A CROSS CULTURAL STUDY OF EIDETIC IMAGERY AND SHORT TERM MEMORY

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ABSTRACT

The complexity of behaviour necessitates a clear and concise approach in order to comprehend its functioning. An example of such an approach is highlighted by the field of cybernetics. Cybernetic models have been used extensively throughout the various fields of Psychology but perhaps never more so as in the case of short term memory (STM). This particular field abounds with behavioural models and research workers are constantly developing new models or testing the unviversality of existing models. Universal validity is essential to the strength of the behavioural principles inherent in any model but unfortuanately such validity tends to be neglected. The present study attempts to reconcile this position with reference to specific models of STM with relation to the phenomena of eidetic imagery (EI).

Certain studies concerning the incidence of EI in illiterate Africans have produced results which are contradictory to those obtained in the Western culture. Two of the most important contradictions concern the fact that the illiterate Africans experienced the absence of an age parameter on the occurrence of such imagery and the fact that the incidence of imagery was more extensive in the African culture. A reason for these contradictions was sought and it was reasoned that as eidetic images have been closely linked with memory images, it may, therefore, be assumed that these particular cultures may use EI as an aid to memory, in the absence of written material. Further, it would not be unreasonable to assume that this visual imagery may tend to dominate the STM process and thereby challenge the universality of those memory models that proposed acoustic domination of this process.

No work has been done in investigating the memory process of

of the Africans. Thus, a study which did so would not only test the universality of specific memory models but would also possibly throw more light on the memory process itself.

In this particular study there were three specific aims; (a) to ascertain the relative incidence of EI on a cross-cultural level, (b) to assess the influence of EI on the memory process, and (c) to ascertain the extent to which principles of STM developed in the West applied to the African groups.

The groups concerned in the study comprised two Xhosa groups and a European group. The European group (WS) was drawn from a White Student population at Rhodes University and was regarded as a control group. The equivalent literate Xhosa group (BS) was drawn from a Black Student population at the University of Fort Hare. The illiterate Xhosa group (RX) was drawn from a population of Red Xhosa people in the Transkei.

Four tasks were administered to the groups with the cross-cultural variable carefully controlled as much as possible. The following comprised the four tasks; (a) eidetic imagery (b) auditory serial recall (c) visual serial recall and (d) an acoustic confusable task.

Each subject commenced with the eidetic imagery task and was then confronted with a random presentation of the other three tasks. The EI task began with an after image task which was followed by three selected pictures which comprised the EI task. After each picture presentation the subject was closely questioned as to the presence of imagery. Scoring was of a subjective nature.

The visual and acoustic confusion tasks constituted serial presentation of ten items over six randomized trials. Each item was presented for 0,75 seconds with a negligible inter-item interval. The presentation order of the items was randomized throughout the trials. Presentation was by means of a pre-programmed 16mm colour film. Items were scored for correct serial position.

The auditory task consisted of the serial presentation of ten items over six randomized trials. The items were once again randomized throughout the trials with regards to presentation order. The presentation speed was one word per second. The presentation was by means of a pre-programmed tape. Items were scored for correct serial position.

The visual task was common to both language groups whilst the other two tasks correlated with the language group. Thus, the items in the auditory and acoustic confusion tasks were different for each language but an attempt was made to control this variable. The tasks were conducted in the subjects home language which was either Xhosa or English.

It was assumed that the RX group would demonstrate a greater incidence of EI, irrespective of the age of the subject, and that imagery would be reflected in the recall performance of the memory tasks. It was suggested that imagery may determine or encourage the mode of storage that the subject employed which, in this case, would be the visual modality. If so then it would be expected that visual storage would circumvent the detrimental influence of acoustic confusability.

The Xhosa university group (ES) was an unknown quantity but was included to ascertain whether there were any marked differences between the group and the other two.

The results revealed that imagery was in fact more prevalent in the Xhosa groups whilst the WS group demonstrated a complete lack of EI but did report the presence of pictorial imagery (PI). However, imagery did not appear to function as an aid to memory. It seemed, however, that in certain instances it correlated with visual encoding. Generally the Xhosa subjects, especially with regards to the visual tasks, tended to encode visually whilst the WS group encoded auditorily.

With reference to recall performance, it was found that in all instances the WS group demonstrated superior recall followed by the BS and RX groups in that order. There was a significant difference in the strength of recall between each of the groups.

The results of the auditory and visual tasks were interpreted within the STM principles developed in the West. It was found that the WS group adhered to these principles thereby justifying its position as a central group. The BS group followed a similar pattern with exception to the recency effect which was much weaker in their case. The RX group reported the absence of any storage and rehearsal strategies and this was reflected in their poor recall performance. They too were characterized by a very weak recency effect. The interesting point arose, however, when the auditory and visual recency effects were compared. According to Crawder and Morton (1969) the influence of the precategorical acoustic store (PAS) on recall should be reflected by a comparatively stronger auditory recency effect. This trend was observed in relation to the WS group but not to the Xhosa groups who tended to demonstrate a stronger visual recency effect. It was therefore, suspected that PAS did not operate with the same effectiveness with the Xhosa subjects. In fact it was suggested that in the case of the Xhosa subjects the visual peripheral store may be stronger than PAS.

Contrary to expectation all three groups exhibited acoustic confusion. This was expected of the WS group as the subjects preferred auditory storage, but not of the Xhosa subjects who preferred visual storage. It was suggested however, that in the case of the Xhosa subjects the visual storage technique would have to be abondoned immediately prior to or during recall as recall was necessarily in the auditory modality.

The outcome of the experiment generally confirmed Doab's conclusions as to the incidence of imagery and its relation with memory. However, due to the Xhosa preference for visual storage and their stronger visual recency effect, Sperling's model was slightly modified. Conrad's findings were, of course, substantiated.

I. INTRODUCTION

Science is set apart from the Arts by it's basic approach to the formulation of knowledge. It demands a high standard of precise and tested statements which may form a concrete foundation for further progress. It's language, therefore, must be one of exactitude and often thereby results in the scientist resorting to mathematics in order to express the precision of his statements. Such an approach is typified in the following statement by Carnap and cited by George (I96I):

> "If certain scientific elements - concepts, theories, assertions, derivations, and the like - are to be analysed logically, often the best procedure is to translate them into the symbolic language. In this language, in contrast to ordinary word language, we have signs that are unambiguous and formulations that are exact; in this language therefore, the purity and correctness of a derivation can be tested with greater ease and accuracy... (p.45)."

If Psychology is to be considered as a science, therefore, it too must adhere to the above principles. The complexity of behaviour in fact necessitates the adoption of the scientific approach. The psychologist cannot make valid statements of behaviour before he has substantiated the validity of the elements of the behaviour pattern. It is, therefore, necessary that the psychologist employ the tools of science to express his knowledge. Although Psychology does not readily lend itself to mathematical expression, it does noutheless lend itself to the field of cybernetics which is another of the scientific tools of expression. Cybernetics is concerned primarily with the construction of theories and models in science. It is wholly involved in translating knowledge into logical theories and models which may be interpreted in both symbolic and hardware form that demands a certain standard of operational effectiveness.

The field of memory lends itself especially to the cybernetic approach as is witnessed by the fact that numerous models have already been generated particularly with regards to short term memory. This means that the principles derived with relation to short term memory have been precisely formulated and open to a test of predictability. However, validation of the principles inherent in any model is dependent on the test environment which may be culturally orientated. As the psychologist is interested in the fundemental principles of behaviour he cannot claim validation until it is proved that these principles are common to all people. Thus, a model of behaviour must ideally be tested throughout the world's various cultures. The psychologist's task, therefore, is not only to create a model of behaviour, but also to ensure its complete validation.

The above remarks provide the context of the present study in which certain models of short term memory are to be tested for specific cross-cultural validity. At the same time the incidence of eidetic imagery amongst the experimental groups will be investigated as will the influence of eidetic imagery on short term memory. Our attention, therefore, now turns to the topics involved in the study.

The subject of memory has fascinated mankind for centuries and yet he is still far from answering the questions involved. Vital issues such as "What is stored?", "How is it stored?" and "How is it recalled?", continue to be pondered over. Although the answers have not been readily forthcoming, at least some encouraging light has been thrown on the issues by a sustained scientific attack. The truth still lies in the future but the road to it is rapidly being cleared.

Brown (I964) defined memory as involving "the retention of information in the brain over a period of time." However, sometimes this retention is in full whilst at other times it is not. As William James put it :

> "The stream of thought flows on; but most of its segments fall into the bottomless abyss of oblivion. Of some no memory survives the instant of their passage. Of others it is confined to a few moments, hours or days. Others again, leave vestiges which are indestructible and by means of which they may be recalled as long as life endures."
>
> (James, I890 p.643).

This observation led James to believe that memory could be divided into two classifications based on a time continuum. It was thus that he coined the terms "primary" and "secondary" memory. He believed that the memory of immediate events could not be termed true memory because they need not necessarily require effort in being recalled. For James then, primary memory consists of "... those events in the span of conciousness itself (Norman, I968)." The idea still prevails to this day as can be seen by Norman's statement that:

> "... the storage of events has at least two different modes of operation: a transient mode for immediate memory and a permenant mode for long-term memory."
>
> (Norman, I968, p. 524).

It would appear, therefore, that there are two separate memory stores. However, as Norman has pointed out:

> "... there must be sufficient interconnections between the storages to allow a comparison of the just-perceived sensory events with the collection of previously experienced perceptions.

"This intercommunication must be direct and complete that formal distinction between the two storage systems become difficult to make. In fact with sufficiently complex interactions the two systems become equivalent to one."

(Norman, I968, p.524-525).

The memory storage, therefore, is an intergration of primary and secondary memory but the two still retain their particular characteristics within the whole. In the present study the focus is on primary or short term memory and the storage systems within this category of memory.

The memory process itself, is dominated by two sensory modalities. These are the visual and auditory modalities. As we have the capability of recalling either pure auditory or pure visual stimuli in short term memory (STM), it would appear that a similar phenomena is present in STM with regards to the integration of the two modalities as was apparent in dividing the memory storage into short term and long term memory. It is possible, for instance, to recall auditory stimuli that have no visual representation and vica versa. For the most part, however, it appears that the two modalities are integrated in the short term memory system. Sperling (I967) proposed a model of STM which illustrated this integration factor as well as introducing the principle of rehearsal. Briefly Sperling envisaged impinging visual stimuli as being stored in acoustic form. For example, a picture of a dog would presumably be matched for recognition purposes with a visual representation in the long term store, but would be stored in STM as the word "dog". In order that the acoustic representation be strengthened, the above procedure is

rehearsed/

rehearsed. The model, therefore, carries an element of predictability and its validity was tested by Conrad (1963). Conrad presented his subjects with acoustically confusable visual stimuli. The presumption was that if the subject did in fact store the stimuli in acoustic form they would become confused because of the acoustic similarity of the stimuli. Consequently recall performance would deteriorate. The presumption was found to be valid thereby lending support to Sperling's model of visual short term memory.

However, in order to be completely valid Sperling's model should be able to demonstrate universal validity. The present study, therefore, attempts to ascertain whether the model would apply to an illiterate society. At the present moment there is little evidence to suggest otherwise, but that may be due to the fact that little work has been done with regards to the memory of illiterate people. All the principles of memory and, therefore, all the STM models constructed are dependent on information gathered in the literate societies. But what of the illiterate societies? Do the STM principles and models apply equally to them? As yet we are still in the dark concerning this question but one author does provide a guiding light.

Although the author in question studied the phenomena of eidetic imagery (EI) his results may still indicate, through extrapolation, the trend which may be found with relation to memory and illiteracy. Eidetic imagery is defined by Haber & Haber (1964) as visual images "persisting after stimulation, relatively accurate in detail, colored positively and capable of being scanned (p. 350)." Such images may be correlated with memory images as has been argued by G. Allport. Allport stated:

> "The EI readily shows itself to be a special variety of MI ... Although the EI shows that

"it is a member of the general class of MI it does possess features which distinguish it in degree."

(Allport, I928, p. 424).

Thus, by definition it appears possible that the presence of EI could determine the quality and quantity of pure visual retention. In fact Doob states:

"On the basis of quite casual impressions and of astonishing anecdotes, it has long been opined (e.g. Jaensch I923; Husen (I945: 84-86) that the incidence of such images among nonliterate peoples is likely to be higher than among the literate. The speculation has been based upon the assumption that the images are present among all or most children, perhaps at an early age, but that they tend to dissapear in literate societies where the emphasis is placed upon verbal memory. The idea behind the speculation is exciting: if validated, it would suggest another way in which people can store essential information in the absence of writing."

(Doob, I964, p.357)

Ther is, therfore, the hint, especially since Doob substantiated the higher incidence of EI amongst illiterates, that such societies may process memory images in different ways to those propounded by the memory models developed in literate societies. Sperling's model, for instance, is characterised by an acoustic conversion mechanism and thus the integration of the visual and auditory modalities. Studies have shown the presence of EI to be sparse beyond the age of puberty in the literate cultures where the auditory modality dominates the STM process. On the other hand, the presence of EI in illiterate cultures has been shown to be extensive, regardless of age. Does this suggest that either the visual modality dominates the STM process in these societies or that the two modalities are not as integrated as in the literate societies? However, as little is known of the illiterate memory system we can only speculate on the circumstances. The critical experiment that Conrad applied to verify Sperling's model would now become critical in determining whether the illiterate person processed memory images in a different fashion or not. If EI is related to memory and if consequently the speculation of visual domination of the STM process is true, then it would be expected that the illiterate person would not experience acoustic confusion.

These then are the speculations and they must remain as such until evidence is brought forward that either supports or refutes them. The only way to investigate these ideas is to set out the principles and models of auditory and visual STM as well as to outline the phenomena of eidetic imagery with a view to making comparisons with the data obtained in the present study. If the results warrent it the models and principles may or may not have to be modified to accomodate the data.

2. VISUAL SHORT TERM MEMORY

2.I. Introduction

This chapter is devoted to the visual modality with relation to short term memory. Initially, a model of visual short term memory (VISTM) and various experimentally proven principles concerned with such a model will be reviewed. Secondly, the latter part of the chapter will be assigned to a review of the experimental literature pertaining to the present field of research.

2.2. A Model of VISTM

Although the literature reveals a number of models of short term memory, the majority of them are concerned with the general framework of this class of memory. Sperling (I963) however, whilst having developed such a framework, has also devoted his attention to details relating to the processing of specific modalities within the model. He described the behaviour his model has to explain in the following general terms:

> "(I) The observer sees the stimulus material for a short time. (2) He scans it, selecting information to rehearse. (3) He later reports what he remembers of his rehearsal. ... In the first place it will be established that even in a brief exposure the observer may have available much more information than he can later report. Because the duration for which he "sees" the stimulus normally exceeds the stimulus exposure duration, this component of the model is called visual information storage."
>
> (Sperling, I963, p.20)

Our concern in this instance, therefore, is of the first two of the above statements with regards to evidence of a visual information store and a scanning component.

2.2I. The Visual Information Store (VIS)

The visual information store (VIS) is peripheral to the short term memory (STM) store and as such constitutes a physical store from which the STM store draws its information by means of the scanning process. The parameters of this visual store are strictly and precisely governed by a number of variables such as luminance of the display, luminance of the intervening field and duration of exposure. Evidence supporting the store's existence can be found in a number of experiments. Glanville & Dallenbach (I929), for instance, concluded from their experimentation that there appeared to be a memory after image which subjects utilized during immediate recall. Pursuing a similar tack Sperling (I963) found that when using a partial report procedure (i.e. only a certain part of the display had to be reported.) with a stimulus duration of 50 msec, recall was inversely proportional to the time lapse marked from the end of stimulation to the commencement of recall. If the onset of recall was immediate 76% of the stimulus items could be recalled. But if the recall procedure was delayed by one second the percentage of items recalled dropped to 36%. Sperling explained this observation in the following way:

> "... the visual image of the stimulus persists for a short time after the stimulus has been turned off and that the subjects can utilize this rapidly fading image. In fact, naive subjects typically believe that the physical stimulus fades out slowly."
>
> (Sperling, I963, p. 2I).

The indication is, therefore, of the existence of a peripheral physical visual store.

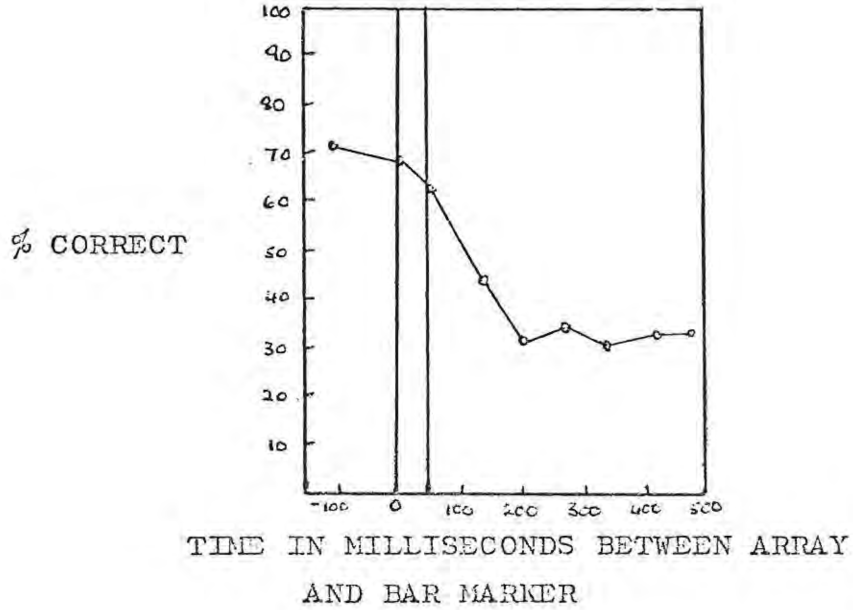
In attempting to discover just why, when using the whole report procedure to investigate immediate memory, subjects could often remember having seen more items than they could later report, Sperling (Averbach & Sperling, I96I) found that in this case exposure duration did not act as a variable and consequently could not be called on to provide an explanation. Sperling consequently designed an experiment to ascertain the amount of information available to the subject after initial stimulation. He first presented a subject with three rows of letters (3-4 in each row.) for an exposure duration of 50 msec. A tonal signal of either high, medium or low frequency corresponded with a particular row of letters. On presentation of the signal the subject was required to recall that signal's particular row of letters i.e. a partial report procedure.). The results of the experiment indicated that the subject performed more successfully with the partial report procedure than the whole report procedure for the same stimulus items. This meant that when the subject was shown the complete set of stimuli, he could not fully recall all of the items. However, when required to reprt only part of the stimulus set the subject could often do so. This led Sperling to conclude that immediately after termination of the stimulus set the subject had available two or three times more information than he could later recall in a whole report procedure.

Sperling's next objective was to "determine how this available information decreased with time." This he did by using the above procedure including a varied delay of the tonal signal which initiated recall. The results revealed that if the tone and subsequent report occurred within one second of stimulus termination, the amount of information available and reported was greater than the memory span (i.e. the average number of items recalled when using a whole report procedure.) for the same material. However, beyond one second it appeared that recall was governed by the principles of the memory span rather than by visual persistence. Sperling, therefore, tentatively concluded that information may be stored in the VIS for approximately one second.

Sperling continued to pursue the idea of a visual information store and further experimentation served to highlight the optimal conditions within which the VIS could effectively perform. The variable that he was concerned with in this case was that of pre and post exposure field luminance. Two different such fields were employed. In the first instance the pre and post exposure fields were dark in contrast to the actual stimulus exposure field luminosity. In the second instance the pre and post exposure fields were equivalent to the stimulus exposure field. It was found that in this instance the dark pre and post exposure fields produced visual persistence of the stimulus for up to two seconds whilst the equivalent fields produced persistence for only 0,5 seconds. Expressing this in bitseconds, the dark pre and post exposure fields realized I20 bitseconds which was in fact 30 times longer than the stimulus duration. The equivalent exposure fields only produced persistence of nine times the stimulus duration. Sperling remarked that "This is certainly information storage; in this case, it is "visual information storage" (p. 202)."

Averbach (Averbach & Sperling, I96I) lent confirmation to Sperling's results. His method of experimentation was to present a two by eight array of randomly chosen letters for a duration of 50msec. After a varied delay a bar marker corresponding to a row of letters was presented for 50msec to signal commencement of the required partial report. The pre and post exposure fields constituted a white blank.

Figure I. Retention
(Reproduced from Averbach &
Sperling, I96I, p. 204.)



The above graph illustrates the results obtained from the experiment and appears to demonstrate decay of the visual store. Averbach however, suggested that this may in fact not be a true reflection of the situation. The reasons put forward by him were (a) True storage should decay completely thereby resulting in a zero response. In fact the decay seems to be relieved by the STM storage component resulting in a lowest response point of 30%. (b) There appears to be a time drag instituted by the bar marker. This can be clearly seen by the fact that a pre stimulation marker only results in a 72% correct response instead of the desired IOO%. However, after removal of these contaminating variables by calculating the before and after marker times, Averbach determined that the visual storage time was in the region of 270msec.

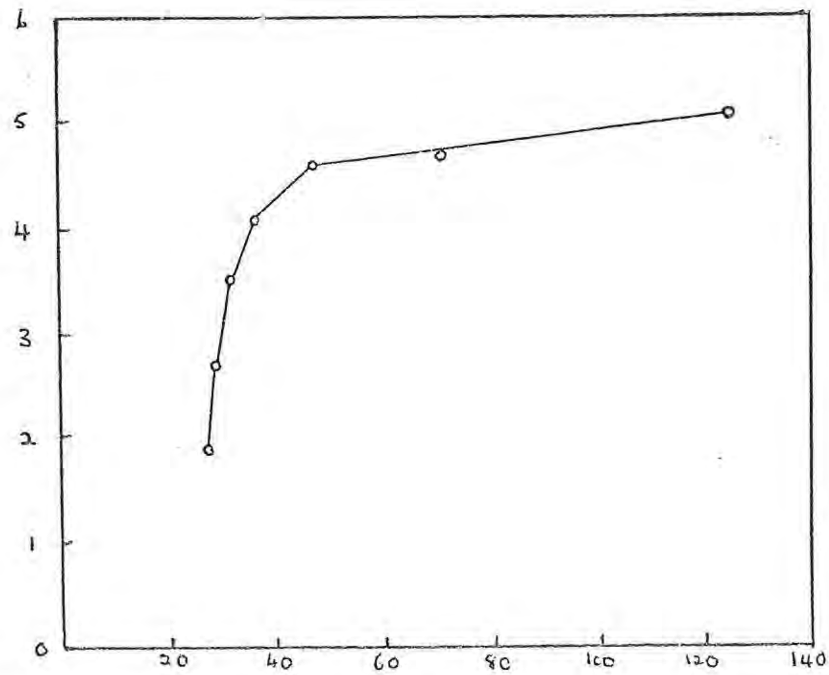
Mackworth (I963) agreed in principle with Sperling's conception of a pre-perceptual visual store. With reference to such a store, she stated:

> "This is in line with an earlier suggestion (Mackworth, I959) that the memory trace goes through two different stages, the first being a direct representation of the visual situation, of brief duration, and the second its translation into more durable form, often verbal."
>
> (Mackworth, I963, p.62).

Mackworth's experimentation in this field was designed to investigate the parameters of the visual store. This can be seen in the following work concerning three major vatiables governing the VIS.

Mackworth (I963) presented ten digits in two rows with a display luminance of 3,9 ft-lamberts for a number of variously timed exposures ranging from 27 - I25 msec. The results indicated that below 50 msec responses were limited by perception whilst above 50 msec they were hindered by rapid decay of the VIS.

DIGITS CORRECT



EXPOSURE DURATION M SECS.

Figure 2. The effect of the exposure duration upon the number of digits correctly reported. (Reproduced from Mackworth, I963, p. 64)

The above graph demonstrates this fact as well as the rapid improvement from 27 - 47 msec and the plateau from 47 - I25 msec.

As a result of the experiment a further one was designed to detail the characteristics of the above graph. Because of the variance between subjects, an optimal range of exposure times was designed for each subject, in order to gain the maximum amount of information concerning the graph. Two levels of display luminance, 3,0 and 3,9 ft-lamberts, were used to investigate the effect of luminance on the 50 msec barrier. The experiment also incorporated a design to verify Sperling's (I960) observation that if the display brightness was greater than the intetvening field , there would be no difference in the amount seen between exposures of I5 and 500 msec. In this case a luminance of 3,0 ft-lamberts and exposures of six and I25 msec were used. Subjects were also tested for memory span with the use of nine digit messages with exposures ranging from 0,75 - I,6 seconds. Results indicated that; (a) shorter exposures were dependent on the relation between the display and intervening field luminance. (b) with no intervening light field the acceleration of the curve decreases to an extent where there is little difference between exposures of six and I25 msec. (c) there was a small increase in responses with increase in exposure time with no effect demonstrated by luminance conditions. (d) the mean memory span was 7,24 whilst that of the visual span was 6,2. Mackworth concluded that "the limitation on the amount reported at I25 msec does not appear to have been the memory span (p. 67)." She also felt that the results of the experiment lent support to the theory evolved from the first experiment. That is that below 50 msec the number of responses was hindered by the exposure time i.e. the total amount of light reaching the retina, as with increase in the amount of light there was a corresponding increase in the number of responses. However, the absence of any difference at I25 msec between lighting fields is contrdictory to the results obtained by Sperling. Mackworth suggested that the reason lies in the fact that Sperling used a stronger luminance (3I ft-lamberts) which might possibly produce an after image.

Further experimentation by Mackworth was designed to ascertain the duration of the visual image by using the duration of the response as an indication of visual persistence. One such experiment using an exposure time of I25 msec, showed that I,5 seconds after stimulation (a time which excluded reaction time estimated to be 0,7 seconds) there was a probability of 0,87 for correct recall. At 2,4 seconds this probability became 0,I2. This led Mackworth to remark that the "probability of a correct report diminished after I sec, and by 2,5 seconds the probability was below IC per cent (p. 69)."

Another experiment by Mackworth was aimed at discovering the effects of display duration and rate of reporting. In order to evaluate these effects two response rates were used (a) free reading and (b) paced reading. In both cases the stimuli were digits. Exposure duration varied from 0,I to two seconds with I4 digits in a display set. The results revealed that the number of responses was directly proportional to the increase in exposure duration. This fact contrasted with Sperling's results which demonstrated no such relation. Mackworth's results also indicated that there was an increase in the number of digits reported after stimulation when the response time was increased by external pacing. This led her to deduce that any apparent limitation on the speed of response must be internal. If this were true then material differing in recognition complexity should reveal differences in the number of responses with relation to exposure time. Taking up this point Mackworth designed an experiment to determine:

> "... (a) the amount reported after the display when these three kinds of material were used; (digits, colours and a combination of both) (b) the rate of reporting, both during and after the display; and (c) the duration of the post - display report as in the previous experiment. It also included a comparison of letters and digits."
>
> (Mackworth, I963, p. 73).

The conditions for the first experiment were; display luminance of 32 ft-lamberts, inter-display luminance 3,9 ft-lamberts and an exposure duration of IOO msec. The stimuli employed were; (a) digits and digits on a coloured background with only digits to be recalled, (b) plain colours and digits on colours with only the colours to be recalled, (c) all three types of stimuli were presented with the subject required to recall the stimulus in its entirity. The presentation rate varied from 0,I - 2 seconds. Finally, capital letters were presented with a one second exposure duration followed by letters and digits at a 0,I second exposure duration.

The results of the experiment indicated that; (a) there was a significant difference between the number of digits, colours and letters reported. However, it was noted that there was no difference between the respective response times. Mackworth, thereby concluded that the reason that digits, letters and colours were recalled in that order of superiority, was due to the fact that although the duration of the visual image remained constant, the limiting factor was that of recognition, (b) there was an optimal recall factor such that beyond this limit an increase in display items did not necessarily result in an increase in responses, (c) the combined display appeared to function as a unit, this was supported by the fact that neither digit nor colour were favoured during recall. Mackworth, therefore, concluded that:

(a) under optimal (as opposed to usual) conditions, the duration of the visual image is two seconds. Given this, it follows that the number of items reported in a single display is proportional to the speed of reporting.

(b) in a combined display the reporting time is equal to the single unit reporting time plus the time required to report the last half of the last unit. This is due to the fact that the unit is recognised as a whole and the components are reported separately.

(c) the duration of the visual image is independent of the display luminance as well as the ratio of the display and field or intervening luminance.

Thus, it can be seen that through her experimentation, Mackworth has been able to establish the existence of a peripheral visual store and to have designated certain parameters to this store. As a result of this work Mackworth has speculated as to a distinction between the properties of the visual image and the memory image. The visual image is seen as a rapidly decaying image which holds more information than the memory image which is conceived of as a store which holds the names of the display items. Such experimentation and the conclusions drawn from it must inevitably lend telling evidence to Sperling's conception of short term memory.

Independently pursuing the same theme, Haber & Standing (I969) also established the existence of the VIS as well as several parameters which governed it. They achieved this by means of an illusion produced either by an oscillating opaque slit or a cycled tachistopic presentation. The subject was required to report whether the illusionary stimulus was continuous, discontinuous or absent. The threshold of visual persistence and the duration of the visual image was ascertained by means of ascending and descending presentations. The authors concluded that this method revealed a visual persistence of 250 msec with the tachistoscopic presentation and 300 msec with the slit method. It was suggested that the discrepancy in these duration times was due to the subjectivity factor inherent in the experiment. Both times are, however, similar to those obtained by Averbach (Averbach & Sperling, I96I). With regards to variables which governed the visual store, it was found that reduction in luminance slightly increased the visual persistence and that removal of the adapting field increased it by I00 msec. Further experimentation using the less subjective tachistoscopic presentation revealed that:

> " Visual persistence was found to be independent of stimulus duration over a range of four to 200 msec, where all durations were above recognition threshold for the stimulus. Persistence was unaffected whether

> " the stimulus was repeatedly presented in the same eye or alternated between eyes, strongly suggesting that the storage is central."
>
> (Haber & Standing, I969,p.43).

Erikson & Steffy (I964) challenged the results of Sperling (I963) and Averbach & Sperling (I96I) which indicated rapid decay of items in the visual store when there was a delay in the reporting time. Keele & Chase (I967), however, suggested that the reason for this discrepancy might have been due to the fact that Erikson & Steffy used a small number of items in their stimulus array thereby favouring chance recall. The authors also pointed out that the luminance used by Sperling was vastly different to that used by Erikson & Steffy.

With the above design faults in mind Keele & Chase replicated the study done by Erikson & Steffy. Their results demonstrated a monotonic decline for each luminance intensity with stimulus duration from 0-250 msec. The degree of decline was found to be greater for the high intensity luminance as compared to the low intensity luminance which produced the least decline. It was also found that the 3,7 ft-lambert Erikson & Steffy luminance also produced a decline thereby contradicting the results obtained by them. The outcome of the experiment also lent support to the existence of a visual information store. The authors remarked that:

> " The fact that there was no evidence of acoustic confusions in the present experiment suggests that short - term visual storage is a separate system from that studied in short-term memory experiments where retention of material is studied over longer intervals."
>
> (Keele & Chase, I967, p. 385).

The arguement put forward by the authors to substantiate the above statement was as follows:

> " Visual variables such as visual similarity and luminance would have their effect while the material is still in the visual storage system, whereas acoustic and associative variables would have their effect after the information is processed and is in a short-term auditory store or more permenant memory."
>
> (Keele & Chase, I967, p.385).

2.22. The Visual Image and the Memory Trace

In I962 Mackworth remarked that:

> " It seems that there are two different phenomena which should be distinguished, the visual image and the memory trace. The visual image is that referred to by Glanville and Dallenbach as the memory after-image. It is supposed to be a representation of the visual patterns of the stimulus, somewhere in the visual system, while the memory trace is a record of the name of the stimulus. The visual image is part of the sensory or stimulus side, the memory trace is a record of a response."
>
> (Mackworth, I962, p. 55).

This line of thought resulted in Mackworth attempting to further detail the effect of stimulus duration on recall with reference to the limiting factors or parameters of the visual image and the memory trace. She presented message lengths of eight and I2 digits with a variety of stimulus durations. The results of the experiment with the eight digit message revealed a linear relation between the stimulus duration and recall below one second. In this instance there was a rapid improvement in recall as the stimulus duration increased to the above figure. However, this rate of improvement dropped rapidly between stimulus durations of one and I,5 seconds. It was also calculated that four digits were recalled independent of time and that three further digits were added by the one second stimulus duration time. The twelve digit message results were similar except that the increased message length slightly lowered the number of digits recalled.

Mackworth concluded that both the VIS and the STM processes may be limited by the duration of the initial stimulus duration. It was suggested that the nature of the VIS was the limiting factor due to decay, up to 0,I second it appeared that all the material was read from the VIS. However, after 0,I second decay and interaction of the STM naming process produced recall limitations. This type of limitation was manifest between 0,I and four seconds for after four seconds the STM process appeared to dominate the system. It is, therefore, likely that the naming process, which is related to the speed of reading and recognition, is the major limiting factor in STM recall.

Further experimentation by Mackworth revealed that there was a positive correlation between the type of material to be recalled (e.g., digits, letters, colours and shapes.) and the reading speed, indicating the influence of the recognition variable. The above correlation was further substantiated and it was also found that the rate of presentation and message length, were in this case, insignificant variables. Finally, it was discovered that there was no correlation between the speed of reading and the exposure duration at the 0,I second level.

It, therefore, appears that the recognition factor i.e. naming is the limiting factor for the VIS and consequently STM.

As a result of the above experimentation Mackworth came to evolve an equation for predicting STM recall. She proposed that STM can be considered to have four components: (a) reading into store; (b) storing; (c) other intervening activities and (d) reporting. The total process is dependent on the use of a constant quantity of some factor which she calls the A-factor. The total quantity of A units used in this process was arbitarily chosen as IOO A-units. If a' is the number of A-units used by (a) reading into store, b' the number used by (b) above, etc. then $a' + b' + c' + d' = IOO$ A-units. Now, if M items are read into store and each item uses a A-units, then the total amount used is Ma A-units. If there is no intervening activity, and storage and report are called recall, there are IOO Ma A-units available for recall.

If each item requires s A-units for recall, recall of N of the M items requires Ns A-units, so that reading M items and recalling N of them gives the equation $Ma + Ns = IOO$. When the total message is recalled as in the limiting case of the memory span, $M=N=M'$, and the equation becomes $M' \; (a+s) = IOO$ or $a+s = \frac{IOO}{M'}$. That is, the total number of A-units per item is the reciprocal of the memory span.

It can be seen, therefore, that through detailed experimentation Mackworth has been able to conclusively substantiate the existence of a VIS and also to assign specific parameters to it, culminating in not only the verification of other work done in the field, but also a clearer picture of the details involved in the STM process.

2.23. Erasure in the VIS

It follows that if there is a limit on the number of items that the VIS can process at any one time, that an erasure mechanism must exist in order that further material entering the store may be processed. Otherwise some material would just never be processed. Thus, an erasure mechanism is necessary in order to maintain a steady flow of attended material.

Averbach & Coriell (I96I) investigated the nature of an erasure system within the VIS. The authors found that an erasure effect could be obtained if a circle was used as a marker in a probe report experiment. The method was to present a blank field, followed by an array of letters and then another blank field. The subject was required to report the letter encircled by the marker. The time at which the marker was presented could be varied. The results of the experiment were compared to those of an identical experiment in which a bar was employed as a marker instead of a circle. It was found that initially the recall performance was similar for both types of marker. However, when the markers were delayed for I00 msec the performance when using a circle marker was vastly different and produced inferior recall. With delays of more than I00 msec the performance when using a circle marker gradually improved to the recall status obtained with the use of a bar marker.

The authors maitained that the above discrepancy in recall obtained by the two different markers was due to the relative distance of the markers from the stimuli to be recalled. The bar marker was relatively distant from the stimulus and thus there was little chance of it disturbing the storage of the stimulus. However, the circle was in much closer proximity to the stimulus as it closely encircled it. The circle marker was, therefore, more capable of producing erasure of the stimulus in the VIS. Thus, if the delay between the presentation of the array and the circle marker was less than IOO msec, the two entered the VIS simultaneously and were stored with one superimposed on the other. The subject could still read the stimulus even though it was superimposed with the circle. The circle, in this case, did not produce erasure. However, when the delay was timed at IOO msec, the circle erased the visual image of the stimulus thereby adversely affecting recall. In this instance recall was also difficult because of the small duration for which the stimulus was stored i.e. the time was too short for the subject to read the stimulus. With longer delays of the circle marker, however, the subject was able to read the stimulus before erasure took place, thereby improving his recall performance.

It would appear, therefore, that the visual image may be lost either by means of natural decy within the VIS or by erasure of the initial stimulus by a following one if the second stimulus is presented within the natural decay time of the first.

2.24. The Scanning Mechanism

We have seen that the amount of information available from the VIS is a function of a number of variables. However, the availability of this type of information and of STM data must also be affected by the rate at which material in the VIS can be scanned. For instance, no matter how long the visual image persists in the VIS, the ultimate determinant of recall is the speed at which this image can be scanned. STM because it is the end product of the VIS process must also be affected by the scanning speed. The scan speed must, therefore, be viewed as a governing factor in a model of short term memory.

Baxt (1871) was the first to investigate scanning speed. He followed the stimulus exposure with a bright light or flash which was designed to obliterate the original stimulus by means of erasure. He could, therefore, control the period of visual persistence and in doing so determine the speed at which the stimulus could be scanned. From his experiments Baxt concluded that one letter could be scanned in ten milliseconds. Impressed by these results Sperling (1963) replicated the experiment and verified Baxt's results. However, a few design faults were noted in Baxt's experiment and this caused Sperling to slightly modify the experiment. In the new design the scanning period was controlled by introducing a pre-exposure and a post-exposure field of visual noise. There were also two types of presentation which differed in respect to their pre-exposure fields. The first employed the dark exposure field and the second constituted visual noise. It was found that the dark pre-exposure field produced immediate scanning but that the visual noise field delayed scanning by 20 msec. However, the rate of scanning, which was one letter per ten milliseconds, was not affected by the time at which scanning commenced. Sperling, therefore, concluded that the speed of scanning, as far as letters were concerned, was constant. However, this speed only held for the first three or four letters. It was further discovered that for exposure durations over 50 msec the speed of scanning slowed down. This was probably due to the transition from the VIS process to that of the STM.

2.3. Conclusion

This part of the chapter has, therefore, substantiated the existence of particular components pertinent to Sperling's conception of short term memory. Sperling's contention that visual information may be held temporarily in a visual information store has shown itself to be an experimentally proven fact. Further, his conception of a scanning mechanism which selects information from the VIS has also been proved. However, not only has this chapter lent proof to Sperling's model, it has also provided information regarding the duration of the visual persistence inherent in the VIS. This duration assumes particular importance when recall of a visual stimulus is compared with recall of an auditory stimulus. The reason is that physical stores such as the VIS may or may not directly influence the recency effect during recall thereby resulting in different recall profiles for the modalities under comparison.

2.4. Pertinent Studies of VISTM

Studies pertaining to the present experiment are limited by the precise nature of STM. For instance, because of the cross-cultural factor, pictures of objects had to be used as visual stimuli instead of the usual letter or digit. As very few experiments have used such stimuli it meant that few were pertinent to the present experiment. This fact, combined with the present type of recall used, in fact meant that no studies at all were directly pertinent to the present study.

However, as a lead it was felt that the following study by Pavio, Rogers & Smythe might be of some value. These authors investigated the fact that " Free verbal recall is generally higher for objects or pictures than for their labels (I968, p.I37)." From this they concluded that verbal coding _per se_ cannot account for this result and thus the reason must either be that the object has an advantageous physical attribute such as vividness or that the objects are more readily organised in STM. Their hypothesis was, therefore, to compare:

> "... colored and uncolored sets of both pictures and their noun labels. To the extent that either physical vividness or compounding of stimulus elements is effective, recall should be better for colored versions of words as well as pictures. To the extent that color is ineffective, concrete meaning may be the important factor. Organizational processes should be reflected in intertrial (subjective) organization."
>
> (Pavio, Rogers & Smythe, I968, p.I37).

The results of the experiment revealed ; (a) that the colour variable was insignificant ; (b) that mode of presentation was significant with picture superiority and (c) there was a better primacy and recency effect with the pictures. The authors concluded that:

> "... pictures of familiar objects can be readily coded and stored in memory in a verbal form and, in addition, they associatively arouse concrete memory images of the things that they represent (as distinguished from immediate memory images of the stimulus pictures). Recall probability is higher because the appropriate verbal response can be retrieved from either symbolic mode. Concrete nouns presumably

" can evoke nonverbal images as well ...
but the probability of dual coding is
apparently lower than in the case of the
pictures."

(Pavio et al, 1968, p.138).

Thus, although the above experiment employed free recall, one fact does emerge which may be of value and that is that pictures are readily recalled probably because of an associative factor. This is a factor which could apply to the encoding of the stimuli in the present study.

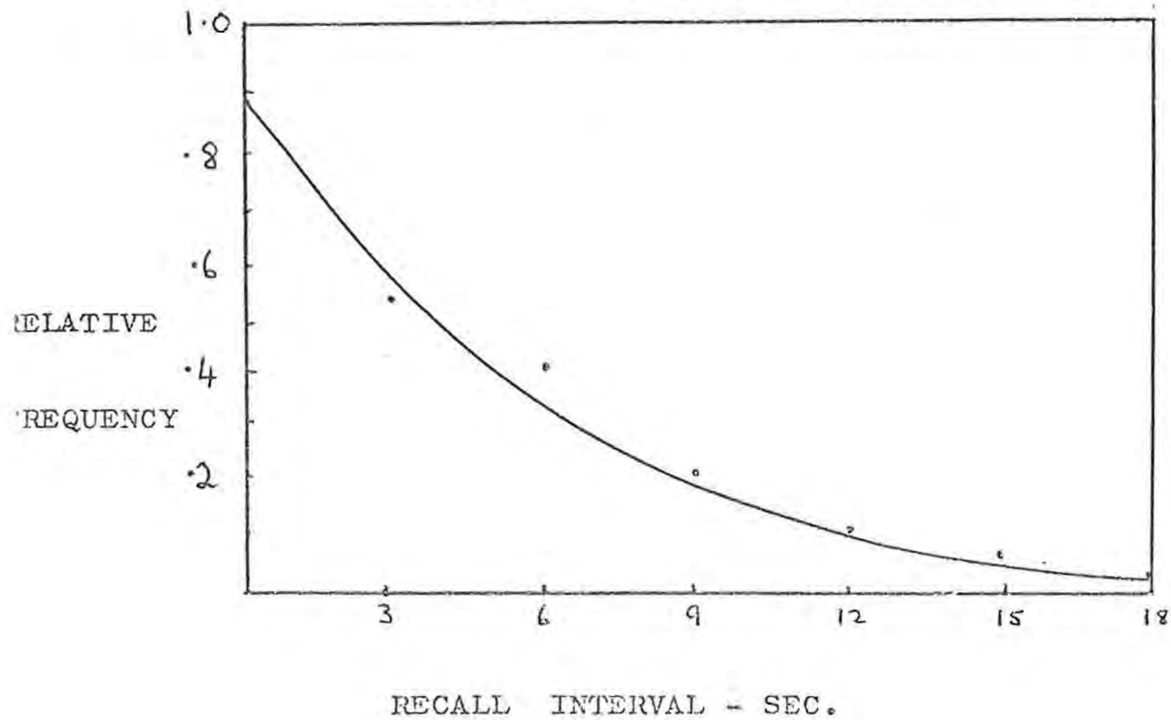
3. AUDITORY SHORT TERM MEMORY

3.I. Introduction

Peterson & Peterson (I959) were the first to discard the Ebbinghaus approach to memory and in doing so set the vogue for further investigations which produced relatively more valuable information on short term memory. Essentially the Peterson experiment was very simple but its importance lay in the novel approach which the authors had adopted. The aim was to examine the retention of aurally presented trigrams with increasingly delayed recall intervals. The results showed a striking decrease in recall with increasing delays, (See Fig, 3).

Figure 3. Delayed Recall.

(From Peterson & Peterson, I959, p. I95)



Murdock (I96I) replicated the experiment and obtained the same results. Further investigations by him led him to assume that recall was a function of message length rather than presentation speed. Pollack (I952), however, found that a fast presentation rate adversely affected recall. These results are directly in contrast with those obtained by Conrad & Hille (I958) who found that the faster the presentation rate, the more improved the recall. As a consequence of these conflicting results, Mackworth (I964) studied the effects of the following four variables with relation to auditory short term memory; (a) type of material; (b) message length; (c) presentation speed and (d) the effect of vocal rehearsal during presentation. She found that there was a significant effect of type of material on recall with digits recalled better than letters, colours and shapes. Message length was also found to be significant and was inversely proportional to recall. Presentation speed interacted with message length such that the longer the message, the less the fast presentation aided recall. It was also found that rehearsal served to combat decay at slow presentation speeds but did not function as effectively at fast presentation speeds. However, not only did the experiment serve to produce the above results, but it also served to throw some light on the nature of the auditory trace. This was important to Mackworth as she had already previously studied the nature of the visual trace and a comparison between the two could now be made. The outcome of the comparison could be crucial in relation to modality recall. Thus, concerning the nature of the auditory trace she concluded that:

> " If the interval between presentations and
> recall of the last correct item at high rates

" represents the mean duration of the auditory trace, this would appear to last about 3-4 seconds, or twice as long as the visual image (Mackworth, I963). It is conceivable that it is more difficult to transfer information to the short-term store from the auditory trace than from the visual image."

(Mackworth, I964, p. 302).

The pertinent feature of the above conclusion involves the duration of the auditory trace and its comparison with the visual trace. It would appear that there exists a pre-perceptual auditory store analogous to the visual pre-perceptual store. However, the duration of the auditory trace is twice as long as that of the visual trace and consequently there may be important implications which might arise from the fact.

3.2. The Precategorical Acoustic Store

Crossman (I958), Crowder & Morton (I969) and indirectly Murdock (I967) all conceived of and substantiated the existence of a pre-perceptual store operating in the auditory modality. Morton (I970) termed this store the precategorical acoustic store (PAS) and utilized it as an important component of his functional model of memory. He envisaged PAS as a store which receives information from the ears. It is conceived of as comprising three components; a store for each ear and a binaural store. Information may be drawn from any one of the stores whilst data within the store may be subject to overwriting and decay. The storage time is estimated at two seconds, a time similar to that proposed by Mackworth but vastly different from Sperling's estimated time. The distinguishing feature of this store, according to Morton, is that it is a pre-processing store of physical energy.

Some of Morton's PAS parameters have been substantiated by Crowder (1969). His investigation of PAS led him to also conclude that the storage time could be estimated as two seconds and that PAS appears to be soley of physical nature and as such is independent of behavioural strategies.

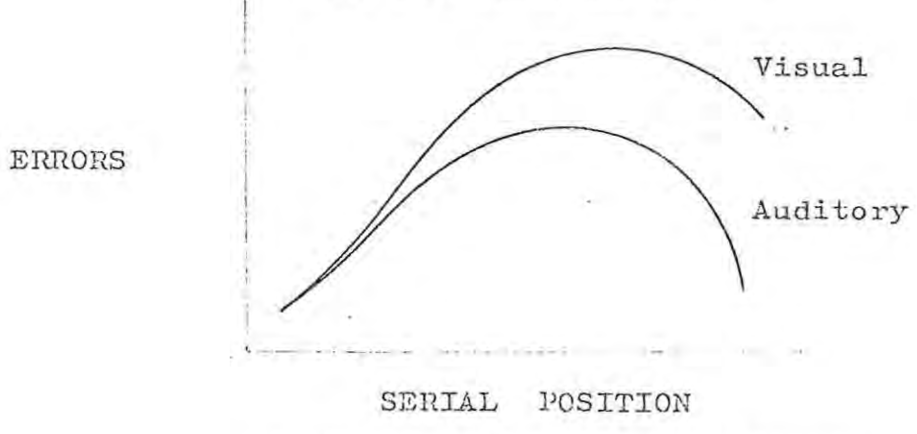
Crowder & Morton (1969) envisaged PAS data as being immediately made available to what they termed categorization i.e. further processing identified with storage in STM. However, a major point is asserted by the authors concerning the outcome of categorization. They state:

> "The outcome of this categorization is identical regardless of the original source of stimulation. That is, the informational content of a symbol once extracted from the preperceptual input, is not different when that input was auditory from when it was visual. In the broad context of language recognition two kinds of outcome appear to be necessary. One of these is coded in an articulatory mode and could (but need not) lead directly to speech. The other outcome of categorization is in a form suitable for long-term processing."
>
> (Crowder & Morton, 1969, p. 366).

Crowder & Morton, therefore, join the group proposing articulatory storage as opposed to acoustic storage in short term memory. This aspect of STM assumes greater importance in the discussion below concerning modality integration.

Returning to the nature of PAS, Crowder & Morton believe that because of its duration, this store is likely to be utilized by the subject during an auditory STM task. The duration of the visual preperceptual store, on the other hand, is believed to be so brief as to be comparatively inconsequential to recall of a similar visual task. Thus, because PAS is capable "of holding information long enough to affect the immediate memory task (Crowder & Morton, 1969, p. 366)," the theoretical serial recall profiles of the two modalities should reflect the influence of this store. The arguement inherent in this modality difference lies with the duration and overwriting features of PAS. Assuming that two seconds is a consequential storage time, then recall of the last few serial positions should be strengthened by this fact plus the fact that distortion of information due to overwriting should be considerably lessened with regards to the penultimate and ultimate serial positions. The visual modality, on the other hand, has no recourse to such an influential store and the recency effect must, therefore, be comparatively weaker than that of the auditory modality. A comparison of the two modalities in relation to visual and auditory presentation of letters or digits is made in the figure below where recall errors are plotted against serial position.

Figure 4. Modality Recall (Reproduced from Crowder & Morton, 1969, p. 366)



Idealized serial position functions for visual and auditory presentation.

Evidence of the above state of affairs was provided by Crowder (I967) and Morton (I968. b.). In these two cases investigation of the Suffix effect (recall of a terminal redundant item) produced data which was consistent with the proposed nature of PAS. It was, for instance, determined that terminal serial positions were less error prone than middle order positions. This was attributed to the influence of PAS on the recency effect produced by auditorily presented material as described above.

Further evidence is provided by Murdock (I965) when he attempted to ascertain the point at which the modality difference occurred. Thus, whilst acknowledging the existence of preperceptual stores, he wanted to determine the "locus of retrieval by comparing retention after auditory and visual presentation of verbal material (p. 206.)". A probe technique used paired associates presented at a rate such that no processing nor rehearsal could occur. Murdock then reasoned that if retrieval was purely from memory then there would be no modality difference since the recalled material would originate from the same source. If, however, retrieval could be made direct from a preperceptual store there would be a significant interaction of retention interval with input modality. The results of the experiment indicated a significant difference in modality recall with the auditory modality demonstrating a stronger recency effect but less primacy and a general overall recall superiority. Murdock concluded that:

> " The implication of these findings would seem to be that retrieval can be either from sensory stores or from memory. Certainly storage cannot be a-historical or modality

"would not have had such a large effect."

(Murdock, I965, p. 2I0).

However, as he points out, "whether the modality effect is due to differences in storage or differences in retrieval is not quite so easy to determine (p. 2II)." Consequently he designed another experiment in an attempt to solve the problem. His assumption was that recognition is a function of storage and as such any difference revealed by a recognition task is a result of the type of storage. Serial presentation of both modalities using a probe technique should, therefore, result in the auditory modality being superior in both recall and recognition. The result was duly obtained and Murdock concluded that:

> "The results suggest, then, that the modality effect represents differences in storage, and that these differences are manifest even when sequential associations are not required."
>
> (Murdock, I968, p.85).

The above results lend support to the contentions of Crowder and Morton. Because the auditory preperceptual store is of a duration that can significantly influence recall whilst the visual store cannot do so, it would be expected that the auditory modality would at least reveal a superior recency effect.

However, it appears from the work of Kaplan, Kaplan & Sampson (I968) that the stimulus material may seriously influence the modality recall effect as cited above. Working with words and pictures, they found superior picture recall. They concluded that whilst both types of stimuli may be encoded in verbal form, the picture is likely to be encoded in both modalities thereby resulting in superior recall. The same does not apply to the word stimulus for as they say :

> "... when S views a picture of an object, he tends to think of its name as well; when he views the name of an object, he does not tend to think of the picture or image of the object."
>
> (Kaplan et al, 1968, p. 74).

The relative influence of PAS, therefore, appears to be subject to certain conditions.

In conclusion, substantiation of PAS and definition of some of its parameters has revealed the important implications which this store may have concerning auditory presentation. It is interesting to note these implications in relation to the acoustic storage school discussed below. In this case it may be speculated that the reason for acoustic storage may involve PAS by way of vocal rehearsal resulting in improved recall and thereby accounting for visual stimuli being stored in acoustic form as proposed by Sperling.

3.3. The Phonemic Model

Sperling & Speelman (1970) developed a phonemic model of auditory STM which was aimed at explaining the capacity of the auditory store with regard to the acoustic properties of the auditory stimulus.

The basic assumptions underlying the model are that when letters are used as auditory stimuli, the phonemes comprising the acoustic properties of the letter are stored independently and are, therefore, subject to independent loss which may subsequently make for guessing from syntactical information presumably stored in long term memory. These particular assumptions were evolved from experiments on acoustic confusability where it was found that letters which were acoustically similar (AS) were more readily confused than acoustically different (AD) letters. It was assumed that the AS letters were placed at a disadvantage in that all such letters had an equivalent final phoneme which was acoustically constant. Thus, discrimination amongst the phonemes of such letters was more difficult than in the case of AD letters where the phonemes were always acoustically dissimilar.

The model is only intended to account for gross similarities among letters as it was created to explain the data obtained from experiments on acoustic confusability using letters as the stimulus material. The memory store is conceived of as having N individual and independent phonemic stores or as Sperling and Speelman term them slots. Theoretically there are an infinite number of these slots available for storage. When a letter consists of two independently stored phonemes, it can only be recalled if one or both of the phonemes are correctly identified or if both are correctly guessed when neither is remembered. Further, the probability of a phoneme being recalled is a function of its storage recency because of the decay factor. There is, therefore, exponential decay with relation to the probability of recall and phoneme recency.

Rehearsal is viewed as a re-introduction of an item into the phonemic store, this time, if necessary, in completed form if guessing of a component phoneme was called for. It is assumed that rehearsal strengthens the probability of recall due to two factors. Firstly, the item is now stored in two sets of slots and must, therefore, be more resistent to loss. Secondly, re-introduction of an item makes it the most recently introduced item at that time and as such has the greatest probability of being recalled.

Sperling & Speelman estimated from experimental evidence that the capacity of the store was 7,5 AD letters plus one post stimulus cue or 4,25 AS letters, thereby substantiating their above assumptions concerning acoustic confusability.

3.4. Conclusion

It can be concluded, therefore, that the auditory modality may operate under the advantageous influence of PAS and that this advantage should be highlighted in the recency effect. One would, therefore, expect there to be a significant difference between the recency effects exhibited by the auditory and visual modalities as concerned in the present study.

The phonemic model proposed by Sperling & Speelman dealt only with the storage of letters in STM and consequently its importance lies mainly with the field of acoustic confusability in relation to that type of stimulus material. At the same time it may be noted that the authors proposed acoustic confusability as opposed to articulatory confusability as suggested by Crowder & Morton.

4. ACOUSTIC CONFUSABILITY

4.I. Introduction

So far the characteristics of visual and auditory short term memory have been dealt with. However, although these modalities were discussed independently, they need not necessarily operate as such. In fact, it would seem that integration of the modalities should provide a more effective storage system and thus an improved recall performance. This chapter, therefore, is concerned with modality integration and its consequences.

4.2. A Model of Visual STM

In pursuing the subject of visual short term memory, Sperling (I966) developed three models in an attempt to incorporate the experimental data at hand. He described his first and basic model in the following way:

> " When a row of letters is exposed briefly, i.e., for I/20th sec, an adult subject can reproduce about 4 or 5 of the letters. The simplest model for the action of reproducing visually presented letters might be organized into two main components: (1) a visual memory containing the letters (called visual information storage) and (2) a translation component, which can translate a visual image of the letters into a series of motor actions; namely, copying the letters onto a piece of paper. ... The limited memory span of the subject might be represented in a model by

> " progressive deterioration - a fading into illegibility - of the contents of visual storage. While the subject is writing, the contents of his visual memory are decaying, so that when he finally comes to write the fifth or sixth letter his visual memory of the stimulus no longer is legible."
>
> (Sperling, 1966, p. 63).

It can be seen that this model assumes that deterioration of the visual image is a variable of time. Thus, as soon as the stimulus impinges on the sensory receptors it must immediately begin to decay. Consequently the strength of the stimulus trace and therefore, presumably the probability of recall, is dependent on the serial position. However, Sperling noted that the subject may combat this effect by mumbling the stimuli to himself as he is writing them down. This state of affairs was found to be most marked when the subject was required to wait for a specific time before recalling the stimuli. Sperling comments that the subject:

> "... repeats (rehearses) the entire letter sequence several times with a pause between each repitition during the interval. Then at the time of writing each letter he may speak it simultaneously."
>
> (Sperling, 1966, p. 64).

Obviously his first model does not account for this phenomena and consequently a further model was developed to incorporate a rehearsal mechanism. However, as this mechanism is to become crucial in his final model, it would be advantageous to digress from Sperling for a moment and take a closer look at rehearsal.

4.2I. Vocal and Sub-Vocal Rehearsal

Rehearsal may be of a vocal or sub-vocal nature. As both methods have been observed it would seem that the choice of method is a personal one. However, extraneous variables may influence tha choice of method. For instance, Sperling (I963) sought to interfere with the auditory rehearsal process by playing loud noise or speech into the subject's ear whilst he was involved in a recall task. As a control there were times when no interference was created. He found that "the number of letters S reported correctly was the same in noise and in silence (p.28)." Recall during speech interference was, however, significantly lower. It was also noted that, in general, the presence of auditory noise produced vocal rehearsal more frequently than in its absence. Two factors may, therefore, be noted; (a) speech interference affected recall more than noise interference and (b) auditory noise produced vocal rehearsal more frequently.

The first factor may be explained in terms of Broadbent's (I958) model of attention. The noise interference was presumably continuous and of relatively homogeneous nature. Consequently, with time, the interfering strength may have declined according to Broadbent's attentive properties. Speech interference may, however, produce different interference effects. Speech is structured and carries more information than pure noise and consequently may arouse attention more so than noise. Further, speech incorporates a large variety of acoustic signals which, after Broadbent, would constitute a greater interference factor than homogeneous noise.

The second factor illuminates the rehearsal process and its auditory nature. The first presumption is that S rehearses in order to better his chances of recall. This he may do by means of silent inner speech. The second presumption is that in the presence of competing stimuli i.e., interference, the role of rehearsal may be defeated as the subject can no longer fully attend to his inner silent speech. He must, therefore, vocalize the rehearsal process in order to affect it more prominence and thereby increase its effectiveness. Murray (1965) found that the advantage of vocal rehearsal is negated unless the volume of vocalization is sufficient to overcome the volume of interference. Thus, in extraneous circumstances vocal rehearsal may prove to be necessary and in fact more effective than sub-vocal rehearsal.

Turning to the situation in which normal circumstances prevail, we find that the issue has not been settled because experimental data has given rise to several contradictions. Corballis (1969) remarked:

> "The question arises as to whether overt rehearsal is likely to differ in any important way from covert or silent rehearsal. There is certainly compelling evidence that rehearsal of verbal items is verbal (Conrad, 1964; Sperling, 1963), so there seems no reason why it should not be spoken aloud rather than silently. Indeed, subjects often do rehearse audibly even when not instructed to do so."
>
> (Corballis, 1969, p.41).

Peterson & Peterson (1959), in fact, found that vocal rehearsal was more effective than sub-vocal rehearsal. Murray (1966) also found that vocalization facilitated recall. Corballis, however, claimed that vocalization impaired recall. Murray (1965) arguing in favour of vocalization, suggested that it may be a means of strengthening the storage of an item. Support for this may be offered in terms of PAS, however, Crowder & Morton (I969) claim that evidence is only circumstantial. They suggest that improved recall may be due to kinesthetic feedback. In general, however, it would appear that vocalization enhances recall to a greater extent than sub-vocalization.

Hintzman (I967) disputes the fact that vocalization is a key factor. He, like Crowder & Morton, suggests that kinesthetic feedback is the prominent factor in rehearsal. His hypothesis is that sub-vocal rehearsal ...

> "... produces small movements and tensions in the vocal apparatus. This activity in turn, produces kinesthetic feedback and it is this feedback, a secondary stimulus trace, which is monitored for retrieval purposes."
>
> (Hintzman, I967, p. 3I2).

Thus, as long as kinesthetic feedback occurs the memory trace will increase in strength . However, kinesthetic feedback must be inextricably entwined with vocal and sub-vocal rehearsal. Consequently it would appear to be very difficult indeed to separate the effects of kinesthetic feedback and vocalization. Hintzman claimed, though, that his previous study (Hintzman, I965) did just that. He found that loud "white" noise did not act to the detriment of recall. He concluded, therefore, that rehearsal was not by means of vocalization as the noise would have interferred with the auditory trace and produced inferior recall. Murray (I965), however, found that noise produced inferior recall unless vocal rehearsal was afforded more prominence. Sperling (I963) found that noise had a tendancy to produce vocal rehearsal. This must be contradictory to Hintzman's hypothesis. Thus, evidence appears to be against Hintzman's claims.

It can be concluded, therefore, that sub-vocal and vocal rehearsal are at least two mechanisms which serve to strengthen the memory trace. However, whether they do so by means of kinesthetic feedback or by the auditory properties of vocalization, is a matter of debate.

4.22 Patterns of Rehearsal

Corballis (1969) conducted an experiment in which eight digits were presented visually and in series. Four of the subjects were allowed to recall freely and six had to recall serially. Analysis of the results indicated that there were basically two ways in which data could be rehearsed. These were grouping and cumulative rehearsal. There appeared, however, to be no statistical difference in recall between the two methods.

Grouping is a strategy whereby incoming data is divided into groups and rehearsal is of the groups themselves instead of individual items. One of the reasons as to why this should strengthen recall is provided by Wicklegren (1964). He assumes that:

> "... rehearsal of two items in close succession strengthens the association between them. It is the rehearsal of an item that takes time. Therefore, the more associations that are strengthened for each item rehearsed, the better. When one rehearses a group of n items he strengthens n-1 direct forward associations (and perhaps (n (n-1) /2) - (n-1) remote forward associations). If no other factor were operative this would imply that the larger the rehearsal group the better because the ratio of strengthened direct (and remote) associations

"to rehearsed items becomes progressively more favourable with increasing size of rehearsal group. This explains why grouping in 3's is superior to grouping in 2's or I's."

(Wicklegren, I964, p. 4I7).

However, experiments have shown that this principle only operates as far as groups of three, after this larger groups produce inferior recall. Wicklegren suggests that this decrement in recall may be due to the fact that the subject does not have the time to rehearse large groups before the next item is presented. Thus, presentation speed could be a factor in determining the size of the rehearsal group. If the presentation speed is slow the size of the rehearsal group must necessarily diminish accordingly. Similarly the size of the group may increase with increase in presentation speed.

Another factor which may determine the effective size of the rehearsal group concerns serial order cues. Wicklegren presumes that:

"... rehearsing in groups introduces two sets of serial ordering cues - the first set corresponding to groups and the second set corresponding to positions within a group."

(Wicklegren, I964, p. 4I8).

In each set, therefore, there are three serial order cues; beginning, middle and end. Thus, if there are three items in a group the above cues may operate at an optimal level of effectiveness but given more items in the group there is likely to be a greater probability of within group position error. The same must, of course, apply to a series of groups. The general role of grouping, therefore, appears to be that of providing serial cues in order to facilitate recall.

Cumulative rehearsal is a strategy whereby the previous items are rehearsed each time a new item is presented, together with the new item. Thus, time once again may determine the effectiveness of the strategy. At the slow rate the subject may have time to rehearse but at the fast rate it becomes increasingly more difficult. In Corballis's (1969) study only one of the six subjects rehearsing cumulatively, was able to rehearse fast enough to account for the entire presentation list. What happens when the presentation speed catches up with the time taken to rehearse a particular number of items, is that the subject tends to neglect new items and on realizing this, drops his rehearsal in order to attend to further items thereby creating a new rehearsal unit. In fact Corballis (1966) conducted an experiment to investigate the time variable and the effect it had on recall. He employed two time conditions: in condition D the inter-digit intervals were initially long and gradually decreased and in condition I the opposite occurred. He assumed that by the nature of cumulative rehearsal (CR), condition I would yield a better recall score because it was more condusive to CR strategy. This, in fact, was found to be the case.

With regards to the purpose of CR, Corballis put forward an explanation similar to that of Wicklegren. He stated that:

> "Cumulative rehearsal probably serves to establish "subjective organization" (Sanders, 1961; Tulving, 1962, 1964) rather than to strengthen the traces of individual items."
>
> (Corballis, 1969, p. 47).

However, it appears that this strategy is dependent on presentation modality. Corballis (1966) found that subjects do not necessarily employ the strategy when presentation is auditory.

CR is, therefore, established as one possible strategy of rehearsal especially when presentation is visual but its effectiveness is determined by the presentation speed.

Grouping and CR, then, are at least two rehearsal strategies which may be employed by a subject when asked to recall a series of items. The purpose in employing these strategies seems, as Brown (1958) states, to reduce the memory load. This is done by providing a more benificial organization of the information by means of serial cues.

As far as acoustic confusability is concerned, these rehearsal strategies point to the fact that rehearsal is of an auditory nature (no matter whether presentation is visual).

4.23 Acoustic Confusability

Having briefly discussed the nature of rehearsal, we may now return to Sperling's model of visual STM. Sperling noted that his first model did not account for the phenomena of rehearsal and consequently a major modification had to be made. He, therefore, describes his second model in the following way:

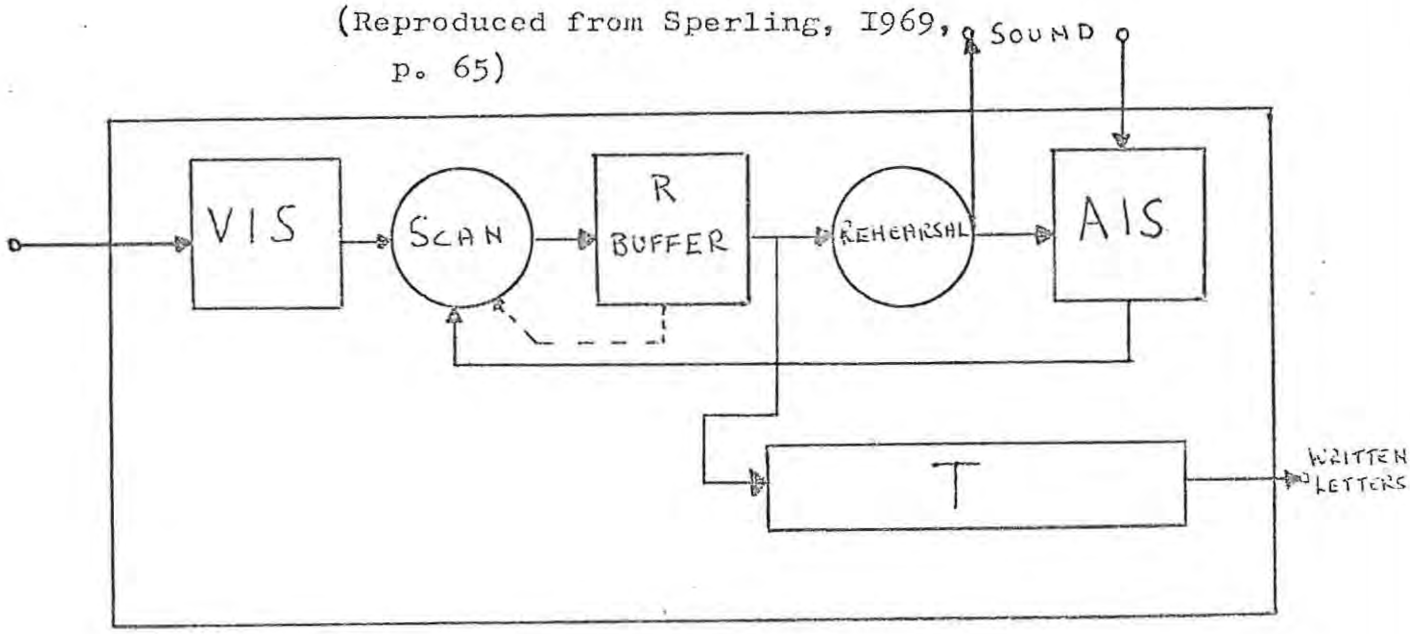
> "According to Model 2, stimulus letters first are retained in visual storage. They are rehearsed, one at a time (i.e., converted from a visual to an auditory form), and then remembered in auditory storage. Subsequently they may be rehearsed again and again as required until they are written down. The limits on performance may arise either from

"the limited duration visual storage (so that some letters decay before they can be rehearsed) or from the limited capacity of the rehearsal-auditory storage loop, depending on the stimulating conditions."

(Sperling, 1966, p. 66).

Sperling's objection to this model was the slow rehearsal speed at which it must necessarily perform. Experimentation had revealed a significantly faster speed of rehearsal. Consequently the third and final model aimed at accounting for a competent rehearsal speed.

Figure 5. Sperling's Model
(Reproduced from Sperling, 1969, p. 65)



MODEL 3.

VIS= Visual Information Store, R Buffer= Recognition Buffer, AIS= Auditory Information Store, T= Translator.

The scan-rehearsal process which was previously handled by a single unit is now divided into three components in an attempt to increase the rate at which information is processed. These three components are the scan, recognition buffer and rehearsal units. The scan component, which has a limited capacity, works in conjunction with the recognition buffer which converts information into a "program of motor instructions" which is then stored. It is this feature that increases the speed at which information can be dealt with, for such programs are presumed to be quick to set up and a number of them may be run at the same time. Rehearsal is then conducted by the rehearsal component with the use of the recognition buffer programs. The rehearsal material is stored temporarily in auditory form after rehearsal and may then be scanned and converted into motor instructions by the recognition buffer thereby creating a rehearsal loop. This loop may function until such time as the response is called for.

Thus, the basic features of the previous model are still adhered to, the only difference being the adaptions necessary to improve the speed of rehearsal.

The above then, is Sperling's model for visual short term memory. But in proving that visual material may be stored auditorily, Sperling came accross the phenomena of acoustic confusability which is the concern of the present chapter. He remarked that:

> "The existence of auditory memory in visual reproduction tasks also may be inferred from the deterioration in performance which occurs when the stimulus letters sound alike (B,C,D, etc.). We have studied a large variety of tasks in which stimuli were presented visually or auditorily and found almost the same rule to apply to both modalities of presentation.

"When the memory load is small (about 2.5 letters in an auditory task, 3 letters in a visual task) it makes little difference to performance whether the stimulus letters sound alike or sound different. Additional letters beyond the minimal number are remembered only about half as well when they sound alike as when they sound different."

(Sperling, 1966, p. 65).

Sperling's suggestion, therefore, is that stimuli with similar sounding names are susceptible to acoustic confusion because, no matter in which modality the stimuli are presented, they are stored temporarily in acoustic form as proposed by his model. Two facts have, therefore, to be proved; (a) that stimuli are, in fact, temporarily stored in acoustic form and (b) that acoustic confusion may occur.

4.24 Evidence of Acoustic Storage

In 1957 Blair conducted an investigation into the visual memory of deaf as opposed to hearing children . He hypothesized that:

"... the visual memory of children severely deaf from early life would differ from that of children with normal hearing experience. In other words it was proposed that a severe deprivation in one sensory avenue such as hearing, might influence the effectiveness of another sensory avenue such as vision. This does not mean visual acuity as we think of it, but rather the mental activity which is stimulated by the act of seeing in this "instance, the memory for certain information presented visually."

(Blair, I957, p. 255).

The results of the experiment indicated that there was a difference in the visual memory of the two groups but that the direction of difference depended on the type of memory task. Blair argued that the superiority of the deaf in the Knox Cube, Memory for designs and Object location tasks, could be attributed to the fact that these tests involved a "visual perception act". On the other hand the memory span tests involved mental abstraction which could be more easily organized with the aid of vocalization which was denied the deaf and thereby led to their inferior performance. The suggestion is, therefore, that the visual material was stored and rehearsed auditorily. Blair's suggestion that the necessity to handle the visual information in auditory form is that it facilitates the organization of the material thereby reducing the memory load and thus increasing the probability of recall. This idea is supported by Glanzer & Clark (I963) who investigated perceptual organization. They found that a verbal description was necessary to recall visually presented line drawings. In fact as the stimulus became increasingly complicated so the necessary verbal description increased in length. From this they developed their verbal loop hypothesis which states that:

"... an S carrying out a perceptual task translates the input-information into words, stores these words, and then uses them as the basis of his final response. ... The hypothesis implies that the extent of the

> "S's covert verbalization (or translation) for a given stimulus-object is critical in determining the effeciency of his performance. For example, if the S uses a long verbalization for a given object, then a short exposure of the object will not permit the S to complete the translation. His final response is therefore likely to be incorrect. Since accuracy of performance with respect to an object often is used to define its "organization" or "simplicity", the verbal-loop hypothesis offers a basis for reinterpretation and reanalyzing "perceptual organization"."
>
> (Glanzer & Clark, I963, p.62I).

Thus, we once again have the suggestion that visual material may be processed auditorily.

Cohen & Granstrom (I966) attempted to provide experimental evidence for the above hypothesis. From their results they concluded that:

> "The positive correlation found between the ability to memorize and the ability to describe (verbalize) supports the view that verbalization plays an important part in memorizing so-called conventional figures, so that the Verbal Loop hypothesis receives experimental support as an actual memory mechanism rather than just a method for quantifying the figures."
>
> (Cohen & Granstrom, I966, p. 383).

Independent studies have, therefore, pointed to the fact that

Sperling's conception of visual short term memory may be correct.

4.25 Evidence of Acoustic Confusability

The critical experiment for Sperling's above conception would be one which could demonstrate that visually presented stimuli with similar acoustic properties would have significantly inferior recall as opposed to stimuli with dissimilar acoustic properties. Such an experiment would kill two birds with one stone as it would prove acoustic storage and the fact that acoustic confusability could occur. This is in fact what Conrad did.

Conrad (I963) investigated Sperling's theory by visually presenting letters that had high in-group confusability and low between-group confusability. The letters used were; B, C, T, V and F, M, N, S, X. These letters were photographed frame by frame on a I6mm film such that each letter was presented for 0,75 seconds with a negligible time lapse between presentation items. The same letters were also used in a separate experiment in which they were presented auditorily. The results indicated that:

> "... the selection of these ten letters was suitable in that confusions are relatively high within the two groups BCPTV and FMNSX and relatively low between them whether presentation was visual or acoustic."
>
> (Conrad, I963, p. 77).

A further analysis of the results revealed that the confusions were not random but that errors were made by substituting letters which sounded like the correct letter. Conrad concluded that "the memory trace, in this kind of situation, has an acoustic or verbal basis is at least convenient (p. 83)."

Conrad's critical experiment, therefore, lends considerable support to Sperling's theory.

Further experimentation by Conrad substantiated his initial results and lent further support to Sperling. Conrad (I964) hypothesized that:

> "... if letters which are acoustically confusing are more likely to be confused in memory, then sequences drawn from acoustically homogeneous vocabularies would be more difficult to recall than those drawn from vocabularies which were acoustically hetrogeneous. It was suggested that the acoustic nature of the vocabulary might in fact be a more important variable in determing memory span than the size of the vocabulary from which the sequences were drawn."
>
> (Conrad & Hull, I964, p. 429).

To test this hypothesis Conrad used four vocabularies of two sizes each of which was divided into two subsets. The vocabularies were;

(a) J, K and N.

(b) C, D, F, H, L, N, Q, Y and Z.

(c) F, S and X.

(d) B, C, D, G, M, N, P, T and V.

These vocabularies were then presented visually by means of a I6mm film at a rate of 80 letters per minute. The results indicated that:

> "... the means of the two 3 letter and of the two 9 letter vocabularies are significantly different at better than the 0.00I level. So that, with vocabulary size (information

"per item) constant, memory span is affected by the probability of acoustic confusion within the vocabulary set. Indeed vocabulary size might seem to be irrelevant, since vocabulary 2 (b) is significantly better than vocabulary 3 (c) (p 0.00I)."

(Conrad & Hull, I964, p. 430).

Thus, one can say that it has been definitely determined that visually presented material may be stored in acoustic form and as such may give rise to acoustic confusability.

Baddeley (I968), who was also of the acoustic school, went on to determine the location of acoustic confusability. In all three locations were investigated; input, storage and retrieval. The storage location was the first to be ruled out as there was found to be no difference in the rate of forgetting between acoustically similar and control sequences. If it did occur at this point one would expect the acoustically similar sequences to be forgotten more rapidly than the control sequences. Consequently the input and retrieval locations were observed more closely. Two hypothesis were made concerning the input location; (a) that the input can be described in terms of sensory traces which would be similar for acoustically similar items and would thus be difficult to discriminate and (b) the input storage encodes raw data for processing in STM. This input has a limited capacity and thus acoustically similar items which are difficult to discriminate may overload the channel to the detriment of STM. It was, therefore, reasoned that if acoustically similar and control sequences were presented together with noise then both systems would suffer. However, it was found that noise did not produce the required result as increase in noise did not predict decrease in recall. Thus, the only location left was that of retrieval. Again two hypothesis were generated. The first concerned Wick-legren's (1965) phonemic association hypothesis which proposes association as a strategy which strengthens recall. However, as acoustically similar items have phonemic similarities this strategy may produce a deterioration in recall. The second hypothesis describes retrieval in terms of a "treasure hunt". Thus, the more similar the items to be retrieved, the more difficult discrimination amongst such items becomes thereby resulting in more recall errors with acoustically similar items. Results indicated that errors occurred on and not following acoustically similar items as the associative theory would predict. Thus, Baddeley tentatively concluded that acoustic confusion arose during recall and could be attributed to the treasure hunt effect.

Hintzman (1965) however, having noted Conrad's work wondered whether:

> "It is possible to infer the particular coding strategies an S has employed from the errors he makes in recall (and also to some extent from verbal reports at the end of an experimental session). This technique was used in the present study to determine (a) to what degree aural coding is evident when another means of coding is available, and (b) whether loud random (White) noise during presentation and recall can interfere with STM and thus force S to abandon aural coding for a non-aural classification strategy."
>
> (Hintzman, 1965, p. 161).

Hintzman's method was to present a randomly ordered sequence of four letters and four digits from a ten letter/digit vocabulary.

Presentation was singly and at a one second rate. The vocabulary was as follows; 2, 3, 5, 6 and 8; Q, T, Y, X and H. Thus, each digit had a corresponding acoustically similar letter. At the same time it was a serial order memory task. The results indicated that:

> "... when S's have an opportunity they will code in several ways. In the present case aural coding is very evident, but classificatory coding also shows up strongly. How classification coding could be attempted is illustrated in one S's report that he had "tried to make mathematical formulas" out of the sequences. This S made few aural confusions. Thus, it appears that the types of errors made depends in part upon the particular coding strategy S adopts. Most S's made both aural and classification errors with high frequency."
>
> (Hintzman, 1965, p. 162).

However, closer analysis of his recall confusions led him to suggest that:

> "... what have been called "aural" or "auditory" confusions are really kinesthetic confusions, arising from similar muscular feedback patterns produced by sub-vocal rehearsal. Since the majority of acoustically similar items are also articulationally similar, virtually all the data showing acoustic confusions in STM can be accounted for by a kinesthetic feedback hypothesis."
>
> (Hintzman, 1965, p. 162).

Hintzman, therefore, basically believes in the acoustic conversion principle but differs as to the point of confusion. In (1967) he designed an experiment to challenge Conrad's interpretation of the matter. He stipulated that there were two ways in which the acoustic confusion phenomena could be interpreted and that this experiment was an attempt to discriminate between them. He stated the two interpretations as follows:

> "The first, the auditory image hypothesis, is that presentation of the visual image immediately brings to mind an associated image of the corresponding auditory stimulus. This image fades out much like the trace of an auditory stimulus and produces effects similar to those found in audition when the signal-to-noise ratio is lowered namely confusions among acoustically similar items."
>
> (Hintzman, 1967, p. 312).

On the other hand, Hintzman's point of view is that:

> "... the S subvocally pronounces or names the visual stimulus and produces small movements and tensions in the vocal apparatus. This activity, in turn, produces kinesthetic feedback and it is this feedback, a secondary stimulus trace, which is monitored for retrieval purposes."
>
> (Hintzman, 1967, p. 312).

Thus, the kinesthetic feedback hypothesis predicts that recall confusions will arise when presentation items have similar places of articulation.

These then, were the two approaches which Hintzman attempted to discriminate between. In order to do so he made use of consonants with and without similar places of articulation, thus creating a crucial experiment. The results indicated that; (a) S's were confusing consonants with similar places of articulation and (b) place of articulation contributed to errors, not as a discrete variable, but as one graded similarity ordered from front to middle to back. Consequently, Hintzman claimed that his feedback hypothesis was the correct interpretation of the confusability phenomena.

However, Sales, Haber and Cole (I969) found that blocking of gross articulatory movement had no effect on the pattern of errors. It was, therefore, assumed that articulation had no effect on encoding and that consequently articulatory movements are not necessary in short-term memory tasks. The authors in fact concluded that recall might be based on an auditory image. However, they pointed out that articulation and acoustics are so interwoven that both may be involved in encoding.

Crowder & Morton (I969), on the other hand, contend that encoding of both visual and auditory information is of an articulatory nature thereby lending support to Hintzman. The authors also add that due to the relatively extensive duration of PAS, it must be unlikely that confusions are due to misinterpretation at input and are, therefore, more likely to be a function of storage and output.

However, Sperling (Sperling & Speelman, I970) suggested that whilst there is no specific evidence to oppose a muscular memory, there are reasons to doubt its existence. It is contended that Hintzman's model would suppose a separate memory store which must consequently result in improved recall because; (a) the memory trace would be strengthened by virtue of the fact that the muscular store would supplement the STM store and would also be possibly affected by different interference variables and (b) if material could be stored in another memory store this would result in the original storage space in auditory STM being freed of the original material and then possibly used by material which supplemented or strengthened the original material. Sperling, however, found the opposite to be the case i.e., (a) that rehearsal reduces memory capacity and (b) as a result both rehearsed and unrehearsed items must be stored in the same auditory store. He further discovered that capacity deficits are independent of presentation rate and therefore of rehearsal. Thus, in this respect as acoustic similarity impairs both rehearsed and unrehearsed items, then they must come from the same store.

Sperling concluded, therefore, that although there may be motor similarities as with acoustic similarities, experimentation pointed to the fact that it is sufficient to designate an acoustic store with acoustic properties and as such there is little evidence or reason to attribute other factors to this store.

4.3 CONCLUSION

The most important feature of the above discussion has been Sperling's model and the evidence related to it. The critical principle of this model entails the conversion of visual stimuli into acoustic form during the storage process. At first a speculation, this principle was later substantiated by the work of Conrad. However, Hintzman claims that his experimental evidence points to the fact that material is encoded in articulatory form rather than acoustic form and has been supported in this by Crowder & Morton. Sperling, however, has disputed the existence of an articulatory storage system. Thus, the issue is still under debate, but for the purposes of the present study the views of Sperling and the supporting evidence of Conrad will be adhered to.

Literature has also been reviewed which is pertinent to the rehearsal and organizational strategies which are found to influence recall performance as these are basic principles and it is such principles that the present study will attempt to verify within a cross-cultural setting.

5. EIDETIC IMAGERY

5.I Introduction

The early 20th Century heralded the discovery of eidetic imagery, a subject which was subsequently vigorously pursued especially by the German psychologists. The Marburg Institute headed by Jaensch became one of the major research centres. Opening up not only a new field of research, but also a new "scientific" experimental approach to Psychology, the subject aroused considerable interest which was eventually to spread throughout Europe and the United States. In an endeavour to account for the phenomena a two prong attack was instituted; the study of eidetic imagery (EI) per se comprised one prong whilst the study of the individual who possessed this form of imagery comprised the other. The energy with which the subject was pursued is reflected in the following quote:

> "Perhaps 200 empirical, semi-empirical and clinical studies, mostly German, have been made of this phenomena, although by I925 as many were being done in this country as abroad. Kluever has been the major reviewer of this work, with extensive reviews in I928, I93I and I932, whilst Jaensch has been the primary systemizer, as a representative of the Marburg School, with a major book in I925 and another in I930."
>
> (Haber & Haber, I964, p. 350).

However, by the thirties the subject had absorbed the energy with which it had been attacked and consequently interest began to wane. As the above authors stated:

> "By 1937, however, interest and research, as judged by publications, had nearly ended, with only 12 papers listed in Psychological Abstracts during the past 25 years."
>
> (Haber & Haber, 1964, p. 351).

The issue, however, was never fully resolved and many of the problems raised continue to be debated to this day.

5.2 Eidetic Imagery Defined

Haber & Haber (1964) defined eidetic imagery as a visual image "persisting after stimulation, relatively accurate in detail, colored positively and capable of being scanned (p. 350)." Kluver (1928) quoted Herwig as having stated:

> "The eidetic image is a subjective visual phenomena which is found in a large number of young people, but much less frequently in adults. If, for instance a person with eidetic imagery is asked to look attentively at an object - regardless of whether it be of two or three dimensions - this person sees the object again either when he closes his eyes or looks at a ground which serves as a background for the image."
>
> (Kluver, 1928, p. 69).

Jaensch described eidetic imagery as images which:

> "... take up an intermediate position between sensations and images. Like ordinary physiological after-images, they are always seen in the literal sense. They have this property of necessity under all conditions and share it

"with sensations. In other respects they can also exhibit the properties of images (Vorstellungen). In those cases in which the imagination has little influence, they are merely modified after-images, deviating from the norm in a definite way, and when that influence is nearly, or completely zero, we can look upon them as slightly intensified after-images. In the other limiting case, when the influence of the imagination is at its maximum, they are ideas that, like after-images, are projected outward and literally seen ... the slightly intensified after-image and the projected, literally visible, memory image are the limiting cases between which the memory image and eidetic images lie."

(Jaensch, I930, p.36)

It can be said, therefore, that the eidetic image is characterised by the following basic features:

(a) its persistence after initial stimulation.

(b) the fact that it is literally seen.

(c) it is as detailed as the original stimulus.

(d) its nature is such that on an image continuum it lies between the after-image and the memory image.

(e) it is most commonly found amongst children.

5.3 The Nature of the Eidetic Image

Haber & Haber (I964) described eidetic images as being:

"... distinguished from memory by the preservation of fine detail (which is usually lost in memory), "by S's report that a visual image still persists after the stimulus has been removed and by the behavior which indicates that S is indeed attending to such an image. Eidetic images have been distinguished from after images by their persistence (after images fade rather rapidly), by their reliability of evocation from even low-contrast stimuli (after images are usually difficult to arouse from such stimuli), by their positive representation of color (after images, especially long ones, are usually negative), by their independence of visual fixation (after images usually require fixation to form, while eidetic images do not), and by the lack of effects of eye- movements during report (after images move with the eye, while eidetic images can be scanned visually."

(Haber & Haber, I964, p. 350).

Thus, from the above definitions and this brief description of the eidetic image, it can be seen that there are indeed a number of points to be discussed concerning the image per se as well as the relation of the image to the after image (AI) and the memory image (MI). In all four major points will be covered:

(a) Colour.

(b) Localization.

(c) Age and EI.

(d) The relation between EI and the MI.

5.3I Colour

Jaensch (I930) believed that the AI task may be employed to single out the eidetiker. The reason given was that the eidetiker perceived the AI not in the complementary but in the original colour. A.L. Allport (unpublished study quoted by G.W. Allport, I928) however, expressed doubt about this contention quoting Kiesow (I924) and Kluver (I926) as reporting no such colour correlation. Consequently A.L. Allport conducted an investigation himself in order to verify the situation. He found that in fact only 8% of his sample (N=24) reported positively coloured AI, and that none of these subjects were found to possess EI. There is, therefore, some doubt as to the validity of Jaensch's contention.

However, turning to the colouration of EI, it would appear that positive colouration is a common characteristic. G.W. Allport (I928) stated that " Eidetic images are supposed to appear in positive colors or without chroma (as does the MI), or in negative colors (as does the AI) (p. 4I8)." This seems to be an indefinite statement but it is nevertheless supported by experimental observation. For the most part, however, evidence points to the fact that positive colouration is most commonly obtained. It would appear though, that positive colouring of the EI may be subject to certain variables. Four dependent variables have been isolated and they are; complexity of the picture; the interest the picture holds; the stability of the image and fixation of the stimulus. G.W. Allport (I928) quoted an experiment by Kluver in which it was found that "the more complicated the picture and the less rigid the fixation, the greater was the tendancy to keep the image in the original colour (p. 420)." This observation was substantiated by Jaensch (I930) and Zeman (quoted by Allport, I928). Jaensch also pointed to the definite selective process concerning the influence of the interest variable. His view was supported by Krellenberg (I922) who also found that interesting material was reported in positive colour. Herwig (quoted by Allport, I928) and Jaensch (I930) have both noted the stability variable, pointing out that the EI is more likely to be stable when positive colouration is achieved. Allport attributes the influence of the fixation variable to cases where negative colouration occurs. He stated:

> "It seems probable that every case of negative EI may be explained by AI aroused through fixation, even though the subject may not have been aware of keeping his attention constant enough to produce the required retinal fatigue."
>
> (Allport, I928, p. 420).

It can be concluded, therefore, that the EI may occur in positive or negative colouration and that the colouration may be due to either psychic or physical variables.

5.32 Localization

The most common characteristic of the EI is that it is literally seen, a fact which is constantly emphasized. It is this property to which localization refers. Initially it was claimed that the image occured as a projection outside of the subject and never within him. However, Allport (I928) suggested that this phenomena was merely a result of the manner in which the eidetic experiment was conducted. He pointed to the fact that the normal procedure was to commence the experiment with an AI task. As a result he claimed that "It is possible that the attitude aroused through the first experiment determines the localization of the EI (p. 42I)." In fact he went so far as to suggest that "there is in reality nothing to account for the phenomenal projection of either the AI or the EI excepting attitude (p. 42I)." In substantiating this statement he quoted Braddock (I924) as saying of the AI :

> "An attitude of one sort may give the AI sharp outline and definite texture ... but as soon as this "objective" attitude becomes ever so slightly critical, the localization ceases to be definite, the outlines blurred, and the image is again essentially soft and insubstantial."
>
> (Allport, I928, p. 42I).

Allport further points out that; (a) it is natural through habit, for the adult to project the image outward and (b) the concrete attitudes of children result in the image being projected in order to "stimulate perceptual data".

Some evidence concerning Allport's views on localization may lie in the work done by Doob (I965). Doob stated:

> "At this point the procedure was drastically changed because most of the S's had been reorting that ordinarily they did not see "pictures" in front of their eyes or themselves- rather they referred just to "pictures" without locating them or more usually, to "pictures in my head"."

As a result of this observation Doob created a category of imagery which he termed "pictorial imagery" (PI). Although he envisaged more in this particular class of imagery, what is of concern at the present moment was the fact that Doob described it as being very closely allied to the eidetic image. Thus, there may be some validity in Allport's arguement concerning localization of the EI.

5.33 Age and Eidetic Imagery

Experimental evidence developed in the Western world has revealed that the incidence of EI is much greater amongst children than amongst adults. Haber & Haber have stated that:

> "Percentages of children said to possess some form of eidetic imagery ranged from 30% to 90%, depending upon the age and population sampled, with a rough average of all studies around 50%. Nearly every investigator has reported that eidetic imagery was common, and that the eidetic Ss could be easily be found among any population of children. Different investigators have reported different peak ages; some have indicated a negative correlation with age, while others have pointed to puberty or shortly before as the age of greatest prevalence. All investigators have reported zero or near-zero frequencies among adults, although, as far as is known, no longitudinal studies have been reported."
>
> (Haber & Haber, 1964, p. 350).

Thus, the age factor probably constitutes the most distinctive feature of EI and could quite likely hold the key to its function.

In order to explain the age parameter the Marburg investigators ascribed to the theory of memory levels. Allport quotes Busse as stating:

> "The AI, the EI and the MI represent progressively higher states in a "teleological continuum". As the individual advances in years he comes to depend more and more upon the higher

"grades of memory, while the lower fall into disuse."

(Allport, I924, p. II3).

Jaensch went even further and claimed that EI is the source from whence arises MI and perception. It was his belief that at first the child has no distinct faculties of memory nor perception but only an undifferentiated conscious which is in fact EI. In defense of this theory Jaensch points to the high incidence of EI and the presence of what seems to be the unitary type (the type of EI in which imagery and perceptions are sometimes confused) in primitive people. In doing so he is, therefore, assigning these primitive people to the developmental stage of children in the Western world. However, in attacking this theory, Allport (I924) points out that before it can be accepted EI must be shown to be universally present amongst all children which at his time of writing had not been done. He further argued that the teleological part of the theory was incorrect for in his opinion incidence of EI did not necessarily decrease with advance in age. He also pointed out that statistics revealed that the age of greatest eidetic ability was between I2 and I5 years and it is consequently unlikely by Jaensch's theory that at this stage the eidetiker only possess EI. Allport then continues by discrediting the basis of Jaensch's theory which must necessarily lie with the existence of a unitary type of EI. His objections are that: (a) AI-like EI which forms a link in the unitary type theory, is nothing but AI due to fixation and (b) that it is an unproved fact that the unitary type exists in any case. He further argues that Jaensch's support for his theory is drawn from anecdotal material concerning primitive cultures which was gathered by explorers and does not, therefore, constitute strict scientific observation thereby lowering the validity of this material. Allport concludes that:

"The mere fact of resemblance between the various types of imagery does not prove that memory and imagination have evolved through lower stages. On the contrary, memory, whether conceived in terms of recognition, or of disposition to repeat responses, seems from the biginning to exist as an independent phenomena. Not all children have eidetic images, and yet all have memory."

(Allport, I924, p. II6).

Allport's attitude towards the role of EI is expressed in the following way:

"The EI seems to serve essentially the same purpose in the mental development of the child as does the repitition of a stimulus situation. It permits the concrete "sensory" aspects of the surrounding world to penetrate thoroughly into his mind."

(Allport, I924, p. II7).

However, as the child grows older the necessity to prolong the image decreases so that by the time puberty is reached " His experience has been broad, and his responses so often repeated that a mere skeleton memory-image alone suffices to facilitate his reactions (p. II8)."

Allport's view seems to be shared by modern day investigators. Haber & Haber, for instance, state:

"Eidetic imagery ... is sufficiently long and "accurate to allow extensive and complete reports of the stimulus to be made without the benifit of the intervening processes described in Sperling's model. Indeed, if eidetic imagery is as prevalent as the literature indicates, then perhaps initially in the life of the child, all translations from stimulation to reports may be through eidetic images, and not until later are the elaborate encoding and rehearsal processes necessary."

(Haber & Haber, 1964, p. 350).

Thus, although most psychologists are in agreement on the prevalence of EI in childhood, the opposite seems to be the case as far as explaining this fact is concerned. The reason probably lies with the fact that some of the old school of eidetic investigators tended to make sweeping conclusions from invalid data.

5.35 Memory and Eidetic Imagery

Jaensch observed that the EI may be like the AI or like the MI and in certain cases may in fact encompass both (i.e., the unitary type) and consequently he envisaged the EI occupying a position midway between the AI and the MI on an imagery continuum. In such a case, because the EI could be similar to the AI, it would be difficult to argue of the EI as being a class of MI. However, Allport believes that this difficulty is created by Jaensch's conception of the unitary type. But as Allport has suggested that no such type exists, the difficulty is readily overcome by him. He in fact argues that the AI is dissimilar to the EI whilst the MI is very similar. He states that "the EI readily show itself to be a special variety of MI (Allport, 1928, p. 424)." His reasons are that:

"(a) both are influenced in content according to interest and other associative determinants;

(b) a brief exposure of the Vorlage serves to arouse both types of image ... ;

(c) the frequency of production conditions the clearness and intensity of both;

(d) the richness and detail of both greatly exceed that of the optimum AI;

(e) the content of both is influenced by preceeding images;

(f) both alter their content within the limits of experience at will;

(g) if colored at all, both tend to retain their original color;

(h) their behavior under condtions of distraction stimuli is the same;

(i) they persist as long as desired, and recur after intervals of time, sometimes bidden, sometimes unbidden;

(j) they grow indistinct and less accurate with disuse;

(k) they may arise spontaneously (i.e. without Vorlage), which of course is never the case with AI."

(Allport, I928, p. 424).

Allport, therefore, concludes that EI is "a member of the general class of MI (p. 424)," though certain features distinguish it in degree.

Doob (I965), on the question of PI, observed that such images "have elements in common with both EI and MI (p. I7)." In fact he went on to remark that "The possibility that PI are nothing more than MI cannot be excluded (p. I7)." Thus, if PI closely resembles EI and if PI may be considered as closely allying MI, then EI must also be allied to MI.

It would appear, therefore, that EI may be viewed as a class of MI. If true then interesting speculations arise. For instance, does EI enhance memory or more specifically will it enhance recall on a short term memory task?

5.4 Recent Studies in EI

Recently Haber & Haber (I964) conducted a survey of I5I school children in the United States whose ages ranged from eight to twelve years. They found that 84 Ss reported at least one image and of these only twelve reported imagery in each of the test cases. Consequently only twelve were classified as EI. This figure constituted 8% of the sample which is a figure vastly different to that quoted in previous research where the figure ranged between 30 and 90%. The authors suggest that the difference may be due to their strict criteria which they claim are lacking in the earlier studies. Thus, although Jaensch claimed that his approach was governed by rigourously strict and scientific methodology, it would appear that he was exaggerating somewhat. On the other hand cultural change may have served to decrease the incidence of EI though this is difficult to imagine if one views EI as a necessary developmental stage in the child's concept formation.

Doob (I964, I965) pursued Jaensch's contention that the incidence of EI was much higher among primitive nonliterate people. In the first study, which was of the Ibo, the two necessary dimensions relating to the above contention were investigated. The dimensions were child/adult and rural/urban. Three eidetic classifications were used; (a) E (detailed imagery), (b) E- (less detailed imagery) and (c) O (no imagery). The results indicated that of the sample (N=45) only 20% could be classified as E and 33% as E-. Thus, overall 53% of the sample reported to have experienced EI. Breaking down these figures, it was found that of the rural group (N=30), 67% reported imagery of which 30% were classified as E. Of the adults in this group (N=I9), 79% reported imagery of which 2I% were classified as E. A further breakdown of the results revealed that of those reporting imagery, a higher proportion belonged to the rural group (p 0.05). There was also no significant difference between the incidence of EI reported by the child and adult subjects in the rural group, whereas the incidence amongst the children of the urban group was higher than that amongst the adults of this group (p 0.05). In the total sample the incidence of adults experiencing imagery was higher in the rural group but there was no such difference amongst the children. Doob concluded that:

> "This exploratory study has demonstrated a high incidence of eidetic imagery in a small, haphazard sample of Ibo. The presence of such imagery decreases slightly with schooling and age but not significantly so from a statistical standpoint. It seems most closely related to residence in a rural rather than an urban area. In the latter area but not in the former, the results roughly parallel those from the West: children, not adults, tend to be eidetikers."
>
> (Doob, I964, p. 36I).

The above study, therefore, substantiated Jaensch's claim that the incidence of EI would be higher among such people and that presumably the age parameter would not apply in their case. The reason, however, is not readily forthcoming. Doob reflected after his Ibo study that:

> "The precise significance of these images within the Ibo culture remains unclear. On the one hand, in this study they lasted, the investigator irregularly noted, no longer than four minutes. Such a mechanism is not very effecient for storing information. On the other hand, many of the informants, when directly questioned, indicated that they are accustomed to revive images long after they have perceived aspects of the external world. For example some stated that before falling asleep and in the dark of their houses they voluntarily recall and "scan" images of the day's activities. Some university students claim to use images of studied materials in replying to examination questions."
>
> (Doob, 1964, p. 362).

It was, therefore, with the purpose of EI in mind that Doob conducted a survey of the East African Kamba people. Using the same method as before, 49 subjects were processed (20 females and 29 males) with ages ranging from 14 to 70 years with a mean of 27.8 years. Initially the same eidetic classifications were employed, but during the experiment a further classification was necessitated. This class of imagery was termed pictorial imagery (PI) and was very similar to EI with the distinguishing feature being that this type of imagery was not projected but kept "in the head" of the subject.

The results indicated that, as in the Ibo study, 20% of the subjects could be classified as E whilst out of the whole sample 39% reported experiencing imagery. Of those subjects tested with PI as a category (N=24), 91% reported this type of imagery. It was further discovered that the Ss themselves distinguished between PI and EI and that PI lasted longer than EI.

Most of the subjects reported that EI was foreign to them and that PI appeared to be a natural phenomena. Subjects also claimed that PI helped them to remember. However, further testing produced contrary results with regards to memory.

Thus, although the results were similar to those obtained in the Ibo survey, the purpose of EI/PI remains unclear. In the light of the preperceptual stores discussed above, many interesting speculations could be made on the function of such imagery but all are quashed by Doob's observation that there was no correlation between EI/PI and memory. For instance, one could view EI as a special type of preperceptual store with a storage duration far exceeding that of even PAS. It would, therefore, be able to directly influence recall and might even do so in spectacular fashion. Further, if Western adults store information in predominantly acoustic form and do not possess EI/PI, then one could speculate that if Africans possess EI/PI then they may store information in predominantly visual form. This in fact could be tested by an acoustic confusability test because if the Africans stored visually they could not be susceptible to acoustic confusion.

One just cannot visualize what appears to be a raw data store of long duration not influencing recall. If this is not its function what is?

6. THE PRESENT STUDY

The literature has, therefore, posed several questions on the subjects of eidetic imagery and short term memory. Consequently the present study was created to investigate the field, in instances treading on new ground and in other instances verifying the results obtained by previous research workers. It was mainly concerned with ascertaining whether the Xhosa subjects reflected the principles of short term memory evolved in the West. It was felt that previous work on eidetic imagery may indicate that the imagery would influence the Xhosa short term memory process in such a way as to produce a deviation from the Western principles.

Although Doab found that imagery (eidetic imagery (EI) and pictorial imagery (PI).) did not enhance memory, it was felt that a more rigorous experimental procedure was needed to fully determine the fact. The nature of EI/PI was felt to be too conducive to the memory process not to influence it in any way. An experiment was, therefore, designed to identify those subjects who possessed EI/PI and ultimately through other experiments, to determine whether imagery influenced the recall procedure in any way. In identifying these people results would also be obtained which could confirm the high incidence of EI/PI among primitive people and the absence of the age parameter. Further experiments would then assess the influence of EI/PI on the memory procedure. This influence could be demonstrated in two ways: (a) by these subjects demonstrating superior recall and thereby, showing that imagery enhanced recall strength and (b) by the subjects reporting that they stored information in visual form, thereby, presumably indicating the influence of imagery on the mode of storage. Here it was hoped that the acoustic confusability experiment would objectively ascertain the mode of storage used by the subject. If he stored information in visual form then he should not be susceptible to acoustic confusion.

Four experiments were, therefore, designed. The first to identify EI/PI, the second and third to assess the recall performance on auditory and visual serial recall tasks and the fourth to see whether the Xhosa subjects, especially those classified as EI/PI, were susceptible to acoustic confusion.

Three groups of subjects were chosen to perform the tasks. First of all, as the study aimed at ascertaining whether primitive adhered to Western short term memory principles, a suitable group had to be selected to represent these principles. Consequently a sample was drawn from an English university population to act as a control group. Secondly a group of primitive people had to be selected with which to compare Doab's results and to determine the universality of the Western principles. Thirdly a Xhosa university group was chose, out of interest, to determine where they stood in relation to the other two groups.

It was assumed that the primitive group (The Red Xhosa Group) would demonstrate the highest incidence of EI/PI and that the age parameter would prove to be absent. If imagery enhanced recall then recall performance would be superior on both the auditory and visual tasks. In the auditory task information would be stored in both modalities thereby enhancing the recall probability and in the visual task the presentation modality would be conducive to the aid of imagery. If imagery influenced the mode of storage then subjects reporting EI/PI would store information in the visual modality. They would then presumably circumvent the detrimental effects of acoustic confusability.

The English university group on the other hand would adhere to the Western principles. They would, therefore, report the absence of EI and presumably PI. They would store information in the auditory modality and consequently be susceptible to acoustic confusion.

These, therefore, are the assumptions underlying the following experiments. Each of the experiments are reported on separately and develop the assumptions in finer detail.

EXPERIMENT I

I. Aim

The aim of the experiment was to ascertain the incidence of eidetic imagery (EI) within each of the experimental groups. These groups were selected such that the influence of both cultural and literacy factors on EI could be studied. This design also afforded an opportunity to compare the present results with those obtained by Doob (I964, I965).

2. Design

The groups concerned in this experiment were intended to be representative of a white student literate population (WS), a black student literate population (BS) and an illiterate Red Xhosa (RX) population. These three distinct groups, with 42 subjects in each group, were subjected first of all to an after image task and then to the EI task.

3. Method

3.I Stimulus Material

A large board, fitted with a stand and painted neutral grey, was used as a background in both the after image and the EI task. Smaller boards measuring ten inches by twelve inches and also painted neutral grey were used to mount the stimulus material. In the case of the after image task these boards were mounted with a coloured square measuring four inches by four inches. The colours used were red, black and blue. In the case of the EI task they were mounted with photographs measuring eight inches by 9,75 inches. These photographs were specially chosen and aimed at satisfying the following criteria:

(a) The objects within the picture should be clearly defined so as to be easily recognisable.

(b) The number of objects illustrated should be a reasonable one so that they could all be scanned easily within the time alloted to the task.

(c) The number of objects should be such as to differentiate between subjects relying on memory and those who experienced imagery.

(d) The cross-cultural factor inherent in the experiment should be carefully considered when selecting the stimulus material. Thus, the material should not reflect a bias towards scenes of a common nature within any one of the cultures involved. The reason for this is that one cannot expect a subject to report on objects which he cannot identify.

With these criteria in mind three pictures were finally chosen. One picture illustrated a Red Xhosa rural scene and another an urban scene. Both of these pictures were in black and white. A further picture, which was in colour, depicted a tribal scene in West Africa.

3.2 The Role of the Interpreter

Language difficulties probably present one of the major problems in cross-cultural research. Ideally the experimenter (E) should be fluent in the language of the culture which he is investigating. However, this ideal condition is rarely met and consequently E usually resorts to the aid of an interpreter (I). But even in this case several problems arise. For instance it is sometimes difficult to translate from one language to another without losing some of the original meaning. This applies particularly to the

African and English languages where there may not even be an equivalent word in one or the other languages. However, besides this problem there is also the problem of test duration. The interpreter method becomes impractical when so much time is spent translating questions and answers especially in relation to the EI task where only a limited amount of time is available to question the subject on the content of his imagery.

The present study, therefore, attempted to circumvent the above problems by training a Xhosa assistant to undertake the experimentation when dealing with the Xhosa groups. This assistant was fully briefed and tested before going into the field. Thus, the author was confident in the ability of the Xhosa E to undertake the task. Nevertheless he was constantly present and acted in a collaborative capacity. His task was to observe the behaviourisms of the subject which were pertinent to the evaluation of EI. In this way he could lend confirmation to the opinion of the Xhosa E.

3.3 Method of Presentation

After the subject (S) had seated himself, the instructions concerning the task were then read to him. Any queries pertaining to these instructions were appropriately answered. The S then placed himself at a distance of approximately 30 inches from the background board. In order to accustom him to the nature of the eidetic image, S was then shown a series of coloured squares which produced strong after images on the board. For this task S was instructed to fixate his eyes on the coloured square for a period of ten seconds. After this time the stimulus was removed but the S was required to continue to fixate on the area where the stimulus had previously been presented. S was then asked whether he could see anything on the board. If he did, he was asked to report on the image and its colour. His answer were duly recorded.

The EI task immediately followed. The S was told that the coloured squares would now be replaced by photographs that would be presented for 30 seconds. During this time the S was required to concentrate on the photograph. He was instructed that he should not necessarily fixate a point as he did with the coloured squares, but could scan the picture within its boundaries. After the picture had been removed, the S was asked whether he could see anything on the board. If he answered in the positive, E then questioned S on the nature of the image. At this stage the conversation was monitored by a tape recorder.

3.4 Scoring Method

Both E's subjectively scored S on the criteria mentioned below. The S was then placed in one of the following categories: EI, if he reported imagery, PI, if he reported pictorial imagery and O if no imagery was reported.

The following criteria were adhered to in ascertaining whether the subject experienced EI or PI:

(a) If S concentrated on the board after the removal of the stimulus it was seen as an indication of the presence of EI. If his eyes had a look of apparent "deep concentration" in them this was taken as an indication of PI.

(b) If S spoke in the present tense it was taken that he was experiencing imagery.

(c) If the S combined (a) above with the action of pointing to the apparent position of an object in the image it was taken as an indication of EI/PI.

(d) If the S appeared to be experiencing imagery and reported the presence of positive colours this was taken as further confirming the fact that he was experiencing EI/PI.

(e) If S could answer detailed questions concerning the stimulus it was taken as an indication of the presence of imagery, EI or PI.

4. Subjects

Only males over the age of I8 years were eligible as subjects. The reason for this lay with the RX group. It was felt that in their case (a) males would be easier to come by and (b) the females would be difficult to handle in the experimental situation.

Three groups of subjects were tested with 42 subjects in each of the groups. These groups were:

(a) WS - a white university group from Rhodes University, Grahamstown. The average age of the group was 2I,3 years. The average educational standard was second year at university. In all cases the home language was English. Members of this group came from homes spread throughout Southern Africa. They were tested in a departmental room allocated to the author.

(b) BS - a black university group from the University of Fort Hare at Alice. The average age was 20,3 years and the average educational standard was second year at university. In all cases the home language was Xhosa as members of this group came from the Transkei. The group was tested in a departmental room at their university and the experiment was conducted in Xhosa.

(c) RX - a Red Xhosa group from the Transkei. They are described by Mayer as:

"The people known as abantu ababomvu, "Red people," or less politely as amaqaba, "smeared ones" (from the smearing of their clothes and bodies with red ochre), are the traditional Xhosa, the conservatives who still stand by the indigenous way of life, including the pagan Xhosa religion. "Red" Xhosa are not just a few picturesque survivals: on the contrary, they are a flourishing half of the Xhosa people today, and are particularly strong in the areas nearest East London."

(Mayer, 1970, p. 4).

In contrast to the university groups, this was an illiterate group. The average age was 34,4 years and they had received no education whatsoever. The home language was, of course, Xhosa. This particular group was tested at a trading store 14 miles east of Iduytwa in the Transkei.

5. Results

5.1 The incidence of Eidetic and Pictorial Imagery

The frequency of each category of imagery and the association of this with the three groups of subjects is presented below in Table I.

TABLE I

Imagery Classification

Group	Eidetic (EI)	Pictorial (PI)	None	Total
White Students (WS)	0	7	35	42
Black Students (BS)	I0	I9	I3	42
Red Xhosa (RX)	8	7	27	42
Total	I8	33	75	I26

X^2 = 27,98, 4 d.f., p 0,00I.

A chi-square analysis of the results revealed a difference between the groups at the 0,00I level of significance.

6. Discussion

6.I Eidetic Imagery

The fact that no subjects in the WS group reported any eidetic imagery was not unexpected. The general implication of EI surveys in the Western societies has been that an age parameter limits the demonstration of EI beyond puberty. The reason is to be found in the basic theory of EI which attempts to explain the function of such imagery. Busse (I920), for instance, described the after image, the eidetic image and the memory image as a "teleological continuum" with the lower forms of memory (i.e.,EI) falling into disuse as age increased. Thus, by the time puberty is reached only the memory image is prevalent. Consequently as the mean age of the WS group was 2I,3 years one would not expect any positive indication of EI.

The above age parameter, however, was long suspected to be absent with regards to primitive peoples. Jaensch (I930) noted that anecdotal material provided by explorers pointed to the fact that EI appeared to be prevalent in such civilizations even amongst adults. Doob (I964) subsequently clarified the situation with a survey of the Ibo people of West Africa. It was found, in this instance, that such imagery did not depend on age. The fact was further borne out in a study by the same author, of the Kamba people of East Africa. The study revealed that 59% of the sample (N=49, 20 females and 29 males) experienced EI. The mean age of the sample was 27,8 with ages ranging from I4 to 70 years.

The literature, therefore, indicated that a large proportion of the RX sample would possess eidetic imagery. However, this was not realised. It was found that only I9% of the sample (N=42) reported EI. The absence of an age parameter, however, was realised. The mean age of the subjects reporting EI was 35 years with a range extending from I9 to 56 years.

In conclusion it can, therefore, be said that the results of the RX sample lend support to the fact that the age parameter falls away in primitive cultures. However, the incidence of EI amongst the Red Xhosa's was found to be much less than that obtained in studies of the Ibo and Kamba people.

No prediction as to the incidence of EI in the BS group could be made because of the lack of comparable data. Perhaps the closest set of results with which a comparison could be made would be those obtained from an Ibo group by Doob (I964). This author found the incidence of EI to be much lower in an urban group as compared to a rural group. It would, therefore, be reasonable to assume that the BS group would reveal less incidence of imagery than the RX group as the former could be termed an urban group and the latter a rural group. However, the assumption was not obtained as the incidence in the BS sample was 23,8% as compared to I9% in the RX sample. A situation which cannot be readily explained although material discussed below in relation to PI may throw some light on the matter. The present sample unlike Doob's, had no female subjects, but as Doob noted no association of EI with sex this fact cannot be called to account for the differing results.

6.2 Pictorial Imagery

A basic characteristic of the eidetic image is that it occurs as a projection outside of the subject. Allport (I928), however, suggested that this projection may be a direct result of the manner in which the eidetic task is normally conducted. He suggested that the procedure used in the after image task may determine the attitude towards the localization of the eidetic image. He, therefore, saw no reason for the EI to occur without projection. Doob (I965) lent experimental support to the suggestion when he discovered that many of his Kamba subjects reported that they did not experience projection but instead referred to an image "in their heads". A consequence of this was that Doob reviewed his eidetic classification and included a class of imagery named pictorial imagery (PI) which he maintained was closely allied to EI. This class of imagery was extensively reported by his Kamba subjects. In fact 9I% of the sample (N=24) reported PI. The incidence of PI in this group, therefore, was greater than that of EI (59%). This situation, however, was not obtained by the RX group in the present study. Of this group I9% reported EI and I6,6% reported PI.

No comparable results exist with relation to the WS group. However, using the age parameter argument one would not expect PI to be reported by the subjects. Nevertheless it was reported, in fact to the same extent as the RX group, viz I6,6% (N=42).

If the BS group was viewed as being comparable to Doob's (I964) Ibo urban group, one would be lead to expect less PI in this group as compared to the RX group. However, the opposite was found to be the case with 45% (N=42) of the BS subjects reporting PI. An explanation could lie with the fact that the subjects were students. Anecdotal material provided by lecturers at their institution, revealed that students often "pictured their notes in their minds" whilst writing exams. Noting that these students had a great amount of contact with the primitive tribal environment in the Transkei, one wonders whether this contact did not pervade their academic environment. In other words they had contact with both cultures and may have used implements of the one culture as an aid to adaptation in the other. Thus, in attempting to adapt to the academic environment, the students may have utilized imagery as a memory aid. If this was in fact the case one would expect them to develop the use of imagery probably to a greater extent than was intended by the primitive society in which it prevails.

It must be concluded from the overall results, therefore, that; (a) both eidetic and pictorial imagery may exist in the primitive societies without an age limit; (b) the incidence of EI reported by the RX sample is very much less than in the case of Doob's (I964,I965) samples; (c) the present results provide a direct contrast to the above results of Doob's if one could assume that the BS group was comparable to the Ibo urban group. However, in this case there seems to be a contaminating factor in the fact that the members of the BS group were students whereas presumably there were no students in the Ibo urban group.

Experiment 2

I. Aim

The aim of the experiment was to ascertain whether principles of auditory short term memory developed in the Western societies, applied equally to the Xhosa groups. Of special interest in comparing the results of the groups involved was the mode and strategy of storage as well as their relative effects on recall.

2. Design

The same three groups of subjects were used as in Experiment I. The presentation of the present task and those involved in Experiments 3 and 4 was randomised, all following Experiment I. The task comprised six experimental trials. Each trial consisted of the presentation of ten three syllable words common to the respective languages. The same words were used throughout but their order was randomized throughout the trials. The presentation speed was one word per second. After each trial, the subject was required to recall the serial order of the words. In order to achieve the aims set out above the WS group was viewed as a control group.

3. Method

3.I Stimulus Material

Ten three syllable words were drawn from each of the languages. The English words were selected from the Thorndike - Lorge book of words and the G count ranged from three to one hundred.

The Xhosa words were submitted by the Xhosa E according to the specifications of the author. All the words chosen were nouns.

3.2 The Role of the Interpreter

The interpreter was trained in presenting the task and assumed the role of the experimenter during the testing of the Xhosa groups.

3.3 Method of Presentation

The subject was asked to seat himself and the instructions were read to him. Once he indicated that he understood these instructions, he was asked to put on a pair of headphones and the tape recorder was started. The tape was pre-recorded and commenced with further instructions and examples which preceeded the experimental trials. If the subject was satisfied that he understood the instructions and examples, the experimental trials were commenced. After each specific trial the tape was stopped and the subject was required to recall the serial order of the presentation items. The results were recorded by the experimenter. At the end of the task the subject was asked certain questions pertaining to the mode and strategy of storage.

3.4 Scoring Method

The results were scored for correct serial position

4. Subjects

See above, (p. 85)

5. Results

5.I Recall Performance

Raw scores of items recalled in correct serial position for each trial are recorded in Appendix I-3. These scores are summarized below to present a description of relative recall performance, (Table 2).

TABLE 2

Mean Number of Correct Responses
Over Each of Six Auditory Trials
(N=42 for each group).

Group	Trial Number						Overall Group Mean
	I	2	3	4	5	6	
White Student (WS)	3,4	3,07	2,55	2,62	2,36	3,I2	2,85
Black Student (BS)	2,I9	2,48	I,7I	2,02	I,95	I,60	I,99
Red Xhosa (RX)	I,I4	I,07	0,93	I,02	I,I0	I,02	I,05
Overall Trial Mean	2,24	2,2I	I,55	I,89	I,8	I,9I	

Analysis of variance showed groups to be a significant factor (p 0,00I), while a pair-wise comparison using the t-test showed that the performance of each group was different to the others (p 0,00I).[I]

Performance across trials did not change due to any practice effect, and the overall group mean is, therefore, a satisfactory index of recall for each group. No learning was expected, of course, as each trial presented a new order of items practiced in the pre-trial session for content learning.

[I] Multiple comparisons using the t-test are appropriate in this case, viz. planned orthogonal comparisons. (Kirk, I968, p.73).

It can be concluded, therefore, that recall was best in the White student group, followed by the Black student group, and with the Red Xhosa group showing the weakest recall. This phenomena is elaborated upon below.

5.2 Mode of Storage

On completion of the task Ss were asked whether they had remembered the words per se or a picture representation of the words. There were, therefore, three ways in which the words may have been encoded; auditorily, visually and by using a combination of both modalities.

The majority of subjects in the WS group reported auditory storage. Of the 42 subjects, 32 encoded auditorily, five visually and five used a combination of the two modalities. With so few Ss reporting the presence of imagery in Experiment I, an analysis of the association of this with mode of storage is of little interest.

In the RX group 30 encoded auditorily, ten visually and two combined the modalities. With a higher proportion of imagery reported in Experiment I, these figures were analysed with relation to eidetic imagery (EI) and pictorial imagery (PI). It was found that of the 30 subjects reporting auditory storage, six were classified as EI, five as PI and I9 as O. Of the two subjects who reported combined modality storage, one was classified as PI and the other as O. The ten subjects who reported visual storage were of particular interest but it was dissapointing to find that only two were classified as EI and one as PI whilst the other seven were classified as O. One would have assumed that those subjects who reported visual encoding would also be classified as EI/PI. In other words it would be assumed that the imagery faculty served a purpose which might be expressed as an effective means of storage during a memory task. Or that the tendancy to image would be carried over to the encoding process during a memory task. However, this was not found to be the case. Of the eight subjects classified as EI, six reported auditory encoding and of the seven classified as PI, five reported auditory encoding. It must, therefore, be concluded that as far as the RX group is concerned there is no correlation between mode of storage and EI/PI classification.

TABLE 3

Association of EI/PI with Mode of Storage in the RX Group

Imagery Class	Recall Mode		
	Auditory	Visual	Total
EI/PI	II	4	I5
O	I9	8	27
Total	30	I2	42

X^2 = 0,023, I d.f. , not significant.

With regards to the BS group, five subjects claimed visual storage, I6 combined modalities and 2I auditory storage. Of the five subjects claiming visual storage, two were classified as EI and one as PI. In the group claiming combined modality encoding five were classified as EI and eight as PI. Of those claiming auditory encoding three were classified as EI and ten as PI. Thus, modality storage cannot be predicted by EI/PI classification. (See Table 4, p.96)

The conclusion to be drawn from the analysis of modality storage is that the majority of subjects tested encoded material in auditory form. However, a relatively greater proportion of the BS subjects incorporated the visual modality into their encoding strategy. It was also concluded that the encoding modality could not be predicted by eidetic classification. Thus, the purpose of such imagery still remains unclear.

TABLE 4

Association of EI/PI with Mode of Storage in the BS Group

Imagery Class	Recall Mode		
	Auditory	Visual	Total
EI/PI	I3	I6	29
O	8	5	I3
Total	2I	2I	42

X^2 = 0,0I, I d.f. , not significant.

5.3 Association of Recall Performance with Imagery of Experiment I.

An analysis was made of the recall performance of subjects classified as EI, PI or O in Experiment I. It was found that in the RX and WS groups there was no correlation between recall performance and eidetic classification. Analysis of the BS results, however, revealed a slight trend which was not, however, statistically significant. It was discovered that the mean recall score for the EI class was 2,I5, the PI class 2,02 and the O class I,73. This tendancy for those classified as EI/PI to demonstrate slightly stronger recall complements the above suggestion concerning the higher incidence of imagery in the BS group. The nucleus of these suggestions is that the BS subjects had a tendancy to utilize and in fact develop their imagery ability. As the use of imagery should be to improve their recall performance, one might have expected the above trend to be stronger.

5.4 Storage Strategy

On completion of the task subjects were also asked how they stored the material. This question related to the storage strategy which the subject employed. The literature revealed two common storage strategies which were grouping and association. These strategies, of course, are identified with the Western subjects and the present instance afforded an opportunity to determine whether they were prevalent in relation to the Xhosa subjects as well.

The main storage strategies used by the WS group were association and grouping. Of the 42 subjects, I5 reported using association, I3 grouping, II no particular strategy and three attempted cumulative rehearsal. Further analysis of the results revealed no statistical difference between the recall scores of those subjects reporting to have used the associative strategy and those who used the grouping strategy. This confirms the findings of Corballis (I969). However, there was a significant difference between the recall scores of those subjects who used the above techniques and those who reported using no strategy in particular. This result would be predicted by Brown's (I958) suggestion that such strategies serve to reduce the memory load and thereby increase the recall strength.

The majority of the BS subjects reported using some form of strategy. The main categories involved were association and grouping with the subjects evenly divided between the two. One factor that came to light was that those subjects who reported using visual encoding to any extent tended to associate the stimuli with the aid of a compound picture. There was, however, no statistical difference between those associating with the use of visual encoding and those grouping with predominantly auditory encoding.

It was difficult to determine the strategies used by the RX subjects because they often failed to grasp the meaning of the questions put to them. No matter how hard E tried the necessary information was not readily forthcoming. However, it appeared, and was substantiated by those who understood the questions put to them, that no strategies were employed at all. In general the subject merely listened to the list of presentation words and then attempted to recall them.

It can be concluded, therefore, that two types of strategies were identified with relation to the WS and BS groups. These strategies were association and grouping and they appeared to have an equal effect on recall strength. It was also statistically demonstrated that their effect produced better recall than if the strategies were not employed. In the case of the BS group the associative strategy appeared to correlate with visual encoding and grouping with auditory encoding. The RX subjects did not employ any strategies at all.

6. Analysis of Recall Profiles

For each group the frequency of correct responses over the six trials was plotted against serial position. The frequencies may be directly compared, as N for each group remains the same. As it is sometimes useful to refer to recall probabilities, the probabilities associated with frequencies are shown in parenthesis in the graphs.

6.I The WS Group

The profile of correct responses of the White Student group is that predicted by theory, and as such, can be used as a control against which to assess the profiles of the other two groups. This profile (See Fig.6) is primarily determined by the rehearsal strategy adopted by the subjects. It is generally hypothesised (Sanders, I96I, Tulving, I962, I964, and Brown, I958) that such strategies serve to structure the stimulus material in such a way as to increase the recall probability. Strategy does not directly influence trace decay but it does serve to strengthen recall by reducing the memory load. Wicklegren (I964) maintained that in the absence of contaminating variables, the size of the rehearsal group is proportional to the recall strength due to the large number of structural associations formed between the items in the group. However, contaminating factors are constantly present. Time, for instance, is a major overlaying factor. The inter-item presentation time may exert a direct influence on the pattern of rehearsal. Wicklegren maintained that the faster the presentation speed, the larger the size of the rehearsal group. However, the number of presentation items must also determine the size of the group. The purpose of any strategy is to reduce the memory load, thus the more presentation items the more the purpose is negated and therefore, the more likely there is to be an optimal group size. In other words the number of rehearsal groups must increase with the increase in the number of presentation items. These two variables must, therefore, interact to determine the size of the rehearsal group. The difficulty then lies with explaining how the characteristic bow shaped recall curve is obtained by Wicklegren's method. Although he fails to define grouping (op. cit.) it is assumed that his underlying assumption pertains to the fact that a group is re-

rehearsed/

hearsed only when the last group item has been presented. In such a case it is difficult, for a start, to believe that no cumulative rehearsal takes place. Secondly, if the group items are rehearsed at the same time such that the rehearsal produces the same recall probability for each item the bow shaped curve cannot be obtained. The reason is that each item must necessarily have the same recall probability and thus a plateau would result instead of a decreasing recall probability curve. Wicklegren admits that presumably middle order or inter-group items would be lost thus accounting for the normal profile but even so what remains is a graph with two plateaus or more, separated by minimum recall points. In fact if there was any differentiation between the recall probabilities of group items, peaks rather than plateaus would occur in the recall profile. Consider n items subjected to group rehearsal. When the n^{th} item is presented the n items are rehearsed each for the first time. Thus, if the group was sufficiently large, the latest presentation items would achieve a better recall probability because of the recency effect whereas the earlier items would be subject to decay and overwriting. If the group was small then the decay factor would decrease in effect and thus the probability of the items being recalled would become equal.

Thus, on the whole, it is difficult to envisage a strategy where at least some cumulative rehearsal does not occur. Further, Wicklegren's grouping assumptions cannot explain the characteristic recall profile.

The recall profile can, however, be explained in terms of cumulative rehearsal (CR) of grouped items. In this case items are cumulatively rehearsed until a saturation point which then determines the size of the rehearsal group. This is the context in which the present author uses the term "grouping".

Corballis (I966), however, states "It is plausible, then, to suppose that subjects do not rehearse cumulatively when presentation is aural, or at least not to the extent they do when presentation is visual (p. 49.)." This information was gained from a design whereby digits were presented aurally and visually with an increasing and decreasing inter-item interval. Corballis assumed that decreasing the inter-item interval would assist CR and that there would, therefore, be a difference in the recall profiles which would express the effect of inter-item interval on CR. The results obtained from the experiment revealed that visual presentation resulted in the two presentation speeds expressing different recency effects. Recall over the last four presentation items was stronger for the increasing inter-item interval condition (I) than in the case of the decreasing inter-item condition (D). Corballis thereby assumed that the stronger recall of condition I was due to the increasing inter-item time which increased the effectiveness of CR. Items presented aurally, however, showed a much smaller difference in the recency effect produced by the two presentation types. Corballis, therefore, assumed that CR did not occur with aural presentation. However, Corballis seems oblivious to contaminating variables which may disrupt the thread of his theory. Firstly, it may be pointed out that only 24 subjects were tested and thus by sampling theory, conclusions drawn from the experimental results must have limited validity. Secondly, the design of the experiment was such as to highlight the different presentation effects especially over the last few presentation items. Thus condition I should produce stronger recall of these items than condition D because of the time available for CR. However, it is over these items that the different peripheral modality storages will tend to effect the recall strength. Various authors have, for instance, estimated the duration of the visual information store (VIS) as between 270msec and two seconds under optimal conditions (Averbach & Sperling, I96I, Mackworth, I962). The corresponding auditory store, on the other hand, has an estimated duration of three to four seconds which Mackworth (I963) claims to be twice as long as the VIS storage time. As a result Crowder & Morton (I969) have theorized that auditory presentation should reflect a stronger recency effect than visual presentation because the auditory store has a storage time which is long enough to directly effect recall whilst the VIS has no such effect. The effect of these modality stores on recall is, in fact, aptly demonstrated in the Corballis experiment. Thus, the differences in recall strength of the last few presentation items for both conditions and modalities may be explained in the above terms. Corballis expected condition D to produce an inferior recency effect in both modalities. However, because this condition was not as inferior as expected with relation to the auditory presentation, he concluded that CR was absent. But consider this situation in the light of the above peripheral stores. The VIS has a storage time which does not directly effect recall. Thus, this fact together with the disadvantages of condition D may lead to a large difference in the recency effect produced by the two presentation conditions. Consequently one may hypothesize that either CR has increased the recall strength of condition I or the disadvantages of condition D plus the ineffectual VIS storage time have decreased the recall strength under this condition. Thus, in fact, what is required in this experiment is a control condition with which to compare the results of the experimental conditions.

In the case of aural presentation Corballis claimed the absence of CR because the recall strengths of the two presentations were similar especially as concerned the recency effect. But in the case of condition D the increasing inter-item interval may aid the recency effect produced by the peripheral store and may, thereby, decrease the difference in recall strength between the two conditions (Note that the largest inter-item interval is I,9 seconds which is within the storage duration of the auditory peripheral store.). It is, therefore, spurious to claim that auditory presentation does not result in the use of a CR strategy. Consequently one must be entitled to use this strategy in order to explain the present recall profile of the WS group.

Consider five stimuli presented serially and being rehearsed by a CR strategy. When the fifth and last stimulus has been rehearsed for the first time, the first stimulus has been rehearsed five times, the second four times, the third three times and the fourth twice. Thus, the strengthening of serial order cues and the association factor would result in the probability of recall decreasing with the serial position of a stimulus item.

In the light of the above consideration, also consider a situation which involves a large number of serially presented stimulus items. As the size of the rehearsal group increases, it does so to the advantage of previously presented items but to the relative disadvantage of the most recently presented item. There must come a time, therefore, when it is no longer to the subjects advantage to increase the size of the rehearsal group. In other words there must be an optimal rehearsal group size. This size may be determined by either or both the number of presentation items or the presentation speed. The presentation speed may determine the group size by preventing a full rehearsal of that group in which case it is of no advantage to the subject to continue to increase the size of the rehearsal group.

These two variables may, therefore, interact to determine the size of the rehearsal group. Thus, if there are a large number of stimulus items the subject may be forced to abandon the first group and create another rehearsal group and these variables would then determine the number of rehearsal groups needed to recall N items.

In the present case it is suggested that the above variables necessitated the creation of two rehearsal groups. It is assumed that the initial rehearsal group incorporated the first five stimuli. The above variables then forced the subject into deciding on whether to create another group. This decision was probably made during the presentation of the seventh stimulus and the new group then incorporated the last three stimuli. The initial decreasing recall probability is then explained by the above argument. The problem at this stage is to explain the increasing probability incurred by the second rehearsal group which is contradictory to this argument. The explanation is achieved by the introduction of a new variable which constitutes the recency effect. This effect overlays the CR strategy and acts to the advantage of the penultimate and ultimate serial positions especially. The work of Crowder & Morton (I969) and Mackworth (I963) which is cited above, introduced the concept of an auditory peripheral store which Crowder & Morton termed the "precategorical acoustic store" (PAS). The duration of this store is such as to directly influence recall. Thus working on this principle, the probability of recall would increase with serial position due to the overwriting factor and the fact that the last two positions constitute increasinly important recently presented serial cues. Working on the CR factor the opposite would, of course, occur. Does the fact that recall probability increases with serial position indicate, therefore, that CR is absent in the present case?

Further, surely if both factors were in operation the recall strength of the last group of items would equal that of the first items of the first group especially since the last group is very small? However, the recall strengths are quite different. The first three items have recall probabilities of 0,68, 0,47 and 0,34 and the last three 0,I3, 0,2I and 0,45. Two points of view may be taken here. One is that the first three items have been rehearsed many more times than the last three and that this fact may determine the differences in recall strength. The second is that CR is absent and that the effect of PAS is not as strong as that of CR on the first few presentation items. An interesting suggestion that arises, therefore, is that the subject may realize the potential recall value of PAS and may thereby utilize its properties either with or without a brief CR strategy. To throw some light on the suggestion what is needed is an experiment which prevents any rehearsal of the last few presentation items. An indication as to the outcome of such an experiment is provided by the Corballis (I966) experiment. As was detailed above, condition D was intended to seriously hinder CR of the last few presentation items. Thus, if this situation was obtained the only way these items could be recalled would be with the aid of PAS. In fact the results obtained by Corballis revealed that for both presentation conditions the auditory recency effect was much greater than the visual. Further, there was not much difference in the recency effects produced by both the auditory presentation conditions although one favoured CR and the other did not. The indication is, therefore, that the properties of PAS may be realized and utilized by the subject.

In conclusion, therefore, the results of this group produced the characteristic bow shaped recall profile thereby strengthening its position as a control group. An interesting suggestion which arose was that the subjects may have relied, to a large extent, on the properties of PAS in order to recall the last few presentation items.

6.2 The BS Group

The recall profile of the BS group is initially similar to the above group but differs dramatically with relation to the recency effect (See Fig. 6). The probability of the BS group recalling the last three presentation items was 0,02, 0,02 and 0,04 as compared to 0,I3, 0,2I and 0,45. Expressed as a frequency of correct responses the figures for the same three positions were: WS group 27, 54 and II4, BS group 4, 5 and II. Thus, these figures tend to highlight the total lack of a recency effect with regards to the BS results. Comparing the proportions[I] of correct

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[I] The proportion of correct responses of the WS group, which is construed as the control profile, was used as an estimate of the population parameter in the standard error term.

responses from each group at every serial position (Blommers & Lindquist, I960,p.3I9), revealed no difference in the recall frequencies as far as the first seven serial positions were concerned. Positions thereafter, however, were all significantly different at the 0,00I level. The problem, therefore, is to explain why the BS group results reveal a total absence of the recency effect.

Two explanations may be put forward. The first assumes that the recency effect was negated by the extent to which the rehearsal group was rehearsed. Thus, it is suggested that the first five or six items were extensively rehearsed to the detriment of further presentation items which were relatively neglected. The probability of recalling further items was, therefore, decreased; (a) by neglect and (b) by overwriting due to rehearsal.

This assumption may also be interpreted in terms of Mackworth's (I962) A-units. Presumably there are X A-units available for storing N items and ideally these units should be distributed evenly between the N items. However, if the X A-units are exhausted by less than N items then N-n items are not effectively stored and consequently less effectively recalled. However, PAS is independent of behavioural strategies and, therefore, the n items, which in this case are the last three presentation items, should be as effectively recalled as in the case of the WS group. That they are not is due to the extensive rehearsal which overides and thereby negates the properties of PAS.

It would be expected from the above argument that the BS group would exhibit stronger recall of the initial presentation items than the WS group. This does apply to the first and second serial positions but not to the others. Does this, therefore, indicate that for some unknown reason the BS subjects needed to use more storage units to obtain the recall strength of the WS subjects?

That more storage units were expended by the BS subjects without a resulting increase in recall strength may be due to the storage modality. Thus, if presentation was in the auditory modality but the subject preferred to store in the visual modality one would expect storage units to be expended by this modality conversion and, therefore, explain the increased expenditure of this group.

Of the 42 subjects in the BS group, 2I claimed that they employed either pure visual storage or a combination of visual and auditory storage. These subjects, therefore, reverted to visual storage to at least a certain extent. Thus, these subjects were viewed as one group and their results were then compared with those who did not employ visual storage to any extent. (See Fig. 7)

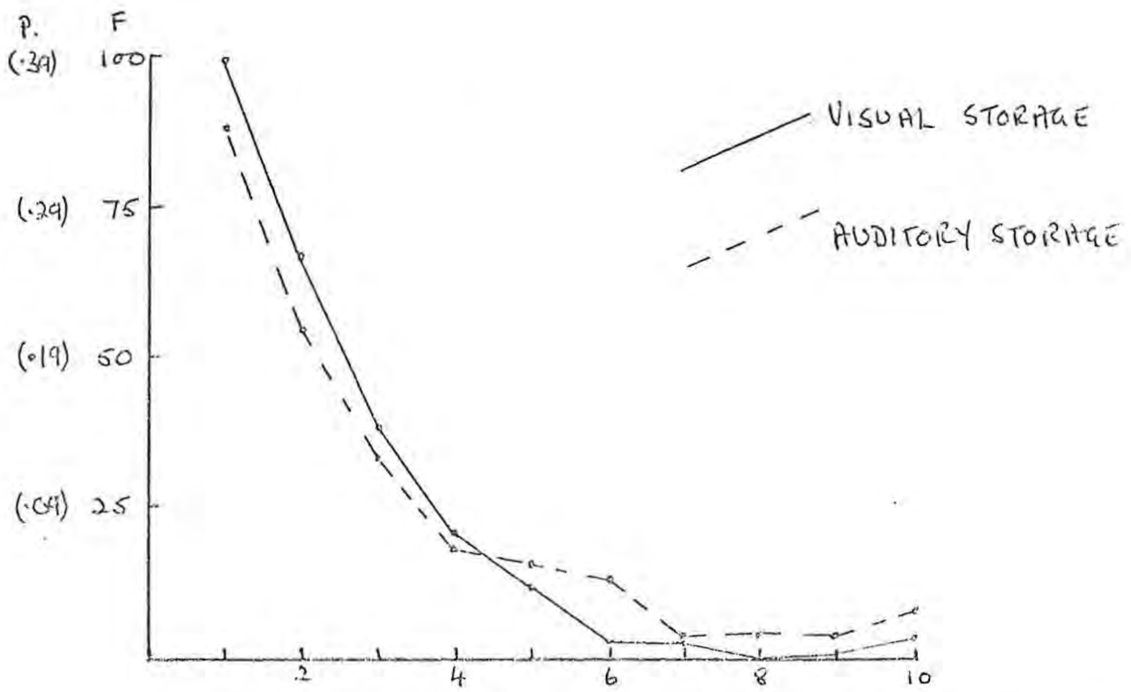


Figure 7. Visual and Auditory Storage Comparison.

However, as can be seen, the above analysis did not reveal much in the way of encouraging data. The most interesting fact concerned the comparative frequency with which the sixth position was correctly recalled. This position appeared to constitute a definite cut off point for the initial rehearsal group. Thus, it can be assumed that whilst the size of the visual rehearsal group was five items, that of the auditory group was six items.

There was an indication, therefore, that modality conversion might result in excess A-unit expenditure which would be reflected in the size of the rehearsal group. In the present case it might be suspected that such expenditure resulted in the loss of rehearsing a further item.

The puzzling feature that still remained, however, was the absence of a recency effect even in the case of those subjects who claimed auditory storage.

The only other assumption that can be made in connection with the recency effect is that the properties of PAS may differ with regards to the present subjects. Some support for this is given by the argument above that these subjects appeared to be using every means available to cope with the academic environment thereby resulting in the increased frequency of EI/PI. One would, therefore, expect them to fully utilize the properties of PAS unless in their case these properties were comparatively ineffectual. However, this is mere speculation at this stage as there is a lack of experimental evidence.

In conclusion, therefore, it can be stated that the results of this group in comparison with those of the WS group differed only with respect to the recency effect. However, the startling absence of a recency effect in the case of the BS group was difficult to explain and calls for further experimentation.

6.3 The RX Group

The recall profile of the RX group differs quite radically from the profiles of the other two groups (See Fig. 6), especially the control (WS) group. The primacy effect is short lived and not nearly as strong as in the case of the other two groups. Whilst middle order recall is similar to the other groups, it too is relatively weak. The recency effect, on the other hand, is very similar to the position obtained by the BS group. Two factors have, therefore, to be explained: one that the primacy effect is weak and short lived and two that the recency effect is absent.

The general trend of the profile and the weak primacy effect may be attributed to the fact that the subjects reported that they did not employ any structural techniques nor did they resort to rehearsal. The relative strength at which the first item was recalled may, therefore, be attributed to its position as a structural cue. The recall probability of items two to six is very similar thereby supporting the assumption that little organisation or rehearsal of these items took place. This fact was supported by further analysis of the results which incorporated the frequency of incorrect responses. It was found that of the responses made, 68,4% of them were incorrect. This would support the notion that no organizational techniques were used. The notion was further strengthened by the fact that only 36,4% of the possible responses were in fact made.

The primacy and middle order effects, in this case, may, therefore, be interpreted in terms of the lack of organizational and rehearsal techniques.

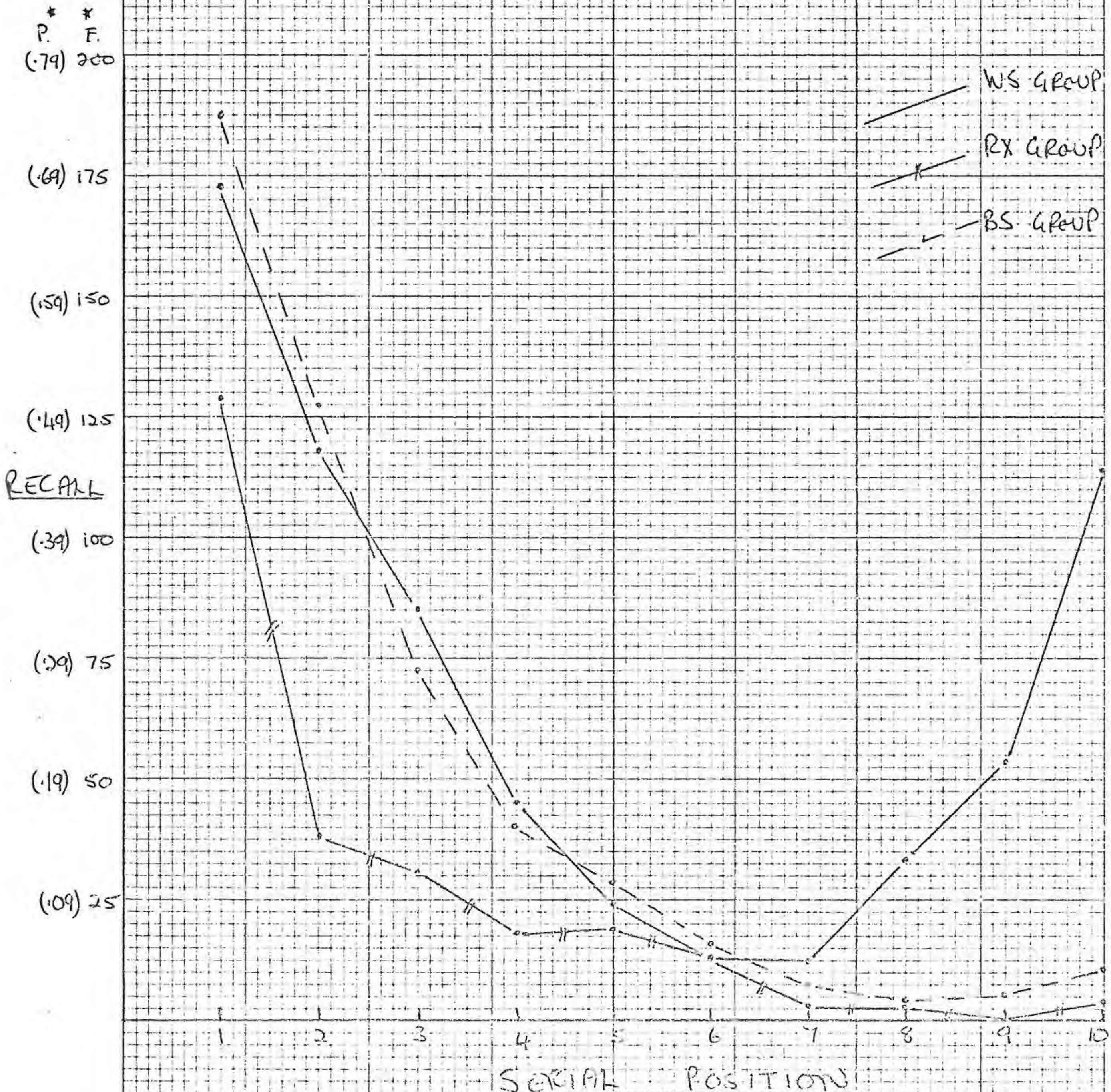
The recency effect is very similar to that of the BS group but it is difficult to explain its absence in the present case. With regards to the BS group one could see that the effect could possibly be negated by rehearsal. However, in the present case the argument cannot apply. The alternative, therefore, is that the Xhosa subjects do not use the same PAS or do not possess the same PAS properties as the WS subjects do.

It is, therefore, of considerable interest that neither of the Xhosa groups revealed a strong recency effect. At the same time it may be noted that these groups revealed a greater incidence of EI/PI as compared to the WS group which demonstrated a strong recency effect. The suggestion, in other words, is that the reason for the absence of the effect may be tied up with the imagery ability of the Xhosa subjects. It would seem that the WS subjects prefer to work in the auditory modality with memory tasks and that this modality is more conducive (i.e.,PAS) to such tasks than the visual modality. However, could it be that the Xhosa subjects prefer to work with the visual modality, a modality which appears to be incompatible with memory tasks?

6.4 Conclusion

Briefly it may be concluded that the WS results demonstrated the characteristic recall profile thereby upholding the memory principles that have been developed in the Western culture. The Xhosa recall profiles, on the other hand, deviated with regards to these principles and especially with regard to the recency effect. From the overall results of these subjects it was speculated that PAS did not operate with the same properties in this case. However, further experimentation is needed in order to substantiate the speculation.

FIG 6 RECALL PERFORMANCE
(AUDITORY TASK)



* P = RECALL PROBABILITY
* F = FREQUENCY OF CORRECT RESPONSES

Experiment 3

I. Aim

The aim of the experiment was to ascertain whether principles of visual short term memory developed in the Western culture applied equally to the Xhosa groups. Of special interest in comparing the results of the groups involved was the mode and strategy of storage as well as their relative effect on recall. Correlation was also attempted between EI/PI classification and performance on this memory task.

2. Design

The same three groups of subjects were used as in Experiments I and 2. The task comprised six experimental trials. Each trial consisted of ten pictures pre-programmed in a different random order on a I6mm film. The objects depicted were common to a rural environment so that they were familiar to the subjects of all three groups. Objects were photographed in colour using a frame by frame technique to produce the sets of pictures. The presentation speed was 0,75 seconds per picture with a negligible inter-item interval. After each trial the subject was required to recall the serial order of the pictures. On completion of the task, the experimenter posed several questions as to the subjects mode and strategy of storage. In order to achieve the aims of the experiment, the WS group was regarded as a control group.

3. Method

3.I Stimulus Material

The ten objects photographed were common to a rural environment.

It was felt that as such, all the objects would be familiar to all the subjects thereby negating the necessity for separate stimuli for each of the language groups and therefore, enhancing the validity of comparing the group results. The objects were photographed in colour in order to reduce the effect that any contaminating recognition factor might have. As far as possible all the objects filled the picture frame to approximately the same proportion.

The objects were also photographed in colour with a 35mm camera and these pictures were mounted on a board. The pictures were used to familiarize the subjects with the stimulus material before any experimental trials were undertaken.

3.2 The Role of the Interpreter

The interpreter was trained in presenting the task and assumed the role of the experimenter during the testing of the Xhosa groups.

3.3 Method of Presentation

The subjects was asked to seat himself and the instructions were read to him. He was then introduced to the presentation stimuli by means of the 35mm photographs. Once the experimenter was sure that the subject understood the instructions and recognised the objects in the photographs, a test trial was run as confirmation of this, and then the experimental trials were commenced. The onset of a trial was signalled by a large black circle which appeared for 2,25 seconds. The stimuli were then presented in serial order the end of which was signalled by a large black triangle. As soon as the triangle appeared the subject was required to recall the serial order of the presentation items. The results were recorded by the experimenter. At the end of the task the subject was asked certain questions pertaining to the mode and strategy of storage.

3.4 Scoring Method

The results were scored for correct serial position.

4. Subjects

See above (p. 85)

5. Results

5.I Recall Performance

Raw scores of items recalled in correct serial position for each trial are recorded in Appendix 4 . These scores are summarized below to present a description of relative recall performance, (Table 5).

TABLE 5

Mean Number of Correct Responses

Over Each of Six Visual Trials

(N=42 for each group).

Group	I	2	3	4	5	6	Overall Group Mean
White Student (WS)	3,24	3,38	3,79	3,33	2,86	3,05	3,28
Black Student (BS)	2,I9	2,29	2,I2	2,38	2,0	2,9	2,3I
Red Xhosa (RX)	I,9	I,7I	I,7I	I,4	I,52	I,69	I,66
Overall Trial Mean	2,4	2,46	2,54	2,33	2,I6	2,54	

Analysis of variance showed groups to be a significant factor (p 0,OOI), while a pair-wise comparison using the t-test showed that the performance of each group was different to the others (p 0,OOI).

It can be concluded, therefore, that recall was best in the White student group, followed by the Black student group, and with the Red Xhosa group showing the weakest recall. This phenomena is elaborated upon below.

5.2 Mode of Storage

The majority of subjects in the WS group reported auditory storage of the visually presented material. Of the 42 subjects, 26 claimed auditory storage, eight visual storage and eight used a combination of the modalities.

In the RX group, I3 claimed auditory storage, 27 visual storage and two used a combination of the modalities. These figures were then analysed with relation to eidetic and pictorial imagery.

TABLE 6

Association of EI/PI with Mode of Storage in the RX Group

Imagery Class	Recall Mode		
	Auditory	Visual	Total
EI/PI	5	Io	I5
O	8	I9	27
Total	I3	29	42

X^2 was not significant.

It was found that of the I3 subjects reporting auditory storage, four were classified as EI, one as PI and the rest as O. Of the two subjects reporting combined modality storage both were classified as PI. The visual storage was the interesting one and it was found that four subjects were classified as EI and four as PI. Thus, looking at it from the other side of the coin, the eight subjects classified as EI were evenly divided between visual and auditory storage whilst of those classified as PI four stored visually, one auditorily and two combined modalities. One would have assumed that imagery would have gone hand in hand with visual storage, however, this only appeared to be the case with those classified as PI where six of the seven subjects used visual storage to at least some extent. Probably PI is more conducive to visual storage during a memory task whereas, by its nature, EI is not. In other words EI has to be projected whereas PI is "kept" in the head.

A further analysis was made which disregarded the mode of storage but concentrated on a comparison of the results of those subjects as either EI, PI or O. It was found that the mean of the EI group was I,7, the O I,6 and the PI I,25. However, there was no significant difference between either of these groups nor between them and the overall group mean. Thus, once again it did not seem that imagery enhanced the subjects recall performance.

A comparison was then conducted between those who stored visually and those who stored auditorily. The mean for the visual group was I,6 and that of the auditory I,5 so there, therefore, was no difference between the groups. Storage modality, therefore, did not effect recall performance.

The majority of subjects in the RX group, therefore, claimed visual storage. Contrary to expectation, however, there did not appear to be a correlation between classification as EI and storage modality. The results, are of course, contrary to Sperling's model which predicts auditory storage.

In the BS group, I7 subjects claimed auditory storage, IO visual and I5 used a combination of the two modalities. Of the IO subjects classified as EI, three stored visually, four auditorily and three used a combination of the modalities. Of the I9 subjects classified as PI, six stored visually, six auditorily and seven used combined modality storage. (See Table 7)

TABLE 7

Association of EI/PI with Mode of storage in the BS Group

Imagery Class	Recall Mode		
	Auditory	Visual	Total
EI/PI	I0	I9	29
0	7	6	I3
Total	I7	25	42

X^2 was not significant.

It was, therefore, once again dissapointing to find that there was no correlation between EI/PI and modality storage.

A further analysis of the results which sought to compare the modes of storage with recall performance, revealed that there was no correlation between mode of storage and strength of recall.

A comparison of the imagery classes also revealed that there was no correlation between any of these classes and recall performance. This was dissapointing as it was expected that EI/PI would aid recall. Thus, once again it must be concluded that the function of EI/PI is obscure.

In conclusion it may be stated that the Xhosa subjects appeared to have a greater tendancy to store material in the visual modality. This is, of course, contradictory to Sperling's model which predicts auditory storage.

5.3 Storage Strategy

The WS subjects were divided between the grouping and associative storage strategies. In all I3 subjects claimed to have used the associative technique and I2 the grouping technique. Of the rest, seven claimed an accumulative grouping strategy and five no strategy at all. Analysis of the results of the above groups revealed no difference as to recall performance. It can be concluded, however, that the majority of subjects attempted to organise the stimulus material in such a way as to aid recall.

The above strategy trend was repeated by the BS group, the majority of whom reported that they either used an associative or grouping technique. Once again there was no difference between the strategies used and recall performance.

Communication and understanding hindered an evaluation of the strategies used by the RX subjects. However, it appeared and was substantiated by the subjects who adequately reported on the matter that little or no strategy nor rehearsal took place.

6. Analysis of Recall Profiles

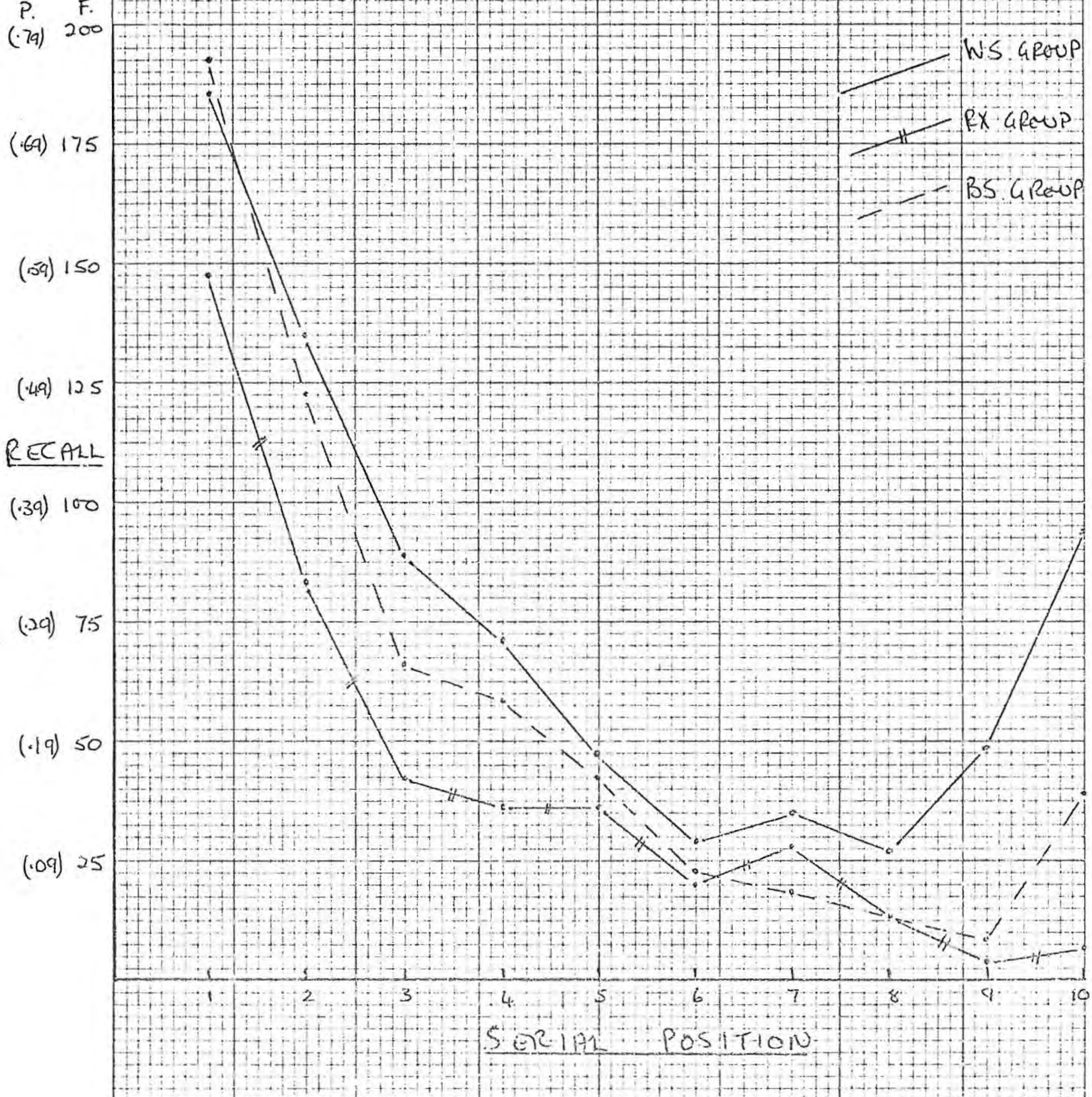
For each group the frequency of correct responses over the six trials was plotted against serial position in order to obtain a recall profile.

6.I The WS Group

The characteristic recall profile was again achieved by the WS group (See Fig.8). There was a strong primacy effect with a decline in recall strength correlating with serial position until the ninth position which came under the influence of the recency effect as did the last serial position. The overall strength of recall was greater than either of the other two groups.

The reason as to how the bow shaped recall curve is obtained was discussed in Experiment 2 above. The only addition that can be made concerns greater detailing of the profile. It was reported by the majority of the subjects that the initial rehearsal

FIG 8 RECALL PERFORMANCE
(VISUAL TASK)



* P = RECALL PROBABILITY

* F = FREQUENCY OF CORRECT RESPONSES

group consisted of the first five presentation items. They then found that the time taken to rehearse a group of this size precluded at least the sixth item from being attended to. This appeared to fluster the subjects who then left the initial rehearsal group to attend to further items but subsequently discovered that they needed to further rehearse the initial group and so returned to it to the detriment of the seventh and eigth items. The subjects appeared to be aware of the recency effect and in fact took advantage of it commenting that they "just relied on remembering" the last two items. The strength of the recency effect can be judged by ranking the frequency of correct recall for all the serial positions. Thus, serial position one was recalled the most times followed by 2, I0, 3, 4, 9, 5, 7, 8 and 6. If in fact the subjects did not rehearse the last two presentation items and just relied on remembering them, the recency effect is quite strong.

However, taking the argument from basics one would not expect such a strong recency effect. Crowder & Morton (I969) argued that the storage duration of the visual pre-perceptual store is inconsequential to the recall outcome whereas that of the auditory store does influence the outcome. How, therefore, is the strong visual recency effect obtained? It might be that it is obtained by the intervention of PAS during the naming process established in Sperling's model. Thus, the naming process may provide "acoustic feedback of the subject's voice, effectively converting visual presentation into auditory presentation (Morton, I970, p. 22I)." Visually presented material which is stored acoustically according to Sperling (I967) may then come under the influence of PAS thereby enhancing the recency effect. This of course only applies in the case of vocal rehearsal. Conrad & Hull (I968) have shown that vocal rehearsal produces a far superior recency effect than sub-vocal rehearsal. Crowder & Morton (I969), therefore, conclude that sub-vocal rehearsal did not involve PAS at all but may incorporate an articulatory feedback instead. The articulatory feedback system must then necessarily operate at a lower level of effectiveness in order to explain the results of Conrad & Hull.

Consequently visually presented material which is sub-vocally rehearsed must reflect a weaker recency effect than auditorily presented material. A recency effect is achieved by the visual material, however, and this is presumably due to the articulatory feedback system.

A contradiction arises, however, in that no significant difference is revealed, according to the chi-square test, between the auditory and visual recency effects exhibited by the WS group. Both modalities were rehearsed in predominantly sub-vocal fashion and as such one would expect a significant difference in the recency effects according to Conrad & Hull. Consequently one can only assume that the role of PAS in sub-vocal rehearsal has not been fully resolved.

Looking at the above situation from another point of view, the stimulus material could have made a contribution. One would for instance, expect a letter or a digit to elicit less connotations and emotive states than a picture of an object. If true, then superficially the picture would be recalled better than the letter or digit because it would be stored in multiple fashion via the connotations and emotive states. However, this would probably only apply in the case where the object was easily recognisable and was the only object in the picture. Thus, if this was the case the probability of recall would be slightly enhanced as would the recency effect, thereby decreasing the difference between the modality recency effects as predicted by Crowder & Morton (Note that these authors base their assumptions on the use of letters and digits as stimulus material.).

In conclusion, therefore, the recall profile of the WS group reflected both a strong primacy and recency effect. It was found that the visual recency effect did not differ significantly from that of the auditory modality and it was suggested that the reason may lie with the stimulus material that was employed.

6.2 The BS Group

The recall profile of the BS group is characterised by a strong primacy effect but a weak recency effect (See Fig. 8). Overall the strength of recall is not as great as in the case of the WS group and this may be attributed to the differences in the recency effects. In comparing the two groups with regard to frequency of correct recall (Using the statistical procedure adopted in analyzing the results of Experiment 2.), there appeared to be no difference in the case of the first six serial positions with the exception of position three which was significantly different at the 0,05 level. The last four serial positions, however, reflected a large difference between the groups which was statistically significant (At the 0,05 level for position 8 and at the 0,00I for the others.). Thus, once again the BS group has demonstrated a weaker recency effect than the WS group. The reasons may be due to the same as those put forward in Experiment 2 where the recency effects of the two groups were compared with relation to the auditory task.

With regards to modality difference, the recall strength of the visual task was significantly stronger than that of the auditory task (t= 2,I p 0,05). However, the comparison of the two modality recall profiles reveals a situation which is different to that obtained by the WS group. The WS group demonstrated a slightly stronger auditory recency effect which was, however, not statistically significant. This situation was attributed to the stimulus material that was employed, as according to Crowder & Morton (I969) the auditory recency effect should be significantly stronger than the visual recency effect. However, in the case of the BS group the opposite is obtained. A comparison of the BS profiles reveals that the visual recency effect is significantly superior to the auditory recency effect. It was found that the seventh and eigth serial positions were significantly superior at the 0,05 level whilst the tenth was significantly superior at the 0,00I level. This constitutes a major deviation from the theory proposed by Crowder & Morton.

Several explanations may be put forward to account for the above state of affairs. Firstly, one may argue in terms of the strength of PAS and the effect of the stimulus material employed. The group demonstrated a very weak auditory recency effect and it was suggested that this may be due to the fact that in this case PAS may be absent as a significantly influential variable or if present, was not capable of exerting a significant influence on recall. It was also argued above that the stimulus material may be of such a nature as to enhance the normally weak visual recency effect as proposed by Crowder & Morton. Thus, if in the present case PAS was absent or of an uninfluential nature then the effect created by the stimulus material create a superior recency effect in the visual modality.

Secondly, it could be argued that, in the case of the BS subjects, the visual preperceptual store exerts a greater influence on the recency effect than PAS whether it be absent or present. The argument would go hand in hand with a proposed function of EI. Thus, if one views EI as being retained by a preperceptual store, the store would be of long duration (possibly longer than the duration of PAS as proposed by Crowder & Morton.) and consequently capable of influencing recall such that the visual recency effect would be stronger than the auditory recency effect. Further, as the auditory recency effect is slight, one is forced to assume that it does not possess the advantageous properties as proposed by Crowder & Morton. Consequently the higher incidence of EI exhibited by the BS group, the greater tendancy to store information visually and the superior visual recency effect may reflect an underlying state of sensory dominance which differs from that of the WS group. Whereas the auditory modality may dominate the memory process of the WS subjects, that of the BS subjects may be dominated by the visual modality.

6.3 The RX Group

The recall profile of the RX group is characterised by a general decline in recall probability with relation to serial position. Although there is a relatively strong primacy effect over the first two positions, the strength of recall decreases rapidly. A major feature of the profile, therefore, is the absence of a recency effect. (See Fig. 8)

The overall strength of recall is considerably weaker than either of the other two groups. The reason probably reflects the advantageous aspects of organizing and rehearsing stimulus material. The group did not use any strategy nor did it rehearse, instead subjects tried to "burn" the presentation items into their heads and consequently paid the penalty when it came to recalling them. One subject, who incidently was classified as a non eidetiker, remarked that he tried to keep the picture in his mind by naming it loudly. His strategy was to keep the present stimulus in his mind in visual form until the next stimulus was presented. Then he would discard the first stimulus and do the same with the next. Eventually when all the stimuli had been presented, he returned to the beginning and tried to conjure up each of the stimuli. He further remarked that he preferred the visual presentation because he could visually retain the stimuli whilst he could not retain the auditory stimuli as they immediately "faded from his mind".

At this stage three aspects of this subjects remarks should be noted; (a) he was not classified as an eidetiker (b) he stored information visually (the loud naming of the picture seemed to be a command to himself to keep the picture in his mind) and (c) he preferred visual presentation because he could retain the stimulus longer than he could retain the auditory stimulus. These points lend support to the theory proposed above with relation to the BS group and the modality recency effect. The subjects remarks accord with the suspiscion that the visual preperceptual store is of a longer duration and of greater influence than PAS.

Nevertheless, the fact remains that recall by the RX group was considerably weaker than either of the other groups and this can be attributed to their lack of strategy and rehearsal.

In comparing the frequency of correct recall with relation to serial position, it was found that the WS group had superior recall (p 0,00I) for all but the fifth, sixth and seventh serial positions. This can be attributed, in the significantly superior cases to the influence of strategy and rehearsal. In the cases where no significant difference was revealed, the middle order effect may be used as an explanation. With regards to the RX group the probability of recall would decrease with serial position because of the lack of strategy and rehearsal. On the other hand recall of the same serial positions by the WS group would not be subject to very influential strategy or rehearsal and therefore, the probability of recall would be nominal and thus equivalent to the RX recall performance.

There is also a considerable difference between the BS and RX recall profiles. Overall the BS group displays significantly stronger recall. This is apparent with regards to all the serial positions with the exception of the sixth, eigth and ninth positions. The sixth position is difficult to explain unless one envisages the first rehearsal group as constituting the first five stimuli and the sixth as being unattended to whilst a decision is being made by the BS subject as to the formation of another rehearsal group. The seventh position reflects the formation of this group which is immediately abandoned. Thus, the BS group may not process the sixth, eigth and ninth serial positions thereby reducing the recall probability to a par with the non-rehearsing RX group. With regards to the tenth position one can only assume that either the BS group has cultured the visual preperceptual store to a greater extent than the RX group or that they made some attempt to process the stimlus.

There are, therefore, occassions where the BS and WS recall profiles coincided with the RX profile, but for the most part they reflected serial positions which had not been processed by these groups and consequently their recall probability had been reduced to that of the RX profile.

Analysis of the srength of recall of the visual and auditory results revealed that visual recall was superior to auditory recall (t= 3,98, p 0,00I). As far as frequency of correct recall and serial position was concerned, there was no significant difference in the recall of positions one, six and ten. That the visual modality reflected an overall recall superiority may be attributed to those aspects mentioned above concerning a subjects comments on recalling the modalities under discussion. Or the results may be interpreted in terms of the findings of Kaplan, Kaplan & Sampson, (I968). These authors proposed that visual recall has an advantage in that the stimulus may be stored in both modalities whereas it is more difficult to visually store an image of an acoustically presented item. As all three groups have demonstrated significantly stronger visual recall this, in fact, may be the case.

With regards to the recency effects, visual recall of the seventh, eigth and ninth serial positions was significantly stronger than the auditory recall (p 0,05). However, there was no difference over the tenth position. Overall it would appear that the visual recency effect is stronger than the auditory recency effect, however, a definite state of affairs is complicated by the comparative recall of the tenth position. But even if there is no significant difference between the modalities for this position the situation is still vastly different to that which arose in conjunction with the WS profile and even more so with relation to the theory of Crowder & Morton. Thus, the indications still are that the RX subjects may have a more influential visual preperceptual store than

PAS.

It can be concluded, therefore, that the RX group exhibited a decrease in recall probability with serial position and demonstrated a lack of a recency effect. The visual recency effect, if measured by recall of the last item, was equivalent to that exhibited by the auditory modality and represents a different situation to that envisaged by Crowder & Morton.

6.4 Conclusion

It can be concluded that the recall profile of the WS group conformed to theory, thereby, substantiating its position as a control group. That a comparison of the auditory and visual recency effects exhibited by this group did not statistically uphold the theory of Crowder & Morton, was attributed to the nature of the stimulus material. Nevertheless, the Crowder & Morton trend was apparent.

The BS group, which comprised of a number of subjects who utilized the visual modality during storage, followed the general trend of the WS group but at a significantly inferior recall strength. The recall profile of this group was characterised by a relatively weak recency effect. This effect, however, aroused considerable interest when it was discovered to be significantly stronger than the auditory recency effect thereby contradicting the theory of Crowder & Morton. It was speculated that this trend represented an underlying state of sensory dominance which differed from that of the WS group. It was, thus, also speculated that the major influential preperceptual store was the visual store and not PAS which had a major influence on the WS auditory recall profile and thus on the comparison of the modality recency effects. In attempting to resolve the problem and at the same time to find a function for eidetic imagery, it was suggested that this imagery originated in the visual preperceptual store and reflected the storage duration and potential influence of the store on recall.

The RX group was characterised by a decline in recall probability with serial position and the absence of a recency effect. This was attributed to the fact that the subjects did not employ any storage strategy nor did they rehearse items in store. It was more difficult to explain the absence of a recency effect. However, if one studies the comments made by a subject which are quoted above, some light is thrown on the matter. The strategy of this subject was to detain an image of the stimulus in his mind (note incidently that this is akin to the PI process) until the next stimulus was presented whereby he would discard the first image and concentrate on detaining the next image. Then after all the items had been presented he would attempt to conjure up the stimuli. This is a cumbersome and muddling process which must take some time and effort. Consequently (a) because there are no serial cues and (b) because recall requires much time and effort, it is unlikely that the subject will correctly recall the last few presentation items. The recency effect was, therefore, very weak and statistically no different to the auditory recency effect. However, the relation between the two recency effects was still considerably different to that proposed by Crowder & Morton.

Experiment 4

I. Aim

The aim of the experiment was to ascertain whether all three groups were susceptible to acoustic confusion. Also of interest was the mode and strategy of storage which the subjects employed.

2. Design

The same three groups of subjects were used as in the previous experiments. The task comprised six experimental trials. Each trial comprised a fixed order of ten pictures each depicting a single object. The serial order of these items was randomized for each trial. The objects depicted were chosen for the acoustic similarities which existed in their names. Due to the nature of the task it was difficult to find ten depictible objects with the above qualities so that of the ten items, five were exclusive to a sub-group and five to another sub-group. Their presentation order, however, was randomized without reference to sub-groups. Two series of acoustically confusable objects were generated; one for each of the language groups. The presentation speed and format was the same as in Experiment 3. The control for the experiment was the visual task (Experiment 3), where acoustic confusability was absent.

3. Method

3.I Stimulus Material

Previous experiments in the field of acoustic confusability employed letters as stimulus material. However, as the present experiment incorporated an illiterate group such material was out of the question. Consequently pictures of objects were chosen instead. In choosing these objects it was kept in mind that they should only be identified by one specific name, that they should be easily recognisable and that their names should be acoustically similar. The objects chosen may be referred to in Appendix 20. These objects were photographed frame by frame on a 16mm film and were in colour. The objects were also photographed on 35mm film and the coloured pictures were mounted on cardboard. These photographs were used to familiarize the subject with the stimulus material prior to undertaking the experimental trials.

3.2 The Role of the Interpreter

The role of the interpreter was the same as that which he assumed in the previous experiments.

3.3 Method of Presentation

The method of presentation was the same as in Experiment 3.

3.4 Scoring Method

The results were scored for correct serial position.

4. Subjects

The same subjects were used as in the other experiments (See Experiment I, p. 85)

5. Results

5.1 Recall Performance

Raw scores of items recalled in correct serial position for each trial are recorded in Appendix 7. These scores are summarized below to present a description of relative recall performance, (Table 8).

Analysis of variance showed groups to be a significant factor (p 0,001), while a pair-wise comparison using the t-test showed that the performance of each group was different to the others (p 0,00I).

TABLE 8

Mean Number of Correct Responses Over Each of Six Confusability Trials (N=42 for each group).

Group	Trial Number						Overall Group Mean
	I	2	3	4	5	6	
White Student (WS)	3,I9	3,29	3,26	2,24	2,83	I,86	2,78
Black Student (BS)	2,I9	2,I7	I,98	2,02	I,7I	I,67	I,96
Red Xhosa (RX)	I,05	I,05	I,2I	0,7I	0,62	0,86	0,92
Overall Trial Mean	2,I4	2,I7	2,I5	I,65	I,72	I,46	

It can be concluded, therefore, that recall was best in the White student group, followed by the Black student group, and with the Red Xhosa group showing the weakest recall. This phenomena is elaborated upon below.

TABLE 9

A Comparison of the Visual and Acoustic Confusable Tasks.

Group	Mean Recall	
	Visual Task	Acoustic Confusable
White Student (WS)	3,28	2,78
Black Student (BS)	2,3I	I,96
Red Xhosa (RX)	I,66	0,92

A comparison of the visual (control) results and the acoustic confusable results revealed that recall of the visual task was significantly stronger for each of the groups (p 0,00I). It can be concluded, therefore, that acoustic confusability was present.

5.2 Mode of Storage

In the WS group 25 of the subjects reported that they had stored material in the auditory modality. Of the remaining subjects four claimed to have stored visually and I3 used combined modality storage.

In the BS group I5 subjects reported auditory storage whilst I9 claimed visual storage and eight used combined modality storage. Of those subjects who claimed visual storage, four were classified as EI and I0 as PI. Of those claiming combined modality storage, four were classified as EI and four as PI. Whilst of those claiming auditory storage, five were classified as PI and two as EI.

TABLE I0

Association of EI/PI with Mode of Storage in the BS Group

Imagery Class	Recall Mode		
	Auditory	Visual	Total
EI/PI	7	22	29
0	8	5	I3
Total	I5	27	42

$X^2 = 3,96$, d.f.= I, p 0,05

Table I0 illustrates the association of the imagery classification of Experiment I with the recall mode reported by subjects of Experiment 4. EI and PI are classed together, and auditory storage is distinguished from visual or visual-and-auditory storage. This association is significant at the p 0,05 level. Subjects who were, therefore, classified as EI/PI tended to store material in the visual modality. However, imagery classification did not correlate with recall strength. There was no difference in recall between the imagery and non-imagery classes.

An analysis of recall and storage modality revealed an interesting result. It was found that there was no difference between recall of the visual control task and the acoustic confusable task for those subjects who either stored visually or used combined modality storage in the present experiment. There was, however, a significant difference (p 0,00I) between the visual control recall scores and the acoustic confusable scores of those subjects who reported auditory storage in the present experiment. It would, therefore, appear that visual storage may circumvent the detrimental effects of acoustic confusability.

In the RX group, 25 claimed visual storage, 6 combined modality storage and II auditory storage. Of the 7 subjects reporting PI in Experiment I, four stored visually, one combined modalities and two stored auditorily. Of the 8 reporting EI, 5 stored visually and 3 auditorily.There is, however, no association between EI/PI and visual storage (See Table II).The majority of those subjects in Experiment I who reported the absence of imagery also stored information in a predominantly visual form. Of the 27, I8 stored visually, two combined modalities and seven stored auditorily. Thus, overall there was a definite tendancy for the members of this group to store information in visual form.

There was no significant correlation between storage modality and acoustic confusability as was found with the BS group. Both those who stored visually and those who stored auditorily experienced acoustic confusability at a significant level (p 0,0I).

TABLE II

Association of EI/PI with Mode of Storage in the RX Group

Imagery Class	Recall Mode		
	Auditory	Visual	Total
EI/PI	5	I0	I5
0	7	20	27
Total	I2	30	42

X^2= I,89, d.f.= I, not significant.

5.3 Storage Strategy

The general trend followed that which was noted in Experiment 3 with regards to all three groups.

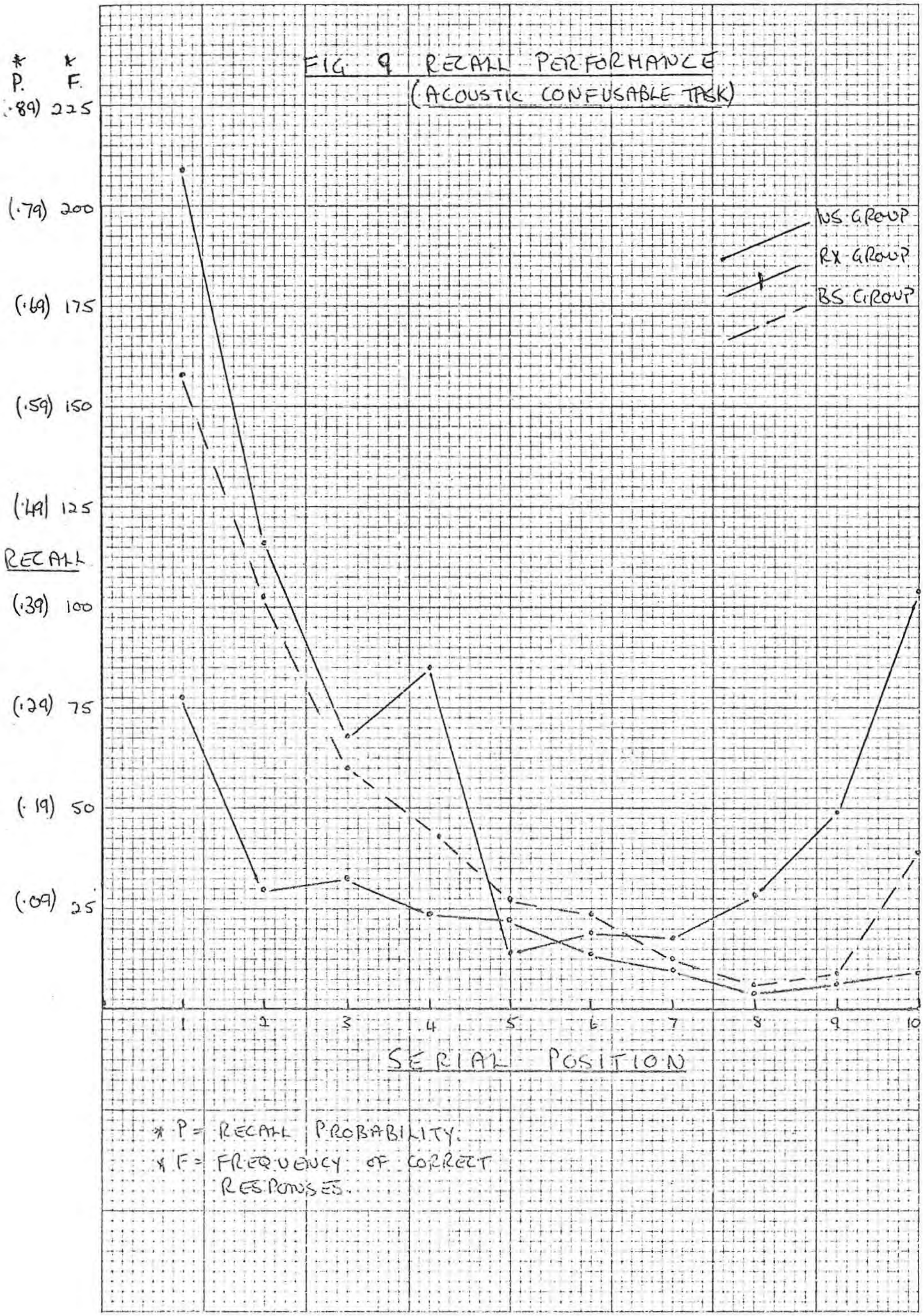
6. Analysis of Recall Profiles

For each group the frequency of correct responses over the six trials was plotted against serial position in order to obtain a recall profile.

6.I The WS Group

The characteristic recall profile was once again obtained (See Fig.9).It is characterised by strong primacy and recency effects and weak middle order recall. The strength of recall is, however, significantly weaker than recall of the visual control task. That this is so must lend further support to Conrad's (I964) findings and ultimately to Sperling's model of visual short term memory. That is that visual stimuli may be encoded acoustically and that acoustic similarities may exert a detrimental influence on recall.

FIG 9 RECALL PERFORMANCE
(ACOUSTIC CONFUSABLE TASK)



A further point to note is that previous work in the field of acoustic confusability (e.g., Conrad, 1964.) used letters as stimulus material. In this experiment, however, photographs were used to produce the same effect.

6.2 The BS Group

The recall profile of the BS group (See Fig. 9) is very similar to their visual task recall profile. It is characterised by a primacy effect, weak middle order recall and in comparison to the WS profile, a weak recency effect. This recency effect is almost identical to that obtained in the visual task. Thus, once again the visual recency effect is superior in strength to that obtained in the auditory task.

A recall comparison between the acoustic confusable task and the visual task revealed that recall of the former was significantly weaker, thereby, indicating the presence of acoustic confusability. However, two major contradictions arise at this point. Firstly, according to Sperling's model, visually presented material is stored in auditory form in STM. But as we have seen this group has a tendancy to store such material in visual rather than auditory form. The question as to why they do so may revolve around the high incidence of imagery reported by this group. If we cannot exactly pinpoint the function of imagery we can propose that imagery may encourage visual storage in STM. Although such storage does not produce superior recall when compared to those in this group who store auditorily, subjective reports indicate that those subjects storing visually believe that such storage is stronger than auditory storage.

The second contradiction involves acoustic confusability.

According to Sperling's model, acoustic confusability occurs as a direct result of acoustic storage. Thus material which is acoustically similar should be susceptible to confusion either during rehearsal or retrieval. Consequently material which is stored visually may not be open to acoustic confusability, although one could probably argue that it may be open to visual confusability. However, in the present case, because of the divergent visual forms, visual confusability must be ruled out. The question still remains, therefore, as to how the recall of this task is significantly weaker than recall of the control task, taking into account the tendancy for subjects in this group to store visually. As the serial order of the tasks themselves was completely randomized, fatigue or practice effects may be ruled out. Thus, what remains is the bare fact that the acoustic confusable task was recalled to a weaker extent than the visual task and yet in both cases there was a tendancy towards visual storage. We can only assume that somewhere, somehow, acoustic confusability did arise even though the information was stored visually. A clue as to how confusability may have arisen might be found in Baddeley's work (Baddeley, 1968). Baddeley determined the point of acoustic confusability to be the retrieval process on the understanding that the more similar the items to be retrieved the more difficult it is to discriminate between such items and, therefore, the more errors that occur. He is presumably referring to acoustic similarities and acoustic storage. Thus, although his underlying principles may not concern us here, his major one of retrieval being the focus of confusability may do so. As information was stored visually there must, at the retrieval stage which Baddeley refers to, be little chance of discriminative error. However, recall must necessarily be of an auditory nature and, therefore, at some stage during the retrieval process the visual image must be translated into acoustic form. It is suggested that it is at this stage of the proceedings that acoustic confusion may occur.

Recall in the auditory modality must at some stage force the subject to abandon his visual images and translate them into auditory form in preparation for recall. Because this is the first time that the auditory trace has been laid down and because it is susceptible to trace decay, rehearsal must take place to reinforce the probability of correct recall. Rehearsal in this modality may be even that much more necessary as this group preferred visual storage rather than auditory storage. Bearing the above factors in mind a number of outcomes may be possible.

One may postulate that the subject may translate all the visual images into auditory form, discarding the imafes completely, and then concentrate on rehearsing the auditory form. This would take place immediately prior to recall. Acoustic confusability would occur in the normal fashion.

It may also be possible that the subject may follow the above procedure but retain the visual images which would be replaced as the first source of reference by the auditory form. The reason behind retaining the visual form would be a safegaurd against losing the whole sequence during the translatory period. The visual form may then also act as a cross-reference. Confusion may then occur in either or both of the following ways; (a) cross-reference itself may lead to confusion even when the memory traces are not of an acoustically confusable nature and especially so when they are. During this procedure the subject must monitor two sequences of different modalities in order to check the serial positions in the auditory sequence. The auditory sequence must be rehearsed because of its recent formation, whilst the cross-referencing is in progress. Thus, the subject must attempt to cross-reference the two modality sequences and rehearse the recently formed auditory sequence. Consequently it is difficult to envisage the subject correctly recalling the final serial positions in the time available to him. (b) the cross-referencing process must be further complicated when the auditory traces are acoustically similar as the acoustic confusion variable may then intervene to the detriment of recall.

Both the above processes take place immediately prior to recall but the translatory process might also be reserved until the recall process actually takes place. In this case one may postulate that the subject might simultaneously sub-vocally review the visual sequence and recall it. Such a process would also be open to acoustic confusability.

There are, therefore, a number of possible ways in which acoustic confusability may occur even though the material was stored visually. The principle reason being that recall must be in the auditory modality and as soon as this modality is resorted to the acoustic confusable variable comes into operation.

The question is though whether material may be stored in visual form without any aid from the auditory modality. It will be noted above that the presumption is that material is stored in pure visual form and as such acoustic confusability only arises immediately prior to or during the recall process. Auditory storage is reinforced my sub-vocal or vocal rehearsal. Without this rehearsal mechanism the auditory trace would decay. The above presumption must assume that either the visual trace does not decay as rapidly as the auditory trace or that visual rehearsal is a possibility. It would be difficult to pass judgement on either. That visual storage is a possibility, however, may be indicated by the high incidence of imagery reported by this group. There may be a drawback in correlating the two for images are susceptible to overwriting and, therefore, so must be ten serially presented stimuli that are stored visually. This is overcome, however, by the subjects reporting that they used a compound picture technique. Thus, as each stimulus was presented, it was added to the picture in the visual store which was a compound of all the stimuli presented. In this way only one picture needed to be retained. That this is a possibility is again indicated by the stimuli presented in Experiment I which were, of course, compound pictures. An interesting speculation would concern the formation of EI/PI with relation to serially presented visual material whether compounded or kept separately. Normally EI/PI is generated by a stimulus with a presentation time of at least ten seconds. Could such imagery be generated by the stimulus presentation time in the present experiment? It appears doubtful that EI could be generated by such a limited stimulus duration. However, the type of imagery which we must be relating to in this experiment is PI and as little has been done to clarify the parameters of this imagery we cannot dismiss the fact that it may be generated by a limited stimulus duration time. In support of the suggestion that visual storage may have been by means of PI, we have the correlation between imagery classification and storage modality. It will be remembered that of the I9 subjects classified as PI, I4 utilized the visual modality in storing material. Could the material have been stored, therefore, with the aid of

PI. If it could it would help us to explain the prolonged duration of the visual image which is suggested above. However, a possible argument against PI storage would be that with such storage duration few mistakes should be made in recall even in an acoustic confusable task. If the image is stable and prolonged the subject may have an extensive period in which to recall the presentation items and would not, therefore, be hurried into making potentially incorrect responses. Further acoustic rehearsal would not be necessary, thereby, circumventing the main source of acoustic confusability. However, as there has been no indication of imagery enhancing recall, PI storage may not be as perfect a storage mechanism as one would think.

In concluding overall, therefore, it was substantiated that the BS group was susceptible to acoustic confusion even though a large number of them reported visual storage. It was suggested in the case of visual storage, that acoustic confusion took place immediately prior to or during recall. The reason was that it was at this stage that an auditory translation was necessary for recall and that this translation became immediately susceptible to acoustic confusion. In explaining prolonged visual storage it was suggested that PI may be the accounting factor.

6.3 The RX Group

The recall profile of the RX group is characterised by a relatively weak primacy effect, weak middle order recall, and a recency effect which is relatively slightly stronger than that exhibited in the recall profiles of the other tasks. An analysis of the results revealed the recall strength of this task to be significantly weaker than the recall of the visual control task. It can be concluded, therefore, that acoustic confusion must have been a factor which resulted in the significantly weaker recall of the acoustic confusion task.

A comparison of the recency effects exhibited by the auditory task and the present task showed the latter to be slightly stronger. The frequency of correct recall over the last four serial positions was higher in all cases for the confusability task with statistical significance being attained by the seventh and ninth serial positions (p 0,05). This situation is, once again, contradictory to that proposed by Crowder & Morton. It may, therefore, lend further support to the notion that these subjects possess a stronger visual peripheral store as opposed to PAS.

With regards to acoustic confusability the case appears to be very much the same as with the BS group. It was determined that 31 of the subjects utilized visual storage and yet acoustic confusion was evident. It is suggested that the arguments concerning this fact are the same as those relating to the BS group.

Overall it may be concluded that all three groups demonstrated acoustic confusion. The reasons, however, differ considerably. The WS group was characterised by auditory storage and was, therefore, susceptible to acoustic confusion during rehearsal and retrieval. The Xhosa groups, on the other hand, stored in predominantly visual form and as such should have circumvented acoustic confusion. That they did not was attributed to the fact that recall necessitated an auditory translation either immediately prior to or during recall and it was at this stage that acoustic confusion may have intruded.

5. A MODEL OF STM

The purpose in conducting the present study was primarily to ascertain whether principles of short term memory developed in the Western culture, were equally applicable to the Xhosa culture. Previously Jaensoh (1923) and Doob (1964,65) had speculated that the reportedly high incidence of EI amongst primitive illiterate peoples, regardless of age, may indicate a different way in which information may be stored. It was assumed that EI might encourage the subject to store information in visual form as opposed to the characteristic auditory form observed in the Western culture. If this were the case then one might expect the Xhosa subject to; (a) be exempt from the phenomena of acoustic confusion and, (b) be able to utilize his imagery to the advantage of recall during an STM task. Doob (1965), in fact, investigated the influence of imagery on memory but found it to be negatively correlated. The present study was intended to observe the case more closely and introduced the critical acoustic confusability task. Sperling's model of visual STM was employed to represent the principles developed in the Western culture. The results of the present study were revealing and contradicted Sperling's model in several important ways. Consequently various adaptations to the model are proposed.

Sperling's model advocated acoustic storage of visually presented material and herein lies the most important contradiction produced by the Xhosa subjects. There was a definite tendency for these subjects to store information in visual form. This not only applied to those classified as EI/PI but also those who reported the absence of imagery in Experiment I. Further

Further, although it was most applicable to the visual tasks, this tendency, in lesser strength, was also observed in the auditory tasks. Western subjects, as epitomized by the WS group, on the other hand stored the information in predominantly auditory form. It has been propounded that, in the Western culture, auditory storage has the advantageous influence of PAS especially if rehearsal is of a vocal nature. Whether PAS encourages the subject to store in the modality or not is a matter of debate but nonetheless it is the strongest form of storage. Thus, assuming the case preperceptual storage properties apply to the Xhosa, it would seem that they are choosing the disadvantageous modality in which to store material. However, the high incidence of imagery and the tendency to store visually, may be an indication of preperceptual stores with different properties. The effect of these stores is most marked in relation to the recency effect and in this case Crowder and Morton (1969) propose that the auditory modality should reflect a stronger recency effect with Western subjects. The Xhosa, however, demonstrated a stronger visual recency effect. Thus, it may be assumed that the visual preperceptual store, in their case, must be of at least a longer duration. Turning to imagery, the question arises as to whether the two are linked. Both forms of imagery represent a prolongation of the visual stimulus in almost complete form. This would suggest a visual store capable of holding raw data for a relatively long time. Is this not the exact function of a preperceptual store? Could the two, therefore, be one and the same or at least related?

Further indication of the possible involvement of the visual perperceptual store (VPS) and imagery, is found in the storage strategy adopted by the Xhosas. These subjects tended to use an associative group strategy in the form of a compound picture. Such a technique and its duration without rehearsal, is akin to imagery and the most suitable storage point would be the VPS.

In summarizing, therefore, the Xhosa subjects tended to store in the visual modality which exhibited a stronger recency effect. Consequently it is suggested that the VPS has a longer storage duration period and may, therefore, be related to imagery. Sperling's model must, therefore, be modified to account for visual storage which appears to take the form of a prolonged image and as such does not neccesitate rehearsal. The model does, however, stand with relation to auditory storage.

As a result of the above facts Sperling's acoustic translation mechanism may become redundant in the case of visual storage. In the model, the visual image is translated into acoustic form and stored in the auditory information stage (AIS). However, the results of Experiment 4 led to the suggestion that translation only takes place immediately prior to or during recall. Consequently the visually stored material must have access to a translatory mechanism in order to be recalled. This mechanism must then be linked to an AIS so that temporary storage and rehearsal may take place.

The simplest way of accounting for these contradictions is to account for prolonged visual storage within Sperling's existing structure. This may be done by assuming that imagery encourages visual storage and that it is maintained at a peripheral level in relation to Sperling's AIS. The visual information store in his model (equivalent to the VPS) now assumes a fluctuating strength of duration depending on the culture involved. Thus, visual information is prolonged in this store until needed for recall whereupon it follows a normal processing into the AIS which is again of fluctuating strength dependent on the culture. This system also neatly accounts for the combined modality storage technique which was observed as the visual image could be held in the VIS and at the same time in the AIS.

The only modification necessary to Sperling's model, therefore, concerns the properties of the VIS and the AIS.

APPENDIX 1

TABLE 1. WS Group Raw Recall Scores for the Auditory Task.

Trial						
1	2	3	4	5	6	MEAN
1	2	3	5	2	6	3.1
3	1	1	4	0	3	2.0
2	2	1	2	2	2	1.8
4	2	1	3	2	5	2.8
0	1	1	1	1	2	1.0
2	4	5	2	4	2	3.1
5	3	2	1	5	5	3.5
4	2	1	4	6	6	3.8
4	4	2	5	2	1	3.0
3	3	4	1	2	2	2.5
3	3	3	3	4	3	3.1
5	3	2	4	4	3	3.5
2	4	1	2	0	5	2.3
5	1	2	3	4	3	3.0
5	4	1	2	1	2	2.5
4	5	3	1	5	2	3.3
3	1	4	2	2	5	2.8
5	5	1	1	3	1	2.6
2	3	1	1	3	6	2.6
2	3	6	2	2	2	2.8
3	1	2	3	1	5	2.5
5	1	3	3	2	4	2.8
4	1	3	3	3	1	2.5
3	3	3	3	2	3	2.6
5	6	6	3	5	5	5.0
3	2	1	0	1	2	1.5
5	1	5	2	2	3	3.0
3	3	3	1	1	1	2.0
5	5	4	2	2	4	3.9
4	6	3	3	0	6	3.6

TABLE 1 (CONT)

	1	2	3	4	5	6	MEAN
	7	5	5	6	1	3	4.5
	4	5	5	3	4	5	4.3
	1	1	2	5	2	4	2.5
	0	3	3	2	2	2	2.0
	5	3	2	1	1	0	2.0
	10	7	2	7	0	3	4.5
	0	4	1	3	3	1	2.0
	3	4	3	3	0	4	2.8
	2	3	2	2	1	1	1.8
	3	1	0	5	6	3	2.6
	1	1	4	0	4	3	2.1
	3	7	0	1	2	3	2.6
MEAN	3.40	3.07	2.55	2.62	2.36	3.12	2.85

Mean Recall = 2.85 (N = 42)

APPENDIX 2

TABLE 2. BS Group Raw Recall Scores for the Auditory Task.

Trial						
1	2	3	4	5	6	MEAN
2	2	3	4	1	0	2.0
3	0	1	0	1	0	0.8
9	4	2	3	3	0	3.5
3	3	0	1	6	1	2.3
2	2	1	0	1	2	1.3
3	4	2	2	1	4	2.6
3	4	1	2	2	1	2.1
2	1	0	2	1	0	1.0
1	1	0	3	1	2	1.3
3	2	0	2	1	2	1.6
2	3	3	5	4	4	3.5
1	5	0	5	2	1	2.5
2	3	2	1	1	3	2.0
1	4	2	3	3	2	2.5
2	3	1	0	1	2	1.5
2	3	4	1	2	5	2.8
2	3	2	1	1	0	1.5
1	2	2	4	1	1	2.1
3	0	1	1	3	1	1.5
2	4	3	1	2	4	2.6
4	1	0	4	1	1	1.8
3	2	2	1	1	0	1.5
2	2	2	1	1	4	2.0
1	3	2	3	4	1	2.3
2	3	1	1	2	1	1.6
3	0	3	3	2	0	1.8
2	3	1	3	4	3	2.6
2	2	4	0	2	2	2.0
3	5	5	2	1	4	3.3
1	3	2	1	2	0	1.5
0	2	0	3	3	0	1.3

TABLE 2 (CONT)

	1	2	3	4	5	6	MEAN
	2	2	2	3	1	1	1.8
	2	3	4	2	2	3	2.6
	2	3	1	4	1	3	2.3
	2	3	4	2	2	3	2.6
	2	3	1	4	1	3	2.3
	1	3	2	2	1	1	1.6
	2	1	1	0	3	1	1.3
	2	3	2	2	4	0	2.1
	2	1	2	2	2	1	1.6
	1	1	0	0	1	0	0.5
	2	2	1	1	3	0	1.1
MEAN	2.19	2.48	1.71	2.02	1.95	1.6	1.99

Mean Recall = 1.99 (N = 42)

APPENDIX 3

TABLE 3. RX Group Raw Recall Scores for the Auditory Task.

Trial						
1	2	3	4	5	6	MEAN
1	1	1	1	1	0	0.8
1	0	1	1	0	0	0.5
1	0	1	0	1	1	0.6
1	2	0	2	1	1	1.1
1	0	1	2	2	2	1.3
2	0	0	2	0	0	0.6
2	4	0	0	0	1	1.3
0	2	0	0	2	2	1.0
0	0	0	0	1	1	0.3
1	1	2	1	0	2	1.1
3	0	1	1	1	3	1.5
2	1	1	1	2	0	1.1
0	0	0	0	0	1	0.1
2	3	2	4	1	1	2.1
1	0	0	0	1	1	0.5
1	0	2	0	1	2	1.0
0	2	2	0	0	2	1.0
1	1	1	0	2	0	0.8
0	3	3	1	2	0	1.5
1	2	1	0	1	4	1.5
1	0	1	3	1	0	1.0
1	0	1	2	1	1	0.8
0	1	0	0	2	0	0.5
0	1	1	0	1	1	0.6
1	2	0	0	0	0	0.5
2	2	1	2	1	0	1.3
0	1	2	2	1	1	1.1
1	1	0	2	1	1	1.0
1	1	1	0	1	1	0.8
2	1	1	2	1	1	1.3
1	1	0	2	1	2	1.1

TABLE 3 (CONT)

	1	2	3	4	5	6	MEAN
	2	0	1	1	1	1	1.0
	1	2	0	0	0	0	0.5
	1	1	1	0	1	0	0.6
	1	2	4	4	3	2	2.6
	2	1	1	0	2	1	1.1
	1	4	1	4	4	2	2.5
	1	0	1	0	1	1	0.6
	2	2	2	0	0	1	1.1
	1	0	1	1	1	0	0.6
	3	0	0	2	1	1	1.1
	2	0	0	0	2	2	1.0
MEAN	1.14	1.07	0.93	1.02	1.10	1.02	1.05

Mean Recall = 1.05 (N = 42)

APPENDIX 4

TABLE 4. WS Group Raw Recall Scores for the Visual Task.

Trial						
1	2	3	4	5	6	MEAN
6	4	3	5	4	6	4.6
2	3	5	1	3	1	2.5
1	4	4	2	2	2	2.5
2	2	2	1	1	0	1.3
5	4	6	2	4	1	3.6
2	4	4	4	2	2	3.0
3	5	4	4	5	7	4.6
2	3	5	3	1	4	3.0
9	7	4	7	4	6	6.1
4	4	3	4	3	4	3.6
2	2	4	4	1	5	3.0
4	4	1	1	0	4	2.2
4	3	5	3	2	2	3.1
2	5	4	4	6	1	3.6
2	3	3	4	0	2	2.3
6	5	4	1	0	5	3.6
5	2	3	5	3	3	3.5
1	1	2	1	1	4	1.5
3	6	5	5	6	6	5.0
6	8	8	1	5	2	5.0
2	1	3	3	3	1	2.1
5	5	3	2	4	2	3.5
4	3	4	5	1	2	3.1
1	3	1	2	8	1	2.5
4	3	5	4	4	6	4.3
2	1	6	0	1	2	2.0
3	3	3	4	4	3	3.3
2	2	2	4	1	2	2.1
0	4	4	4	4	2	3.0
3	2	3	6	5	3	3.6
5	3	4	5	2	4	3.1

TABLE 4 (CONT)

	1	2	3	4	5	6	MEAN
	2	4	5	7	1	1	3.3
	1	6	3	1	4	3	3.0
	1	0	3	1	2	2	1.5
	6	5	4	2	4	5	4.3
	7	5	7	5	1	6	5.1
	3	3	5	6	0	2	3.1
	4	2	1	6	6	2	3.5
	3	1	1	0	3	6	2.3
	4	3	2	4	5	3	3.5
	1	1	4	4	3	2	2.5
	2	3	7	3	1	1	2.8
MEAN	3.24	3.38	3.79	3.33	2.86	3.05	3.28

Mean Recall = 3.28 (N = 42)

APPENDIX 5

TABLE 5. BS Group Raw Recall Scores for the Visual Task.

Trial						
1	2	3	4	5	6	MEAN
4	2	2	4	4	3	3.1
1	1	5	3	0	1	1.8
4	3	1	3	4	4	3.1
1	4	1	2	3	3	2.3
2	0	1	3	2	4	2.0
5	3	5	6	3	8	5.0
3	4	2	2	1	2	2.3
4	2	2	2	1	4	2.5
3	1	3	1	3	6	2.8
4	3	2	4	3	3	3.1
3	2	1	2	2	2	2.0
2	2	1	2	2	1	1.6
4	2	5	5	3	4	3.8
3	4	3	3	1	5	3.1
0	0	1	3	1	3	1.3
2	4	2	3	2	0	1.8
2	1	2	0	0	3	1.3
1	2	2	1	1	2	1.5
2	2	1	2	0	1	1.3
1	4	3	2	3	4	2.8
2	1	2	1	2	6	2.3
2	4	1	0	0	3	1.6
4	1	1	2	0	0	1.6
3	5	1	3	5	2	3.1
2	3	3	4	1	3	2.6
1	1	2	1	0	3	1.3
2	2	2	4	2	2	2.3
2	0	1	1	2	1	1.1
2	1	4	1	4	1	2.1
3	2	2	0	2	2	1.8
4	2	2	2	3	3	2.6

TABLE 5 (CONT)

	1	2	3	4	5	6	MEAN
	1	-	1	3	1	2	1.3
	1	1	2	2	3	4	2.1
	1	5	4	5	1	5	3.5
	1	1	2	2	3	4	2.1
	1	5	4	5	1	5	3.5
	2	2	3	3	2	2	2.3
	0	2	2	1	2	5	2.0
	1	2	1	4	3	-	1.8
	1	3	1	1	3	2	1.8
	2	4	1	2	2	2	2.1
	3	3	2	-	3	2	2.1
MEAN	2.19	2.29	2.12	2.38	2.0	2.9	2.31

Mean Recall = 2.31 (N = 42)

APPENDIX 6

TABLE 6. RX Group Raw Recall Score for the Visual Task

Trial						
1	2	3	4	5	6	MEAN
0	1	0	0	1	0	0.3
0	1	2	1	2	1	1.1
2	0	1	0	0	1	0.6
4	1	3	1	1	2	2.0
0	1	2	1	0	0	0.6
7	2	0	2	3	2	2.6
1	0	2	4	3	0	1.6
1	0	1	1	2	2	1.1
1	1	1	2	1	-	1.0
2	1	0	2	1	0	1.0
2	5	3	1	1	5	2.8
3	4	1	0	0	1	1.5
1	3	0	0	1	1	1.0
2	4	1	4	3	5	3.1
0	2	4	0	0	4	1.6
3	2	0	2	1	5	2.1
0	0	0	3	1	3	1.1
1	2	0	0	1	2	1.0
1	0	1	0	2	4	1.3
1	0	2	0	0	0	0.5
2	3	0	1	3	1	1.6
2	1	0	1	0	1	0.8
2	2	2	0	4	0	1.6
1	1	2	1	0	1	1.0
2	0	2	2	0	2	1.3
4	2	3	1	1	1	2.0
0	1	3	1	3	0	1.3
3	3	2	4	3	4	3.1
1	2	2	1	2	1	1.5
2	3	2	1	2	0	1.6
4	1	3	3	3	4	3.0

TABLE 6. (CONT)

	1	2	3	4	5	6	MEAN
	3	1	0	1	0	1	1.0
	1	2	2	1	2	1	1.1
	1	3	1	1	0	1	1.1
	4	1	4	3	0	1	2.1
	1	2	3	1	2	2	1.8
	3	3	4	0	0	3	2.1
	2	3	4	1	3	0	2.1
	4	1	1	4	1	3	213
	1	1	2	2	3	1	1.6
	2	2	2	2	3	2	2.1
	3	4	4	3	5	3	3.6
MEAN	1.9	1.71	1.71	1.40	1.52	1.69	1.66

Mean Recall = 1.66 (N = 42)

APPENDIX 7

TABLE 7. WS Group Raw Recall Scores for the Acoustic Confusable Task.

Trial						
1	2	3	4	5	6	MEAN
7	1	6	4	5	1	4.0
2	0	4	3	3	1	2.1
3	2	2	0	1	1	1.5
0	2	3	2	1	1	1.5
5	4	3	5	4	1	3.6
2	2	2	3	0	2	1.8
6	5	3	3	4	4	4.1
3	5	2	6	4	4	4.0
4	6	3	2	4	1	3.3
5	3	5	2	5	2	3.6
2	4	2	3	4	2	2.8
6	3	4	2	3	1	3.1
4	5	3	3	0	1	2.6
2	6	1	0	1	2	2.0
2	2	2	1	1	2	1.6
4	3	0	3	2	2	2.3
1	4	5	2	2	4	3.0
3	5	3	0	1	3	2.5
2	5	4	4	2	1	3.0
6	5	5	1	2	3	3.6
5	1	5	2	2	2	2.8
1	3	4	3	4	1	2.6
0	3	4	0	1	1	1.5
4	2	5	1	5	1	2.6
4	6	5	6	5	4	3.0
1	3	1	1	3	2	1.8
3	0	3	2	2	2	2.0
5	3	3	2	1	1	2.5
5	4	4	3	3	2	3.5
1	3	4	1	3	1	2.1

TABLE 7. (CONT)

	1	2	3	4	5	6	MEAN
	3	5	4	6	3	0	3.5
	4	4	5	2	4	0	3.1
	3	1	1	0	1	4	1.6
	4	1	5	1	2	1	2.3
	4	4	2	1	3	3	2.8
	5	7	8	5	8	4	6.1
	4	4	2	2	3	1	2.6
	2	0	3	2	5	1	2.1
	3	4	3	0	2	6	3.0
	1	3	2	1	4	1	2.0
	3	2	1	2	3	0	1.8
	0	3	1	2	3	1	1.6
MEAN	3.19	3.29	3.26	2.24	2.83	1.86	2.78

Mean Recall = 2.78 (N = 42)

APPENDIX 8

TABLE 8. RX Group Raw Recall Scores for the Acoustic Confusable Task.

Trial						
1	2	3	4	5	6	MEAN
1	1	0	2	1	2	1.1
1	0	0	0	.0	0	0.1
3	1	2	0	0	2	1.1
2	2	2	0	2	1	1.8
0	2	2	2	1	1	1.3
1	1	1	0	0	2	0.8
0	0	0	0	0	0	0.0
2	2	1	4	0	1	1.6
0	0	4	0	0	1	0.8
4	1	1	2	3	1	2.0
1	1	1	1	0	1	0.8
1	3	1	0	0	1	1.1
2	1	0	0	1	1	0.8
4	4	2	3	3	0	2.6
1	2	3	0	0	1	1.1
1	0	1	0	1	0	0.5
0	0	2	1	0	0	0.5
0	1	1	0	1	0	0.5
3	0	2	1	0	0	1.0
2	4	1	0	2	1	1.6
1	0	0	0	0	1	0.3
0	1	2	0	0	1	0.6
0	0	1	2	0	0	0.5
0	1	1	0	0	0	0.3
0	0	1	0	0	0	0.1
1	0	0	0	1	1	0.5
0	0	1	0	0	3	0.7
0	1	1	2	0	0	0.7
0	2	2	1	1	0	1.0
1	0	0	0	0	3	0.6

TABLE 8. (CONT)

	1	2	3	4	5	6	MEAN
	0	2	1	1	1	1	1.0
	1	0	1	2	0	2	1.0
	1	1	0	1	1	0	0.6
	1	0	0	1	0	2	0.6
	1	1	1	0	0	4	1.1
	0	0	0	0	0	0	0
	2	2	2	0	0	1	1.1
	0	4	2	1	0	1	1.3
	2	1	2	1	2	1	2.5
	0	2	4	1	1	0	1.3
	0	0	1	0	1	0	0.3
	4	0	1	1	3	1	1.6
MEAN	1.05	1.05	1.21	0.71	0.62	0.86	0.92

Mean Recall = 0.92 (N = 42)

APPENDIX 9

TABLE 9. BS Group Raw Recall Scores for the Acoustic Confusable Task.

Trial						
1	2	3	4	5	6	MEAN
5	1	3	1	0	7	2.8
2	3	3	1	1	2	2.0
1	2	2	1	1	3	1.6
2	3	3	2	1	3	2.3
0	0	0	0	2	0	0.3
3	4	1	3	1	1	2.1
1	1	1	0	1	1	0.8
4	4	0	3	1	0	2.0
3	4	3	3	3	3	3.1
1	1	1	3	2	1	1.5
3	0	3	0	2	0	1.3
5	2	2	4	7	0	3.3
3	0	1	2	3	1	1.6
3	2	1	2	1	3	2.0
1	0	1	0	2	2	1.0
3	4	6	5	2	4	4.0
1	2	2	5	3	1	2.3
5	4	3	1	1	3	216
2	1	2	2	3	1	1.8
0	1	0	2	0	2	0.8
2	3	4	2	0	0	2.0
1	4	1	3	0	0	1.5
4	1	1	1	2	1	1.6
2	0	1	1	2	3	1.5
1	2	2	3	0	2	1.6
1	0	2	1	0	1	0.8
5	7	3	4	2	5	4.3
2	0	0	0	1	2	0.8
2	3	8	2	2	2	3.1
3	4	5	3	1	0	2.6

TABLE 9. (CONT)

	1	2	3	4	5	6	MEAN
	4	2	4	1	2	1	2.3
	1	0	2	0	2	2	1.1
	1	1	2	1	0	0	0.8
	3	4	0	4	5	2	3.6
	1	1	2	1	0	1	1.0
	3	4	0	4	5	2	3.0
	1	5	0	1	4	2	2.1
	1	1	2	4	1	2	1.8
	1	4	1	3	1	2	2.0
	2	3	1	1	1	0	1.3
	1	2	4	4	3	1	2.5
	2	1	0	1	1	1	1.0
MEAN	2.19	2.17	1.98	2.02	1.71	1.67	1.96

Mean Recall = 1.96 (N = 42)

APPENDIX 10

TABLE 10. WS Group : Frequency of Correct Responses for the Visual Task

Serial Position	Frequency of Correct Responses	Recall Probability
1	186	0.74
2	135	0.54
3	89	0.35
4	71	0.28
5	48	0.19
6	29	0.12
7	35	0.14
8	27	0.11
9	49	0.19
10	94	0.37

APPENDIX 11

TABLE 11. BS Group : Frequency of Correct Responses for the Visual Task

Serial Position	Frequency of Correct Responses	Recall Probability
1	192	0.76
2	123	0.49
3	66	0.26
4	59	0.23
5	42	0.17
6	23	0.09
7	19	0.08
8	13	0.05
9	9	0.04
10	39	0.15

APPENDIX 12

TABLE 12. RX Group : Frequency of Correct Responses for the Visial Task.

Serial Position	Frequency of Correct Responses	Recall Probability
1	147	0.58
2	84	0.33
3	42	0.17
4	36	0.14
5	36	0.14
6	20	0.08
7	28	0.11
8	12	0.05
9	4	0.02
10	6	0.02

APPENDIX 13

TABLE 13. WS Group : Frequency of Correct Responses for the Auditory Task.

1	172	0.68
2	118	0.47
3	85	0.34
4	45	0.18
5	24	0.10
6	14	0.06
7	13	0.05
8	34	0.13
9	54	0.21
10	114	0.45

APPENDIX 14

TABLE 14. BS Group : Frequency of Correct Responses for the Auditory Task.

Serial Position	Frequency of Correct Responses	Recall Probability
1	188	0.75
2	127	0.50
3	73	0.29
4	40	0.16
5	28	0.11
6	16	0.06
7	7	0.03
8	4	0.02
9	5	0.02
10	11	0.04

APPENDIX 15

TABLE 15. RX Group : Frequency of Correct Responses for the Auditory Task.

Serial Position	Frequency of Correct Responses	Recall Probability
1	129	0.51
2	38	0.15
3	31	0.12
4	17	0.07
5	18	0.07
6	13	0.05
7	3	0.01
8	3	0.01
9	0	0.0
10	4	0.02

APPENDIX 16

TABLE 16. WS Group : Frequency of Correct Responses for the Acoustic Confusable Task.

Serial Position	Frequency of Correct Responses	Recall Probability
1	209	0.83
2	116	0.46
3	68	0.27
4	85	0.34
5	14	0.06
6	19	0.07
7	17	0.07
8	28	0.11
9	49	0.19
10	104	0.41

APPENDIX 17

TABLE 17. BS Group : Frequency of Correct Responses for the Acoustic Confusable Task.

Serial Position	Frequency of Correct Responses	Recall Probability
1	158	0.63
2	102	0.40
3	65	0.26
4	43	0.17
5	27	0.11
6	24	0.10
7	12	0.05
8	6	0.02
9	8	0.03
10	39	0.15

APPENDIX 18

TABLE 18. RX Group : Frequency of Correct Responses for the Acoustic Confusable Task

Serial Position	Frequency of Correct Responses	Recall Probability
1	77	0.31
2	30	0.12
3	32	0.13
4	24	0.10
5	23	0.09
6	14	0.06
7	10	0.04
8	4	0.02
9	6	0.02
10	9	0.04

APPENDIX 19

Objects used in the Visual Task:

Axe
Goat
Bird
Mealie
Dog
Gun
Hoe
Snake
Pot
Comb

APPENDIX 20

Words used in the Auditory Task:

English	Xhosa	
Admiral	Intombi	(girl)
Officer	Umbhali	(writer)
Pioneer	Intonga	(stick)
Buffalo	Umdlolo	(widower)
Cabinet	Umlenze	(leg)
Alcohol	Umhambi	(pilgrim)
Horizon	Umfundi	(scholar)
Gallery	Ingwelo	(wagon)
Javelin	Umgwebi	(magistrate)
Tobacco	Umhlaba	(soil)

APPENDIX 2I

Objects used in the Acoustic Confusable Task:

English	Xhosa	
Bail	Intsimi	(field)
Tail	Iintsiba	(feathers)
Nail	Intsika	(pillar)
Pail	Intamo	(neck)
Veil	Ithambo	(bone)
Paw	Intsimbi	(iron)
Door	Uthango	(fence)
Core	Umlambo	(river)
Bore	Iintsinga	(muscles)
Saw	Intambo	(rope)

APPENDIX 22

1. INSTRUCTIONS

A general comment as to the nature of the task was made at the beginning before the specific instructions were given.

1.1 The After Image

I am going to show you three coloured squares. These squares will be presented one at a time and each will be exposed for ten seconds. I want you to fixate your eyes on the square and try not to blink or let your attention wander. After ten seconds I will remove the square but I want you to continue to fixate on the spot where the square was.

Do you see anything on the board?

What colour is it?

1.2 EI/PI

I am now going to present you with three pictures. The pictures will be presented one at a time and will be exposed for 30 seconds. Do not fixate your eyes on the picture as you did with the coloured squares. Just look at the picture. You can let your attention wander within the borders of the picture but do not take your eyes away from it. After 30 seconds the picture will be removed and I will then ask you some questions.

Do you see anything on the board?

Do you see a picture in your head?

Whether the answers were positive or negative the subject was still questioned on the content of the picture.

1.3 The Acoustic Task

You will be given ten words to remember. You will hear them six times but in a different order. Each time you hear the ten words I will stop the tape recorder and then I want you to tell me the order in which you heard the words. At the beginning of each trial you will hear a high pitched sound. As soon as you hear this sound you will know that the words will follow and so will be able to prepare yourself. After the words have been presented you will hear a low pitched sound. This sound indicates that all the words have been presented and you may then start to recall their order of presentation. These are the words which you will hear......You will hear what I have told you over the head-phones as well as the sound of the high and low pitched signals. So put on the head-phones and we can start unless you have any questions.

After the subject had heard the taped instructions he was once again asked if he understood everything.

When the subject had completed the task he was asked several questions about the mode and strategy of storage. The experimenter was allowed some leeway here in order to fine this out so no hard and fast questions were adhered to.

1.4 The Visual Task

You will be given ten pictures to remember. You will see them six times but in a different order. Each time you see the ten pictures I will stop the projector and I will then want you to tell me the order in which they were presented.

Here are the ten pictures. (The subject was then shown the

35mm photographs.) You see this is a comb etc. (The subject then named all the objects.)

In the beginning you will see a large black dot. This means the pictures will shortly follow. After the pictures have been presented a black triangle will signal the end of the sequence and you may then recall the order of the pictures.

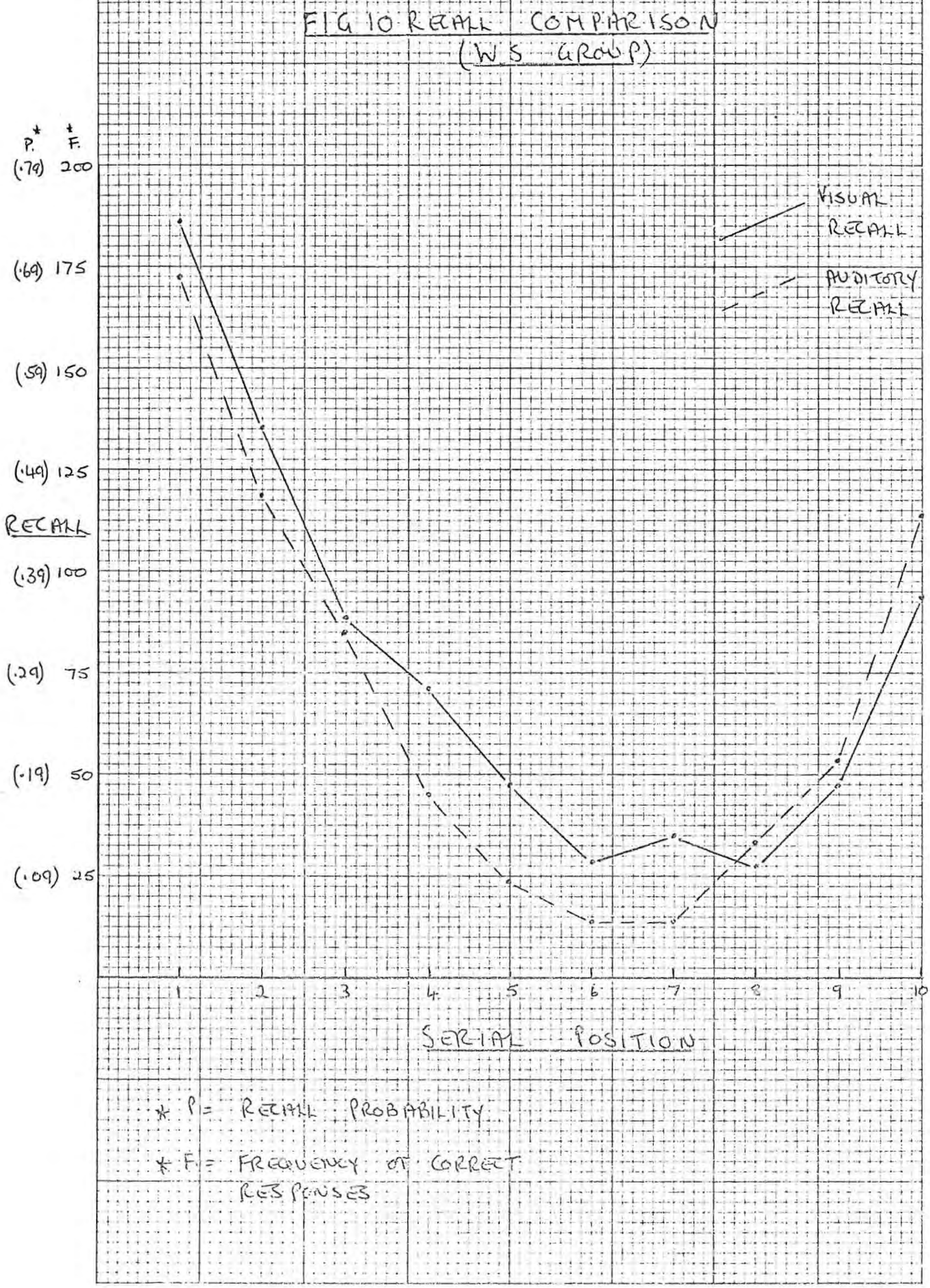
I will now show you some other pictures to get you used to the speed of presentation and the format. You don't have to remember these particular pictures. This is just a practice.

At the end of the task the subject was asked questions on the mode and strategy of storage.

1.5 The Acoustic Confusable Task

This was presented in exactly the same way as the visual task. The only difference being that at the end the subject was also questioned on whether he experienced acoustic confusability.

Appendix 23 Graphs of Modality Recall Comparisons



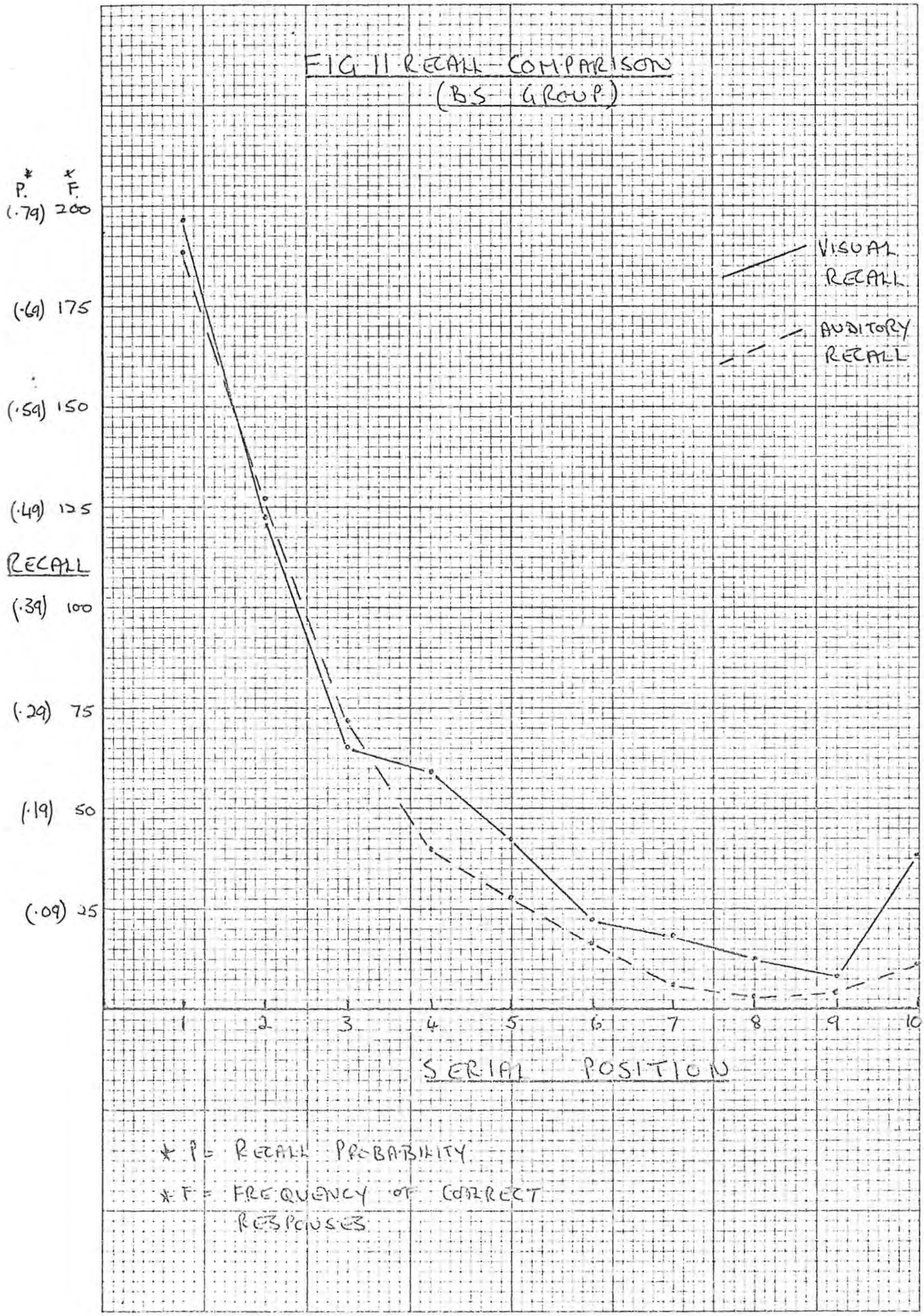


FIG 11 RECALL COMPARISON
(B.S GROUP)
P.* F.*
(.79) 200
(.69) 175
(.59) 150
(.49) 125
RECALL
(.39) 100
(.29) 75
(.19) 50
(.09) 25
VISUAL RECALL
AUDITORY RECALL
1 2 3 4 5 6 7 8 9 10
SERIAL POSITION
* P = RECALL PROBABILITY
* F = FREQUENCY OF CORRECT RESPONSES

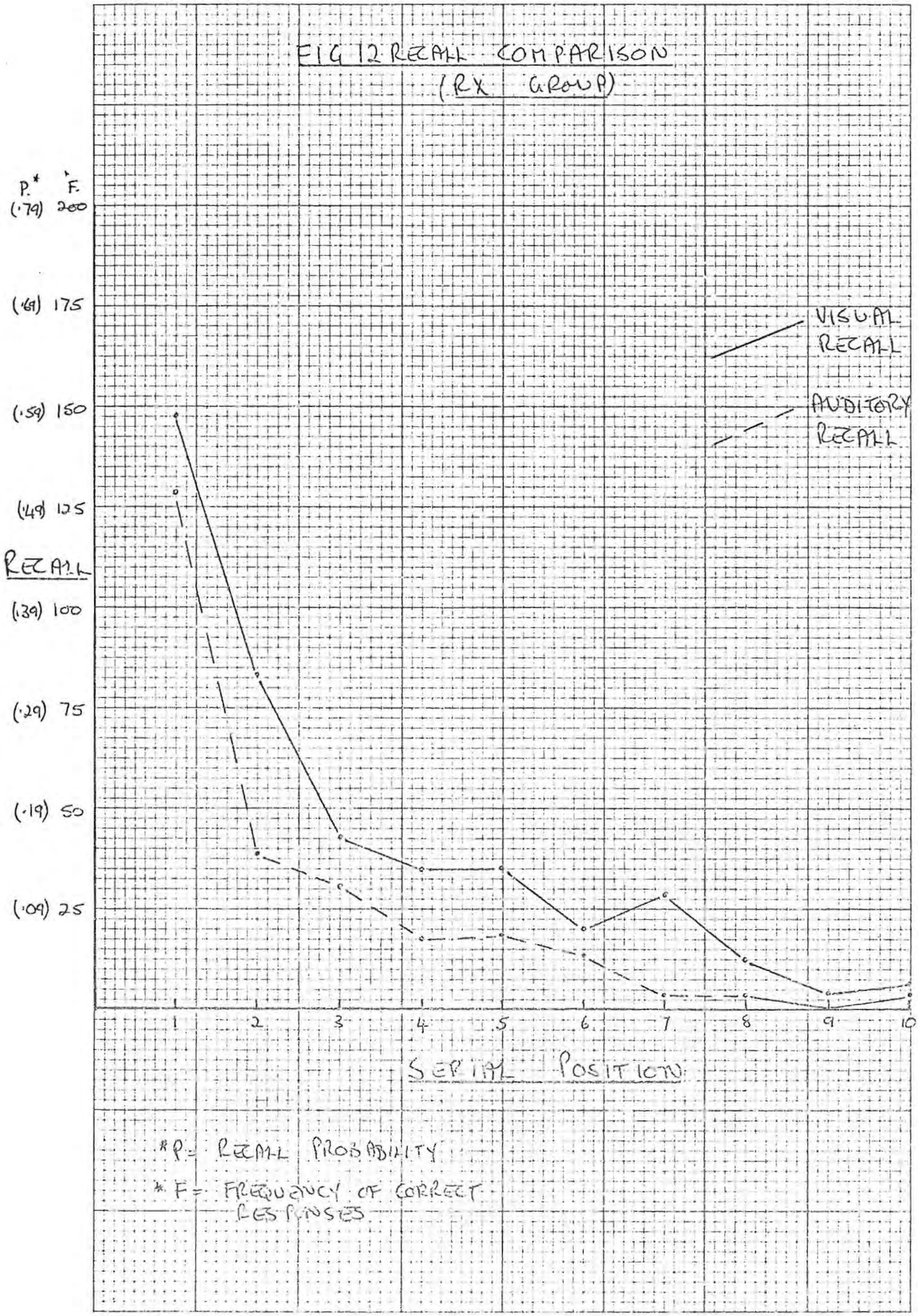


FIG 12 RECALL COMPARISON
(RX GROUP)
P.* F.
(·79) 200
(·69) 175
(·59) 150
(·49) 125
RECALL
(·39) 100
(·29) 75
(·19) 50
(·09) 25
VISUAL RECALL
AUDITORY RECALL
1 2 3 4 5 6 7 8 9 10
SERIAL POSITION
*P = RECALL PROBABILITY
* F = FREQUENCY OF CORRECT RESPONSES

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