were judged for likeableness or honesty than judgements of gender. Mueller, Carlomusto and Goldstein (1978) found that body-type inferences did not differ from personality trait judgements, and both of these judgements were better than rating physical features of faces.

Judgements of abstract personality characteristics may increase the number of features of the face that subjects examine; and conversely, the judgement of features may restrict scanning. When subjects look at all facial features with the instruction to find the most distinctive feature, recognition is almost as high as judgements of personal traits (Winograd, 1978; Courtois & Mueller, 1979). Generally the differences reported here for depth effects are small, but appear to be reasonably reliable across experiments.

The studies cited above employed a recognition paradigm, and indicate that a witness is likely to be more successful in the various forensic matching tasks if he/she has processed the facial information in a way that might be characterized as person oriented or wholistic. Different results have been reported, however, in research in which subjects produced a facial composite. Wells and Hryciw (1984) used Identi-Kit composites as stimuli and had subjects either do a series of trait judgements or physical feature judgements. Subjects then either constructed an Identi-Kit composite of the face or did a recognition task where the materials were composite faces. The trait judgements led to better recognition performance, but the physical feature judgements resulted in better composite likenesses. Similar results using face production tasks, sketch artists and the Identi-Kit, were reported by Laughery, Duval and Wogalter

(1986). A cluster analysis was used to categorize subjects on the basis of reported strategies for encoding a target's face during a live exposure. Two resulting clusters were labeled wholistic processors and feature processors. The results indicated that performance in the production tasks was better for subjects characterized as feature processors.

A further demonstration that the processing at exposure affects facial memory comes from a study by Shepherd, Ellis, McMurran and Davies (1978). Subjects viewed a male face that was labelled either a lifeboat captain or a multiple murderer. Subsequently Photofit constructions produced by these subjects were judged for various qualities by another group of subjects. The ratings for the two sets of Photofits were found to differ according to the qualities of intelligence and attractiveness. This result suggests that face memory representations can also be affected by irrelevant attributions.

Another relevant question concerns whether the awareness of a subsequent test or intention to remember affects facial memory. No difference between intentional vs incidental instructions has been reported for facial recognition (Bower & Karlin, 1974; Chance & Goldstein, 1976; Light, Kayra-Stuart & Hollander, 1979; Strand & Mueller, 1977). However, Brown, Deffenbacher & Sturgill (1977) and Deffenbacher, Brown and Sturgill (1978) have found that accuracy in face identification is lower when witnesses were not aware that a 'laboratory crime' was occurring at the time. In general, the effects of awareness or intention have not been robust in the laboratory.

Arousal and stress

Certainly it is reasonable to assume that at the time a crime is committed most victims and witnesses experience some increased level of arousal and stress. Similarly, while the forensic task may also lead to heightened arousal and stress, it is likely that the level is less than during the crime event. How does the level of arousal and stress during the crime affect encoding of facial information? Do differences in arousal and stress levels during the crime and during the forensic tasks influence matching or production performance?

These are important research questions and they have important practical implications. A good deal of research addressing these issues has been carried out to date. Deffenbacher (1983) has provided a very good review and analysis of this research, and we will not attempt to duplicate his efforts. His basic conclusion is that an apparently wide range of results on these issues can be understood in the context of the Yerkes-Dodson Law. The Law states that facilitation or interference in performance will occur depending on the level of arousal. The relationship is an inverted-U function where moderate arousal provides better performance than either lower or higher arousal.

It should be noted that research in this area is not easy. As discussed earlier, the manipulation of arousal and stress in a controlled experimental paradigm is severely and appropriately limited by ethical considerations.

Implications for forensic procedures

There is a clear message that comes from most of the work on the effects of facial changes and context changes between the initial exposure and the subsequent identification. Not surprisingly, the message is that change lowers performance on the identification task. Regarding face changes, the implications are that forensic procedures, where possible, should attempt to minimize these differences. Mugfiles and photospreads would benefit from colour photographs, multiple poses, and efforts to use photographs that are as up-to-date as possible. The use of dynamic representations such as video recordings would be expected to improve the utility of the files. Consideration might be given to adding or deleting accessories to faces in the files where initial verbal reports from a witness indicate such changes are appropriate. It may be important to minimize the time between exposure and identification tasks. The point here is that the passage of time increases the probability that facial changes will occur. (It is possible that time may also affect the witness' memory for the face, an issue we will address shortly).

The work on context effects indicates that guided instructions to recall the setting in which the crime took place may improve witness performance in the forensic tasks. Presumably, where circumstances permit, it may even be worthwhile to recreate the setting, perhaps by returning to the scene.

The research on processing at exposure may have implications in the area of training potential witnesses - bank tellers, convenience store clerks (such as the girl in our scenario), and so forth. Previous training efforts (Baddeley & Woodhead, 1983; Malpass, 1981) have focussed on feature analytic procedures without much success. The research reviewed here suggests training procedures that focus on wholistic processing or encoding are more likely to lead to better recognition performance. Another implication might be to attempt some sort of initial assessment of what kind of processing the witness did at the time of the crime and take that information into account in deciding which forensic procedures to employ or what confidence to place in the results. For example, wholistic processors might be directed towards forensic matching tasks, while feature analyzers may be more useful in producing facial constructions. We are aware of no research to date that directly addresses the potential for such an approach, although the Wells and Hryciw (1984) results certainly point to the potential of such procedures.

There are ways in which research results on arousal and stress can potentially be applied to forensic procedures. For example, efforts could be made to minimize the stress associated with the forensic task itself. Attempts might be made to assess the stress associated with exposure to the crime. On this latter point, it may be possible to assume very high stress levels for certain categories of crime such as rape or murder and base the procedures on these assumptions.

Post-Exposure Processing

We have already pointed out that a good deal of time may elapse between the crime event and the forensic tasks. Furthermore, as was the case in our convenience store scenario, the witness may be involved in a series of forensic tasks. How does the time elapsed influence performance on matching or production tasks? How does the participation in one of these tasks affect performance on subsequent tasks? In the scenario the clerk worked with an Identi-Kit technician to construct a facial composite and two days later examined a photospread. Does the construction task facilitate performance in the identification, does it interfere, does it matter? In this section we will address these questions.

Retention interval

A number of research efforts have addressed the effects of the passage of time on recognizing a previously encountered face. Chance, Goldstein and McBride (1975) found no difference in identification between immediate testing and a 48 hour delay. In other studies, no effect was found between immediate testing and a 2-day interval (Goldstein & Chance, 1971) or a one week interval (Laughery, Fessler, Lenorovitz & Yoblick, 1974). Deffenbacher, Carr and Leu (1981) not only found no recognition loss from two minutes to two weeks but in some cases found a small improvement. Shepherd and Ellis (1973) found no effect of a week's delay. However, they did note an interaction of attractiveness and delay. After 35 days recognition performance decreased for faces rated moderately attractive but did not change for faces that were rated least and most attractive.

Other research has found facial memory decreases with delay. Davies, Ellis and Shepherd (1978b) reported that with short duration presentations (250 ms) at study, recognition memory for a single face decreases over a 3-week interval. Krouse (1981) using police officers as subjects, found deterioration of identification accuracy over a few days following exposure. Shepherd (1983) examined identification performance for an unexpected staged event at delays of 1 week, 1 month, 3 months and 11 months. Despite a steady decline with delay, only the 11 month retention interval difference was statistically significant. The miss rate (failure to select the target) increased at the 11 month interval, while the false alarm rate did not differ at any delay. Malpass and Devine (1981a) staged an unexpected act of vandalism and reported that after a delay of five months compared to a 1-3 day delay, the hit rate decreased and the false alarm rate increased. Egan, Pittner and Goldstein (1977) using delays of two days, 21 days and 56 days found the false alarm rate increased with delay but there was no change in the hit rate.

Interestingly, several experiments have noted facial recognition improvement with increasing delays. This phenomenon, reminiscence, has been reported in several experiments. Milner (1968) found recognition improved with a 90 second delay compared to an immediate test. Wallace, Coltheart and Forster (1970) found face recognition increased from an immediate test to 45 second study-test interval. And, as noted above, Deffenbacher et al. (1981) found a small recognition improvement in some circumstances.

Deffenbacher (1986) has attempted to sort out these apparently inconsistent research findings. He has pointed out that the data can be described by a power or exponential function where the rate of loss increases with time.

Faces intervening between exposure and test

In virtually all forensic situations other things go on beside the passage of time between the initial encounter with the criminal and a subsequent matching or production effort. One intervening experience is seeing other faces. These faces may merely be other people with whom the witness comes into contact, they may be other faces in the forensic tasks, or both. A forensic task example would be the faces in the mug file search that precede the target face (if in fact the target face is there). Do these intervening faces have a negative influence on identification?

Laughery, Alexander and Lane (1971) and Laughery et al. (1974) found identification accuracy decreased as the number of intervening faces increased and as the faces were more similar to the target face. Davies, Shepherd and Ellis (1979a) reported that searching through intervening faces decreased both hit rate and false alarm rate. Deffenbacher, Carr and Leu (1981) found that inspection of interpolated faces decreased hits but had no effect on false alarms. They also found that a two-week delayed presentation of the interpolated face set produced a smaller effect than when presentation of the set immediately followed exposure to the target.

Brown, Deffenbacher and Sturgill (1977) exposed subjects to live targets and then had them examine a photospread that sometimes contained the target and sometimes not. A week later subjects returned and were confronted with a live parade that sometimes contained the target and sometimes a nontarget that had been shown in the earlier photospread. They found that nontarget faces seen in the photospread were just as likely to be selected as target faces not exposed in the photospread.

In a related study on the confusion effect - one that could just as well have been discussed in the section on exposure factors - Loftus (1976) found that a face may be wrongly selected if it was exposed near in time to the event. Subjects were given a description of several individuals as their photographs were shown. One of the six pictures contained the suspect. When a 'bystander' face was present in a lineup with new faces it was often identified as the target.

In the previous section, evidence was presented suggesting that increasing the retention interval up to several weeks and perhaps two or three months produces little or no effect on recognition memory. Since it is likely that a witness would see many people's faces on a social basis during such an interval, a negative effect on recognition would be expected. Contextual similarity may play a role in this phenomenon. John Shepherd (Ellis, 1984) has suggested that the more similar the context of the intervening situation to the original encounter, the greater the interference. Conversely, the more different the situations, the less interference.

Generally, however, the research results indicate that exposure to other faces between the crime and the identification task has a negative effect. It appears that subjects may confuse a nontarget face with the target face and make wrong selections - an important and undesirable outcome.

Face rehearsal

Seeing other faces in natural settings or as part of a forensic task is not the only type of post-exposure processing of faces that goes on. In the robbery scenario the clerk engaged in at least two forensic tasks between seeing the criminal and examining the photospread; she verbally described the person to the police officer and she worked with a technician to construct an Identi-Kit composite. Almost certainly both of these tasks involved some sort of visual imaging of the face - thinking about what he looked like. Several research efforts have explored the effects of these kinds of intervening activities on subsequent identification.

Phillips (1978) has demonstrated that 90% of the subjects in a study could image a face picture 20 minutes later. Graefe and Watkins (1980) have also demonstrated that facial images can be effectively rehearsed. Read (1979) has shown that mentally rehearsing facial images improves recognition relative to other post-presentation tasks.

A few studies have examined the effects of producing a sketch or composite of a face on subsequent identification. In an informal followup to a study on sketch and Identi-Kit procedures, Laughery and Fowler (1977) found that recognition was very high, virtually perfect, 6-12 months after the constructions were completed. Mauldin and Laughery (1981) and Wogalter, Laughery and Thompson (1986) found that recognition was facilitated by an intervening construction. On the other hand, Hall (1977) found a decrease in identification performance for subjects who had worked with artists to construct a sketch of the target face. A third study by Davies, Ellis and Shepherd (1978a) showed no effect of Photofit constructions on subsequent recognition. Obviously, the results of these studies paint a less-than-clear picture.

A final question here concerns the effects of verbally describing a face on later identification. Wogalter et al. (1986) report two experiments in which a verbal description of a target face had no effect on subsequent recognition. Mauldin and Laughery (1981) had subjects complete an extensive verbal checklist of facial feature descriptors after exposure to a target face. A positive but not statistically significant effect of this task on subsequent recognition was found. Wogalter et al. (1986) found that a verbal descriptor checklist had a negative effect on later recognition. These results reflect no clearcut pattern.

There are some possible explanations as to why verbally describing a face, which might be regarded as a form of rehearsal, does not facilitate subsequent identification. One possibility is that people are simply not good at this particular verbal task, and the verbal code being generated and rehearsed is not helpful. A second possibility may be that success on facial recognition tasks is more a function of wholistic representations of facial information, and verbal descriptions tend to be feature oriented.

Implications of post-exposure processing research results

What do the results of these various research efforts tell us about the forensic tasks? Certainly this is an important question, since as illustrated by the robbery scenario a variety of forensic memory tasks are commonly employed over a substantial period of time between the crime event and the final decision in the court. Of the various intervening activities and events studied, one clearly seems to be important; namely, the number and similarity of faces encountered by the witness in carrying out the matching tasks. The implication of this research is that efforts should be made to reduce the size of the mugfiles before the matching task is begun. Sex, race and type of crime are factors currently employed for this purpose. It may be worthwhile to consider other potentially useful factors for culling files.

Perhaps of even greater concern is the possibility of false alarms resulting from exposure to a decoy face in one of the early forensic tasks. In the robbery scenario the clerk noted a second face in the photospread that had some resemblance to the target but was not so likely as the first face. In each subsequent matching task, the lineup and courtroom, the witness was increasingly confident of her identification. The research results provide a basis for concern about the effects of sequencing procedures in this fashion. We will return to this point in the general discussion.

While the evidence seems to indicate that time delays of many weeks or months result in poorer performance, it is interesting to note that time delays of the order of several weeks or less do not have much effect on identification. These results suggest some forensic tactics. First there may be no reason to rush the identification or production tasks. Care can be taken to construct photospreads and lineups or to arrange other procedures without having to worry about memory losses. Second, in situations where the witness or victim has experienced a great deal of stress, time need not be a constraint in dealing with the stress problem before attempting the forensic tasks.

Person Factors

A great deal of research on facial memory has focused on factors that are person oriented - characteristics of the witness and target. While such factors cannot be manipulated in the design of forensic tasks, an awareness of their potential effects can be important.

Cross-racial factors

Considerable facial memory research has been done on cross-racial effects; that is, racial differences between the witness and the criminal. Most of this work has been carried out using Blacks and Whites, although some research has included Orientals. Two recent papers, Lindsay and Wells (1983) and Brigham and Malpass (1985), have provided very good reviews and analyses of the research. Consequently, we will discuss this topic only briefly.

Generally, people can distinguish faces of their own race better than faces of other races. This has been termed the own-race bias or cross-racial effect. A number of studies provide support for a complete or nearly complete crossover interaction using Black vs White subjects and target faces (Brigham & Barkowitz, 1978; Brigham, Maas, Snyder & Spaulding, 1982; Shepherd, Deregowski & Ellis, 1974). Chance et al. (1975) have shown that Japanese vs Caucasions also display the cross-racial effect. Other studies have not reported a complete crossover interaction using Black vs White subjects (Brigham & Williamson, 1979; Cross, Cross & Daly 1971), and some have reported no crossover (Brigham & Barkowitz, 1978; Luce, 1974; Malpass & Kravitz, 1969).

Bothwell, Brigham and Malpass (1985), reported in Brigham and Malpass (1985), carried out a meta-analysis in which they examined the size of the differences in performance in identifying own and other race faces from 14 studies. This analysis supported the conclusion that Whites and Blacks better recognize own-race faces than other-race faces.

Shepherd (1981) reviewed the research to determine whether prejudice can account for the crossover effect. He concluded the evidence on this question is weak. The reason most often given for own-race bias is that through greater experience with members of one's own race, greater knowledge of within-race variation is acquired. Presumably, for other races some of the important information cues for distinguishing within-race differences are different and are not so well acquired by other-race members. Thus, members of the other race may not pay attention to relevant distinguishing features. With greater exposure to other-race members, the cross-racial effect should disappear. Indeed, local racial integration moderates the cross-racial effect, increasing recognition performance for cross-racial faces (Cross et al., 1971; Feinman & Entwistle, 1976; Shepherd et al., 1974). For example, using white convenience store clerks in a study, Brigham et al. (1982) found a small but significant relationship between cross-racial face recognition ability and self-reported cross-racial experience.

On the other hand, some research has shown no significant relationship between recognition accuracy and self-reported cross-racial experience (Brigham & Barkowitz, 1978; Luce, 1974; Malpass & Kravitz, 1969). According to Brigham and Malpass (1985) the interracial experience explanation has been shown to be supported only weakly by research. They suggest that investigators need more refined measures of the nature and quality of contact.

Can training improve face memory skills so that the cross-racial effect disappears? Malpass, Lavigueur and Weldon (1973) found that training can improve white subjects' identification of Black faces up to a level equal to White faces. Lavrakas, Buri and Mayzner (1976) also found that with training White subjects' identification of Blacks improved to a level equal to that for White faces, but the effects of the training did not survive long. Elliott, Wills and Goldstein (1973) found that with training White subjects did as well as on Oriental faces as White faces.

Lindsay and Wells (1983) argue that because only a few published cross-racial studies employed a forensic paradigm, conclusions characterizing the cross-racial eyewitness as less accurate are premature. The most consistent finding in this area is that White witnesses identify White faces with the highest accuracy. The other-race effects are less consistent across studies.

Lindsay and Wells (1983) have also questioned whether cross-racial differences are important. Interestingly, they argue that cross-racial lineups provide better diagnosticity than same-race lineups when using the forensic paradigm. Diagnosticity (Lindsay & Wells, 1980; Wells & Lindsay, 1980) is a measure of identification accuracy; it is the ratio of identifications of a suspect when the suspect is the actual criminal to the identifications of the suspect who is not the criminal. They have demonstrated that diagnosticity of a lineup increases with increased similarity between the lineup decoys and the suspect - in spite of the fact that accurate identifications of the guilty person were reduced. They argue that cross-racial identifications from lineups are better than same-race identifications and they are more fair because the members appear more similar. The criminal that was actually seen by the eyewitnesses will continue to draw a relatively large proportion of choices compared to decoys who simply resemble the criminal. Data to support this argument are provided by Lindsay, Wells and Rumpel (1981) in which same-race subjects made slightly more hits but also made more false alarms to others who resembled the suspect.

Unique physical appearance

Faces differ in how well they are remembered. What are the characteristics or properties of a face that influence its memorability? A number of research efforts have addressed this question.

Peters (1917), cited in Ellis (1975), found that faces that had been rated for pleasantness were recognized more frequently if they were on the extremes of this scale than if they were rated intermediate. Since then, there has been additional research on this topic with faces rated on attractiveness (Fleishman, Buckley, Klosinsky, Smith & Tuck, 1976; Shepherd & Ellis, 1973) and beauty (Cross, Cross & Daly, 1971). Faces which depart from a medium or neutral value on attractiveness are more likely to be recognized than faces rated at the medium level. Furthermore, an interaction of attractiveness and delay has been found by Shepherd and Ellis (1973) where memory was found to deteriorate faster for faces of moderate attractiveness than faces of high and low attractiveness.

Shepherd (1981), in a review of this literature, suggests that the evidence points to distictiveness (or atypicality) rather than attractiveness. Attractive and unattractive faces are very distinctive. Research on typicality (or atypicality) has used faces defined by ratings of usual to unusual in appearance (Light, Kayra-Stuart & Hollander, 1979) and high vs low uniqueness (Going & Read, 1974). Higher recognition was found for atypical (unusual, unique) faces.

In an identification task distractors will differ in how often they produce false alarms. Davies, Shepherd and Ellis (1979b) found that distractor faces previously determined to be similar by a cluster analysis were responsible for most false alarms. Also, atypical distractors are less likely to be false alarmed (Courtois & Mueller, 1981).

Age

Since recent reviews (Carey, 1981; Yarmey, 1984) have covered much of the facial research concerning age differences, only a few important studies will be briefly mentioned here. Carey (1981) concluded that face encoding performance increases from 2 to 10 years old. At 8 years, children are very bad encoders of unfamiliar faces, but by age 10 they are approaching the performance of adults.

Carey and Diamond (1977) and Diamond and Carey (1977) suggest that young children use piecemeal/featural extraction in facial encoding, whereas adults tend to use more wholistic/configurational/relational information when unfamiliar faces are encoded. They suggest this difference is due to the lack of a sufficiently developed facial schema in children. In addition, at younger ages, salient, though sometimes irrelevant, stimuli may capture attention - perhaps diverting it away from important face information.

Research has also been done at the other end of the age spectrum with elderly subjects. Yarmey (1984) in his review of this literature concluded that younger adults perform better on facial memory tasks than the elderly.

Gender

Many studies have been reported on the issue of male-female differences in facial memory. The results have not been consistent. According to Shepherd (1981), out of 35 published face recognition experiments, 17 showed a female superiority and 18 showed no difference. Overall, the research suggests that women may be marginally better at recognizing faces. However, studies have shown that following exposure to a target under violent conditons, females were less accurate (Clifford & Scott, 1978) and less complete (Kuehn, 1974) in their recall than males. Further, some research (McCall, Mazanec, Erikson & Smith, 1974; Powers, Andriks & Loftus, 1979) has shown that details are retained better for one's own sex.

To the extent that there is a gender difference favouring females, perhaps this difference is a reflection of a greater interest in facial appearance. This interest may lead to more processing of facial information. Hence, the difference may be primarily motivational.

Implications of research on person factors

In this section we have cited research on several person factors - race, target uniqueness, witness age and gender. As noted, these are not factors that can be manipulated in the forensic setting, but an understanding of their effects on performance in forensic tasks may provide a basis for properly interpreting the outcomes of forensic tasks. In their reviews of the cross-racial effects, Lindsay and Wells (1983) and Brigham and Malpass (1985) have discussed the implications of this research.

There are a couple of rather obvious points that can be made regarding the forensic implications of the findings on facial uniqueness or typicality. To the extent that a target face has unusual characteristics, the confidence that an identification is correct may be greater. In the construction of photospreads or lineups, typicality of the decoys is a factor that should be taken into account if the procedure is to provide a fair test of memory.

THE COMPUTER: A USEFUL FORENSIC TOOL

The increasingly ubiquitous computer has the potential to make substantial contributions to forensic tasks involving memory for faces. Laughery, Rhodes and Batten (1981) discussed computer applications in this area and reviewed a variety of research efforts. They categorized the research into three types of computer applications: as an aid in facial construction, as a device for measuring facial images, and as a tool in recognition systems. The second of these categories, measuring images, is not particularly relevant to the issues in this paper; the other two clearly are.

In the half-dozen or so years since the Laughery et al. (1981) paper, enormous advances have occurred in computer hardware and software that are relevant to these forensic applications. Low-cost micro computers with large amounts of memory and excellent image processing software now exist. While a greater potential exists for using the computer as an aid in constructing images from memory, we are aware of no recent research or developments on this application. Two research activities have been reported on computerized recognition systems, however, that seem noteworthy. The two systems are called CAPSAR and FRAME, and they employ different types of algorithms.

Laughery et al. (1981) characterized computer based recognition systems as being of two types: sequencing algorithms and matching algorithms. A sequencing algorithm takes as input some information (parameter values) about a target face. These parameter values are then compared to the values for each face in the search set (i.e. mugfile) and a 'distance' is computed for each face in the set. This distance is defined by some predetermined distance function and is a measure of similarity between the target face and the faces in the set. The faces can then be ordered, sequenced, on the basis of similarity to the target face. However, a 'pruning' procedure is employed in which faces in the set that fall outside the values of the search parameters are eliminated, pruned, from the set. As more parameter values are entered, the size of the set to be searched is reduced. The objective of both types of procedures is to end up with a small number of faces to be searched by the witness.

It should be noted that procedures such as these are included in the types of forensic tasks currently employed. When the clerk in our scenario reported that the criminal was a black male, probably in his 20's, and about 6 feet tall, a photospread of 10 faces was assembled in which these parameters were taken into account. The utility of the computer in these situations comes from its ability to handle large amounts of data - many parameters and files with many faces. We will comment further on this point.

CAPSAR - A Matching Algorithm Approach

Lenorovitz and Laughery (1984) reported a study on the potential utility of a matching algorithm. They developed a witness-computer interactive system for searching a simulated mugfile. The system is labelled CAPSAR (Computer-Assisted Photographic Search And Retrieval). The faces in this study consisted of 335 Identi-Kit images, of which five were used as targets and the remaining 330 made up the file. The witness was shown a face which was to serve as the target. The search procedure began by showing the witness a face from the file selected at random. The witness responded to this face by noting differences between it and the target face in his/her memory. These differences then served as a basis for pruning the file. For example, if the witness said the target had thinner lips than the displayed face, all faces in the file with lips as thick or thicker than the displayed face were eliminated from the file. When the pruning procedure was complete, another face was randomly selected from the remaining file and displayed. Again differences were identified and faces eliminated from the file. This cycle continued until either of two criteria were met: a face was displayed and identified as the target, or the file was reduced to 50 or fewer faces. In the latter case the remaining faces were then presented serially as a standard search and identification task.

The results of CAPSAR using the interactive, matching algorithm procedure were compared with results from a procedure employing a straightforward linear search through the entire file. These results are presented in Table 1. The CAPSAR system led to a greater number of correct identifications and fewer false identifications. Another result worth noting from the linear search procedure concerns identification performance as a function of where in the set the target face occurred. Six different target positions were used, and the results are shown in Figure 1. Clearly the hit rate decreased across positions. While the pattern of false alarms is not so clearcut, generally more false alarms occurred when the target appeared late in the sequence.

There are numerous questions to be answered before concluding that this type of interactive, matching algorithm procedure should be employed for searching real mugfiles. CAPSAR is a prototype system using artificial faces. The facial differences were defined on the basis of an 18-feature code (Yoblick, 1973), and pruning decisions were based in part on results of a study of subjects' abilities to detect differences in these feature codes for Identi-Kit features. Applying the procedures to real faces will require defining those dimensions of faces on which differences are detected and what kinds of errors subjects make in the difference detection task. This latter point is critical, because one type of error the system cannot tolerate is pruning the target face. While these and other similar issues require serious analysis before such a system could be implemented, the results are certainly promising. Furthermore, such procedures address some of the problems encountered in current forensic tasks that were discussed in the earlier sections. We will return to this point in the discussion.

FRAME - A Sequencing Algorithm Approach

Shepherd (1986) has recently reported on a witness-computer interactive system being developed by him and his colleagues at Aberdeen. Their system called FRAME (Face Retrieval And Matching Equipment) employs a sequencing algorithm. In this study 1000 male faces were photographed to serve as the file. The faces were selected to be representative of a police file with regard to age, moustaches, beards and glasses. The faces are stored in photographic form on a videodisc and can be addressed individually by a computer for display on a television set.

Table 1
Identification Results with CAPSAR and Linear Search Procedures

	CAPSAR	Linear Search
Hit rate	.53	.32
False alarm rate	.00	.26

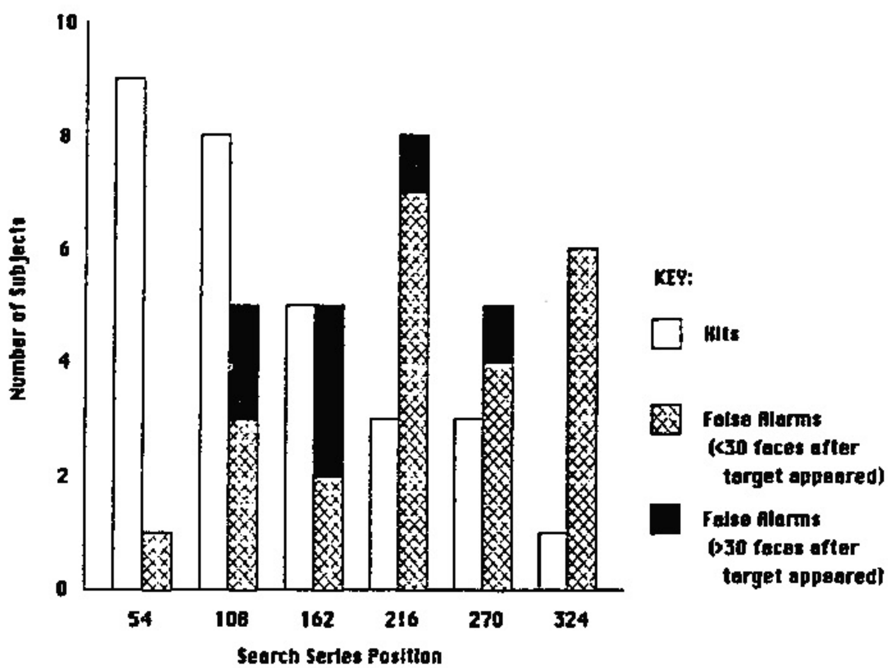

Figure 1
False-alarm frequencies for six different search series positions

The second component of FRAME is a data base consisting of 50 attribute/parameter values for each of the 1000 faces. Three of the 50 parameters are height, weight and age. The remaining 47 parameters are facial attributes. The values of 21 of these attributes were physical measurements and the remaining 26 values were determined by ratings from trained judges.

The third component of FRAME is a computer program that takes information from the witness and computes distances, similarities, between the target face and the faces in the file. The algorithm uses those parameters about which the witness has provided information. It is also capable of using confidence judgements from the witness to weight the parameters. The file is then ordered on the basis of similarities, and faces can be presented via television to the witness for identification starting with the most similar face.

Shepherd (1986) reported three experiments using the FRAME system. In the first experiment subjects were exposed to a target face on television, while in the second the target face was identified as someone they knew and who was in the file. Subjects then provided information about the face. The specific procedure here was the subject described the target to the experimenter and then the experimenter had the subject rate on a five point scale those parameters which had been mentioned spontaneously. Distances were then computed between the target face and each face in the file. The 10 most similar faces were presented sequentially to the target, beginning with the most similar. Following this 10-item identification task, subjects were permitted to amend search parameter values, similarities were recalculated, and a second 10-item identification task was carried out. This amend-recalculate-identify cycle was repeated three times in the first experiment, resulting in four identification trials, and twice in the second experiment, resulting in three identification trials. In the first experiment where the target was presented on television the hit rates on the four trials were .56, .72, .78 and .84. The second experiment involving known targets had hit rates of .70 and .80 on trials 1 and 3 (trial 2 was not reported).

In the third experiment the FRAME procedure was compared to a full file linear search procedure in which subjects searched through all 1000 photographs which had been arranged in four albums each containing 250 faces. The target exposure consisted of projecting the face on a screen. Two variables were manipulated in this experiment; distinctiveness (distinct or nondistinct) and the position of the target face in the album search (97, 353, 649 and 898). Results for the distinct and nondistinct faces are shown in Figure 2. With distinct target faces, the FRAME and album search procedures led to similar performance levels, and there were no position effects. For nondistinct faces identification performance with FRAME was similar to distinct faces, but performance on the album search was significantly poorer. As shown in Figure 3, performance clearly deteriorated across positions when the face was nondistinct.

A final point of interest in these three experiments concerns the attributes or facial features reported most often by subjects. Characteristics of hair (length, colour, texture) and eyebrow thickness were among the most frequently mentioned attributes in all three experiments. Other characteristics often mentioned were lip thickness and eye colour. Not surprisingly, more attributes were described by more subjects in experiment 2 where the target was known.

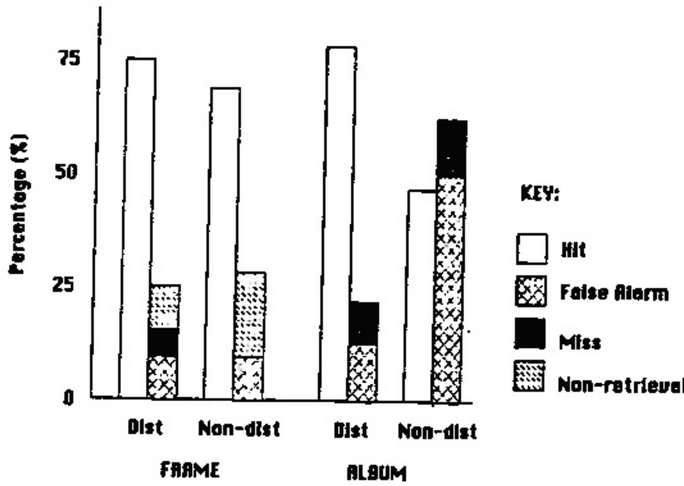

Figure 2
Hits, false alarms and misses for Frame and Album procedures on distinctive and non-distinctive targets

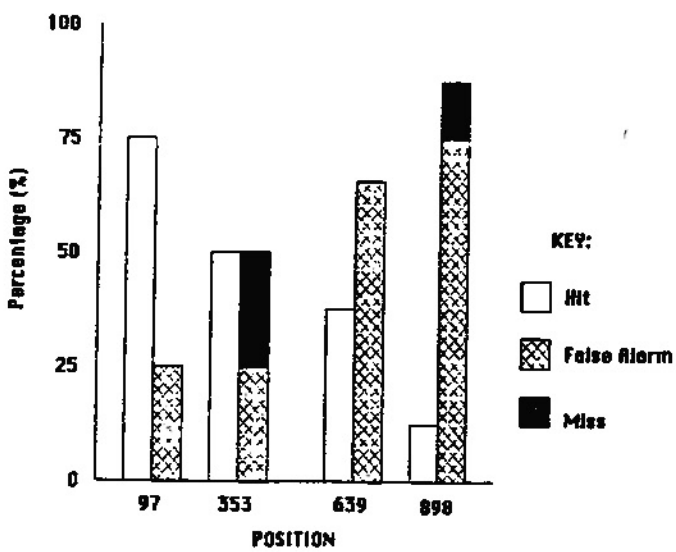

Figure 3
Position effects for album search
Non-distinctive targets

Implications of research with computerized systems

Both the CAPSAR and FRAME systems have provided results that are exceptionally promising. By using the power of the computer to store large quantities of facial information which can then be analyzed and evaluated on the basis of information obtained from a witness, some of the problems of using large mugfiles effectively are addressed. There are other issues and potential advantages associated with such systems. Cost, file maintenance and personnel are examples, and we will address them in the general discussion.

GENERAL DISCUSSION

In this paper we have attempted to review the research on memory for faces that has the greatest implications for forensic procedures. As noted in the beginning, our efforts have been selective. Most of the research reviewed has focused on identifying factors that influence facial identification. Other work has explored the quality of facial constructions. While we have presented some ideas about the implications of the research, in this section we will summarize those ideas and discuss some others.

Factors that Influence Performance in Forensic Tasks

There are several factors related to or a part of the forensic tasks themselves, what Wells (1978) calls system variables, that influence the performance of a witness. The research has shown that among the most powerful of these variables are: (1) changes in the target face between exposure and the identification task, and (2) exposure to decoy faces. Another factor that can have a strong effect, although it is not part of the forensic procedures, is any unique characteristic(s) of the target face. It is also of considerable interest to note that one potentially important factor, time delay, does not appear to matter very much; at least not over time periods of several weeks.

We mention the above factors here because they are important to the design of forensic systems. We have discussed implications of the individual factors earlier. If we consider them together, however, some general principles of forensic systems design emerge. A first principle is that the system should be careful to avoid altering or influencing the memory of the witness. Other faces that make up the decoys in the matching tasks have such an effect, and the consequences may be fewer correct identifications as well as more false identifications. Emphasis should be placed on reducing the size of the face sets and keeping the number of different forensic tasks to a minimum. We realize that in photospreads and lineups some minimum number of alternatives, appropriately selected, is necessary to have a fair test of memory. Situations where a witness may be involved in several mugfile, photospread or lineup tasks, such as those described in our robbery scenario, may in some situations be counterproductive.

A second principle concerns time; usually there is no need to rush into the forensic tasks. Time spent gathering other evidence that may help reduce the set of alternatives to which the witness will be exposed in the matching tasks may be time well spent. Of course there may be many reasons for law enforcement agencies to move quickly, but witness memory is not one of them.

Changes in the face between the crime and the forensic task have potent effects, and minimizing these differences where possible is an important third principle. Keeping files up-to-date is an obvious step. But it may also be possible to use the files more creatively in ways that will take advantage of the witness' memory. For example, if the witness reports the criminal had a moustache, it is possible to add a moustache to faces in the file. Such modifications may be particularly useful in dealing with possible changes in facial accessories (glasses, beards, moustaches, hair styles, makeup, etc.).

Unique or atypical faces are better remembered. Frequently, the properties of a face that make it unique are not obvious. But sometimes they are, such as scars, unusual markings, or an extreme value of a feature dimension. Advantage should be taken of such information, a fourth design principle.

It is our opinion that these principles, and others, need to be considered in the context of managing a rather complex information system. Mugfiles, photospreads, lineups are examples of information systems where one is attempting to locate or retrieve some information that meets a set of criteria. One important criterion is to match the memory of the witness. The principles tell us how the system needs to work in order to maximize success. But how do we effectively reduce the size of the mugfile without pruning the target face? How do we keep the file up-to-date, alter faces in the file, and make extensive information about each face available in a useful way? In our opinion, the most promising approach to achieving these goals is computers.

Computerized Facial Information Systems

Computers, of course, are not new to law enforcement. Our concern here is focussed on the application of computers to forensic tasks involving a witness attempting to identify a target face in a set of alternatives. There is a second application of computers to forensic tasks involving facial memory on which we will also comment; namely, the production of a hard copy representation.

In an earlier section research on two computerized identification systems, CAPSAR and FRAME, was reviewed. The results of these efforts are quite promising. It was demonstrated that information from the witness' memory for the target face could be used effectively to reduce the size of the file and increase the probability of a correct identification. As promising as these results are, especially the FRAME system which employed a real-face data base, this work has only scratched the surface with respect to computer applications in this area. The hardware and software technology available today offers excellent possibilities for applying other design principles. Faces in the computerized file could be altered, such as modifying accessories. Virtually unlimited information about the faces (and other characteristics of the person) could be stored and processed. Also, importantly, the procedures can be interactive enabling the system to take advantage of information as the witness remembers it.

There are other potential applications that a computerized facial information system could provide. An example would be situations where a photograph is taken of the criminal's face during the crime, such as with a hidden camera during a bank robbery or a forged check cashing incident. Computerized pattern recognition systems offer excellent potential for such identifications by matching the photographic image to the file images.

The above discussion of computer applications concerns identification procedures. A different forensic application of computers concerns the construction task. The research on generating hard-copy representations (Davies, 1981, 1983, 1986) indicates that performance on such tasks is usually poor - at best. There may be many reasons for this lack of success, including limitations in the devices and difficulties in communication between the witness and the artist/operator. One possibility that would address some of the shortcomings would be to have the witness directly produce the image. The usual problem here, of course, is on the response or output side. Few people can do a good job in drawing a face. Laughery et al. (1981) in their earlier review discussed this application and the research that had been reported up to that time. We are not aware of any significant research on this application since then. However, considering the hardware and software developments that have occurred, the potential for progress in this area seems substantial.

As stated, the hardware and software technology is available today to implement these ideas. Furthermore, it is available at costs that are within reason for many law enforcement agencies. We should not overlook the fact, however, that there are other costs associated with the implementation and maintenance of such systems. Specifically, there may be significant personnel costs in training people to use the system and in coding information as new files are developed and as new people are added to existing files. We cannot say at this point what the cost-benefit ratios of such systems might be, but it is well worth exploring.

Future Faces Research for Forensic Applications

Past research on memory for faces has contributed substantially to our understanding of the problems and potentials of forensic tasks involving the eyewitness. Most of the research has been guided by hypothesis testing strategies; that is, efforts to identify factors that have a significant influence on performance. Relatively little research to date has emphasized the quantitative relationships between these factors and performance, i.e. parameter estimation research. We are not simply referring to differences in hit rates between conditions of some experiment. For example, the research on the effect of time interval or delay between exposure and test has established that under certain conditions there are performance decrements following longer intervals, but facial memory seems to hold up well in the early stages of several weeks. What the research has not told us about is the nature of the forgetting function. This is a question of considerable interest to law enforcement. Deffenbacher (1986) has recently attempted to define this function.

It is not our intent to be critical of past research on this basis. Indeed, given the status of our understanding of this kind of memory, including very little theory about how people process faces, the hypothesis testing research mode has been appropriate. We do believe, however, that much progress has been made in identifying factors that matter most to performance on the forensic tasks, and that it is appropriate to direct more research activity towards defining these functions and setting the parameter values. Increasing efforts to develop theories of facial processing will articulate well with such activities. More to the point of this paper, defining the functions or relationships will represent a significant step in making research on faces applicable to forensic procedures.

In discussing methodological concerns in the introduction, we pointed out that almost all of the faces research to date has been experimentally oriented. Some of it has been concerned with how the human information processing system works in dealing with faces, and some of it has been directed at forensic issues. There is a need for field research; that is, research on real witnesses exposed to real crimes carrying out real forensic tasks. For obvious reasons, such research will be constrained. Independent variables cannot be manipulated (although there might be some options here) and obtrusive measures must be avoided. Such work as a rule will generally be descriptive; but it is our contention that much can be learned by observing actual forensic procedures. There may be other factors that influence outcomes that research efforts to date have not adequately addressed. For example, what kinds of instructions are given to the witness as he/she sits down to examine a photospread? We know that instructions can have a powerful effect on the criterion employed (in the signal detection sense) in such tasks. Another example concerns the constructions, sketches and composites, that are produced by witnesses. How good (or bad) are they in actual practice? It may be possible to learn more about the effectiveness of these procedures and how they might be improved.

Field research, of course, is not easy to do. It is costly, time consuming, and there are some severe practical limitations on the questions and issues that can be addressed. But, as noted above, there are potential payoffs. To date, we have been assuming that our laboratory findings, including the work employing forensic paradigms, is generalizable to law enforcement situations. Some field research may help to establish this generality.

Finally, we have made a strong pitch for introducing computers into forensic settings for managing forensic tasks involving faces and for assisting in face constructions. Computers offer some exciting options for addressing many of the problems inherent in forensic tasks, and there is a need for research and development on such applications.

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Edited by

Andrew W. YOUNG
Department of Psychology
University of Lancaster
Lancaster, England

and

Hadyn D. ELLIS
Department of Applied Psychology
University of Wales
Institute of Science and Technology
Cardiff, Wales

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