An investigation into the effect of formatting manipulations on reading and information retrieval from text documents

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DECLARATION

I declare this thesis is my own work and carried out under normal terms of supervision.

ABSTRACT

The BBC Audience Lines, a call centre based in Glasgow, voiced an interest into whether their system of responding to queries from the general public via telephone could be improved. In response to this, a detailed Task Analysis was conducted, which identified information retrieval as the specific area in which time was misused during call answering. A series of experiments was then conducted to investigate whether manipulating the layout of a text document could influence participants' reading behaviour or their strategies and latencies in a subsequent search task. Studies 2 and 3 illustrate that more fluent reading experiences and faster search latencies are evident when participants first read plain, unformatted text. Initially reading blanket bulleted text disrupts the reading process by affecting reading time and all eye movement measures, and also creates an impoverished memory of the text as evidenced by poorer search latencies. This pattern of results held during both paper and computer screen search of a document. Study 4 revealed that many of the problems associated with blanket bulleted text were seen to be resolved by the use of stem sentences in combination with the bullet points, resulting in fluent reading and a faster search latency than plain formatting. The reason for this advantage for stem bulleted formatting was probed during Study 5 by investigating whether there is a stronger visual representation of the text created in memory during the reading of stem bullet formatting. Weak results were obtained, suggesting the task used in Study 5 may not actually probe the same representation created in memory as Studies 2 to 4 did. This is discussed in depth. It is concluded that during reading both semantic and visual information is encoded and play a role in information retrieval. In addition, the way the document is formatted can alter the way a person reads a piece of text and hence encodes its information content, particularly in leading participants to have a greater or lesser semantic representation of the passage. However, all formatting influences occur at the time of encoding, and no difference is seen in the ability of participants to locate information within a page of text they have not first read, regardless of format. The implication of these findings are discussed in relation to the work of the BBC Audience Lines.

TABLE OF CONTENTS

CHAPTER 4 84

CHAPTER 5 106

CHAPTER 6 135

TABLE OF FIGURES

TABLE OF TABLES

CHAPTER 1

1. INTRODUCTION AND OVERVIEW

This thesis is completed as part of an ESRC CASE studentship in collaboration with the BBC Audience Lines (formerly the BBC Helpline). As a result, the research conducted throughout the course of this studentship has had twin aims: to produce findings that will be of use to the BBC Audience Lines in their ongoing attempts to improve customer service, and to produce an original piece of scientific research.

The BBC Audience Lines aims were unspecified. In initial meetings, they acknowledged the work conducted at the Audience Lines was complex and that any help in clarifying and improving this task would be appreciated. As a starting point, therefore, it was decided that a detailed Task Analysis should be conducted to more fully understand what processes Helpline Advisors go through when answering a call from the general public on the Audience Lines. It was hoped that this Task Analysis would illustrate what steps are involved in answering a call, and specifically what steps were involved in the retrieval of information in order to answer a call. It was also conducted in order to indicate any particular area of difficulty that may be experienced during the course of a conversation with a caller making an incoming request for information. In this way it was designed to help me understand what direction of research the BBC Audience Lines might find useful.

The Task Analysis, in fact, revealed that many calls are quite standard, following similar patterns and time courses, and eliciting similar amounts of information during each call. One area which did reveal particular problems during certain calls was in the ease of information retrieval. Information retrieval was characterised by the length of time it took the Helpliner to access the appropriate information document, the time it took for the Helpliner to use this document, and also whether the caller was put on hold or not. It seems that the main differentiating factors between short and long calls are that long calls are associated with far longer information retrieval times, and the fact that a caller is much more likely to have been put on hold during a long call. If a caller was put on hold during the course of a conversation, then they were likely to spend on average 29.5% of the duration of the call in that situation. It can also be seen in this study that the longer information retrieval times are not related to the Helpliner having difficulty ascertaining what information the caller requires: an equal number of information eliciting statements are made during both short and long calls. Therefore, the greater length of time spent on longer calls cannot be attributed to a difficulty in *knowing* what the caller wants, it is a difficulty *finding* the relevant information to give them. These findings indicated that information retrieval seems to be one of the biggest areas of reclaimable time on the Audience Lines.

The poor information retrieval found during some calls in the Task Analysis led onto an empirical, lab based investigation into what may affect the speed of information retrieval from a text document. This investigation (and all subsequent ones), presumed that the participant in the study (substituting for a Helpline Advisor) has found the relevant *document* and is now searching within that document for a specific piece of information. It is understood that finding the relevant document in the first place is a complex task, and worthy of detailed investigation. However, it was decided to concentrate on within-document search as this can develop on from what is already known about a reader's representation of text and work that has been conducted into the psychology of reading, while also remaining relevant to the aims of the Audience Lines.

The first lab based investigation (Study 2) used a paper document which participants read and then searched for discrete pieces of information. The experimental manipulation was the format of the document the participant read and searched, which could have been one of three formats commonly used within the BBC Audience Line's briefing documents. This first study revealed that participants are faster searching the same format as they have already read, indicating that the layout of document must form part of the representation of the text as identical semantic information was repeated on both occasions. The results also revealed that participants are faster searching documents when they have initially read plain, unformatted text than if they had read either of the specially formatted texts, that is in either a bulleted or separated layout. This outcome was counter our expectations; bulleted text is commonly used to aid text search, whereas here we find it impeding search.

A second study (Study 3) was run to follow up these initial findings. This study was similar to the first, but this time the document was presented on a computer screen, and the participant's eye movements were monitored during both reading and searching. This study was designed to see if the same pattern of results found in the previous study were found when the material was presented on a computer monitor. Different patterns of results were expected here because research in the rereading and HCI literature has demonstrated marked differences between both the reading and searching of material depending on whether it is presented on screen or on paper. The second aim of the study was to attempt to break down exactly *where* the differences between formats were taking place through the use of the eye movement records. The results of this computer based study, however, broadly replicated the findings of Study 2. Of particular interest was the way participants read the document. There were gross differences in the reading times between the two types of formatting. Participants read the bullet formatted text far slower than the plain, unformatted text. When the eye movement records were inspected these too also revealed marked differences between formats. During the reading of plain formatted text, participants tended to have fewer fixations per page, shorter fixations, and longer saccades. All of these measures are associated with more fluent, trouble free reading. It is therefore concluded that something during the reading of bulleted text is impeding the reading process. Differences were also found between the two formats in the way the text was searched. As in Study 2, an advantage was again revealed when the participant was given the opportunity to search the same document as they had already read, as opposed to a different format. A response time advantage can also be seen for participants who initially read plain, unformatted text, but only when the answer the participant was searching for was not located on the page. Therefore it can be concluded from this second laboratory based study that the formatting manipulations that hold for the search of a paper document also seem to hold for a computer presented document. Participants are at an advantage when searching a document if they had first read the document presented in the same format. There are also at an advantage if they first read plain, unformatted text, as opposed to bulleted text.

The first two laboratory based studies demonstrated that bulleting the text affects both the reading of the text and text search. However, the method of bulleting used in these studies, despite being similar to some formatting techniques used within the BBC Audience Lines, can be considered quite unnatural. It was therefore decided to alter this formatting slightly and create "stem sentences". Stem sentence formatting simply leaves the first sentence of each paragraph unformatted, and then indents and bullets the remainder of the paragraph in the same way as the initial bulleting method. The theory behind this is that the first sentence of each paragraph tends to be an introduction or explanation of the remainder of the paragraph. It also can give a clearer, more defined shape to the paragraph. In theory, therefore, someone searching a document for discrete pieces of information need only sample the stem sentence in order to accept or discount the content of the entire paragraph.

This third empirical study compared stem sentence formatting with unformatted text in three different ways. The first compared reading and search on a computer monitor, while measuring eye movements. The second looked at the differences between the formats when participants were reading and searching a paper document. The third compared eye movements when participants searched the different formats, but in situations where they had not previously read the document.

The change in formatting from the original bulleting to stem bulleting had a great effect. Comparing reading times and eye movement measures revealed no difference between stem bulleted formatting and unformatted text. Therefore, this small change in the formatting of one sentence makes a great difference in how the participant reads the entire document. When search times and eye movement measures are compared between the two formats, it can be seen that stem bulleting actually results in a response time advantage over unformatted text (contrary to the previous studies using what we term blanket bulleting). As in the previous studies which revealed no difference between formats when the search latencies for the passage were compared irrespective of which format was initially read, the advantage for stem bulleted text was only present when the participants had first read the document. When they searched documents that has not been pre-read, there was no difference at all between the formats. From these combined results it can be concluded that the formatting differences revealed in these studies do not relate to how each of the formats are searched, but related to how the differently formatted documents are encoded in the first place. Interestingly, there were no differences between the search times when participants were searching paper documents compared with computer monitor, in contrast with results reported in the literature.

Up to this point, summary conclusions that can be made are:

1. Formatting can influence information retrieval.
2. Blanket bulleting text can impede both reading and searching.
3. Stem bulleted text results in comparable reading times measures and eye movements to unformatted text.
4. Stem bulleted text results in faster search times, if the text has been read first.
5. There is no difference between formats when a participant is searching a document that they have not already read, or in the ability of participants to search a particularly formatted document.
6. The same pattern of results can be seen in both paper and VDU reading and search, along with comparable response times. The reading of a paper document remain faster than reading a document on screen, consistent with the literature.

The reason for these formatting differences could have a number of different explanations. One possible explanation is that there is different semantic information on each page, because each format takes up a different amount of space, and therefore information is grouped differently in the participants memory. However, from Study 3 onward, the semantic information on each page is identical. The only difference between pages is the formatting. A second explanation could be that specific formatting is signalling important information. However, this again seems not to be the case as there is no search time advantage for any format when the document has not been pre-read. Another explanation could be that, when searching, participants need only read the stem sentence to discount the entire paragraph. However, when the likelihood of fixating the stem sentence was compared with the fixations made on the equivalent sentence in the unformatted text, no difference was found. Therefore there seems to be some other explanation for the stem sentence formatting advantage.

Unfortunately, because of software problems, the results for Study 4 were not obtained until after Study 5 had been conducted. However, Study 5 was designed to explore some of the possible explanations for the formatting differences seen in the earlier experimental sessions.

A possible explanation for the difference in the ability of participants to locate information within a pre-read document is that certain formats encourage more visual encoding than others. This visual information is then available to aid a subsequent search of the text. Study 5 was designed to test this theory. If it is the spatial structure of the page that is causing the formatting difference, this would presume that certain formats create a stronger, visual structure than others. A participant's ability to locate information within a blurred image, where no individual words could be made out, after first reading a normally presented text was compared across three formatting manipulations; blanket bulleting, stem bulleting and unformatted text. Despite predictions, no advantage was found for any format type in the ability of participants to indicate where certain pieces of information were located, although a borderline advantage can be seen for stem bullet formatting. When the reading latencies are compared to those found for Study 4, it can be seen that participants are spending far longer reading these documents knowing that there is a spatial component to a subsequent test. It is concluded that the task used to explore the extent of the visual information in this present study is altering the reading strategies of participants, which in turn is altering the representation formed in memory of the text, and is therefore altering the information that is available to aid text search.

This thesis closes with a discussion of the results together, concluding that both visual and semantic information is encoded during reading. These two aspects of the stored representation in memory of the text can be affected by the layout of the text that is initially encoded, leading to either an enhanced or a diminished ability of participants to later retrieve information from that text. Finally I discuss the implications of the findings of this research for the BBC Audience Lines and for the presentation of textual documentation in general.

CHAPTER 2

2.1. THE BBC AUDIENCE LINES

This thesis is concerned with information retrieval in complex time pressured environments. There are many examples of such environments, such as air traffic control, which have been extensively studied in Psychology. This thesis arose out of the study of one such a case, that of call centre operators within the BBC Audience Lines. The growth of Call Centres within Britain, and especially around the West of Scotland, has resulted in it becoming one of the major sources of employment throughout the country. In Glasgow alone the Call Centre industry employs around 9,000 people across a wide range of activities ranging from counselling to banking to stockbroking in over 65 companies[1]. In many ways the task of call centre operators can be seen to be as complex as the task of other more obvious demanding professions such as air traffic control. A call centre operator must locate discrete pieces of information or enter information into a system, while sustaining a conversation with the caller, all under severe time pressure. The demands in such a situation, therefore, can be seen to correspond to many other time pressured cognitive task.

This research is conducted in collaboration with the BBC Audience Lines, who are very aware of the time pressure demands faced by their operators. The task of the Helpliner (call centre operator) is complex. They have to answer sometimes very detailed questions on a large number of possible topics, ranging from finance and benefits to mental health and social issues, that can go back on the database as far as three months. This must be achieved as quickly and as accurately as possible, which is emphasised to the Helpliner by constant updates on the number of calls lost, the awareness of how much each call costs, and flashing lights throughout the phoneroom when there are calls waiting to be answered. Even once the correct document has been located, the Helpliner must then go on to locate the precise answer to the caller's query, or conclude that the question cannot be answered from that particular

[1] Figures attained from the Glasgow Development Agency (GDA), "Locating in Glasgow: Call Centres". 01:06:99

information document. Information retrieval, therefore, is vital if the service is to operate efficiently and the Helpliner is to answer as many queries as possible. However, although this type of task can be applied to many other calls centres which also provide an information dissemination function, research into this area can also be seen to have implications for a number of different areas: information retrieval is a fundamental task in everyday life. From school children and college students to business people, information is retrieved from text-based documents all the time. The increasing use of the Internet and Email had also meant that for the present time at least, more information is being relayed in text form than ever before. Therefore improvements to the layout of documents to aid information retrieval could help a broad spectrum of the population in their day to day lives.

The BBC Audience Lines is a call centre based in Glasgow, set up to support programmes broadcast on BBC Radio, and increasingly on BBC Television. They have twin aims: the first is to disseminate information and support to viewers and listeners about issues raised on BBC programmes; the second is to feed back to the producers of these programmes general demographics of who their callers were, what they were primarily interested in, and whether they had any interesting stories which could then be followed up for future programmes.

At the beginning of this research, the BBC Audience Lines had a tight "Social Action" remit, in that it supported only programmes dealing with concerns the BBC listernership may have had about social issues, for example heath, relationships, benefits and social problems. During a broadcast, a freephone telephone number would be trailed on air inviting the listeners or viewers to call in for information, support or further contacts in relation to issues that were raised during the course of the programme. For example, the Radio 4 programme "File on 4" broadcast a programme in late 1998 discussed the problem of lead in paint; the dangers involved, and what should be done about this. At the end of the programme the Radio 4 Action Line number was broadcast, with the message that if anyone required further information on this subject then they could call that number. To support this issue, the Audience Lines had produced an information document which detailed all of the points covered on the programme, along with step by step methods of how to test for and remove leaded paint. The information document also contained details of contact organisations who could either give further information on the subject of lead in paint, who sell lead testing kits, or who can give information on the removal of such paint. The Helpliner's task was to ascertain what information a caller on this subject was looking for, and disseminate that information as quickly and accurately as possible.

Each of the five network radio stations has its own individual character, and deals with different issues, or different slants on the same issues. Radio 1 conduct frequent campaigns dealing with exam support for young people approaching their GCSE's and A levels. They also have an annual information disseminating campaign about the effects, consequences and legal issues surrounding recreational drug use. Radio 2 frequently uses the BBC Audience Lines to support regular medical and legal slots on the Jimmy Young programme, as well as dealing with many other programmes and issues as they occur on a day to day basis. Radio 2 also run annual campaigns ranging from insomnia, to cancer, to finding relationships later in life. Radio 4 is also a frequent user, dealing with issues such as physical disability, blindness, medical issues, and consumer issues. These topics are typically covered in a deeper and more detailed way than in Radio 2 programmes. Radio 5 primarily deals with fast breaking news stories that may need instant support from the Audience Lines, which can give out information in more detail than can be given over the radio, and can give support to the caller if the issue requires it. For example, large responses were elicited in response to the pill scare in 1995, and every year there is extensive information prepared in response to the budget.

There have been recent changes to the organisational structure of the Audience Lines, in that the "Social Action" remit still exists, but is now running in tandem with new "Radio Lines", which are national rate numbers that listeners and viewers can call for further information on more general issues. For example support is given for many of the Radio 2 music programmes. Listeners can now call up to find out what music was played, the record code, where this can be bought, when certain concerts are on in their area, and what box office to call to book these tickets. The money programmes on all networks also use the Audience Lines to clarify issues that may have been raised on the programme, or to give information about specific bank interest or mortgage rates mentioned on the programme. Due to the knowledge that the caller is paying for the call, many Helpliners have commented feeling under more time pressure during these calls.

There is also more use being made of the Audience Lines in support of television programmes. A major user now is the Watchdog programme which is broadcast in the evening on BBC 1 television. For this programme, the number is advertised on screen throughout the broadcast, inviting viewers to call in to clarify any issues that were raised in the programme; to enquire about what procedures to follow in order to follow up a consumer complaint; or to pass on their story to the Watchdog programme for follow up on future programmes. Television programmes, because of the wider reach they have in comparison to radio programmes, and also because the majority of the programmes requiring the Audience Lines' support are broadcast in the evenings, usually elicit many more calls than any of the radio trails. Again this adds to the time pressure felt by the Helpliners.

Together, this now means that there are over 20 different lines coming into the BBC Audience Lines, which regularly supports more than 20 programmes a day (the average number of trails broadcast on radio and television per day is 22, based on figures from September to November 1998). A Helpliner can, at any time, answer a call and be asked about a number of issues that have been covered that day, or on previous days. The only indication the Helpliner has about what question they may be asked by a caller is knowing what line the call is coming in on before they answer the call (for example the Radio 4 Social Action Line, the Watchdog Line, or the Radio 2 national rate line).

There are certain guidelines which the Helpliners are advised to adhere to when possible. The first is the average call length should remain roughly 2½ minutes long, although it is acknowledged that certain calls may be more difficult than others and therefore take longer. This target is designed to keep the costs of the call low, and to ensure that as many calls can be answered as possible. During the conversation, the caller should be given as much information as they require and also be offered at least two relevant contacts. All callers must be asked for demographic details at the end of the call, so that an idea where the caller lives and their age can be fed back to the producers of the programme they are calling in relation to.

Other important issues that Helpliners must deal with include how to search through both familiar and unfamiliar documents. Although Helpliners are encouraged to read all information documents before answering a call, in practice this is not always possible, so the search for information can either be of an unknown document or one that may have been accessed more than once and which is quite familiar. A final relevant issue is the relationship between paper and VDU presentation of information. Although the BBC Audience Lines have now transferred to on-line access of information, primarily through a Microsoft Word interface, for large campaigns and "difficult" topics Helpliners still use paper documents at their own request. On the introduction of the new system, the Helpliners all agreed that they felt more comfortable with a paper system under these special circumstances. "Difficult" issues are usually those that cover very sensitive areas, and actually result in the Helpliner taking on a task of supportive listening rather than information retrieval. For example in situations where the programme covered child abuse, cancer, or terminal illness, paper documents were used. Also, paper documents are used for campaigns, which are substantial documents, too large for easy navigation using the Word interface.

The BBC Audience Lines are therefore interested in how people search documents and how formatting can affect this search process. This interest relates to the complexity of the Helpliner's task. If a more effective way of presenting a document on screen or on paper could be found, or some insight into how people search documents could be discovered, then the presentation of documents on screen could be improved, or changes could be made to facilitate the search for key information. Not only would this ease the working life of the Helpliner in their search for information within a document, it would also reduce the average call duration, which in turn may save money. Improvements of as little as 1 or 2 seconds for each call would result in literally thousands of pounds of savings over a year. It would also allow for more calls to be answered per staff hour, which in turn would result in an improved service for the callers.

This interest in how people search and scan documents is not only of use to the BBC Audience Lines. The presentation of textual information is pervasive, and oftentimes this information is not simply read and discarded; it is read, scanned, skimmed, re-read, and searched for specific pieces of information. A variety of professions and occupations routinely require people to read or search text, whether they be an Engineer, Doctor or a Journalist. Many other Call Centres also require their operators to locate information from within a text document under equally demanding time pressures. Even on a leisure basis, the growing use of the Internet has resulted in large numbers of people scanning through vast amounts of textual information in order to make judgements as to whether that particular document is relevant or interesting to them, or to relocate information that has interested them before. Efficient document search, therefore, is an important aspect of many reading encounters across a very wide range of situations. However, the current example of the BBC Audience Lines can be thought of as difficult a task as any of those noted above: it is a complex search task over a vast number of different issues, under severe time pressures, while sustaining a conversation.

In summary, the BBC Audience Lines have an interest in how their information documents, both on paper and on screen, can be improved so Helpliners can search for information within these documents with greater ease. How their Helpliners deal with the complex task is also of interest.

2.2. TASK ANALYSIS

As stated earlier, a Helpliner at the BBC Audience Lines has a complex task which usually consists of responding to incoming calls from members of the general public in response to radio or television broadcasts. Once the caller has stated what information they require, or the Helpliner has managed to establish what the caller is looking for, the task is then to locate and disseminate the required information from prepared information documents called "briefing sheets". These briefing sheet vary in size from simple three page documents to large, bound, campaign documents which may encompass many different sub-headings and topics. Although there is no time limit on individual calls, it is understood that each call should be wrapped up in the minimum time possible, as long as this does not mean compromising the service that is being provided.

As a point of departure for this study into information retrieval, a Task Analysis of the processes involved in answering incoming calls by the Helpliners was conducted. By examining a number of caller-Helpliner interactions in detail it was hoped that a better insight into the different skills and tasks involved in the answering of a call and the use of briefing sheets could be attained. From this analysis a firmer idea as to the issues associated with the task could then be developed.

Three specific areas of interest were identified for closer examination:

1. How are the briefing sheets used by the Helpliner/How is information accessed?
2. How is information conveyed from the Helpliner to the caller?
3. How do short and long calls differ?

By examining these specific areas we attempted to achieve a better understanding of how Helpliners go about the task of retrieving information to answer calls, and also whether there are any differences between calls of different lengths in the ease of information access and in the way information is conveyed.

The task analysis involved video recording Helpliners as they answered genuine incoming calls from the general public. The calls that a Helpliner takes at any one time varies from day to day and throughout the course of the day. In parallel with the answering of calls, it is common for Helpliners to "multi-task", and simultaneously be involved in a number of different activities such as researching and writing briefing sheets for forthcoming broadcasts, and the preparation of feedback for the producers of previously broadcast programmes which have used the Audience Lines for follow-up support. For the purpose of this study, however, the Helpliners chosen were involved solely in the answering of calls, so their concentration would be undivided.

At the time of this analysis, the BBC Audience Lines were functioning using paper copies of briefing sheets only. Since then the phoneroom functions primarily through a computer monitor interface for both information retrieval and call logging, except for "sensitive" issues, as stated earlier. However, many of the issues investigated here would be equally as valid for the computerised system, as much of the Task Analysis investigated the transfer of information from the Helpliner to the caller. Differences would be expected between the mediums in features like the amount of time it takes Helpliners to access documents or the amount of time it takes the Helpliner to scan the document (Muter & Maurutto, 1991). There has also been some suggestion that different formatting can serve different functions depending on the medium (Nygren, 1996). Such issues, however, are beyond the scope of the present Task Analysis but will be investigated in the experimentation that follows later in the thesis.

Helpliners were recorded during the course of their normal working day. Their task was to answer incoming calls from the public. The Helpliners were asked to answer their calls in a normal fashion, and to attempt to ignore the fact that they were being filmed. It is believed that the Helpliners did answer the calls in a naturalistic fashion due to the amount of test calls, roll play and supervision the Helpliners normally receive in their day-to-day work: they are used to being monitored, watched and taped. Because of the confidential nature of the Helpline it was only possible to record one side, the Helpliners side, of these conversations. As it is the Helpliner's retrieval of information and their subsequent information transfer that is of interest in this task analysis, that was considered acceptable.

Thirteen Helpliners were recorded answering thirty-two incoming calls from the general public. Their ages, and status (contracted or casual) varied. The number of calls recorded per person varied from one to four calls, depending on the availability of working calls each individual Helpliner received on the day of recording.

2.2.1. Recording and Transcription

This thesis is primarily interested in information retrieval. The task analysis, therefore, was designed to investigate information retrieval within the BBC Audience Lines and also look into whether information retrieval differs between short and long calls. The length of the call is vitally important to the service of the BBC Audience Lines. Each incoming call to the Audience Lines is expensive, and the longer it is, the more expensive. Also, having shorter calls means more can feasibly be answered per Helpliner hour. However, this service is run to support the BBC, a public service broadcaster, so the Audience Lines want to be confident that callers to the service are not receiving a poorer service if they spent less time on each call. The efficiency of the calls were investigated in a number of ways. First, the amount of time it took the Helpliner to find the appropriate briefing sheet was examined, along with the time it took them to first convey information from the document. In this way a precise measure of information retrieval and dissemination can be achieved. The amount of time the caller was put on HOLD was also ascertained using the video. The measure of the time put on HOLD is important because it can be seen from the dialogues and video that this function was only used when information retrieval was difficult, and the Helpliner had to search for the relevant information, which often entailed leaving their seat. There is also a major impact on the telephone conversation when the caller is put on HOLD, as this disrupts the dialogue between the caller and the Helpliner and also unnecessarily prolongs the call.

Because of the communicative nature of the information dissemination in a call centre we were also interested in how information was conveyed from the Helpliner to the caller. So, the 32 recorded dialogues were transcribed and coded in order to probe what was happening during the call:

- how much of the call was spent ascertaining what the caller was looking for? or
- disseminating information from either the briefing sheet or from general knowledge?
- did this differ between long and short conversations?

These coded conversations can give an indication of what was happening during the conversations and also help investigate whether short and long calls can be distinguished by the *content* of the dialogues.

2.2.2. Coding

Each taped conversation was transferred to audio cassette and transcribed. The resulting transcripts were then coded, using both the audio cassettes and the video footage to aid coding.

The coding of the transcriptions was motivated by a desire to understand how information was being retrieved and used in this context, and to see if there were any differences between short and long calls in the way information was conveyed. What is of primary importance is to ascertain how much of this task is information retrieval and dissemination. Therefore, it is helpful to make a distinction between the Helpliner giving the caller information that has been retrieved from a briefing sheet, and information that is given out from general knowledge or from memory. It is also of interest to compare the distinction between these two types of information giving statements with other types of statements that characterise general conversation. These types of statements can be seen in most dialogue analyses, (Kowtko, Isard & Doherty, 1992). Therefore, for the purpose of this study we divided the statements into two distinct categories; dialogue turns which were concerned with information retrieval and dissemination, and general conversational categories.

2.2.2.1. INFORMATION RETRIEVAL

To investigate information retrieval, it is necessary to focus on the time the caller spent looking for information, and also the information that was retrieved. The following two categories can be seen to represent these issues.

HOLD

- When a caller was put on hold for any reason this was noted and time-stamped. It can be seen from the videos that the caller was only put on HOLD when information retrieval was difficult.

BRIEFING SHEET INFORMATION (BR INFO)

- This is information given by the Helpliner from the briefing sheet.
- This can be identified through:
  - * the wording corresponding to the wording of the briefing sheet,
  - * addresses or telephone numbers being given out,
  - * through statements like *"it says here"* and
  - * through the examination of the video to ascertain where the Helpliner is looking, and whether s/he is using the briefing sheet.

The amount of time it took each Helpliner to find the appropriate information document was also examined, along with the time it took them to first convey some information from this document. The finding of the appropriate document was ascertained using the video recording of the conversation. Even if the document was directly in front of the Helpliner, the time for finding that document would be the time it took the Helpliner to realise this was the correct document and pick it up. The latency to first convey information from the document was obtained to the first BR INFO utterance. These time calculations were developed to give an idea of what may facilitate the quick retrieval of information, and what may hinder its transfer.

2.2.2.2. *GENERAL INFORMATION AND CONVERSATION*

Information conveyed to the caller from the Helpliner's memory needs to be differentiated from information that is given to the caller as the result of an information retrieval process. These categories are discussed below.

FREE INFORMATION (FR INFO)

- This is an informative statement that has not come from the briefing sheet.
- This can be identified by not fulfilling the criteria of BR INFO above, especially in the wording of the information, and where the Helpliner was looking while giving out the information.
- FR INFO can consist of information about the Audience Line's service in general, conveying the fact that they have no information available on the subject that is asked for, or can be general information from the Helpliner's own personal knowledge.
- For example, if a Helpliner was to make comments such as:
  "I think these contacts may be able to help you out"
  or
  "If you listen to the Radio this evening, they may mention X on the news".

INFORMATION (INFO)

- These are statements that could be either FR INFO or BR INFO but there was difficulty differentiating between them.
- In this case they were given the general coding of INFO in order to avoid any error.

The three types of information utterances are all general information giving statements, and are the result of the Helpliner fulfilling the callers requests for information. They are often, also, the result of an information seeking process. In order to avoid any artefacts created by dividing the information dissemination categories into three, a final category was created to examine information dissemination in general.

TOTAL INFORMATION (TOTAL INFO)

- This is each of the three information categories being grouped together into one information dissemination category.
- This category allowed the comparison between groups in relation to the overall amount of information that was conveyed. It was used to avoid any artefacts that may have been caused by the segregation of information giving statements into three different categories.

ELICIT

- ELICIT statements are any statements that are made by the Helpliner to elicit a response from the caller: it is a call for information.
- This includes the obligatory questions about the caller's demographics that are asked at the end of each call - how old the caller is and what part of the country they are calling from.
- Eliciting statements would also be used to clear up issues or establish precisely what information was required.
- For example:
  "Could you tell me what part of the country you are calling from?"
  or
  "Have you contacted your G.P?"

ALIGN

- Aligning statements are those that ensure that both the listener and the speaker are understanding each other.
- This category includes both indications that the Helpliner is in alignment, for example,
  "Yeah",
  "I understand",
  or
  "Uhuh".

- And also requests for the caller to show alignment, for example,

  "okay?",

  "do you understand?",

  or

  "have you got that?".
- These are different from eliciting statements in that the Helpliner is not looking for information from the caller, only an indication that the caller is understanding and following what the Helpliner is saying.

INTERRUPT

- Statements that were evidently interrupted by the caller and so were therefore unfinished were categorised as INTERRUPT.
- Any interruption that the Helpliner made into the callers speech could not be recorded and so are not present.

Both the 'align' statements and the 'interrupt' statements would be expected to be found interspersed in normal dialogues (Kowtko, Isard & Doherty, 1992).

ORIENT

- This is basically the beginning and the end of the call; the hello's and goodbyes.

UNKNOWN

- Statements that were difficult to categorise were left as UNKNOWN. All *"Em"* utterances and statements of *"thank-you"* were categorised as unknown.

This categorisation allowed for each conversation to be divided into its constituent parts. Each utterance made by the Helpliner was time-stamped and coded, so that each different type of utterance had its positions in the conversation noted along with the amount of time that was spent on it. For an example of a coded and time-stamped transcript see Appendix 1.

Each time the Helpliner spoke was noted as a 'turn' of the conversation. A normal dialogue proceeds by each speaker taking a turn at speaking, and then listening to the reply of the other. Each turn varies in length depending on what the speaker is trying to convey a turn could be information giving, or merely indicating to the speaker that they are listening. It was these turns that were time-stamped from the start to the end of a speaking episode. A turn can be made up of more than one different type of utterance, for example an align statement, followed by an eliciting statement such as:

"Okay. So is there anything else you would like to ask?"

Because it is difficult to accurately time the end of one type of utterance and the beginning of another within a single statement (that is the end of one word and the beginning of another), both the align statement and the elicit statement in the above example would be given the same time stamps for the beginning and the end of the statement. 11% of the total number of utterances consisted of these "multiple" type of utterance with one or more utterance type sharing the same turn, and therefore the same time stamp.

In order to test for inter-rater reliability, two volunteer Helpliners from the BBC Audience Lines also coded a sample of the transcripts in accordance with the above coding, and a Kappa statistic was conducted on the resulting levels of co-ordination between raters. A sample of eight transcripts was given to each Helpliner, who then coded each turn in the dialogue with the aid of the corresponding videos if they required them[2]. Turns that consisted of more than one type of utterance were already segregated for them on their transcript, and so they did not have to complete this part of the coding. In total 425 utterances were coded, and an inter-rater reliability of κ=0.802 for rater 1 and κ=0.858 for rater 2 was found. An example of the pattern of disagreement between the experimenter and one of the volunteer coders can be seen in Table 1. The coder seen in this example is the one with the lower Kappa statistic.

[2] At the time of filming, each Helpliner was assured that the videos of their calls were confidential and would be used purely for research purposes. However, it was thought that using coders who were familiar with the task of answering calls and the use of briefing sheets was preferable to using volunteers who were totally naïve to the practices of the Audience Lines. Any difficulty that may have arisen from showing Helpliners their colleagues tapes and transcripts were overcome by first making the coders aware that the transcripts they were to code were confidential, and also by the fact that the inter-rater reliability coding was conducted over a year after the initial taped conversations at which time it was mainly possible to use transcripts of people who had since left the service, and so were no longer working alongside the coders.

Coder 1	orient	elicit	align	fr info	br info	info	unknown	interrupt	total
orient	**24**	0	0	0	0	0	0	0	**24**
elicit	0	**74**	5	1	0	0	0	0	**80**
align	0	2	**109**	2	0	0	0	0	**113**
fr info	0	0	0	**29**	2	0	0	0	**31**
br info	0	0	0	2	**121**	4	0	0	**127**
info	0	0	0	4	1	**4**	0	0	**9**
unknown	0	0	4	20	2	0	**6**	2	**34**
interrupt	0	0	1	0	1	0	1	**6**	**9**
total	**24**	**76**	**119**	**58**	**127**	**8**	**8**	**8**	**427**

Table 1: An example of the inter-rater level of co-ordination. The diagonal shows the number of agreements on each of the individual types of utterances. A comparison of the total number of turns coded as each of the individual utterance types can given an indication of any systematic differences between the raters.

Although there is a strong level of agreement between the Helpliner raters and the experimenters ratings, it can be seen from Table 1 that there was a tendency for the volunteer coder to classify what the experimenter thought were "free information" statements as "unknown". After discussion with the volunteer, the experimenter and the coder came to the agreement that some of these differences were due to a lack of confidence in her own judgement, and also is related to the fact that in training, the BBC Audience Lines insist that, even in the Helpliner has a particular expertise in a certain area, they are not to give out information that is not on the briefing sheet. This resulted in this coder in particular having a strong bias not to code statements are "free info" statements.

There was also a small difference in opinion between the volunteer coder and the experimenter with respect to the "align" and the "elicit" statements. Coder 1 was more likely to code what the experimenter classified as an "align" statement as an "elicit" statement. This is thought to be due to the lack of familiarity the coder had with the concept of aligning statements, which again resulted in a small bias towards classifying them as eliciting statements. However, despite this, there was still a strong level of agreement between the volunteer and the experimenter, and we are therefore quite happy with the reliability of the coding methods.

2.2.3. Analysis

Calls were divided into short and long calls in relation to the length of the entire conversation, creating two groups, a Short call group and a Long call group.

Differences between the Short call and the Long call group were investigated using a variety of measures. Variation in the use of the different types of coded utterance were investigated by firstly comparing the proportion of time, the proportion of the total number of turns and the proportion of the total number of words used in each type of utterance between the two groups. This was conducted using a One-Way ANOVA with one between subject's factor, call length, with two levels, Short calls or Long calls. The critical level for all these analyses is $p<0.05$.

The amount of time it took the Helpliner to find the appropriate briefing sheet and also the amount of time it took them to then use the information from the briefing sheet was also investigated. This was again analysed using a One-Way ANOVA with one between subject's factor, call length, with two levels, short calls or long calls. For the briefing sheet locations analysis, one participant's data was removed, that of BW2, because no briefing sheet was found or used in relation to the caller's query. This resulted in the Long calls group having 15, as opposed to 16 subjects in it. When information transfer was investigated 6 participant's data was removed as no briefing sheet information was given out; 3 participants data was removed from each of the groups.

2.3. RESULTS

CODE	PROGRAMME	SUBJECT	CHANNEL	HOLD?	LENGTH
ra4	Budget	Budget/road tax	2		61.0
jm4	Jimmy Young	Autism	2		93.5
jm1	Jimmy Young	Autism	2		108.5
mb1	Food Programme	Sloe Gin	4		138.5
af3	Medicine Now	Prostate Cancer	4		141.0
cb3	NO PROG	Contact for BBC TV			143.5
ra3	NO PROG	Comments on Schools			144.5
ra1	Budget	Budget/road tax	2		146.0
cb1		Ovarian Cancer	2		182.5
eg3	Going Places	Conventions		H	190.5
jm3		CJD & Mad Cow	2		227.0
lc1		Home Efficiency Schemes	4		236.5
ps1	Newsbeat	Ecstasy	1		238.0
cb2	Radio 1 Campaign	CRIMETIME/legal aid	1		281.5
nw4	NO PROG	Friendly Societies	4	H	283.0
wb2	NO PROG	Drugs/Heart conditions			293.0
af4		Home Working	2	H	297.0
ra2	World Aids Day	HIV and AIDS	1		301.5
wb3	Medicine Now	Prostate cancer	4	H	305.0
nw3	Radio 2 Campaign	Elder Abuse	2	H	307.0
mb2	Radio 2 Campaign	Elder Abuse	2		347.0
mm1	Jimmy Young	Methadone	2	H	354.5
jm5	Jimmy Young	Autism	2		359.5
bw2	Jimmy Young	Wills	2		369.0
ps2	Trade Business	Mass Marketing	4	H	376.0
wb4	NO PROG	Missing persons		H	387.5
lc2	Radio 2 Campaign	Elder Abuse/Carers	2		450.0
eg1	Radio 3 Campaign	Manic Depression			454.0
bw1	Radio 3 Campaign	Mental Health	3	H	539.0
og1	In Touch	Children with Disabilities	4	H	566.5
eg2	NO PROG	Contacts booklet			645.0
wb1	Moneybox	Small Business insurance	4		657.5

Table 2: The subject areas, length and broadcast channels of the all the calls.

FIGURE ONE: Colour Coded Conversations

2.3.1. Groups

The calls were divided into short and long calls by the length of the entire call. That is, the length of time from answering to hanging up. This resulted in two groups of 16 calls. The subject areas, Helpliner code and exact call durations can be seen in Table 2.

The range of call length was from 61 to 657.5 seconds. The Short Call group had a mean of 181.8 seconds and a range of 61 to 293 seconds, standard deviation is 69 seconds. The Long Call group had an mean of 419.8 seconds, with a range of 297 to 657.5 seconds, the standard deviation is 134 seconds. The overall mean was 300.8 seconds.

A colour-coded representation of the coded conversations can be seen in

Figure 1, where all the purple colours are information giving statements, the yellow illustrates every aligning statement, and red indicates the length of time the caller was put on hold.

2.3.2. Time to Access Documents

The time it took Helpliners to access the appropriate briefing sheet during each call was measured, along with the time it took them to use the briefing sheet, that is the first time a BR SHEET utterance was made after the briefing sheet was found. These measures were compared between the two groups. Significant results were found for the first analysis only.

- WHEN WAS THE BRIEFING SHEET FOUND? $F(1,30)=4.445$, $p<0.05$. The means for were 46.8 seconds and 115.8 seconds for the Short and Long groups respectively.
- WHEN WAS THE BRIEFING SHEET INFORMATION USED? $F(1,25)<1$. The means are 42.4 seconds and 42.7 seconds from the retrieval of the briefing sheet respectively.

These data are illustrated in Figure 2. Participant are able to locate the appropriate document faster during shorter calls. However, once the document is located, participants first disseminate information from that document in a fairly standard time-frame. The difference between the two groups is therefore not to do with when they *chose* to use the document. Once found, the document was used at a fairly constant interval.

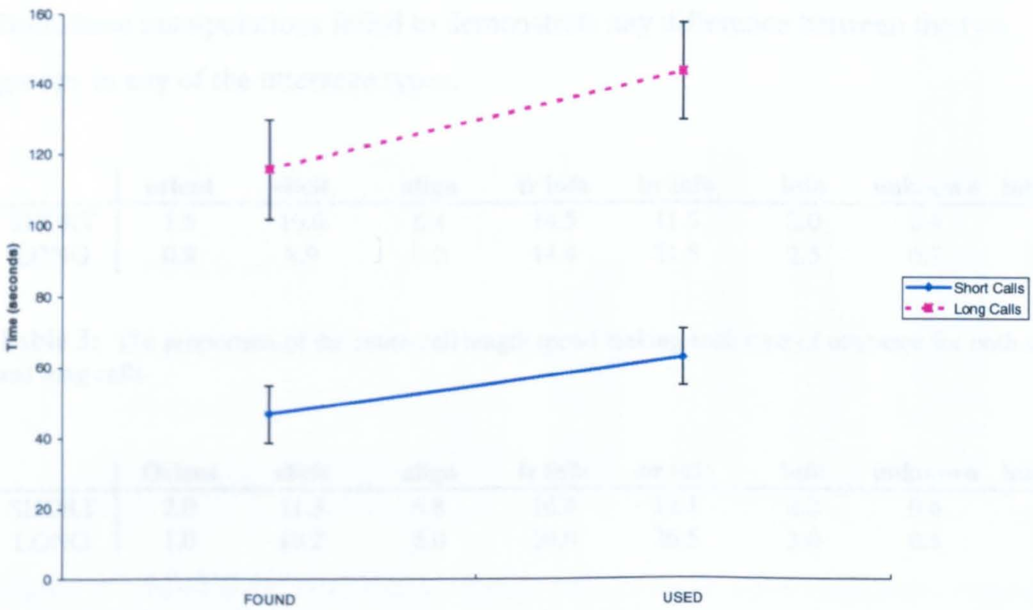

Figure 2: The average length of time in seconds it took Helpliners to locate the appropriate briefing sheet (FOUND), and disseminate information from it (USED). Participants locate information faster during short calls. However, once located, information is disseminated at a fairly constant interval.

Related to the time it took to access the document is the time callers spent on HOLD. Out of the 10 calls which included some time on HOLD, 7 of these HOLD episodes occurred before the relevant briefing sheet was located. Therefore HOLD time can be thought of as largely information retrieval time. A Pearson's chi-square test was used to investigate whether participants were more likely to be placed on HOLD during the longer calls. A significant difference between the groups was found, $\chi^2(1)=5.1$, $p<0.05$. Callers were more likely to be put on hold during a long call. In fact, only 2 of the short calls involved some time on HOLD, whereas 8 of the 13 long calls involved some time on HOLD.

2.3.3. Time spent on each utterance

In order to see if there are any differences between the two groups in anything but their differing lengths, we looked at the proportion of the entire conversation length that was spent on each type of utterance. This could be done in one of two ways.

The first would be to take the total amount of time spent on each utterance as a proportion of the entire call length, from answering to hanging up (Table 3). The other would be to take the time for each utterance as a proportion of the conversation length, that is, removing the time spent on HOLD from the calculation (Table 4). Both these manipulations failed to demonstrate any difference between the two groups in any of the utterance types.

	orient	elicit	align	fr info	br info	info	unknown	interrupt
SHORT	1.5	10.0	6.4	14.5	11.5	2.0	0.4	0.4
LONG	0.8	8.9	7.2	14.4	21.5	2.5	0.7	0.3

Table 3: The proportion of the entire call length spend making each type of utterance for both short and long calls.

	Orient	elicit	align	fr info	br info	info	unknown	interrupt
SHORT	2.0	11.3	6.8	16.4	12.1	2.0	0.6	0.4
LONG	1.0	10.2	8.0	16.0	26.5	3.0	0.8	0.4

Table 4: The proportion of time spent in conversation, that is the total length of the call minus any time the caller spent on HOLD.

A final method of analysing the length of each type of utterance was to take the amount of time on each as a proportion of the total amount of time that the Helpliner spent talking, that is removing the time the Helpliner remained silent, listening to the caller along with the time spent on HOLD (Table 5). However, again this resulted in no significant difference between the two groups.

	orient	elicit	align	fr info	br info	info	unknown	interrupt
SHORT	4.5	23.4	15.1	26.8	21.9	6.0	1.2	0.9
LONG	1.5	15.4	14.6	27.9	33.5	5.4	1.1	0.6

Table 5: The proportion of time the Helpliner spent making each type of utterance, as a proportion of the total time the Helpliner spent talking during the call.

2.3.4. Turns

The number of turns taken by the Helpliner during the course of the conversation was analysed. That is, taking the total number of turns for each utterance type as a proportion of the total number of turns during the entire conversation. This is illustrated in Figure 3. Only one significant result was revealed. This was for the utterance type elicit, $F(1,31)=5.065$, $P<0.05$. 20.1% of short calls were spent making this type of utterance, but only 12.9% turns of long calls. Thus, the longer the call, proportionally the fewer number of ELICIT utterances that are made.

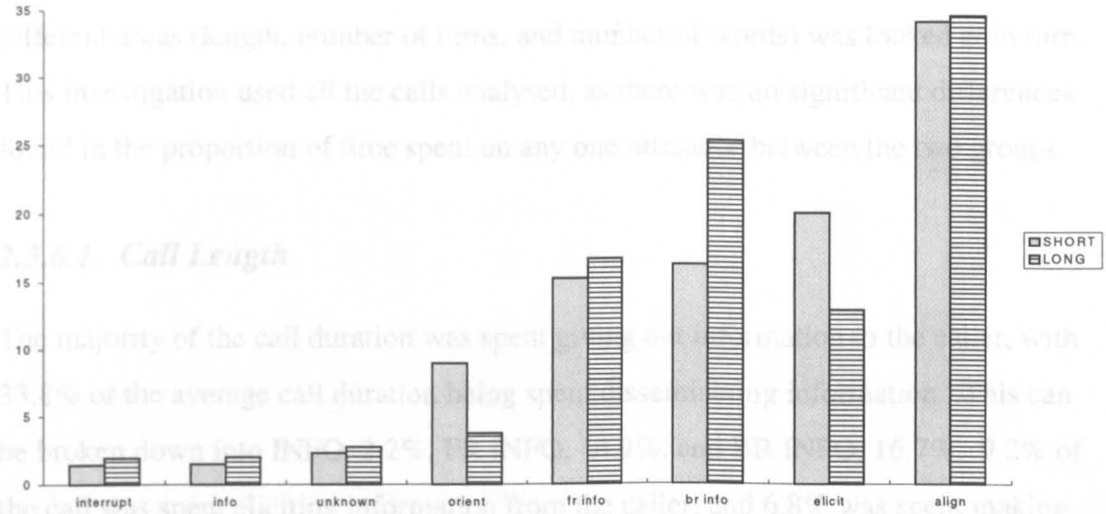

Figure 3: The number of turns made for each utterance during the call as a proportion of the total number of turns per call.

2.3.5. *Words Spoken*

An analysis of the proportion of words spoken per utterance per call again revealed only one significant result which was again for the elicit statement, $F(1,33)=4.353$, $P<0.05$. The mean number of words spoken were 12.4 words per utterance during short calls and 17.1words per utterance during long calls.

The only other way of looking at the number of words spoken during the course of the conversation would be to compare the proportion of words per call. That is taking the number of words spoken for each type of utterance and making that a proportion of the total number of words spoken during the call. Again this resulted in significant results for elicit only, $F(1,33)=4.124$, $P<0.05$. 29.3% of the words spoken during short calls can be classified as elicit statement, and 19.1% of the words during a long call.

2.3.6. Differences Between Utterances

The final analysis to be conducted is whether the utterances differ from each other. What type of utterance predominated? Was this because most turns consisted of this type of utterance, or was it because the longest turns were of this type? Each of the different areas (length, number of turns, and number of words) was looked at in turn. This investigation used all the calls analysed, as there was no significant differences found in the proportion of time spent on any one utterance between the two groups.

2.3.6.1. Call Length

The majority of the call duration was spent giving out information to the caller, with 33.8% of the average call duration being spent disseminating information. This can be broken down into INFO, 2.2%, FR INFO, 14.9%, and BR INFO, 16.7%. 9.2% of the call was spent eliciting information from the caller, and 6.8% was spent making ALIGNING statements.

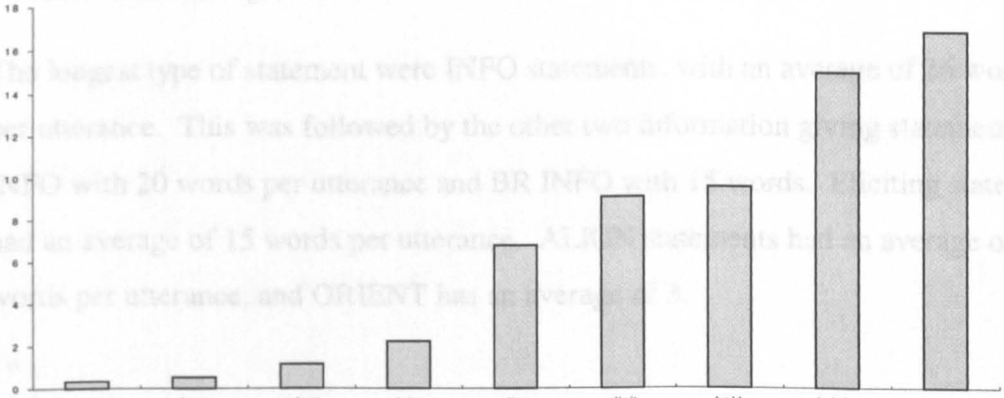

Figure 4: The proportion of the total length of the call spent on each type of utterance.

If a caller was put on hold, then they were likely to spent 29.5% of the entire call length in this situation.

2.3.6.2. Number of Turns

Looking at the number of turns changes the apparent predominance of information giving statements. Information giving statements account for 38.5% of the turns made (INFO, 1.7%, FR INFO, 16.0%, and BR INFO, 20.8%), but ALIGN statements make up a comparable 34.8%. This difference can be accounted for by the fact that ALIGN statements tend to be much shorter than any INFO statements, so although there are a comparable amount, they take much less time. The average call consists of 16.1% of turns making eliciting statement.

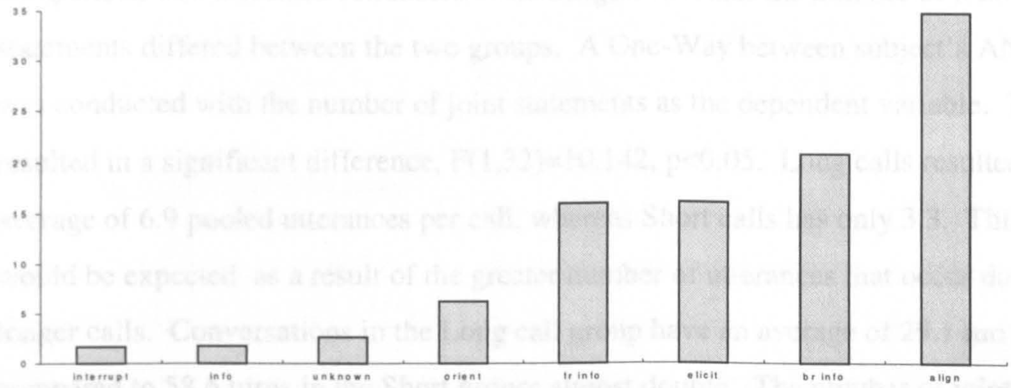

Figure 5: The proportion of turns made for each type of utterance as a proportion of the total number of turns made during the call.

2.3.6.3. Number of Words

The longest type of statement were INFO statements, with an average of 26 words per utterance. This was followed by the other two information giving statements, FR INFO with 20 words per utterance and BR INFO with 15 words. Eliciting statement had an average of 15 words per utterance. ALIGN statements had an average of 5 words per utterance, and ORIENT has an average of 3.

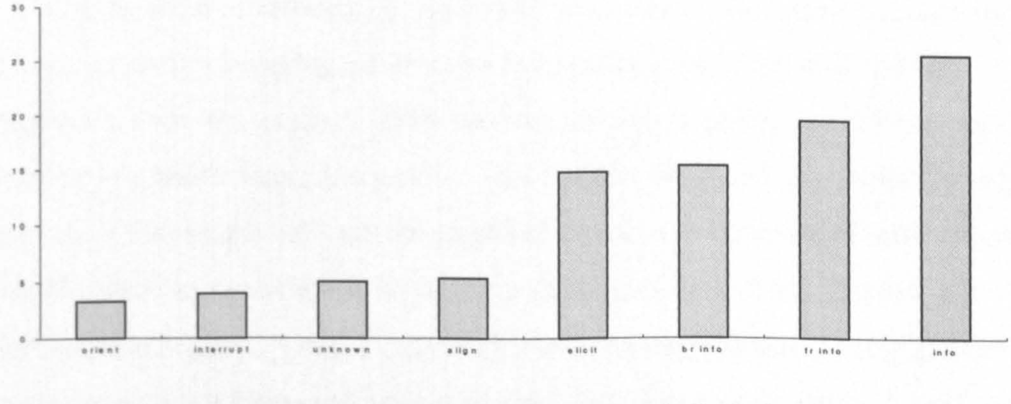

Figure 6: The average number of words spoken during each individual utterance.

2.3.7. Number of Multiple Codings

As stated earlier, due to the difficulty of accurately timing different statements within one utterance or turn, if two different types of statements occurred within one turn they were given the same measurement figures for timing and number of words. A comparison was therefore conducted to investigate whether the number of joint statements differed between the two groups. A One-Way between subject's ANOVA was conducted with the number of joint statements as the dependent variable. This resulted in a significant difference, $F(1,32)=10.142$, $p<0.05$. Long calls resulted in an average of 6.9 pooled utterances per call, whereas Short calls has only 3.3. This would be expected as a result of the greater number of utterances that occur during longer calls. Conversations in the Long call group have an average of 29.1 turns, compared to 58.6 turns in the Short group; almost double. The number of joint codings, therefore, can be assumed to relate to the increased number of turns.

2.4. DISCUSSION

The Task Analysis was conducted in order to investigate exactly what happens during the course of a call, and also to investigate whether Short and Long calls differ from each other in the manner in which they progress. Of particular interest is the manner in which information was retrieved by the Helpliner in order to answer the caller's query, as this was revealed to be the principle difference between the groups.

2.4.1. Information Retrieval

A clear difference was found between Short and Long calls in relation to the criteria designed to investigate information retrieval. The amount of time it took the Helpliner to locate the appropriate briefing document was far longer during Long calls. There was also a higher probability of being put on HOLD during the Long calls. Both these measures indicate that Long calls are characterised by slower, and therefore we can assume poorer, information retrieval. Other possible explanations for the delay associated with information retrieval, such as the Helpliner finding it difficult to ascertain what the caller is looking for, can be discounted by looking at the analysis of the Helpliner's speech. There are proportionally no more ELICITing statements made during Long calls, which would be expected if the Helpliner had to keep clarifying what it was the caller was looking for. In fact, the converse is true. Helpliners make proportionally *less* ELICITing statements during the Long calls.

A third measure of information retrieval is indicated by the amount of time the Helpliner spent conveying information from the briefing sheet (BR INFO). However, there was proportionally no more time spent giving out information from the briefing sheet during Long calls. This fact also discounts any explanation that presumes that longer calls are the results of an increased transfer of information from the Helpliner to the caller, or a greater proportion of the call being given over to information transfer. Longer calls results in a similar proportion of the call being concerned with information transfer to the caller. Support for the fact that Long calls are characterised by poorer information retrieval can be seen in the fact that the first BR INFO statement given during a calls occurs at a fairly standard time after the briefing sheet has been located. Therefore, once the appropriate briefing sheet was found, which took longer during Long calls, information from this sheet was given out in a fairly standard time frame, irrespective of the total length of the call.

2.4.2. Characteristics of the Helpliner-Caller Interaction

No significant difference were found in the proportion of time taken, the proportion of turns per calls, or the proportion of words spoken when each of the utterance types were compared between groups (the one exception is ELICIT, discussed below). These results seem to indicate than the progression of each of the calls is quite standard, without either of the two groups being characterised by differences in the way information is conveyed, or in a larger proportion of any type of utterance. We are therefore again led to the conclusion that the only visible difference between the two groups is in the time it takes to locate and therefore disseminate information from the prepared briefing sheets. Nevertheless, the significant results that were associated with ELICIT may have a bearing on the discussion. There was a difference in the proportion of ELICIT turns that were taken during a call. Short calls resulted in 19.6% of turns being ELICIT statements, Long calls resulted in only 12.5%. Therefore, proportionally more turns were taken during Short calls. This may relate to the fact that only so many questions need to be asked during a call: the Helpliner needs to establish the purpose of the call and exactly what the caller requires and they must also ask the essential demographic questions at the end of the call. These questions may all be fairly standard, regardless of call length. Therefore, proportionally, more time will be spent on ELICITing questions during short calls. This also means that the extra length in the Long Call group is not taken up with the Helpliner having difficulty establishing the purpose of the call, and probing the caller for more information, as discussed aove. The extra length must be due to some other factors.

ELICIT statements also produced a difference between the two groups when the average number of words per utterance were compared. Short calls resulted in an average of 12.2 words per utterance, whereas long calls resulted in an average of 16.6 words. However, this may be an artefact of the experimental design in which different types of utterance were pooled together if they were part of the same turn, in order to keep the timing in individual turns accurate. The number of pooled utterances per call was compared between the two groups and revealed that significantly more statements were pooled together during long calls (6.9 utterances per call) compared to short calls (3.3 utterances per call). It is therefore feasible to suggest that the number of words per utterance type was artificially extended during long calls, due to the fact that there were more pooled utterances. If we look at the type of utterances that were pooled, it can be seen that ELICIT was a common category, resulting from many information giving statements ending in an ELICIT statement, in order to take the dialogue forward. For example:

"...open from 9 to 5. Would you like details of another contact organisation?"

This frequent pairing of information giving statements and eliciting statements would definitely extend the average length of the ELICIT category, as INFO statements were the longest (in terms of time and word length) of all the statement types.

2.5. CONCLUSION

Because of the nature of general queries from the public, each call received by a Helpliner is different. However, there does seem to be quite a standard progression in the pattern of utterances, with the proportion of each type of utterance, as measured by the time, number of turns and number of words, remaining constant across both short and long calls. Table 2 illustrates the fact that the subject matter of the conversations in this analysis differed greatly, with no one topic occurring in more than three individual calls. It would therefore be expected that each call would vary in the amount and type of information that is conveyed, as it is different briefing sheets that are being used. However, the similarity between the conversations in the manner in which they proceeded would suggest that the progression of the conversation has little to do with the content of the information which is being conveyed, but must be due more to a similarity in the way information is being passed from Helpliner to caller during their conversation. The fact that the proportion of eliciting statements does not differ between the two groups simply indicates that ascertaining what information the caller requires remains equally easy across call lengths, and therefore requires the same number of turns in absolute terms, regardless of call length. The calls that noticeably differ in Figure 1 are ones in which little information was passed, and the Helpliner was mainly listening to the caller's comments. If this is looked at more closely, three of these calls related to an Elder Abuse campaign that was ongoing at the time of filming, therefore it may be more emotive calls like these take longer, and may differ in structure to more standard information giving calls.

The biggest differences between the two groups seems to relate to the ease or difficulty of information retrieval. Longer calls are characterised by a significant increase in the time it took the Helpliner to locate the appropriate briefing sheet. This, along with the related higher probability of being put on HOLD during long calls would both indicate that the primary difference between Short and Long calls is the effectiveness of the information retrieval. As stated earlier, a major consideration for the BBC Audience Lines is the financial implication of the duration of each call. Longer calls are more expensive. If these calls were more effective, then this may be an issue that could not be resolved, because of primary importance is the effectiveness of the customer service. However, if the difference is largely due to ineffective information retrieval, then this is an area which could easily be improved with the only impact on customer service being an increase in the caller's satisfaction.

This thesis will now concentrate on the improvements that can be made to the presentation of a document on screen. If a document can be easily navigated, and this improvement could result in savings even as small as one second per call, this could result in huge savings across the service as a whole. For example, working on an average of 2,000 calls being taken by the Audience Lines each day (a minimum target that was largely attained during 1998), with 1 second being saved per call, then the savings can be seen as 33 mins 20 seconds a day or 202 hrs 46 mins 40 seconds per year.

CHAPTER 3

3. INFORMATION RETRIEVAL FROM TEXT

Text presentation on screen is ubiquitous, and with the growth of the Web, Email, and other forms of electronic communication - and the advent of digital television and radio with the possibility of side channels containing textual information - this can only be predicted to increase. The way we present these documents, therefore, is vitally important if we want text to be easily read and searched by anyone who accesses it. The aim of this thesis, therefore, is to investigate how reading and searching for information is affected by different methods of document presentation.

There are a number of questions that are implicit in this increased use of text documents.

- Can document presentation affect reading or search processes, either in terms of the time it takes to read or search the document, or in changes in the eye movement patterns?
- If there are differences between formats, what aspect of the formatting changes are altering the eye movement pattern?
- What do these differences tell us about the mental representation that is stored of the text?
- How does this fit in with current theories of either text search or reading?
- Do changes that occur as a result of formatting alterations behave in a similar manner for both computer screens and paper?
- Do formatting changes affect how participants search previously unread documents? Or do they only affect the search of known documents?

These are questions that are also of interest to the BBC Audience Lines, as well as of general scientific interest. How should documents be laid out in order for information to be accessed as quickly as possible? In the future would this same formatting be a useful way to represent information for general consumption by the public on the Internet or on digital side-channels? This research will investigate factors under which text search is facilitated, what may be causing this facilitation, and how this may be represented in memory. Many disparate areas of research, therefore, feed into this area of study.

Section 1 will begin with an overview of the current thinking about reading, text search and scanning. To investigate what effect formatting manipulations have on reading and searching, it is important to first understand what happens during normal silent reading. I will therefore detail what is known about eye movements as they relate to basic reading processes, and then describe some models of reading. Understanding what is known of how we read can then help us realise and interpret disruptions to fluent reading.

Research on the processes involved in reading leads to the question of whether these findings can be generalised to other tasks. Thus I will also consider how the models of reading behaviour have been expanded to encompass other tasks such as picture viewing and searching. We must again understand how people search under normal circumstances to understand what effects formatting manipulations might have on searching.

The final part of Section 1 will discuss the extensive research that has been conducted on re-reading a text. Investigators have focused on this area of research in order to discover what information is encoded during the first reading encounter, and how this is represented in memory. Studies in this thesis will investigate whether the layout and formatting of a page can alter the memory representation for text. Researchers interested in re-reading have strongly debated what information is encoded and therefore able to facilitate a later reading encounter. The salient points in this debate are laid out in this chapter, along with the conclusions that have been reached as to what information ends up in text memory. Of particular relevance to the research discussed in this thesis is the effect visual information from the text has on both storage and retrieval. This will be discussed in relation to the rereading benefit, and also in more detail in the second section of this chapter.

The second section focuses on what perceptual information is encoded during unrelated tasks, such as picture naming and reading. The encoding of perceptual information is discussed in relation to both objects and words leading on to a discussion of the encoding of visual aspects of text. This area of research will be directly referred to during the following empirical studies. Whether perceptual information is encoded during reading, and whether this additional information serves any function is directly relevant to any investigation into the effect of layout manipulations on reading and text search. Finally, previous work on the effect of medium and formatting manipulations are discussed. This leads directly on to the studies that will be discussed in the remaining chapters in this thesis, which investigate the effects of formatting manipulations within and across mediums.

3.1. SECTION 1

3.1.1. Reading Research

The aim of this thesis is to investigate how reading and searching for information within a written document is affected by different methods of document presentation. We are interested in discovering what aspects of formatting are affecting these processes, and what this can then tell us of how readers and searchers use formatting, and how formatting can affect a searcher's representation of that text. Searching itself can be sub-divided into many different tasks: readers can scan a text for a general overview of the content of the passage, or they may be searching for a specific piece of information from within the text. We are interested in how someone searches a text for discrete pieces of information in response to a query when the information is both present and not present, as this is directly analogous to the task of Helpliners on the BBC Audience Lines. We are also interested in what happens during the initial reading encounter with a text laid out in a specific format that may then influence subsequent search processes. For this reason, many aspects of reading and searching research are relevant, and will be described below.

First I will summarise methods of investigating on-line reading processes, and also briefly discuss some models that have been developed of reading, and how these can be expanded to explain text search or picture viewing. These models of reading give a clearer idea of how current thinking stands on the processes involved in reading and searching, and can help in our attempts to elucidate what representation is created of text that has either been read or searched. Investigating picture viewing can help in the understanding of what a reader or searcher may pick up from the text on a more global level, above that of individual words.

3.1.1.1. Reading Research Techniques

Historically, the processes and representations involved in reading have been studied using a number of different methods. However, it has been accepted for some time that a true insight can only be gained by using some sort of on-line, instantaneous measure (Rayner & Pollatsek, 1987). In order to achieve this on-line measure, researchers have devised many diverse tasks. These tasks include, word-by-word silent reading, word-by-word lexical decision, Rapid Serial Visual Presentation (RSVP), and fragment completion responses. These techniques have produced interesting results and have contributed to progress in the field of reading research. However, there are problems associated with each of them. Primarily, they are all unnatural and may interfere with the usual processes associated with normal, silent reading. For instance, many of the techniques lead to extremely long reading times as compared to normal, silent reading. Others use a secondary task in addition to reading, which may interfere with normal reading processes.

A widely used technique which overcomes many of these issues is to simply measure the total reading time for large segments of text. This technique can be very useful and comes closer to a natural reading situation. It can also give a good indication of any difficulty that may have been encountered during the reading of a passage. However, it does not allow for the precise timing of reading individual words or specific parts of the passage. Nonetheless, if gross changes in the passages are used, and reliable differences emerge, this technique can indicate that one target is easier/more difficult or more troublesome to read. Therefore this technique can be useful for illustrating that there are differences between two passages, although it cannot specify exactly what caused that difficulty.

The most advanced and arguably the most precise and informative measure of on-line processes is to track eye movements during reading. It has been argued that the pattern of a reader's eye movements can provide an insight into the natural language processes that are involved in reading (Rayner & Pollatsek, 1987). Eye tracking has the advantage over other tasks (such as those mentioned above), in that eye movements occur naturally in silent reading, and so their measurement does not directly interfere with the process. In this way very naturalistic tasks can be given to a participant, such as reading, or searching for a discrete piece of information, without the need for a secondary task to inform the experimenter what is going on. There are a few disadvantages of using eye monitoring techniques, for example, the participant may have to have their head restrained by means of either a bite bar or a chin rest. However, a new generation of eye trackers has been developed which have the capability to also measure head movement through the use of sensors attached to a lightweight headband worn by the participant. With these devices, the reader can have free movement of their head and shoulders, and can make responses during an experiment, without affecting the calibration of the equipment. Another problem associated with eye tracking data has also been overcome with the advent of new hardware and software: in the past the presentation of text on screen was fairly limited in terms of both the quantity of information presented and its format. However, there are no longer such limitations.

3.1.1.2. Eye Movement Research on Reading

Detailed investigations into eye movements during reading have produced quite a clear picture of the reading process. While reading, the eyes move across the page in a more or less standard fashion. There are stationary periods (fixations), during which information is obtained from the page. The eyes then move from one fixation to the next through ballistic movements called saccades. During these saccadic movements, virtually no information is obtained from the page (Wolverton & Zola,1983). The pattern of fixations and saccades, and also the probability that a regressive or backward fixation is made, can help researchers gain a fuller understanding of what is happening during the reading process. Under carefully controlled circumstances, a longer fixation duration on a word indicates that the reader is encountering some difficulty processing that specific word or that it is less predictable from the context of previously read material, (Balota, Pollatsek & Rayner, 1985; Ehrlich & Rayner, 1981). This can be due to the frequency of the word (Inhoff & Rayner,1986; Rayner & Duffy, 1986; Rayner & Fisher, 1996; Vitu, 1991), or because the reader is having trouble integrating the word into their representation of the text (Frazier & Rayner, 1982). Shorter saccades can also be indicative of difficulty processing specific words or sections of texts, as can an increase in the frequency the reader regresses and rereads a piece of text. Together all these measures give an insight into which specific parts of the text are causing difficulty, and also what parts of the eye movement pattern is being affected.

The basic facts about eye movements during reading have been well known for some time (Huey, 1908, cf. Rayner & Pollatsek, 1989). Skilled readers typically spend 200-250 msec on each fixation, and move their eyes forward about 8 character spaces with each saccade. In addition, they regress on about 10 to 15% of these fixations (Rayner, Sereno, Morris, Schmauder & Clifton, 1989). However, there is a considerable amount of variability within these measures depending on a number of factors. For example, a given reader may fixate from under 100msec to over 500msec while reading the same passage. It is also common to move the eyes forward as little as one character space to as much as 15 or more. It is this variability that allows for the use of the eye tracking method as a measure of ongoing processing. It has been documented that the variability associated with each of these measures (fixation duration, saccade length, probability of regressing), is related to cognitive processes activated during language comprehension (Rayner, 1978; Rayner & Pollatsek, 1987, 1989). For example, when a text is difficult, readers fixate longer, move their eyes a shorter distance during saccades, and make more regressions (Frazier & Rayner, 1982). Different types of text, for example a newspaper article and a scientific text, will result in different patterns of eye movements, and also differences in the overall reading times. For example Rayner *et al*, (see Rayner & Pollatsek, 1989), demonstrated with college-aged readers that the average fixation duration for reading a newspaper article was 202 msec, saccade length was 9.2 character spaces, the probability of regressions was 6%, and the words read per minute was 321. In contrast, the corresponding figures for reading a biology text were 264 msec, 6.8 characters, 18% and 233 words per minute. This illustrates that the content and the wording of a document can have strong effects on the eye movement data and also gross measures such as reading rate.

Most current theories agree that two of the major attributes of eye movements during reading, the saccade length and the fixation duration, are controlled by different mechanisms. That is *where* a reader looks next (the saccade length), and *when* the eyes move (the fixation duration), are largely independent decisions (Rayner & McConkie, 1976; Rayner & Pollatsek, 1987). *Where* a reader looks next is very much influenced by the length of the words to the right of the fixation (Morris, Rayner & Pollatsek, 1990; O'Regan, 1979; Rayner & Pollatsek, 1987), although this only holds for normal reading situations. Eye movements during text search or while looking at a picture are less predictable and therefore the study of the *where* component under these circumstances is necessarily complex. The decision on *when* to move the eyes during reading seems to be based on more complex processes than the *where* decision. However, it is clear that the ease of comprehending the currently fixated word influences when the eyes move onto another word.

3.1.1.3. Models of Eye Movement During Reading

There have been various attempts to model either the *where* or the *when* component of eye movements, or to incorporate both decisions into one process. The most cited and arguably the most influential of these models, which attempts to account for the *when* aspect of eye movements is that of Morrison (1984). Morrison's model proposed that each fixation begins with visual attention focused on the currently fixated word (word *n*). After the processing of the currently fixated word has reached a critical level, attentions then shifts to the word to the right of the fixation (word *n+1*). This shift in attention initiates the processing of the word at the newly attended location and signals the eye movement system to prepare a saccade. Once this motor programme is completed the eyes then follow attention to the word *n+1*. Because of this lag between the shift of attention and the movement of the eyes due to programming latency, information is acquired from word *n+1* before it is fixated (this is referred to as the parafoveal preview effect). Attention can sometimes move to word *n+2* if word *n+1* is easy to identify. In such a case, the eye movement programme can be changed to send the eyes to word *n+2*, and to skip word *n+1*. Usually there is some cost for this, and the fixation duration for word *n* is then inflated. This would be because the eye had to cancel the programme to go to word *n+1*. If the program is too far gone to cancel the saccade, there may be two different outcomes: there may be a very short fixation on word *n+1*, followed by a saccade to word *n+2*; or the saccade may land in an intermediary position between the two words. In this way the model can account for some puzzling facts about eye movements, such as very brief fixation or fixations on the spaces between words.

There were some reading characteristics that Morrison's 1984 model was unable to account for. For example readers often make more than one fixation on word *n* before moving onto word *n+1*. However, Morrison's model has adequately explained much of the eye movement data that has been produced over the last two decades and is still one of the most comprehensive models available today. Subsequent models have tried to account for some of the difficulties, as well as incorporate the *where* aspect of eye movements during reading, while keeping may of the ideas originally found in Morrison (1984)'s model. For example, Reichle, Pollatsek, Fisher & Rayner (1998) have recently extended Morrison (1984)'s model, to account for many of the previously inexplicable phenomena in reading.

3.1.1.4. Modelling Eye Movements During Other Tasks

It is well accepted, therefore, that Morrison's model, and later models, have produced parsimonious accounts of the reading process. How well these models can explain other complex visual tasks such as visual search or picture viewing is another matter entirely. One development of Morisson's, model is the *Sequential Attention Model,* (Henderson & Ferreira, 1990; Henderson, Pollatsek & Rayner, 1989). This model contains a number of basic assumptions, many of which are suggested by Morrison's original model. The first is that at the beginning of each new fixation, visual attention is allocated to the word/object at the centre of the fixation. The second is that attention is reallocated to a new stimulus (object/word) when the foveal stimulus is "understood", which in its simplest interpretation would mean that it is identified, or there is lexical access (Rayner & Balota, 1989; Rayner & Pollatsek, 1987). However, this reallocation of attention could be prompted by the fixated word or object reaching a critical threshold prior to recognition, or when a process following identification such as syntactic parsing in reading or semantic interpretation in scene perception is imminent or completed. A third assumption of the sequential attention model is that the shift of attention onto the new object or word happens simultaneously with the beginning of the programming of the saccadic movement necessary to bring the eyes to a new location. The model also relies on the assumption that the location of the shift of attention is to the same location the eyes are programmed to move towards. A final assumption is that the eyes will follow the shift of attention after a programming latency.

This Sequential Attention Model can, with very little manipulation, account for many of the phenomena seen in both reading, scene perception and text search. Henderson, Pollatsek & Rayner (1989) investigated the relationship between eye movement and attention during a picture viewing task. Participants viewed displays composed of four line drawings presented in a square around a fixation point. The task was to view each of the four objects in a prescribed order, and then answer a simple memory question. A contingent display paradigm was used to manipulate the presentation of the non-attended objects depending on where the participant was fixating. Henderson *et al* found that when the fixated object plus the object to be fixated next were displayed, with the remaining objects replaced by a pattern mask, the resulting eye movement records (first fixation duration and gaze duration) were equivalent to when the entire page was able to be scanned without any pattern masks. However, when the object to be fixated next was masked, the eye movement measures were disrupted in comparison to the full page display. These findings imply that information is used primarily from the object currently fixated and the object about to be fixated. This held even in the situation where the object to be fixated was below the fixated object and involved a vertical eye movement in order to be fixated. These finding suggests that the asymmetry of the attentional span found in reading is also found in picture viewing, and is not confined to horizontal eye movements. Attention is allocated dynamically during each fixation to the location to be fixated next.

The above studies illustrate that attention can be moved in any direction from the current fixation point. However, this prompts the question, what location will be attended next, and therefore fixated next? It is generally assumed that this is determined on the basis of relatively low level stimulus attributes (Henderson, 1992; Koch & Ullman, 1985; Mahoney & Ullman, 1988). Henderson (1992) proposed that a preattentive map of likely stimulus locations is made available to the attention allocation system, and that these locations are weighted so that attention is allocated to the stimulus location with the largest weight. In reading, the largest weight can generally be assigned to the word to the right of the currently fixated word. In scene perception, however, the situation is less constrained, but a process could easily assign weights on the basis of salience, as derived from a low-level analysis. Rayner & Pollatsek, (1992) supported the above models by proposing that the basic mechanism of eye movement control is the same across tasks (reading, picture viewing, and visual search), although the resulting pattern of eye movements may differ. That is, participants engage in the same cycle of processing the fixated material, shifting attention to some other part of the scene/text, with the saccade following to the attended location at a later stage, regardless of task. Again, they identified the main problem with this theory as a failure to account for the *where* aspect of the eye movements. However, considerable work on scene perception has indicated that the pattern of eye movements when a picture or scene is being looked at is not random. People tend to fixate on areas of a scene that are judged as "informative", either by the experimenter or by other participants. Although "informative" is rather ill defined as either semantically informative (giving a key to understanding the scene), or visually striking, this does support Henderson (1992)'s proposal that it is low level information that is involved in the *where* decision, just as it is in reading. Thus the decision to move the eyes in visual search or picture viewing is most likely to be guided by low-level information such as the nearest large discontinuity in the brightness pattern or a significant contour. Posner & Cohen (1984) also proposed an "inhibition of return" mechanism whereby the location of just processed locations are inhibited by the system, so the viewer will not oscillate between two nearby objects. A system incorporating the above mechanisms into the original sequential attention model could, using quite a "dumb" mechanism, ensure that most significant areas of a scene are inspected in a relatively small number of fixations. However, Rayner (1995) acknowledged that if a participant is searching for a particular target object, or a discrete piece of information, a different, perhaps more systematic, search mechanism may be used.

Therefore during text search, it seems that either salience, a systematic sampling, or a combination of the two will guide the *where* aspect of the search process, with the searchers' eye movements following their shift in attention to the next area or word to be processed. The next section will go on to explore what else is known of the searching and scanning processes, which will help us understand some of the decision that a searcher makes while trying to locate discrete pieces of information from within a piece of text.

3.1.2. Research on Searching and Scanning Text

Reading text and searching text are undoubtedly very different tasks. Skimming or searching the text involves an attempt to focus on information relevant to an immediate goal, and to skip irrelevant information. But, what actually happens during the process of skimming?

Eye movement research into skimming has shown that participants will skip sections of information in the text, and then view other parts of the text in a fashion that resembles normal reading (Masson, 1982). In this way skimmers and searchers are sampling sections of the text material, reading these samples, and then jumping to a different part of the text to sample another section of material. Using this method, they attempt to locate the desired information.

From a naïve position, this does not seem to be the most efficient way of searching a text. Comprehension tests on participants that have been skimming for information have indicated that people are not very accurate at visually selecting goal-relevant information for processing (Masson, 1982). In most texts, there is rarely an obvious basis for accepting a statement as important or rejecting it as unimportant without reading at least part of the statement. Reading time constraints seem to force readers to sample only certain portions of a text while completely missing other, potentially important, information. Masson (1983) looked into the reasons why other, apparently more efficient, search strategies were not used. For example, why do readers not simply reduce the fixation duration and fixate on every word? Although the average fixation duration found when a participant is skimming is reduced, the reduction is no way large enough to permit the doubling or even the tripling of the reading rate that is seen during the scanning of text without skipping material. Using RSVP, Masson's (1983) studies found that when each word was presented for a very short duration, (as little as 86msec), at a fixed location, subsequent question accuracy and summaries were found to be inferior to performance obtained when participants skimmed conventionally presented passages. Therefore, the technique of sampling seems to work better in giving an overall gist of a passage, than if they fixated on each word for a very brief duration.

Other studies have focused on the use of single sentences to investigate what happens when participants read and scan a sentence or phrase. Vitu, O'Regan, Inhoff & Topolski (1995) investigated eye movements when participants read a sentence of normal text, or the same sentence, but with every letter replaced with a "z". The participants were asked to look through these texts as if they were reading. A second task was also set in which participants were to search both the "z" text and the normal text in search of the letter "c". Vitu *et al* were looking for differences in the global characteristics of the eye movements, and also in what was happening to the local behaviour of the eye movements; was there a difference in the probability of re-fixating a word, or skipping a word? The results showed that there was a close resemblance between the eye movements observed in the normal reading condition and both the "c" search condition, where the amount of linguistic processing that was required was minimised, and also in the situation where virtually no processing was required at all, when participants were told to look through the "z" text as if they were reading. Vitu *et al* argued that both the global characteristics (the average saccade length, the average fixation duration, and the frequency distribution of fixation durations and saccade lengths) and the local characteristics (the skipping rates, the landing position within a word, and the probability of refixation) were quite similar in both the imitation of reading (the "z" text condition), and in text search (the "c" search condition). Vitu *et al* took this as support for the hypothesis that it is a predetermined oculomotor strategy that is active during reading, and the processing demands encountered at each fixation have very little influence.

However, this may not be the only explanation. Rayner & Fischer (1996) replicated and expanded the Vitu *et al* design. Their results illustrated some interesting differences between scanning and reading, and also text search. Rayner & Fisher presented participants with either blocked or randomised sequences of normal or "z" text in order to investigate whether the reader's expectation about the processing of the forthcoming sentences had an effect on the global settings of the eye movement parameters. They also looked at the data from specific target words. Sentence frames with either high or low frequency words were prepared and also converted to "z" strings, which allowed an evaluation of how eye movement behaviour depends on visual and lexical content. The third, extra, manipulation that was added was a target word search condition. This involved a condition in which text was present, but the lexical processing of each word was not necessary.

Rayner & Fisher (1996) concluded from this investigation that there were some similarities, but for the most part the eye-movement characteristics for reading and "z" text scanning are quite different. Specifically, they highlighted the differences in word skipping, fixation durations, and the probability of refixation. When reading, how easy a word is to access determined the probability of skipping that word, whereas with "z"-strings, the length of a word predicted the probability of skipping it. With fixation durations, the "z"-string scanning resulted in longer fixation durations than either high or low frequency words. Finally, whether or not there was a refixation was influence by the characteristics of that word. Participants did not refixate when they landed on the end of "z"-strings, whereas they did after an initial fixation at the end of a word.

It is the visual search condition, however, which is most interesting in the context of this current investigation. The visual search and the "z"-string scanning condition resulted in similar fixation durations. There were no word frequency effects when searching for a specific word, so even when the participant is looking at lexically meaningful material, because there is no need to process the meaning of words, there is no word frequency effect. This contrasts with the reading condition in which a word frequency effect was found. This led Rayner & Fisher (1996) to concluded that the trigger to move the eyes in a visual search task is different to that in reading, in that during word search tasks the trigger to move the eyes can be as simple as word-matching. However, during reading there is always a word frequency effect, which suggests that there is always lexical access. The final difference between search and reading is that the landing position in a word was uniform when searching a text for a target word. There were no more fixations in the middle of a word, unlike the pattern found in reading.

These differences in eye movement parameters when comparison is made between reading and searching using the same materials have been known for some time.

Spragins, Lefton & Fisher (1976) compared reading and search pattern strategies when a participant read or searched the same document, while also manipulating the spatial layout of the text. Fixation durations were found to be longer during reading compared to searching, and saccades shorter. The availability of spatial cues was manipulated through alternating the case of the text, as in the sentence "MaNiPuLaTiNg By AlTeRnAtInG CaSe"; and by replacing the spaces inbetween words with a "+" sign, as in "Manipulating+by+filling+in+the+spaces". These manipulations were found to be detrimental to both the reading and searching task, although affecting them in slightly different ways. When the text was extremely disjointed, for example when the case and space filling conditions were combined, this resulted in an almost letter-by-letter processing in the reading condition. However, although the saccade length was decreased in the search condition, it still remained greater than in the reading condition; around 3 or 4 characters in length longer. Rayner & Pollatsek (1992) also found gross differences in fixation duration and saccade length, depending on whether the participant is reading or searching.

Thus, although there are similarities between the eye movement patterns for reading and searching, using precise measures it can be seen that, in fact, they respond very differently to a number of manipulations. It seems that when searching a text, a participant reads a portion of text in a normal fashion for a number of fixations and then jumps to a new part of the page and again reads another short piece of information in the usual pattern. The actual trigger to shift attention also seems different during reading and scanning or searching. During searching, participants have been shown to be immune to any word frequency effects whereas readers consistently exhibit them. Fixation duration tend to be longer during reading, whereas saccade lengths tend to be shorter. However, pseudo reading, in which a reader is told to look at a string a characters as if they were reading, there tends to be a pattern of longer fixation durations, presumably because no preview effects can be used, and guesswork as to the amount of processing each "word" requires has to be used. Thus, in the context of this current research, skimming can be distinguished from reading through the use of eye movement measures, although it is characterised through short periods of reading-like behaviour.

3.1.3. Research Re-reading a Text

The BBC Audience Lines use information documents that are prepared in advance and tend to focus on one specific subject area. These documents may be used to respond to a number of different queries, and therefore are read on a number of occasions. It is also common for the briefing sheet to be searched, rather than read, on separate occasions either for the same piece of information or a different one. We are therefore interested in what kind of representation is obtained during the first reading encounter with the text, and how this can aid the subsequent reading and search encounters. Our interest in how the presentation of a document can affect both reading and search also leads to an interest in the question of how the rereading benefit might be influenced by the overall appearance of a document.

Traditionally, research into the reading process has focused on what happens when a reader encounters a passage of text for the first time. However, there is also a body of literature which has examined differences in reading measures between various encounters with the same piece of text. Readers are almost always faster reading a document if they have already read that document before. By examining this benefit, and changes to its magnitude under various experimental manipulations, researchers have hoped to gain a greater insight into what was actually encoded and stored during the first and subsequent reading encounters.

The rereading of a passage of text results in a faster overall reading time (Hyona & Niemi, 1990; Levy & Burns, 1990; Levy, Di Persio & Hollingshead, 1992; Levy, Masson & Zoubek, 1991; Levy, Newell, Snyder & Timmins, 1986; Raney & Rayner, 1995), and changes in eye movement measures (Hyona & Niemi, 1990; Inhoff, Topolski, Vitu & O'Regan, 1993, Raney & Rayner, 1995). These studies provide evidence that there is a facilitation brought from the first to subsequent readings of a text, even in simple reading tasks. Because of this facilitation, it is presumed that a mental representation has been created on the first reading of the text and it is this that is used to produce the rereading benefit. Studying rereading, therefore, is though to be able to shed light onto the nature of the mental representation readers have of a text they have read, and can elucidate the perceptual and conceptual processes involved in reading.

When Hyona & Niemi (1990) looked at readers' eye movements during repeated reading of a text they found that all eye movement parameters were affected by the repetition; fixation durations became shorter, the overall number of fixations decreased, the saccade length increased, and the number of regressions decreased. As discussed earlier, all these parameters indicate that there is a greater ease in reading on subsequent reading encounters (Frazier & Rayner, 1982). This is similar to the facilitation found by Raney & Rayner (1995) who conclude that the change in these eye movement parameters is consistent with the reduced processing time associated with rereading.

An important question emerges from these findings: what factors are causing this rereading benefit between first and subsequent encounters with a text? When a word is read in isolation, the mere repetition of this word facilitates its processing during a second reading encounter. These word repetition effects are robust and have been found using a wide range of different tasks (Oliphant, 1983; MacLeod, 1989). The rereading benefit obtained when reading a passage of text for the second time, therefore, could be thought of as the sum of the word repetition effects. That is, the word repetition effect and the rereading benefit both result from the previous lexical access of the word; because it has been accessed once, a specific word is more readily accessed a second time. A line of thought within rereading research has taken this theory as the primary explanation for the rereading benefit. Proponents of this view have been classified as "abstractionist" because they suggest that the representation that allows the repetition effect consists of primed abstract word meanings, as in isolated word repetition (Carr, Brown & Charalambous, 1989; Carr & Brown, 1990; Carlson, Alejano & Carr, 1991). This theory suggests that when a word's logogen is activated once, activating it a second time then becomes easier, and this is the sole source of the rereading facilitation. Carr, Brown & Charalambous (1989) tested this theory by conducting an experiment in which participants read a text aloud with the words in either a normal, coherent order or in a scrambled order, and then reread the text in either the same or a different order. In each condition, participants reread the passage faster during the second encounter, regardless of whether the same or the opposite versions of the text was being read. Carr *et al* (1989) concluded from this that the reading context was relatively unimportant because the word's textual organisation was irrelevant to the magnitude of the transfer.

However, there has long been evidence that even using abstract word lists, the word repetition effect cannot have as simple an explanation as the recent activation of a word's logogen. Oliphant (1983) demonstrated that if a word was encountered twice within a lexical decision task there was a repetition benefit on the second occurrence, as would be expected from a lexical access explanation. However, if the word was first encountered in the instructions, or in an "unrelated" questionnaire, there was no repetition benefit in the lexical decision task, suggesting that the context of the initial encounter is important in determining the transfer in rereading.

Studies such as Oliphant (1983) indicate that the repetition effect cannot simply be a case of the logogen having been recently accessed causing the re-reading benefit; it is more complicated than this. Therefore when an entire text is considered, the situation becomes more complicated still. MacLeod (1989) reported a much reduced repetition benefit in a word-fragment completion task when the participant had previously read the word in a text context, rather than in a word list. MacLeod, argued that repetition at the word level decreases as the word becomes textually bound. Masson & Freedman (1990) failed to find a transfer effect when the repeated word was interpreted differently on the two encounters. Thus, there seems to be less facilitation towards isolated words when the initial encounter with the word was within a piece of coherent text, or was interpreted in a different way. It must therefore be concluded that there is more to the re-reading process than simply lexical access priming the reader for their second reading at the individual word level.

Another possible explanation of the rereading benefit could be that the facilitation comes from the repetition of more than individual words. That is, the facilitation may be due to the repetition of the semantic content of the passage: the benefit requires a reinstatement of the original meaning. One way of investigating this would be to compare the rereading benefit across modalities. If the magnitude of the rereading benefit is the same across modalities, then this would suggest that the benefit is due to the repetition of the passage's meaning. Studies by Bassili, Smith & MacLeod (1989; Jacoby & Hayman, 1987; Levy & Kirsner, 1989; Roediger &

Blaxton, 1987b) looked at the change of modality and its influence on a subsequent re-reading test. They found that changes in modality decreased the transfer to a subsequent reading encounter. Levy & Kirsner (1989) presented a passage to participants either in written text form or aurally. The participants' task was to then reread this text. The results indicated that there is always greater facilitation under intramodal conditions, that is, paper to paper, than intermodally. Reading times were always slower in the aural to reading condition. Therefore, although there is intramodal facilitation, this semantic repetition does not account for the entire rereading benefit.

The rereading benefit is therefore not due solely to the repetition of the individual words, nor is it due solely to the repetition of the semantic information contained within the passage. Another possible explanation is that it is the entire episodic representation that is used to facilitate a second reading. That is, the meaning, along with details about how the word was used in the passage, their context and even physical parameters all form an episodic memory of a passage, and it is this episodic whole that then goes on to facilitate reading on a second encounter. The salient features of the episodic position are that there will only be facilitation on a second reading encounter when there is enough information to recruit the appropriate representation, and that the repetition effects are due to a representation that consists of particular episodes and processes that were involved in the initial reading event. In this view, episodic memories of the passage incorporate not only the meaning but also details about how words were used in the passage, the context, and even physical parameters such as typeface.

There is a broad spectrum of research to support this view. For example, Levy & Burns (1990) studied the rereading benefit while varying the linguistic coherence of the passages tested. Participants were to read a normal or scrambled version of a text, and then reread either the same or a different version of the same text. The text could be scrambled in one of three ways: scrambling the paragraph order, scrambling the sentence order, or scrambling the word order of the text. The results showed that the magnitude of the benefit decreased across the three different manipulations. In the scrambled word order condition, first reading this text conferred no benefit to the subsequent reading of normal, coherent text. Levy & Burns (1990) credited the benefits found to the likelihood of the second reading of the text recruiting the representation of the first in order to facilitate rereading. They proposed that the more similar the two versions of the text were, the higher the probability of recruitment, and therefore of facilitation. This is a similar conclusion to the one reached by Levy & Kirsner (1989) who argued that single words cannot recruit the representation of a passage of text that has been read. They propose that representations of individual words are bound within an episodic context and it is only when this episodic representation as a whole is recruited that facilitation effects can be observed.

However, the episodic position may not be able to account for all aspects of the repetition benefit. In a study designed to investigate the effects of word frequency on repetition Raney & Rayner (1995) replaced target words with either a low frequency or a high frequency synonym during the second reading. It was shown that the repetition effects were generally similar in size for repeated words and synonyms, supporting a conclusion that repeating the concept was the important element of the rereading benefit: identical repetition did not significantly enhance the rereading benefit over synonym repetition. However, to counter this, there was a non-significant trend for the spillover effect (an increased fixation duration on the word/s following the target) to be larger following synonyms than following an exact repetition of the target word. That is, during the second reading, spillover following repeated words was slightly less than that following synonyms. However, this implies that if the reader was sensitive to the wording change, it was not noticed until the reader was already processing the next word.

Other conclusions are also inconsistent with the episodic account. As described earlier, Carr, Brown & Charalambous (1989) found equal repetition effects during an oral reading task when the order of the words were altered during the first and second reading task, and when they were kept constant. However, these results were not replicated when tested by other investigators. Levy & Burns (1990) found no repetition effects at all when word order was altered between readings. Carr & Brown (1990) appealed to task differences as a possible explanation for these contrary results. In the Levy & Burns study, participants were advised to read silently for meaning, whereas Carr *et al* instructed their participants to read aloud as quickly as possible. Carr & Brown (1990) conceded that the speeded oral reading task used by Carr *et al* (1989) emphasised the processing of individual words where repetition effects can stem from abstract-text level codes, whereas during reading for meaning, repetition benefits may result from higher, semantic-level processes.

Experimenters have explained these differing results in a variety of ways. Carr & Brown (1990) developed the "Level of Focal Attention" hypothesis, in which they asserted that reading aloud emphasised the processing of individual words, and under these conditions repetition will stem mostly from abstract, lexical codes (consistent with the abstractionist position). However, when forming a well structured representation of a text is emphasised, repetition effects will tend to stem from higher, text level processes (consistent with the episodic position). Subsequent research has supported this, (Carlson, Alejano & Carr, 1991). However, these task differences have also been described on other dimensions. Jacoby, Levy & Steinback (1992) appealed to conceptually driven versus data driven dimensions. Data driven processing is used to refer to processes that analyse the stimulus input (akin to the abstractionist position), and conceptually driven processing includes analyses that contribute contextual information, and linguistic and situation knowledge. Jacoby *et al* hypothesise that it is these two types of processing that come together to form an episodic whole. How much the facilitation relies on one type of processing over the other depends on the task required of the reader. Masson & McLeod (1992) described how tasks may emphasise interpretative versus elaborative encoding mechanisms, again along the lines of the abstractionist/episodic distinction. Current research now seems to be aimed at explaining *when* episodic transfer occurs, and not at demonstrating that this is the only type of transfer. The focus is now put on trying to define more precisely the component processes that contribute to reading.

We will now go on to look at what information is used under which conditions to facilitate the rereading transfer. What is of primary interest in this context to the aims of this thesis is whether the appearance of the text can affect repetition facilitation. That is, to what degree do the perceptual features of the text influence the rereading benefit. Again this is an area of debate. Carr *et al* (1989) demonstrated that the transfer benefit was insensitive to changes in typescript between encounters with the text which involved reading aloud, suggesting that there was no transfer of visual feature specifications from the initial reading encounter. Brown, Sharma & Kirsner (1984) found that repetition effects on lexical decision transferred almost completely across even changes in writing systems. They tested Hindu-Urdu bilingual participants when they read the same words in the same script or in a different script and found almost exactly the same amount of transfer.

In contrast to this, there is some evidence that the perceptual appearance of material can, in fact, have an effect on the re-reading benefit. In a seminal piece of work, Kolers (Kolers, 1975; see also Kolers, Palef & Stelmach, 1980), demonstrated losses in the magnitude of the rereading benefit when the typescript or the spacing of the print of "transformed" text was changed between repetitions. The "transformed text" is text that has been inverted and reversed, slowing the reading process through the difficulty of reading such a typescript. This effect has been replicated using other transformed and unusual typescripts (Jacoby & Hayman, 1987). However, it has proven very difficult to find reliable effects of typescript change when normal scripts are used (Carr *et al*, 1989; Levy & Kirsner, 1989; Levy, Newell, Snyder & Timmins, 1986). This has led some investigators to argue that low-level visual information does not participate in the skill benefits across repeated readings, except under exceptional circumstances of degraded or impoverished text, (Masson & Freedman, 1990). Masson & Freedman (1990) suggested that the representation that is used in the rereading benefit is determined entirely by conceptual processes. Perceptual information, they claim, is only used in the early stages of skill development, so with sufficient practice, the reliance on visual features disappears, and it is only under conditions of impoverished reading that this reliance reappears. Carlson, Alejano & Carr (1991) suggested that a representation in memory of text are context sensitive, but these representations are at the text level and are "accompanied by a loss of surface structure information" (p929). There are others who argue that visual features such as typescript alterations do tend to cause consistent losses in transfer, but these losses are small and often non-significant. These manipulations can be made larger by slowing visual processing through the use of "transformed" text (Jacoby & Hayman, 1987; Roediger & Blaxton, 1987b).

Again, the difficulty in finding perceptual transfer from one reading encounter to another may be related to the tasks that have been used to test the transfer. Jacoby

(1983b) demonstrated that words read in association with other words were better recognised in a recognition memory test than words read in isolation. However, these same words were less well identified in a later perceptual identification task. Jacoby concluded that words read in context receive less perceptual analysis because their identification is aided by associative processes. Isolated words receive primarily data-driven processing, and it is this that facilitates the perceptual identification. Levy & Kirsner (1989) developed this position by positing that surface level information is part of the episodic text representation, but it is only under certain circumstances that it influences transfer to a rereading benefit. As in the Jacoby (1983b) study, they found no transfer to the perceptual identification of a word when that word was first read in text, even though there was facilitation when the words were first encountered in a word display. However, a facilitation from a prior reading experience was found when the entire text was re-read, consistent with the episodic position on the rereading benefit. This reprocessing advantage was modality sensitive, as discussed earlier, indicating that perceptual information was involved in mediating the re-reading benefit. They argued that single words from the text cannot recruit the episodic text representation because the reprocessing stimulus was at a different linguistic level than the memorial representation. The original and reprocessing events must be similar and at the same linguistic level for transfer to occur.

Jacoby, Levy & Steinbach (1992) provided other evidence for the conditions under which perceptual information may influence fluent reprocessing. They reported a repetition benefit in a semantic question answering task, which showed robust effects of change in the typescript between repetitions, even though these same typescript changes did not affect the oral reading of the same text. This difference in results may be seen to reflect the same differences in results that were found between Carr *et al* (1989) and Levy & Burns (1990). Jacoby, Levy & Steinbach (1992) argued that when the task is meaning-based, as in question answering, then the repeated question recruits the prior episode and then the print is processed automatically using memorial representation from the initial encounter. The episodic transfer that is observed under these conditions is sensitive to perceptual features of that memorial representation. Levy, Di Persio & Hollingshead (1992) saw no effect with font change after an initial exposure, but did find one after 4 exposures to the text.

Therefore, multiple identical exposures to stimuli within the experimental context may be another sufficient condition for perceptual specificity to occur.

These studies suggest perceptual specificity effects due to a change in the surface format of the text under certain distinct conditions: (1) when the task is the reading aloud of transformed materials or materials presented in distinct fonts; (2) when the material is very familiar; (3) when the task of reading is automatic; (4) or finally when indirect tests of transfer are used. This is not to say that semantic, conceptual factors do not have an effect. These are most likely to be the main driving force behind the rereading benefit. The point is that part of the representation that is utilised during the transfer benefit can and does contain information about perceptual aspects of the text. These factors are more or less useful depending on the task and the text, and therefore can be manipulated. The four points above relate primarily to the task of reading, but the fact remains that when the entire text is reinstated for the rereading process, there is more or less of an advantage depending on the material itself. This is what will be looked into next. What effect does the appearance of the text to be read have on reading and rereading and text search?

3.2. SECTION 2

3.2.1. Spatial Representations and Visual Search

When asked to describe an object in your home, for example your telephone, a mental image of this object may be created which can then be described. However, there may also be other attributes relating to this image that are also conjured up: you may be able to place this item in it's location; on a work surface in your kitchen, on a table in the hall. In other words, when asked to recall an item, spatial/locative information may also be conjured up, although this attribute of the mental image may not always be necessary or salient. In this sense the spatial location attribute of a representation can be thought of as incidental.

Several studies have examined spatial memory and concluded that the location of items is automatically encoded with the memory representation of that item, (Mandler, Seegmiller & Day, 1977; von Wight, Gebhard & Karttunen, 1975). These studies used evidence that intention to learn the spatial location of items did not enhance any subsequent recall of spatial information, and that participants who were unaware of either an object recall test or a location recall test performed equally as well on a surprise location recall test as those who were prepared for such a test. This evidence is consistent with one of Hasher & Zacks' (1979; 1984) criteria for automatic processing; that intention to learn does not increase the memory representation, because the encoding of that representation is automatic.

There has been some contrary evidence that challenges the idea that spatial encoding is automatic (Kail & Siegel, 1977; Schulman, 1973). These studies found that spatial locations are not necessarily encoded with the memory representations of the test items. Pezdek, Roman & Sobolik (1986) suggested that the reason for these apparently conflicting results may be due to the materials used in each study. Most of the studies that reported automatic encoding of spatial information used pictures or objects as stimuli materials, whereas the studies that failed to find an effect predominantly used verbal or lexical stimuli.

In order to test this theory, Pezdek, Roman & Sobolik (1986) conducted a study in which participants were instructed to learn objects or one word object labels placed on a 16 item matrix for a later recall task. After the recall task, they were given a surprise relocation test in which they had to place the objects or labels on the grid in their initial location. In a variety of manipulations, Pezdek *et al* confirmed that spatial location was more likely to be encoded with the memory representation of objects rather than words. When considered, it is not surprising that words elicit less visual or spatial encoding, as they are quite visually impoverished in comparison to pictures. Pezdek *et al* also found that spatial memory could be manipulated without affecting item recall and vice versa, implying that different processes are involved in memory for objects and words and their spatial locations. Finally, they also demonstrated that the memory for words and their spatial locations were independently affected, again suggesting that different processes are involved in memory for words and their spatial locations.

These results question the notion that spatial information is generally encoded in an all-or-none fashion, as implied by Hasher & Zacks, (1979; 1984). Pezdek *et al*'s study suggests that the nature of the materials (specifically objects versus words), affect the probability of encoding the spatial location of the stimulus. However, the words used in the matrices were not text but single words, and the processes involved in encoding these words may be very different in the task of reading text. Therefore these finding do not necessarily indicate that there is no spatial memory associated with the representation of text. It does seem probable, however, that the spatial locations of words on a page are more difficult to encode and store than the location of picture and images, because of the lack of visually salient features on a page of text. One page of text, by its very nature, looks very similar to another: each page is simply made up of rows of alphanumeric characters, occasionally separated by a paragraph break, or even more occasionally by a title.

Despite the difficulty in encoding and storing such information, there are four lines of evidence that support the notion that reading text might rely on spatial memory codes. First, reading spatially distributed text (i.e. text written normally over a page), leads to higher syntactic sensitivity compared to reading text that is presented in RSVP at a single location (Kennedy & Murray, 1984; Kennedy, 1992). This spatially distributed text is also easier to comprehend (Masson, 1983). A second line of evidence is that regressive eye movements during reading suggest that readers have a spatial representation of the text. Readers can often land on a specific target word beyond the limits of the perceptual span (Frazier & Rayner, 1982; Kennedy & Murray, 1987a). In order to do this, some spatial representation must have been formed as to the exact location of individual words, although it is unclear how long this representation persists. A third line of evidence results from the interference that emerges between lexical and spatial processing during reading. Eddy & Glass (1981) found that sentences that contain visual statements, or text that can be imagined, take longer to read than sentences with an abstract content. This would suggest that the processing of text is using resources that are also used for the generation of visual images. Finally, studies which will be discussed in more detail below have demonstrated readers' ability to recall the location of information on a previously read page (Rothkopf, 1971; Zeichmeister & McKillip, 1972; Zeichmeister, McKillip, Pasko, Bespalec, 1975; Christe & Just, 1976; Lovelace & Southall, 1983).

It is of interest to this current line of research to know under what circumstances the spatial location of words, particularly text, is encoded. As stated above, if the coding of spatial information is not an all-or-nothing process, and pictures can elicit a stronger spatial memory than words, at least in some circumstances, then other manipulations may be able to create a stronger or weaker spatial representation of text. I will first detail the evidence that there is some locative information encoded when reading a passage, and then go on to investigate under what circumstances this ability can be manipulated.

Rothkopf (1971) required participants to read a 3,000 word text without warning them that there would be a location recall test at the end of the passage. He found that incidental memory for location within a page and within the text sequence was more accurate than chance. Zeichmeister *et al* (Zeichmeister & McKillip, 1972; Zeichmeister, McKillip, Pasko, Bespalec, 1975) also showed that participants were able to make judgements about the location of discrete pieces of textual information significantly better than chance. This is not to say spatial memory was automatic; spatial location recall was far lower than the semantic recall of the sentence (over two thirds of the correct responses to the semantic question were not accompanied by the correct location information), suggesting to Zeichmeister *et al*, that locative recall is not a dominant attribute of recall. However, like Rothkopf (1971), Zeichmeister *et al* found that recall of semantic information was correlated with recall of locative information. Zeichmeister *et al* also concluded that recall of location information may be dependant on the particular task and material used.

Zeichmeister *et al* presented data that suggested that neither spatial location cues nor semantic cues would facilitate the recall of the other. When participants were given the spatial information that corresponded to the answer they were looking for, recall was not affected. In their first study, spatial information was provided at the time of recall by telling the individuals the corner of the page on which it occurred (Zeichmeister & McKillip, 1972). This did not significantly improve semantic information recall. In a related study Zeichmeister, McKillip, Pasko, Bespalec (1975) provided participants with the correct answers they were looking for, but again found that the accuracy of their spatial recall was not reliably changed. However, Lovelace & Southall (1983) investigated this relationship between spatial and content memory, and found that they were, in fact, functionally related, under precise conditions. Instead of the semantic information provided referring to the gist of the passage or searched for item, as in the Zeichmeister *et al*'s study, the Lovelace & Southall definition was the verbatim recall of the specific key content words of the queried sentence. They also used the reinstatement of within-page location by providing all the possible sources of information within the page to be reinstated. They achieved this by individually blacking out each word on the page, bar the target sentence. In this way, all the formatting of the page was left intact, including paragraphs and indentation, along with word length. The results indicate that the precise reinstatement of the entire page results in a greater recall of the content of the target sentence. This may relate to the findings in rereading research by Levy *et al* (Levy & Kirnser 1989; Levy & Burns 1990) discussed earlier, who discovered that whereas individual words were incapable of conjuring up the episodic representation of a passage, reinstating the entire text could. Lovelace & Southall (1983) also found that having the correct answer to the questions provided using the specific content words of the target sentence resulted in a facilitation of the recall of the location of the answer, regardless of whether it was the participant herself that remembered the answer, or it was the experimenter who provided it. Thus, although the recall of location may be incidental to performance in most circumstances in which a memory for the text is required, the recall of the precise wording or layout of the text can help facilitate recall of the other attribute.

Christie & Just (1976) continued this train of research by investigating the representation of location information in memory, with the addition of investigating the use of this information during visual search. Christie and Just proposed that locative or spatial memory may be useful in organising a representation of the passage content. They measured response latencies as their dependant variable for retrieving either content or location information with a short prose passage (previous studies had used recall only). Passages were presented in either a coherent sentence order or a scrambled order. Participants were asked the same question for both the content and the location question. The location latencies for the middle of the passage were significantly longer than latencies for content information. It was concluded, therefore, that location information is not necessary for the retrieval of content information. Interestingly, the latencies to respond to content information were similar for the organised and disorganised passages, suggesting that participants may respond to the two passages in a similar way, perhaps by reorganising the disorganised passage, within their mental representation, into a coherent form. If this was the case, it would imply that some of the locative information would, therefore, be destroyed. Following on from this it would be expected that this would add to the response latencies for location information for disorganised passages. This is what was found. Latencies to answer location questions were longer in the disorganised passages. Sentences in the middle of the text has especially long latencies.

In a second study, Christie & Just monitored participants' eye movements while they scanned a previously read passage in search of an answer to a content question. In this way, the participant's recall of location information from the text was measured without any secondary task and therefore more unobtrusively than in previous studies. Christie & Just's results revealed that readers remembered the location of the content of the passage quite well. The initial fixation on the text was often either on the content information or close to the correct location of the content information. The accuracy of the first fixation was quite large for both the organised and disorganised passages (30% correct for organised, 19% for disorganised text). However, when the initial fixation was inaccurate, the subsequent search was more efficient for the organised passage (there were less fixations before the response was made). This data indicates that readers accurately remember the location of sentences within a passage. Moreover, the accuracy of this locative information (as gauged by the accuracy of the initial fixation) was good for both disorganised and organised passages. After the initial fixation, however, visual search is more efficient for organised than for disorganised passages. This may be due to the fact that if the initial fixation is incorrect in a normal passage, there are two possible sources of information to guide subsequent fixations: the information at the fixation point may provide a cue to the location of the appropriate sentence (ie it is earlier or later in the passage), or the participant's previous memory of the passage may also provide a cue to the appropriate location. However, both these sources of information are less informative when searching a disorganised passage. The currently fixated information tells the searcher little about previous or later content information, and, as found in the previous study, locative information may be destroyed when remembering disorganised text.

The conditions that may or may not support a spatial representation of text were also investigated by Lovelace & Southall (1983). Participants in this study were put in one of three conditions. The first was a booklet condition, in which the 12 page passage was formed into a book for the participant to read. The second condition was the "continuous-with-pages" condition, in which individual pages were affixed end to end, and participants were allowed to scroll down this in order to read it. The third condition was a "continuous-without-pages" condition, in which participants could again scroll down the passage, but there were no page demarcations within the text. No differences were found in reading times between the three conditions, and the booklet condition and the continuous-with-pages conditions did not differ in number of items recalled, or in the correct locations recalled. However, recall of both content and location information was found to be poorer in the "continuous-without-pages" condition. It seems that by minimising the location information available in the continuous condition whereby only relative location cues are available and no absolute cues, content and spatial recall is reduced. Therefore, the differences seen between the formats is not due to scrolling per se, but to the formatting of the text as it is presented within the scrolling mechanism. These findings are contrary to the conclusions of Zeichmesiter *et al*, in that Lovelace & Southall seem to have proved that there is a mutual cueing between locative and content information recall from a text document, under the right circumstances.

In summary, these studies into locative memory have indicated that reader's do have a reliable memory for a word or a phrase's spatial location on a page of text. Although this recall is far less than the recall of content information about text, and is not necessary for the recall of semantic information relating to the passage, recall is significantly greater than chance. It has also been shown that this spatial recall is also positively correlated with semantic recall. Like the studies conducted on rereading, investigations into location memory have indicated that recall memory is best reinstated when the exact conditions of the first viewing are recreated. Informing a participant that the information was located at the bottom left of a page is not as powerful as showing that same participant a representation of that page, and indicating where the answer is located. Finally, these studies have shown that the representation that is created of the text, which includes both semantic and spatial information can be manipulated by altering the presentation of the text. Creating a text without any absolute spatial cues, as in the Lovelace & Southall (1983) study, dramatically decreased the participants' ability to recall both content and spatial information.

3.2.2. The Effect of Medium and Formatting

The advent of a "paperless" office has been predicted since the development of the modern computerised office. From a business point of view this is a very appealing concept. Computerised technology results in the transfer of information being quick and efficient across distances and people; the storage of information is simple and many people can access the same document simultaneously without difficulty. But is this really the best medium from which to access information? Since the development of the concept of "electronic paper", research has been conducted into the efficacy of reading from this newer medium. This research has come to an almost unanimous conclusion that a number of common tasks, most notably reading, are actually hindered when information is presented on a computer screen rather than on paper. Differences in reading speed or in the ability to detect errors between paper and various screen presentations of text have been used as evidence of the differences in legibility between the two mediums.

There is a large body of literature which suggests that there is a disadvantage for both reading and proof-reading when these tasks are conducted on a computer screen as compared to the same task conducted on paper. Wright & Lickorish (1984) measured the time it took eight "senior scientists", who habitually reviewed articles to read an article for the first time. The time it took each scientist to read an article presented on paper, and another presented on a computer screen was measured, and it was found that the reviewers were on average 35% slower when they read from a computer screen than when they read from paper. Other reading studies that have demonstrated a difference in reading speed between mediums include Gould *et al*, (1987a), who used experienced computer screen users as participants in his study. Each participant read one eight page article from a computer screen, and another article from a paper presentation, with the task of summarising the document aurally. An average difference in reading speed of 13% was found between the two mediums.

Other reading study comparisons have looked at whether the quality of the computer terminal screen is the cause of the screen disadvantage. Frenckner, Smedshammer, Nordquist & Romberger (1990) compared reading speeds from paper, a standard alphanumeric screen, and a high resolution graphic screen. Contrary to their expectations, Frenckner *et al* again found a disadvantage for reading from both the screens, with the standard screen being read 15% slower than paper, and the graphic screen 13%. However, the graphic screen was smaller than the alphanumeric screen which may have confounded any possible advantage created by a higher definition text: Kruk & Muter (1984) have found that the amount of information presented on each page can alter reading speed. Gould, Alfaro, Barnes, Finn, Grischkowsky (1984) conducted a series of experiments with the aim of explaining why people read more slowly from computer screens. Factors that were studied included letter quality, orientation of the reading material, reading task, visual angle, quality of the screen, polarity and typeface. None of these variables were seen to account for a large part of the difference between reading speed between the mediums, however the difference could be seen to be minimised by a combination of these factors.

These studies cited above have also used reading as the measure of legibility of the text on screen. However, there are other tasks that are frequently conducted on screen, and can give an indication of the difficulties that may be being experienced by participants interacting with the document. Muter & Maurutto (1991) found that skimming from a computer screen was 40% slower than skimming from paper. But again, this does not say *why* there is a computer screen disadvantage. The majority of other studies have used the task of proof-reading to investigate the differences between paper and computer screen. Wilkinson & Robinshaw (1987) had participants proof-read for 4 fifty minute sessions (two sessions with each medium) and found that proof-reading from the screen was 29% slower than proof-reading from paper. Gould & Grischkowsky (1984) instructed 24 clerk-typists to proof-read for one day from paper, and another day from a medium resolution computer screen and found that proof-reading was again 20 to 30% slower from the screen than from paper. Again the clarity of the computer screen has been suggested as a possible reason for the poorer proof-reading times for computer screens. Gould, Alfaro, Barnes, Finn, Grischkowsky (1984) conducted a series of experiments comparing proof-reading from modern high resolution screens using *anti-aliasing*. This is a method of making individual letters presented on a computer screen more resemble these same letters as they would be presented on paper. This is achieved by using grayscale around the letter in order to lessen the "jagged", computerised, look of letters presented on screen. Each of Gould *et al*'s experiments revealed small and non-significant differences in proof-reading speed in favour of the paper condition. However Bender, Crespo, Kennedy & Oakley (1987) also used an anti-aliased typeface and compared participant's proof-reading speed with a high quality paper print of the text. In this case they found a slightly faster, but non significant, reading speed for the screen condition.

The differences between the experimental findings described above may be due to a number of factors. Different equipment has been used, with different quality screens, and different resolutions. Much of these differences can be explained by the fact that the research spans over a decade, in which time the quality of equipment available changed at a rapid rate. Other differences include the fact that both novice and experienced computer users have been used in each of the studies, and this factor is not always controlled for. However, most of these studies do seem to support the conclusion that reading is poorer from computer screen than from paper. Frenckner *et al* 1990 proposed that the reading speed difference is larger when the task calls for a deeper understanding of the text as a whole. Others have suggested that when using a good screen, proof-reading is as fast from a screen as from paper (Haas & Hayes, 1985; Gould *et al*, 1986; Bender *et al*, 1987). Gould *et al* plotted proof-reading speed against screen resolution and found a linear relationship. They then hypothesised that when resolution improves enough proof-reading will be as good, if not better, from computer screens as from paper. It is obvious that using a high enough resolution screen will result in letters and words that are equally discernible as the same letters printed on quality paper. Therefore, if there remains a difference in reading speed between the two mediums that is not present with proof-reading the reason why needs to be explained.

Nonetheless there does seem to be a difference between reading from paper or a computer terminal unless the conditions of presentation on a computer screen are carefully controlled. Even then, there seems to be a difficulty associated with scanning for information from a computer monitor which warrants further investigation. These differences will be looked at further during the course of this thesis. However, Muter *et al* suggested that using an appropriate format could have minimised the differences between skimming rates. What formatting manipulations have been shown to result in reading, skimming or comprehension differences?

The original work on the effect of formatting on reading speeds and eye movements was conducted by Miles Tinker from 1927 to 1965 (see Morrison & Inhoff, 1981 for a review). With a body of data consisting of more than 30,000 participants, it remains one of the most extensive pieces of research on the subject of legibility conducted to date. Some of the most salient points of his research will be detailed below. Tinker found that, in a reading situation, capitalisation resulted in a decrease in reading speed by an average of 11.8%. He also found an increase in the number of fixations required to read the text, and a shortening of the overall saccade length (measured in characters). It can therefore be concluded that the readers were having more difficulty reading capitalised text. Tinker also investigated the effect of point size on the proficiency of reading. Very large type (14 pt) resulted in a reduction in reading speed by an average of 6.4% in comparison with 10pt type. There was a related 20% increase in the number of fixation it took to read the passage, and a decrease in the number of characters per saccade. However, in the original Tinker study, character size was confounded with the number of characters per line; line length, as opposed to number of character was kept constant. A replication, therefore, was conducted, which again revealed a reduction in reading speed, although the effect was less strong under these circumstances (3.3%). A related investigation was conducted into very small type (6 pt) which was again compared to the reading of 10 pt text. This time there was a reduction in reading speed of 5.8% when line length was equated, and 6% when the number of characters per line were equated. Again the number of characters per saccade was reduced with the smaller text, and the average fixation duration increased with the smaller type. Kolers Duchnicky & Ferguson (1981) conducted a related eye-tracking study to compare participants' reading of texts presented in two different spacings, and densities. Kolers *et al* found that reading smaller, more densely packed characters, contrary to their expectation but supporting Tinker's (1963) results, required less fixations without any loss of comprehension. Large characters required more screen space and more time to be read, without any measurable gain in reading.

Tinker also investigated the number of characters per line to see if there was an optimal. In general, he found that large type is most legible in long lines, and smaller ones in shorter lines. However, he found no optimal line width to type size ratio. It is concluded that short lines, because they have fewer characters per line prevent the full use of parafoveal information that may be available in longer lines. When lines are too long, however, there is an increase in compensatory regressions at the beginning of the line to correct for undershooting of the return sweep and inaccuracies, and also to correct for inaccuracies in the vertical plane. Smaller types resulted in a smaller optimal number of characters per line, which may be because smaller fonts are more susceptible to these return sweep errors as they demand a more precise return sweep. Therefore the biggest problems with long lines is the inability of readers to make an accurate return sweep. To compensate, using leading or blank spaces between lines had the general effect of expanding the acceptable range of line widths for any point size.

Finally, Tinker investigated the effect of colour on the legibility of text. The brightness contrast between the page and the print on that page was seen to have a dramatic effect on legibility. Legibility was seen to be high if the reflection on the page was 70% or greater, and the reflectance of the characters was 10% or less. In relation to the legibility of coloured text, this was found to be purely a function of the brightness contrast between print and page: colour, per se, has no effect. Combinations of colours that resulted in a low brightness contrast (for example red print on a green background) were extremely difficult to read.

There has been work by other researchers on factors, other than semantic factors that may affect reading rate and eye movement parameters. Kolers, Duchnicky & Ferguson (1981) used five different scrolling rates and found that optimal performance was obtained when the screen was scrolled at 20% faster than the participant's own preferred speed. However if the reader's preferred, self-selected speed is compared with reading a static page, then the advantage lies with the static page. This can be comparable to the results found by Schwarz, Beldie & Pastoor (1983) who demonstrated that scrolling was inferior to paging on a number of task including reading and sorting, despite the fact that on a simple task like sorting, where frequent small upwards and downward jumps are necessary, it may be thought that scrolling may offer an advantage. Schwarz, Beldie & Pastoor put this advantage down to the fact that there is no absolute, only a relative, spatial orientation to the screen in scrolling.

Trollip & Sales (1986) compared fill-justified and left-justified text, and found that there was a significant decrease in reading speed when participants read fill-justified text, although there was no difference between the two formats when it came to comprehension. Trollip & Sales called on a number of different reasons that might explain these differences. The first of these was if the fill-justification is achieved through the insertion of extra spaces throughout a line, and the number of characters available to a reader on each fixation remains constant, then the insertion of extra spaces may result in more fixation per line (this has not been empirically tested). The reduced reading rate may also be due to the fact that there is a variable number of spaces between words, and so the eye is constantly adjusting where the next word starts.

Beldie, Pastoor & Schwarz (1983) investigated the effect of using proportional spacing between letters and found that proportionally spaced words resulted in faster reading than using fixed spacing for each letter. However, when a search task of the same text was investigated, there was no difference between the two types of letter spacings.

Together these formatting investigations lend support to the conclusion that the way a document is presented, in terms of its medium of presentation along with its layout and formatting, can dramatically affect the efficiency with which it is read. Type that is too large or too small, or without adequate figure/ground contrast can dramatically alter the ability of a participant to perform a number of tasks including reading, scanning and proof-reading. What is of particular interest in the context of this current investigation into information retrieval is that fact that the mere appearance of a piece of text *can* alter the way it is read. As stated earlier, if differences in participants' ability to read a document under different conditions can be seen not to relate to the clarity of the presentation medium, then we can suppose that there is something about the way the document is laid out that is affecting a readers ability to read fluently. Many of the studies discussed above failed to investigate how well the readers comprehended the document under each of the conditions. These are areas which will be looked into in more detail during this thesis.

3.3. CONCLUSION

In this chapter I discussed many of the disparate areas of research that are related to the topics that I will cover in this thesis. I am interested in the effect different presentation techniques have on reading and information retrieval, and also what this can tell us about the representation created in memory from reading a piece of text. Reading research has illustrated what occurs during normal fluent reading, and what signs can indicate that a reader is experiencing difficulty with individual words or with the passage as a whole. This work, along with work on modelling eye movements during reading and visual search, and on scanning and searching behaviour in general, gives a firm grounding on what behaviour is expected during both the reading and text search tasks. This knowledge will be used to motivate much of the experimentation within this thesis. I am also interested in developing the understanding of what representation is produced in memory once a piece of text is read. Research into the re-reading of text highlighted what is known in this area, along with much of the controversy that surrounds ascertaining what is actually encoded during reading. It is widely accepted now that readers encode many aspects of the text they have read, including both semantic and perceptual information. However, the task and the way information is presented on the page can affect both the encoding and use of such information. The way the presentation of a document alters the way it is encoded, in particular the way perceptual information is encoded, will be explored in more depth during the forthcoming experimentation. We will also explore the representation created in memory through tasks other than rereading. Finally, the difference between mediums of presentation and also the layout of textual information has been discussed, which will feed into the investigations to follow which compare both the reading and searching of information across mediums, and the effect of different layout techniques on reading and encoding. This will develop on from what is already known on the effect of formatting on encoding and comprehension, using larger scale layout manipulations that relate to formatting used within the BBC Audience Lines.

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CHAPTER 4

4. STUDY 2: SEARCHING A PAPER DOCUMENT

The Task Analysis discussed in Chapter 2 led to the conclusion that there is scope for quite a large improvement in the speed of information retrieval within the BBC Audience Lines. Much of the time delay found in the Task Analysis involved the location of briefing sheets, with longer calls being characterised by a greater length of time between greeting the caller, finding the appropriate briefing sheet, and the subsequent dissemination of information from that briefing sheet. Longer calls also resulted in a higher probability of being put on hold. Much of the delay associated with information retrieval found in the Task Analysis can possibly be accounted for by the method of information retrieval in use within the phoneroom at the time: helpliners had to search through paper briefing sheets arranged on their desk or in a central bank in order to locate the appropriate information. Roughly six months after this study a computerised system was installed for both call logging and information retrieval that was intended to counter many of the delays inherent in the old paper system, although as stated earlier, paper documents are still used for campaigns and "sensitive" issues. The forthcoming experiments, therefore, will not deal with locating information as it relates to retrieving an entire document, as this has largely been dealt with at the BBC Audience Lines, and is an area which still involves a number of parallel systems. This thesis will focus on information retrieval *from within a document*. That is, once a document is accessed, can navigation around that document be manipulated to improve the speed of information retrieval from within that document?

The extensive use of word processing packages by a wide variety of different users has increased the application of various formatting techniques, previously used to a much lesser degree. Authors who were once constrained by the cost and demands of the printing process, limited their formatting to basic paragraph demarcation and chapter headings. Now, through the use of word processors and the ease of printing, there is an almost limitless variety of presentation techniques and formats that can be created. The form of presentation is now almost solely constrained by what the author wants to see, and not by any technical limitations. The majority of frequently used formatting techniques are primarily decided by what the most common word processing packages have available. In Microsoft Word, probably the most widely used word processing package, the formatting toolbar contains options to alter the font, point size, and the look of individual letters or words (bold, italic or underline), to highlight letters or words, and to change the justification (left, right, full, or centred). There is also the facility to number individual points, to bullet them, or to indent or box a section of text. These techniques are widely utilised across a number of different document types. Particularly, numbering and bulleting is prolific in many business and information documents, and is also an integral part of software packages such as Microsoft Powerpoint.

Authors commonly utilise these techniques to break up the page, and it is presumed that it makes the document easier to read and search, although little is written on the benefits or otherwise of this method of formatting. Therefore, there is no evidence to support these assumptions. The word processing and presentation packages do not assert why these techniques are included, what benefit they provide, and under what circumstances they should be used. If, in fact, they do improve a reader or searcher's abilities, it remains to be explained where this facilitation originates from, and what degree of facilitation is achieved. It may be that the formatting manipulations that can be made to a piece of text can aid memory for that text, or facilitate text search by creating a clearer spatial and structural layout to the text. On the other hand it may be that these changes actually alter *how* someone reads the document, and therefore affect the memory representation of the text in that way. It is also possible that there is neither advantage or disadvantage to manipulating a document's layout, although this is intuitively less appealing.

Formatting must be assumed to have some effect on the way people read and search a document; why else would formatting manipulations be used? However, a long history of psychological and psycholinguistic research has tended to assume that the surface features of a text are relatively unimportant, and are discarded soon after reading (Kintsch, 1971; Begg & Wickelgren, 1974; Sachs, 1974). Van Dijk and Kintsch (1983; Kintsch, 1992) in their text comprehension theory proposed three levels of text comprehension. The first level, the surface level, is characterised by the surface features such as the exact wording and syntax used in the text. The second level, the textbase, consist of a representation of the semantic content of the text, rather than the exact wording. The third level is called the situation model, and represents the situation described by the text as it relates to the reader's pre-existing knowledge. Van Dijk & Kintsch acknowledged that the first of these levels, the surface level, is always involved in text comprehension, although to different degrees depending on the participant and the text (Kintsch, 1993). However, Kintsch *et al* define this surface level representation as the encoding of the exact words and phrases themselves, along with the linguistic and syntactic relations between them. No mention is made of the encoding of the overall layout of the text or any other perceptual features, or whether this could have any effect on the other two levels. Evidence is also put forward by Kintsch to suggest that the surface level representation, as examined by a participant's ability to differentiate between verbatim sentences and paraphrases at various time lags, can only be seen in immediate tests. Over longer time lags, surface memory is no longer a usable part of the memory representation, (Kintsch, Welsch, Schmalhofer & Zimny, 1990).

However, other researchers investigating the transfer of information from one reading encounter to the next support a contrasting view; that surface features, including the document layout, are encoded along with semantic information from the text (the textbase and situation model in Kintsch's parlance), and together form the representation of the text that is stored in memory. In order to support this viewpoint, researchers have tried to find evidence that altering the perceptual features of a text between two reading encounters will affect the ability of the first reading encounter to facilitate a subsequent reading. In the series of seminal experiments by Kolers (1975) discussed in Chapter 3, Kolers demonstrated that a prior reading of a sentence can influence a subsequent reading of the same sentence in that when the modality, language or presentation is altered between two reading encounters with the same sentence, there is a loss of transfer benefit to the second reading encounter. Kolers (1975) concluded that "one aspect of reading, its speed, depends crucially upon pattern analyzing skills directed at the surface representation" (p289). Kolers, therefore, uses the term "surface representation" in a different way to Kintsch (1993) in that when Kintsch refers to the surface representation of text in his three level discourse model, he is referring to the exact wording and syntactic structure rather than the way the text looks on a page, that is its perceptual features. Koler's use of the term refers to the actual *look* of the text, its shape and appearance on the page. Thus Kolers believed that the "look" of the text on a surface level can influence the way a document is encoded into memory, and therefore the ability of the representation formed on the first reading encounter to aid a second reading encounter: if the repeated text also had its surface form repeated, then there would be more facilitation than if it had not.

The importance surface features play in any rereading benefit is not adhered to by all researchers in the area of rereading, particularly Carr and his colleagues, as discussed in Chapter 3 (Carr, Brown & Charalambous, 1989; Carr & Brown, 1990; Carlson, Alejano & Carr, 1991). Carr *et al* concluded that the rereading benefit is at the word level, and these word representations are abstract units which do not preserve the physical appearance of the presented word when they are stored in memory. Carr also believed that these abstract word representations are not sensitive to the discourse structure in which the words appear, which goes beyond Kintsch's assertion that there is always a surface level component to the representation of a text.

The different results and conclusions between these two camps have been investigated by more recent researchers by examining the differences in the tasks used in the various experiments. In this way researchers have explained why evidence has been found both to support and to challenge the view that perceptual features of the text are used in the rereading benefit. Current theory now recognises that perceptual features can affect the rereading benefit. Researchers accept that perceptual features form part of the representation in memory that is created during the initial reading encounter with the text, but believe that these features are only utilised under certain circumstances. When the physical appearance of the text is unusual, or difficult to read, so that reading is slowed down, the second reading of that text in the same format is then facilitated more than reading the same text in a different orientation or typeface (Kolers, 1975; Kolers, Palef & Stelmach, 1980). It has proved more difficult to find an influence of perceptual features for more naturalistic reading tasks. When the task is simply to read the content of the page aloud on two separate occasions, the physical appearance of the page seems to have little effect on the speed of the second reading (Carr, Brown & Charalambous, 1989; Carr & Brown, 1990; Carlson, Alejano & Carr, 1991). Levy & Kirsner, (1989) suggested that indirect text-level tests, like rereading a text for comprehension, are likely to result in evidence for long-lasting surface-level representations. When the reading task that is being altered by the perceptual changes to the text is "backgrounded", as some researchers have described it (Jacoby, Levy & Steinbach, 1992), even simple typeface changes can be seen to have robust effects.

Perceptual information relating to a document can be seen to be encoded along with the information content of the text across a number of studies and reading tasks. For example, as discussed in Chapter 3, Lovelace & Southall (1983) demonstrated that removing absolute spatial cues from a document results in a poorer memory for both the content and the visual features of a text. Trollip & Sales (1986) showed that participants reading ability can be manipulated by whether the passage they are reading is full justified or not. From evidence such as this, most people investigating the rereading benefit now accept that perceptual information is part of the episodic information contained within the representation in memory of the text (Jacoby, 1983b; Levy & Kirsner, 1989; Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992). It is also agreed that not all tasks make use of this aspect of the representation. However, little, work has been conducted to investigate whether altering the *layout* of a page of text can alter either how much perceptual information is encoded, or whether perceptual information is utilised during a later task. This present study will compare the ability of participants to search the same document presented in a number of ways to investigate whether formatting manipulations can alter any transfer benefit in much the same way as altering the task between encounters can.

The BBC Audience Lines, as mentioned earlier, commonly use a number of formatting techniques, particularly bulleting, to separate individual points within a text. However, there is no set criteria prescribed by the Audience Lines of how to use these bullets and under what circumstances they should be used. Numbered points are used less frequently, but both techniques are applied depending on the Helpliner's personal preference and without consistency within the organisation. This present study is designed to explore whether the application of different formatting techniques can have a differential effect on information retrieval from within a document when the documents read and searched are presented on paper. If different formatting manipulations can result in differences in a participant's ability to retrieve information from within a pre-read document, then this would imply that the formatting is either affecting the ability of the participants' to search the document or has affected the ability of the participants to encode the document in the first place.

A number of aspects of formatting will be explored to uncover whether formatting differences are present while reading a text document. What we are therefore exploring in this pilot study is firstly, whether commonly used document layout techniques, such as the use of bullets and the use of "white space", can alter a participant's ability to locate discrete pieces information from within a text document that they are already familiar with. We are interested in whether certain formatting manipulations result in participants finding the document more or less easy to search. Second we are also interested in whether there is more of an advantage for participants to search the same format in which they had initially read the document, or a different one. Thus we are investigating the transfer of information from an initial reading encounter to a secondary *search* encounter, to probe whether the transfer benefit seen in the rereading literature also holds when quite different tasks are used to investigate what information was attained during the initial reading encounter.

4.2. METHOD

4.2.1. Materials and Design

A document entitled 'Skin Disorders', modified from a file used by the BBC Audience Lines was used. The document contained four broad areas: an introduction to the skin, then information about acne, psoriasis, and vitiligo. The text was 1285 words long.

Three different versions of this text were prepared. Each version differed only in its formatting, with each format sharing some common features. All three formats were printed in 14 point Ariel font, were left justified only, and all contained exactly the same text, including punctuation. This is the same page styling as is used at the BBC Audience Lines. Each version had a row of numbers on the right hand side of the page numbered from 20 to 61; a number for each line. The page length in each of the formats was 41 lines long. Each text was single spaced. Each version was prepared in an A4 booklet form, attached together in the top left hand corner by a staple. They all had the same cover page entitled "Skin Disorders".

The first format was plain text. Plain text is continuous text, divided into paragraphs. There were ten paragraphs, and the text took 3¼ A4 pages (Appendix 2).

The second format was bulleted text. In this condition, each sentence started on a new line, and was picked out with a bullet. Lists of items were further indented with a bullet, with each item starting a new line. Again this was divided into the same ten paragraphs as plain text. This took just over 4 pages (Appendix 3).

The final format was separated text. Like bulleted text each new sentence started on a new line, but in this condition each line was separated by a blank line, and there were no paragraph markings. This type of formatting took up 5¼ pages (Appendix 4).

Twenty four questions were prepared about the text (Appendix 5). These were questions which could be answered by a single word or phrase contained within the text. The questions used the wording of the text as much as possible. A pre-test was conducted, which involved making four participants read the text (presented in plain format), once. These participants were then asked if they could remember the answer to the questions. From this, each of the questions were rated for difficulty on a scale from 0 to 4. The questions were then divided into two groups, depending on their difficulty, and where they lay on the page in relation to plain text so that each group contained roughly equivalent questions in terms of difficulty and location. There were 8 questions on each of the three full pages for plain text, with two questions in each of the 4 ten line blocks that make up the 40 line page. This translated into roughly 6 questions per page with bulleted text, and 5 questions per page with separated text. The questions were split into two blocks of twelve questions.

4.2.2. Participants

Twenty-four Glasgow University undergraduates voluntarily participated in the study. All of the participants were native English speakers and under 30. There was an equal proportion of males and females.

4.2.3. Procedure

Volunteers participated in individual experimental sessions that lasted approximately ¾ hour. Each participant was given the text in one of the three formats to read in their own time. They were instructed to read it as carefully as possible, once only, and to not go back and reread any part of it. They were then either given the same format again to be tested on, or a different format.

The prepared questions were read aloud to the participants by the experimenter. During the question the booklet was closed, with the front cover of the document facing the participant. At the end of the question, the experimenter started a millisecond timer. The start "click" of the timer was the participant's cue to start searching for the answer to the question within the document. On finding the correct answer, the participant pressed their timer switch to stop the timer, and simultaneously called out the line number on which the answer was located. The participant was instructed to close the booklet immediately on finding the answer, and the experimenter logged both the answer and the time before resetting the timer and beginning the process again.

This process was executed for the first twelve questions, at which point the participants were given a different version of the text, again either in the same or a different format from the version they had initially read. The final twelve question were then searched for using this new document.

The orders tested ran like this:

Participant	FORMAT READ	FORMAT SEARCHED (1)	FORMAT SEARCHED (2)
1 / 13	PLAIN	PLAIN	BULLET
2 / 14	``	PLAIN	SEPARATE
3 / 15	``	BULLET	PLAIN
4 / 16	``	SEPARATE	PLAIN
5 / 17	BULLET	PLAIN	BULLET
6 / 18	``	BULLET	PLAIN
7 / 19	``	BULLET	SEPARATE
8 / 20	``	SEPARATE	BULLET
9 / 21	SEPARATE	PLAIN	SEPARATE
10 / 22	``	BULLET	SEPARATE
12 / 23	``	SEPARATE	PLAIN
13 / 24	``	SEPARATE	BULLET

Table 6: The order of presentation of formats for each participant. The first 12 prepared questions were asked using format (1), and the remaining 12 questions were asked using format (2).

The question answering task was used to "background" the actual scanning experience as in Jacoby, Levy & Steinbach (1992). The participant's main aim, therefore, is not to scan or selectively read the text, but to locate a specific piece of information within it. This task also compares with the work of the BBC Audience lines. During a call, a Helpliner at the BBC Audience Lines has to locate the information the caller requires are quickly and as accurately as possible. Once the document has been located, the Helpliner's task is a pure information retrieval problem within this text document. As was seen in the Task Analysis, the Helpliner first ascertains what information is required by the caller. After that, their task is simply to locate the relevant information for the caller. Once the particular question the caller is enquiring about has been ascertained, the Helpliner will scan through the document looking for that particular piece of information or relocate it if they have already read the document or if they have used that information for an earlier call. The search of a discrete piece of information from within a text document, without recourse to a table of contents or to section sub-heading is considered valid for a number of reasons. First, although there are contents pages on the BBC Audience Line's briefing sheets, videos of the task analysis revealed that there were not often referred to. Work by Nygren (1996), has also indicated that expert users of paper documentation (in this case technical experts at a military base, conducting routine tasks using elaborate documentation systems specific to their individual jobs), rarely use the table of contents, especially if the document is well known. When a table of contents was used, this was almost always at the highest level of detail. Section sub-headings are not used consistently within the BBC Audience Lines, and so were omitted from the experimental document in this current study. Tracts of text within a heading may be as short as a few lines, or go on for a number of pages. This is not to detract from the fact that the use of sub-headings may help ease navigation around a text document, however, what is of interest in this present investigation is whether the presentation of the text itself can influence information retrieval.

4.2.4. Analysis

Throughout the analyses used in this thesis, various conventions will be adhered to. These will be laid out here for simplicity. Analysis will be conducted on the raw data where possible. However, there is a high degree of variability obtained in many of the analyses, due to the complex processes involved in making many of the responses, which can make some of the data sets difficult to interpret. This variability is predominantly found in response time or latency measures which can result in outliers or atypical responses. Therefore, in conditions in which there is a skew in the data, or there are a few outlying data points affecting the mean of the data, or when a comparison of the variability between groups fails to meet the 1:4 ratio convention (cf. Howell, 1992, pp308), transformations of the data will be used.

The two types of transformations used in this thesis are reciprocal transformations and logarithmic transformations. The first is used to reduce the skew of the data by minimising the effects of a few extreme values found in the positive tail of the distribution, without having to remove data from the data set. This can often be found in the case of response times where participants can not find the relevant piece of information, resulting in response times sometimes as much as a 50 seconds greater than the bulk of the other responses. In this case the use of reciprocals will be noted beside the analysis, and harmonic means will be reported. Logarithmic transformations (of base 10) will be used when the data are noticeably positively skewed, and there is a pattern to the differences in variation between groups in that the mean is proportional to the standard deviation. Again the use of the log transformation will be noted beside each analysis, and the antilogs of the logarithmic means reported. In each analysis, it can be assumed that the difference in the variation between groups is no more than a 1:4 ratio. Homogeneity of variance between groups can be assumed throughout the thesis, unless otherwise stated. All results are measured at the 0.05 level of significance.

In this study, search times recorded for erroneous responses were removed. These missing values, along with missing values for other reasons (for example failure to make a response), were replaced with subject and group means. There were 49 responses removed because of error, making up 8.51% of the total number of responses. These were analysed separately to see if there were any patterns in the error responses, or if there were any speed-accuracy trade-offs.

The response data was analysed by question, and is therefore a by materials design. This was analysed in this way because the questions remained constant through the 24 participants. The data was analysed in two ways. The first was by format read. In this analysis there were two factors, FORMAT INITIALLY READ (three levels, plain, bullet, separate; within measures) and FORMAT SEARCHED (two levels, the same formats as was initially read, or a different one, within measures). The dependent variable was response time.

The second analysis was by format searched. This took the FORMAT SEARCHED as the first factor (plain, bullet or separate, within measures), and FORMAT READ (two levels, same format as was searched, or different, within measures) as the second.

4.3. RESULTS

The first analysis, looked at the differences between groups by what format was initially read. This revealed a main effect for format initially read, $F(2,46)=3.558$, $p<0.05$. Participants were faster searching a document if they had first read the document in the plain, unformatted style. There was also a main effect for format searched, $F(1,23)=6.557$, $p<0.05$, indicating that participants were faster searching the same formats as they had initially read than if they were searching a different format. These results are illustrated in Figure 7. There were no significant interactions, $F(2,46)=1.028$, $p=0.366$.

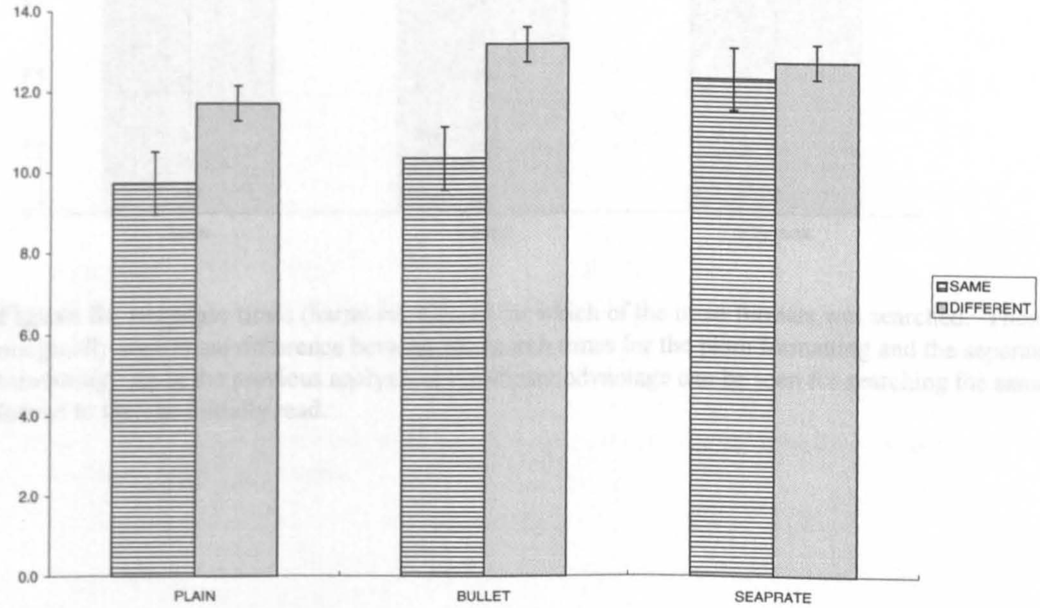

Figure 7: Response times (harmonic means) for format read, measured in seconds. When plain formatted text was initially read, participants were then significantly faster searching both the same and different formats than if either of the other two formats were initially read. Participants were also faster searching the same format as they had initially read than searching a different format.

A second analysis was conducted that compared the response times by looking at which of the three formats was searched, and investigated whether they differed depending on the format that was initially read. This analysis revealed no difference between the three formats in their search times, $F(2,46)=2.019$, $p=0.144$.

There was also a significant effect for format initially read, $F(1,23)=5.584$, $p<0.05$, which indicated, as in the first analysis, that participants were faster searching a format if they had already read the same format, as opposed to a different one, Figure 8. There was no interaction, $F(2,46)=1.950$, $p=0.154$.

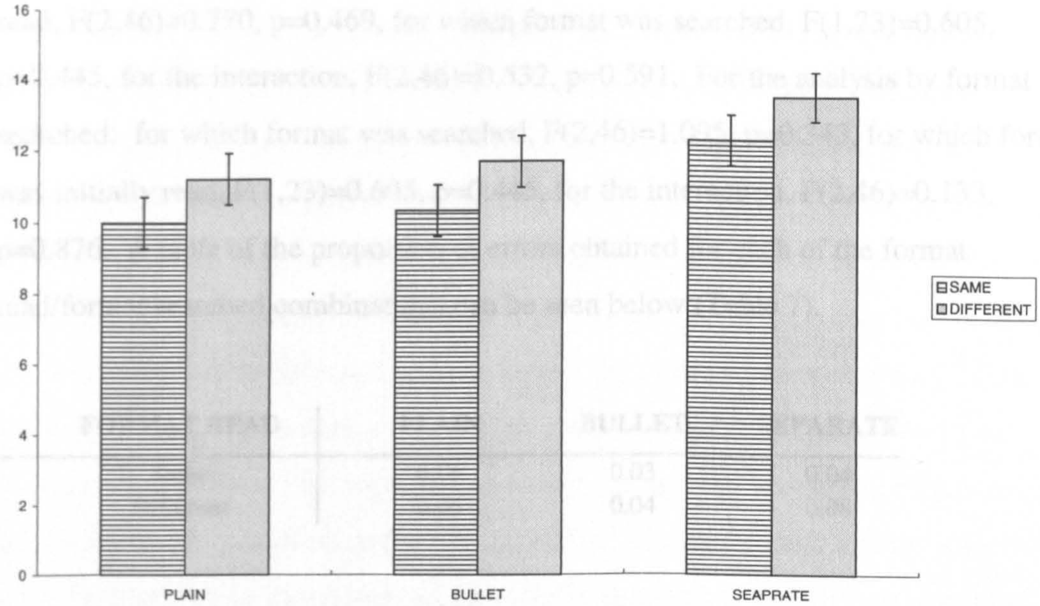

Figure 8: Response times (harmonic means) for which of the three formats was searched. There is a marginally significant difference between the search times for the plain formatting and the separate formatting. As in the previous analysis, a significant advantage can be seen for searching the same format to the one initially read.

4.3.2. Error analysis

The average number of errors for each of the Format Read/Format Searched combinations were investigated. No significant values were obtained for any of the main effects or interactions. For the analysis by format read: for which format was read, $F(2,46)=0.770$, $p=0.469$, for which format was searched, $F(1,23)=0.605$, $p=0.445$, for the interaction, $F(2,46)=0.532$, $p=0.591$. For the analysis by format searched: for which format was searched, $F(2,46)=1.095$, $p=0.343$, for which format was initially read, $F(1,23)=0.605$, $p=0.445$, for the interaction, $F(2,46)=0.133$, $p=0.876$. A table of the proportion of errors obtained for each of the format read/format searched combinations can be seen below (Table 7).

FORMAT READ	PLAIN	BULLET	SEPARATE
Same	0.06	0.03	0.04
Different	0.05	0.04	0.08

FORMAT SEARCHED	PLAIN	BULLET	SEPARATE
Same	0.06	0.03	0.04
Different	0.08	0.05	0.04

Table 7: The average proportion of wrong answers made per trial for both the format read analysis and the format searched analysis.

4.4. DISCUSSION

This study was designed to investigate whether simple formatting modifications to the same document can result in differences in a participant's ability to retrieve information from the document after an initial reading encounter. Important differences can be seen on a number of different levels. First, there is a distinct advantage for a participant to search a format that they are already familiar with. This replicates the findings in the rereading literature which demonstrate an advantage for the repetition of perceptual features during a second reading task. This current study was able to demonstrate these same advantages using both a different task, and different perceptual modifications. Second, there is no conclusive effect for the search factor. Participants seem to be equally effective searching each of the three formatting manipulations when they are investigated independently to the format initially read. This would seem to indicate that the formatting effects seen in this first experiment are related to the encoding and representation of the text, rather than the participants direct interaction with the document. Finally, we have also found differences between the three formats in their ability to facilitate a later search task. There is a distinct advantage to first reading plain formatted text in the later search of both the same and differently formatted text. This plain text advantage implies that the way a document is presented can alter the way it is encoded, and therefore what information is represented in memory of that text that can later aid a subsequent task. These points will now be discussed individually in more depth.

4.4.1. What format was initially read?

The main effect for format read, that is which of the three formatting manipulations was initially read before the text search task, indicates that this factor is critically important in influencing the subsequent search. When participant first read the document in the plain format, that is without any special formatting modifications at all, there was most facilitation between the initial reading and any subsequent search encounters. The reasons for the high degree of transfer from plain, unformatted text are not certain, but it does not seem to be related to the fact that there are a smaller number of pages associated with the plain format. If the difference in the number of pages was the critical factor between the three formats, then this would be expected to be revealed at the search stage of the task. However, as stated earlier, there is no difference between the three formats in their search times. In addition, if the plain-same advantage was caused by the fact that the participant is both familiar with the plain document and is searching a fewer number of pages, this does not explain the plain-different advantage in which the participants will be searching *more* pages than if they had initially read the either of the other two formats. Therefore the advantage for first reading plain formatted text stands despite the fewer number of pages involved.

The difference in the amount of facilitation between the three groups suggests that the different formatting manipulations result in differences in the way the document is encoded during the initial reading encounter. Whatever these difference are results in plain text having the greatest ability to transfer information from the first reading encounter to facilitate the next encounter, resulting in faster search times for any format. There are many possible explanations for this. One explanation is that plain text produces the least rich visual or perceptual encoding of the three formats. If this were the case, then it may explain why there is most transfer from first reading the plain format to the search of other formats; there is little perceptual information associated with the memory representation to interfere with a search of a different format. However, this is an unsatisfactory explanation as it does not account for the fact that there is a greater amount of facilitation for the plain-same condition compared with the bullet-same and separate-same conditions. It also does not account for the difference between the response times for plain-same and plain-different search tasks. There is a distinct advantage to searching the same format as was initially read, and this is evident as much with plain text as with the other two formats.

Another possible explanation is that the bulleted and separated formats are actually impeding the encoding of the text in some way, perhaps on both a visual and semantic level, and for this reason there is less possible transfer to the search of the same or any other of the other formats at the search stage. The likelihood of perceptual information creating the different facilitation brought from each format is supported in the rereading literature. Researchers studying the rereading benefit have noted that different tasks results in more or less use being made of perceptual features of the text (Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992). Other researchers looking into memory for location information have found evidence to support the fact that certain types of presentation technique, for example paging versus scrolling, can results in a greater recall of location information for that text (Kolers, Duchnicky & Ferguson, 1981; Schwarz, Beldie & Pastoor, 1983). This present study has indicated that different ways of presenting within-page information can alter the ability of participants to locate information within these documents. Ignoring the search of different formats temporarily, participants can search the plain-same formatted text significantly faster than they can search either the bullet-same or the separate-same document. Therefore, even when a page-by-page advancement method is being used, which results in strong recall of location information in comparison to scrolling (Lovelace & Southall, 1983) the ability of participants to locate information within a document can be altered by the way that document is presented.

The suggestion that the semantic encoding of a document can be influenced by the way it looks is given support by the fact that participants are significantly better at searching a different format if they have first read plain, unformatted text. As there were no systematic difference between the three formats in the way they were searched, it can only be assumed that the advantage for first having read plain text on a later search of a different format must relate to the way the *content* of the document was retained in memory. The suggestion that the way a document is presented can affect how it is then encoded and remembered has some support in the work of McAteer. McAteer (1996) investigated what happens when a reader encounters text that is either highlighted by italicising or by being presenting in capital letters. McAteer demonstrated that the method of altering the presentation of an individual word or phrase can alter the interpretation of that word. For example, italicising the text was shown to indicate that the highlighted words actually contrasted with some other idea that had been presented in the text. Capital letters, on the other hand, emphasised the meaning of the words, but did not alter the way they were interpreted. Thus it can be seen that even at the word level, the presentation of text can alter the way a participant then interprets that word. Therefore, suggesting that altering the look of the entire passage can alter how it is then read does not seem like an unacceptable idea.

There is other work that supports the conclusion that the presentation of a document can affect the way it is encoded. A number of researchers (Anderson & Pitchert, 1978; Cirilo, 1981; Zwaan, 1994) have investigated into how a reader's prior expectations about the nature of a text can affect the way the document is read and also how the text is remembered. Zwann (1994) altered participants' expectations as to whether they were reading an extract from a newspaper article or from a novel and found that participants were far faster when they were reading a "news" item than if they were reading a "literary" item. Zwaan's (1994) reading and memory tasks revealed that participants allocated more resources to what Kintsch *et al*, (Kintsch, Welsch, Schmalhofer & Glavanov, 1986; Perrig & Kintsch, 1985) referred to as surface-level and textbase-level processes when they were reading what they were lead to expect were literary texts. When other participants read the same text with the expectation they were reading news items, they allocated more resources to the construction of a situational model. Thus, expectations about the genre of a text influence how readers process the text and also mentally represent that text.

It is therefore reasonable to propose that altering the formatting of a passage of text can lead the reader to interpret the passage differently and thus the encoding and the subsequent representation in memory of a piece of text. In this study participants were given as much time as they needed to read the document. Because the document reading time was not measured, it cannot be said if the document was read in any different way between the two formats. However, this will be investigated in subsequent studies.

4.4.2. Was the format searched the same or different?

Participants were faster searching a document presented in the same format as the document they had initially read. Although the information contained within the document remained constant between the three formats, there was a distinct advantage for searching the format with which the participant had become familiar through reading. This implies that there is information attained during the first reading encounter that is specific to that format. In this way it replicates the finding in much of the rereading literature that demonstrates the importance of keeping the perceptual features of a document constant over encounters (Levy & Kirsner, 1989;

Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992). However, it is difficult to assert what information is responsible for the facilitation as there are a number of confounding factors within the same-different comparison. It may be that participants are encoding perceptual features during the first reading of the document, which are specific to that particular document layout. Therefore, during the later text search, participants are more able to search the document because location cues and the overall layout have been encoded during the initial reading experience. Studies into the rereading benefit have asserted that it is the entire *episode* that is encoded during an initial reading of a document, and all the features present in the initial reading encounter need to be recreated during subsequent readings of the text (Levy & Kirsner, 1989; Levy & Burns, 1990). As was stated in the introduction, this does not always hold, and certain tasks seem to rely on perceptual features of the representation more than others. However, the advantage seen here for keeping the layout constant is consistent with the idea that the representation held in memory of the document contains perceptual information which is then used to facilitate the later search task. However, this is not the only possible explanation. Because of the different number of pages each of the three formats use to present the document, it is possible that the encoding that is taking place during the reading process simply creates an idea of what information is contained on what page, or what information is contained on the same page. If this was the case, the disruption of the transfer benefit to the subsequent search task in this study may simply be due to the information being grouped in a different way and have little or nothing to do with any perceptual features found in the text. These are issues that will be addressed in later studies.

4.4.3. What document was searched?

A lack of any significant main effect for which of the three formats was searched, regardless of the format initially read, indicates that it seems not to be the searcher's direct participation in searching the formatted document that had an effect on their ability to locate information within the text. On the contrary, significant effects seem to stem almost solely from the initial reading encounter and how this interacts with subsequent factors. Thus, the effects found are not purely a result of certain formats giving clearer signposts with which a participant can navigate around the text (although separate text seems to be particularly problemsome). It seems to be that it is the information attained during the first reading encounter that then influences the ability of participants to conduct subsequent searches.

This finding can be seen as analogous to the findings of, for example, Tinker, (cf. Morrison & Inhoff, 1981), who found small or no differences between the reading speeds of participants while reading the same documents presented in different typefaces, font sizes, and line lengths. Most researcher who have worked in this field have concluded that there is little difference in measures such as reading speed as long as all the text presentation factors are within "normal" limits (Rayner & Pollatsek, 1989). In contrast, much of the research into whether there are perceptual features encoded when a text is read does not test whether one type of format or typeface is in fact better than another, but rather whether the participant notices any difference in these features between one encounter with a piece of text and the next (for example, ; Roediger & Blaxton, 1987b; Jacoby & Hayman, 1987; Bassili, Smith & MacLeod, 1989; Levy & Kirsner, 1989). It can be seen in this study that, compared directly, there seems to be little difference between formats in the ability of participants to search them. Therefore, if more than one reading encounter is going to be made with a piece of text, then it is important to keep the perceptual features of the text constant (Levy & Kirsner, 1989; Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992). This is especially true of the reading experience on these encounters is backgrounded or made automatic. It is this effect that can be seen in the present study. When the ability of participants to search a document presented in a number of different ways is compared directly, there is little difference between formatting manipulations. However when participants are permitted multiple encounters with a piece of text, distinct advantages can be seen for searching a familiar document.

4.5. CONCLUSIONS

Three important points were uncovered in this present study. First, clear evidence can be seen that altering the way a document is laid out across a page can affect the way that document is encoded, and therefore how much information is available to facilitate later tasks. Plain formatted text can be seen to produce a representation in memory that most facilitates a later search task. Participants were faster searching both the same format and different formats if they had first read plain, unformatted text. The reason for this facilitation could be due to a stronger perceptual representation, as evidenced by the plain-same advantage. However, the plain-different advantage can only be explained by the fact that a stronger semantic representation of the text has been produced. Thus, the information encoded when a document is read can be altered simply by the way the document is presented on the page.

A second important finding is that participants perform the search task far faster if they are searching a format that they have already read. Thus it cannot be the mere repetition of the semantic content of the passage that is causing the facilitation. The repetition of the perceptual features of the text are critically important in the search benefit. What is also certain is that the surface form of the text is not instantly discarded from memory, as previously presumed by some researchers (Jarvella, 1971; Brasford & Franks, 1971; Sachs, 1967). The surface form, whether that be knowledge as to what information is grouped together onto one page or more detailed information about the look of the document and the location of specific pieces of information, is an integral part of the representation of at least some types of formatting, and is used in subsequent tasks such reading and text search.

It is also important to note that the well documented rereading benefit discussed in Chapter 3 can also be seen when tasks other than reading are used to investigate what information was gleaned during the initial reading encounter. Therefore this study shows that as long as the *document* is repeated then the appropriate representation will be recruited in memory which can then go on to facilitate a number of tasks including reading and text search. Advocates of the episodic position within the rereading literature stress the need for the episodic whole to be reinstated during a second encounter for there to be any transfer of information from the first reading encounter to the second. Individual words (Levy & Kirsner, 1989) altered typeface, (Kolers, 1975; Kolers, Palef & Stelmach; Jacoby & Hayman, 1987), or altered word orders (Levy & Burns, 1990) are all insufficient to reinstate the representation from memory. This present study has demonstrated that knowledge that the document is being repeated from one encounter to the next is enough to recruit the representation held in memory of the document. It is not essential for the task to be repeated, or even the exact format, for there to be transfer from one reading encounter to another, although repeating the exact layout between encounters can maximise the level of transfer.

A third finding is that there is little difference between the three formats when their search times are compared directly, irrespective of what format was initially read. This finding supports the conclusion that the differences found in the present study are due to the different formats altering the way the document is encoded, rather than the way it is navigated.

In conclusion, there is a distinct advantage for the repetition of the perceptual features of a text between one encounter and another, even if the task differs between these two events. There is also an advantage for first reading plain formatted text, which manifests itself in a greater transfer benefit to the search of both the same and different document layouts. The reason for this may be due to the more detailed encoding of either perceptual features of the text or the semantic details of the text or both. Later studies in this thesis will attempt to investigate the transfer of these features in more detail. The following study will attempt to investigate whether there are any discernible differences between formats during the initial reading/encoding stage of the experiment, as well as whether there are difference in the pattern of responses when the documents are presented on a computer monitor, as opposed to on paper.

CHAPTER 5

5. STUDY 3: EYE MOVEMENTS SEARCHING TEXT ON A VDU

The previous study indicated that formatting seems to affect the encoding processes at the time of the initial reading of a text document. This present study is designed to investigate a number of possible explanations for the different degrees of facilitation produced by the three formatting manipulations which were suggested in Study 2. This will be achieved by altering the design of the experiment, and by monitoring participants' eye movements during both the reading and the search elements of the task. In this way we aim to narrow down the causes of any particular increased transfer benefit due to formatting manipulations, and investigate whether the difference which was presumed to be created at the encoding stage of the task can be seen in the eye movement patterns during reading. We also intend to investigate whether a different pattern of results emerge when the document is presented on a computer screen rather than as a paper booklet. We cannot be sure whether formatting manipulations that create different degrees of transfer when presented on paper behave in a similar manner when the same task is conducted using a computer terminal. Some researchers have suggested that formatting for paper and formatting for a computer screen may require quite different techniques (Nygren, 1996). However, the "ideal" presentation for either medium is still unknown.

The use of computer screens has become ubiquitous. More and more people are fulfilling their information needs through a computer interface, both during working hours, and in their leisure time. As indicated earlier, the BBC Audience Lines use a number of different presentation mediums (as well as a number of different formatting conventions) in order for their Helpliners to respond to caller's queries over the telephone. Therefore differences in ability to acquire information from a paper document and from a computer screen need to be understood in order for appropriate systems and layouts to be developed. Several experiments have indicated that both reading and proof-reading are slower from computer monitors than from paper, as discussed in Chapter 3 (Muter, Latremouille, Treurniet & Beam, 1982; Gould & Grischkowsky, 1984; 1986; Gould, Alfaro, Barnes, Finn, Grischkowsky &

Minuto, 1987a; Kruk & Muter, 1984; Muter & Maurutto, 1991). Despite attempts to improve both reading and proof-reading from a computer terminal, a series of experimenters have failed to find a single factor that seems to be responsible for the detriment to tasks using this medium (Gould, Alfaro, Barnes, Finn, Grischkowsky & Minuto, 1987a; Muter & Maurutto, 1991), despite some of these investigators achieving equivalent proof-reading times between reading from a computer terminal and paper (Gould, Alfaro, Barnes, Finn, Grischkowsky & Minuto, 1987a; Muter & Maurutto, 1991). What is of most relevance in the context of this thesis is that despite experimenters achieving equivalent reading speeds from paper and from a computer terminal, they have not been able to find equivalent *skimming* speeds using the same materials and apparatus (Muter & Maurutto, 1991). In fact the few studies that have investigated skimming from a computer terminal have indicated severe losses in skimming speed of as much as 41% when a computer terminal is used (Muter & Maurutto, 1991). Muter *et al* (1991) explained this difference in relation to the format of the text. They suggested that it may have been better designed for reading than for skimming. Kolers has also proposed that the optimal presentation for reading and for searching may differ (Kolers *et al*, 1981). Kolers suggested that narrow columns may improve skimming because they eliminate the need for eye movements. None of these theories, however, have been tested empirically although they do suggest the need for the investigation of formatting differences across a number of different tasks and mediums.

The differences found between reading from screen and paper also indicate that because certain formatting manipulations result in greater transfer benefits when a paper document is being searched, it should not be taken for granted that the same manipulations will hold for the same task using a computer screen. The increased reading and skimming rates while interacting with a computer may be indicative of a different type of encoding. Although there is equivalence in retention of content information from the document across mediums in the above mentioned studies, this may be due to participants making up for losses in reading ability through other means, which accounts for the increased reading and skimming times. If this is so, it is only through examining different aspects of the text representation held in memory across mediums that this would be uncovered.

Eye movement research has indicated that eye movements, particularly fixation durations, saccade length and the number of regression, are sensitive to semantic and syntactic alterations to a document (Ehrlich & Rayner, 1981; Frazier & Rayner, 1982; Balota, Pollatsek & Rayner, 1985; Inhoff & Rayner, 1986; Rayner & Duffy, 1986; Vitu, 1991; Rayner & Fisher, 1996). However, little work has been conducted on what effect, if any, formatting has on eye movements. Nevertheless, Christie & Just (1976) did monitor participant's eye movements during a text search task. The document was either in a coherent sentence order, or disordered. It was found that the first fixation on a passage was generally accurate for both passages (first fixation was 30% accurate for coherent passages, and 19% for disorganised texts). However, when the first fixation was inaccurate, participants used far more fixations to locate the correct answer when the passage was disorganised, implying to Christie and Just that some location information is lost in a disorganised passage because participants reorganise these passages during encoding to make more sense of them. Therefore, the accuracy of the initial fixations on a page of text has been seen to give an indication of memory for the organisation of the text.

Study 3 was designed to replicate Study 2, while taking into consideration a number of the points raised above. In this present study we presented a document on a computer screen, and used eye-tracking equipment to monitor participant's eye movements during their reading and search of the document. In this way we were able to compare the way participants interacted with a document presented in two different formats across two tasks; reading and searching. We were also able to investigate whether the difference in the response times between bulleted and plain formatted text found in Study 2 also hold when the document being searched is presented on a computer screen, and thus see if the formatting advantages for plain formatted text held across formats. Finally, any possible differences between the formats could be examined through the way they manifested themselves in the eye movement pattern during both reading and text search.

5.2. METHOD

5.2.1. Materials and Design

Participants in this study were given the same material, entitled "Skin Disorder", as they were given in Study 2. For simplicity only bulleted and plain formats will be examined in this present study.

Each document was edited so that both formats had the same number of pages, seven, with identical information on each page. This resulted in a page of bulleted text being slightly longer than the equivalent plain text page. On average, the bulleted text was 4.7 lines longer that the plain text. The first line of text on each pages started at the same position at the top left hand corner of the page (resulting in the corresponding bullets extending further to the left than the plain text does). No line numbers were inserted at the side of the page. In all other respects, the document was identical to the document discussed in Chapter 4. Formatting the passages in this way also means that there were the same number of answers to the questions on each page for each type of format.

The same 24 questions that were used in the previous study were used. These were separated into four blocks of 6 questions. Corneal eye fixations were monitored using the SMI Eyelink head mounted eye tracker. In most cases binocular fixations were recorded, although only right eye fixations were analysed.

5.2.2. Participants

Twelve Glasgow University undergraduates were paid to participate in the study. Participants volunteered to take part in the study and were paid at the end of the session. All of the participants were native English speakers and under 35. There was an equal proportion of males and females. All had uncorrected vision.

5.2.3. Apparatus

An SMI video based head mounted eye tracker was used to monitor participant's eye movements during this study. This equipment performs real-time eye tracking at 250 samples per second. This is achieved by two high speed video cameras positioned via a headband just below the cheeks of the participant. These cameras simultaneously take 250 images per second of each eye. The eyes are lighted with an infrared light source, with the tracking based on the centre of a circle representing the pupil. A third high speed camera is positioned on the centre of the headband which tracks four marker sources mounted at the corners of the computer screen. This third camera compensates for lateral head movement and enables true gaze position tracking. The image processing system synchronously analyses the images from all three cameras in real time (250 Hz sampling) to determine the pupil position of both eyes and marker position. Pupil and marker positions are processed in real time to compute gaze position.

On-line detection is performed on eye movement events such as saccades, fixations and blinks. These eye movement events record eye position changes identified by the on-line parser. This parser uses velocity and acceleration based saccade detection methods. Typically spatial noise is less than 0.005 degrees RMS, allowing a velocity noise level of less than 2 degrees a second RMS to be achieved. The 250 Hz sampling rate gives a temporal resolution of 4 msec. For each data sample, the parser immediately computes velocity and acceleration, and then compares them to the pre-set thresholds. If either the velocity or the acceleration is above threshold, a saccade signal is generated. The parser also checks to see if the saccade signal is on or off for a critical time before deciding that a saccade has begun or ended. The software also records other events such as participant responses and data messages from applications. This allows for analysis of eye movement parameters in synchrony with changes in the display or the experimental condition.

Calibration consists of either manual or automatic calibrations, depending on which best suits the participant. Participants are required to look at a series of 9 circles presented in no fixed order in the centre and at the extremes of the screen. Once calibrated, the set up programme validates the calibration. This is achieved by repeating the task and scoring the accuracy of the of the system in predicting gaze position from pupil position, and estimating the error. If the validation is poor, the process of calibration and validation must be repeated. The screen was a 17 inch monitor, with a pixel resolution of 480 x 640 pixels, and a refresh rate of 70 Hz.

5.2.4. Procedure

Participants were tested in individual experimental sessions that lasted approximately 1 hour. First they were given a brief summary of the experiment, and shown the eye tracking equipment. They were given the opportunity to ask questions, but also reassured that further opportunity would be given to ask questions during the set-up and example trials. They were then fitted with the eye tracking equipment, and given the opportunity to practice the search task on a test document (entitled "How to become a Writer"). Once comfortable with the equipment set-up and the test procedure, they were calibrated, this calibration was verified, and then they were given the document to read in one of the two formats. Participants were instructed to read for comprehension, because they would later be tested on what they had read, and the task was compared to an English "interpretation" that is commonly used in school classrooms. They then read the document at their own pace, advancing onto the next page by pressing the space bar. The only criterion they were given to adhere to was to not reread any of the material.

Once the document was read, the participants were re-calibrated to avoid any slipping of the measures in the monitoring equipment. During the text stage, the participants looked at a blank screen which had a fixation cross in the middle of the screen. They were told to look at this cross while the experimenter asked a question. As soon as the experimenter finished asking the question, she pressed a key to make a page of the text document appear on screen. The participant's task was to indicate whether the correct answer to the question could be found on that page or not by pressing a key on the keyboard for "yes" and another for "no". They were told that the answer to all the questions could be found in the document somewhere, but their task was to indicate whether the answer was on the page in front of them or not. The importance of both speed and accuracy was stressed: each participant was told that any wrong data could not be used so accuracy was important, and that their speed of response was being monitored, so their response latencies were also very important. As soon as a response was made, the page was replaced by a blank page with a fixation cross again, and the experimenter asked another question.

Questions were asked in blocks of 6, with each block of 6 questions involving the a different format to the previous 6 questions. Participants were made familiar with both formats before the beginning of the experiment. Between each block of 6 question, participants were re-calibrated. The order of presentation can be seen in Table 8. Of the 24 questions, 12 required a "yes" response, and 12 a "no". The order of these questions were randomised, but kept constant across formats.

After all 24 question had been asked, the participant was released from the equipment and debriefed.

Participant	FORMAT READ	1 to 6	6 to 12	13 to 18	19 to 24
1/ 2/ 3	PLAIN	PLAIN	BULLET	PLAIN	BULLET
4/ 5/ 6	"	BULLET	PLAIN	BULLET	PLAIN
7/ 8/ 9	BULLET	PLAIN	BULLET	PLAIN	BULLET
10/11/12	"	BULLET	PLAIN	BULLET	PLAIN

Table 8: The order of presentation of formats for reading and question answering

5.2.5. Analysis

5.2.5.1. Reading Data

Reading speed, as measured by the number of words read per minute, was analysed using a One-Way ANOVA with one between subjects factor, type of format read (2 levels, plain or bulleted). All eye movement measures - fixation duration, number of fixations and saccade length - were measures in the same way.

Because of the variability within a page in the length of saccades, the dispersion of saccade lengths was looked at between the two formats. The proportion of each saccade length (as a proportion of the total number of saccades) was analysed using a One-Way ANOVA, with format read as a between subject's factor. This analysis was conducted for both the forward (left to right) and regressive (right to left) saccades.

Eye movement measures were also examined for the first sentence of each paragraph exclusively. This was to see if, in taking a sample sentence(s) from each page, a more detailed insight into the reading pattern elicited by each format could be attained. These sentences were investigated in the same fashion as above.

5.2.5.2. Searching Data

As in Study 2, response latencies to the question task were analysed by question as the question asked remained constant across participants and formats (which is therefore a by materials analysis). Thus resulted in a 2x2x2 ANOVA with 2 within item factors: format read (2 levels, plain or bulleted text), and format searched (2 levels, same or different). There was one between item factor, ANSWER, (2 levels, yes and no). Another analysis, by format searched (2 levels, bullet or plain formatting), was also conducted.

Analysis of eye movements during the text search was also conducted in this way.

A third analysis involved looking at the number of fixations that occurred before the participant first fixated on the sentence which contained the answer to the experimenter's question (for "yes" responses only), and also the number of fixations made on that target sentence. These were analysed in the same fashion, using a 2x2 ANOVA, with both format read and format searched as within item variables.

5.2.5.3. Error Analysis

The pattern of errors made were also analysed in the same fashion to the above analyses, to investigate whether there were any speed-accuracy trade-offs. In total 19 responses were removed from the data set due to the incorrect response being made. This makes up 6.6% of the responses. These erroneous responses were replaced with series and subject means. The pattern of responses runs as follows:

3 responses were removed when plain text was read then plain text was searched.
7 responses were removed when plain text was read then bullet text was searched.
4 responses were removed when bullet text was read then plain text was searched.
5 responses were removed when bullet text was read then bullet text was searched.

5.3. READING RESULTS

5.3.1. Reading Latencies

The time taken to read each page of text (measured in words per minute) was compared across the two formats. A one way ANOVA with one between subjects factor, format (bulleted or plain) was conducted to see if there was any difference in the way each of the two formats was read. There was a significant difference between the two formats. Participants were significantly faster reading plain, unformatted text, $F(1,10)=8.312$, $p<0.05$. Bulleted text was read at an average of 188 words per minute (SD=20.3), whereas plain text was read at a rate of 273 words per minute (SD=40.2), see Figure 9

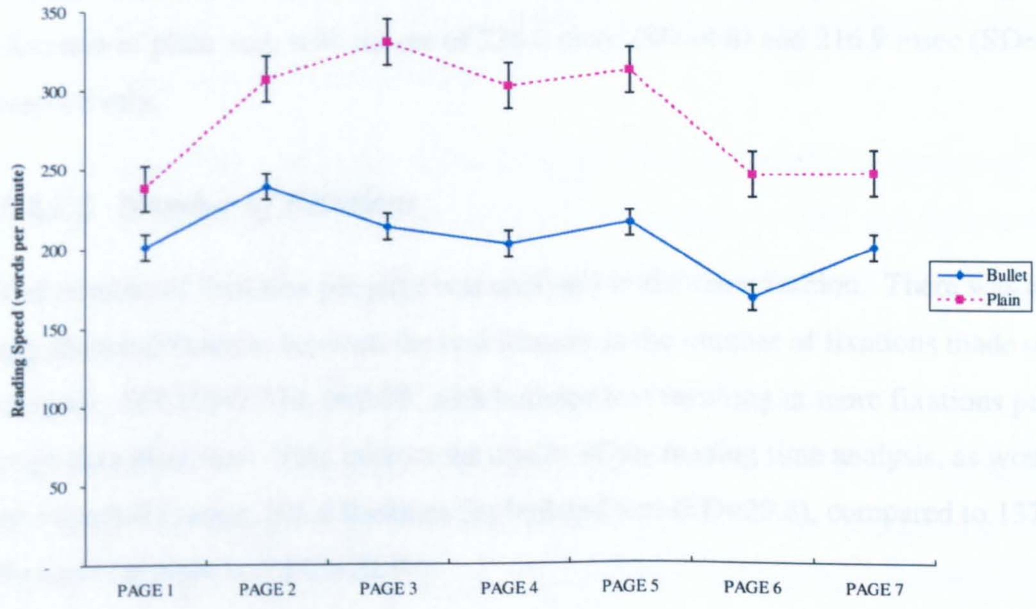

Figure 9: Average number of words read per minute for each page of text. Bulleted text can be seen to result in fewer words read per minute for each of the seven pages of text.

5.3.2. Global Eye Movement Analyses

The next logical question to ask is why there is a difference in reading times between the two types of format. The same information, using the same words, were displayed on each page, and there was an equal number of pages. By investigating the eye movement data obtained during the reading process, we attempted to find out what was happening during this time. All eye movement analyses were submitted to the same ANOVA as the reading latency analyses.

5.3.2.1. Fixation Durations

When fixation durations for reading plain and bulleted text were submitted to an ANOVA, a significant difference was seen between the two formats, $F(1,10)=5.508$, $p<0.05$. Bulleted text resulted in fixation durations that were significantly longer than that of plain text, with means of 236.0 msec (SD=4.8) and 216.9 msec (SD=4.5) respectively.

5.3.2.2. Number of Fixations

The number of fixations per page was analysed in the same fashion. There was a significant difference between the two formats in the number of fixations made on the page, $F(1,10)=7.314$, $p<0.05$, with bulleted text resulting in more fixations per page than plain text. This mirrors the results of the reading time analysis, as would be expected (means 188.6 fixations for bulleted text (SD=29.8), compared to 137.8 fixation for plain text (SD=22.9)).

5.3.2.3. Saccade Length

Related to the fact that there are significantly more fixations per page for bulleted text, we would expect there to be, on average, shorter saccades while reading bullet formatted text, which would explain the fact that more fixations were needed to move around the text. There was a significant difference between formats, $F(1,10)=9.127$, $p<0.05$. Bulleted text resulted in a mean saccade length of 75.0 pixels, and plain text has a mean of 99.9 pixels.

However, these average saccades lengths are very long. When estimated, the average character length is 6.8 pixels long (allowing for the proportional spacing of the letters within the text), resulting in an average saccade length of 11.0 characters for bulleted text and 14.7 characters for plain text. From the reading research literature it is well established that information used to identify a word during a single fixation is generally confined to a region of no more than about 5 to 7 characters to the right of the fixation, (Rayner & Pollatsek, 1987; 1989). The actual perceptual span, that is the area in which *some* information can be extracted from the text, is about 15 characters to the right of the fixation, however, the information attained from these non-fixated characters has been shown not be to at the semantic level, (Rayner, Balota & Pollatsek, 1986). Most of the information acquired outside the fixated word involves the processing of the first few letters of the parafoveal word. Therefore it can be assumed from the figures above that there is some factor in this original analysis that is unnaturally extending the saccade lengths which we assume to be the return sweep during reading.

In order to investigate this increase in the saccade length, a further analysis was conducted, this time partitioning the data into left-to-right saccade, and right-to-left saccades, which would encompass any regressions and all the return sweeps.

5.3.2.4. Left to Right Saccades

Saccade lengths were broken into 34 separate lengths, with each length increasing by 15 pixels (this measure was used because the accuracy of the eye tracking hardware can only be relied on up to 11 pixels.). The number of occurrences of each saccade length was tallied and the number of saccades were transformed into a proportion of the total number of saccades made while reading the document. These proportions were then analysed using a one-way ANOVA with format read as a between subjects factor.

No significant results were found between the two formats in the proportion of forwards saccades made, see Figure 10, although lengths 120 pixels (≅17.6 characters), 150 pixels (≅22.0 characters) and 240 pixels (≅35.3 characters) all approached significance:

- 120 pixels, $F(1,11)=4.180$, $p=0.068$;

- 150 pixels, $F(1,11)=4.383$, $p=0.063$
- 240 pixels, $F(1,11)=4.687$, $p=0.056$

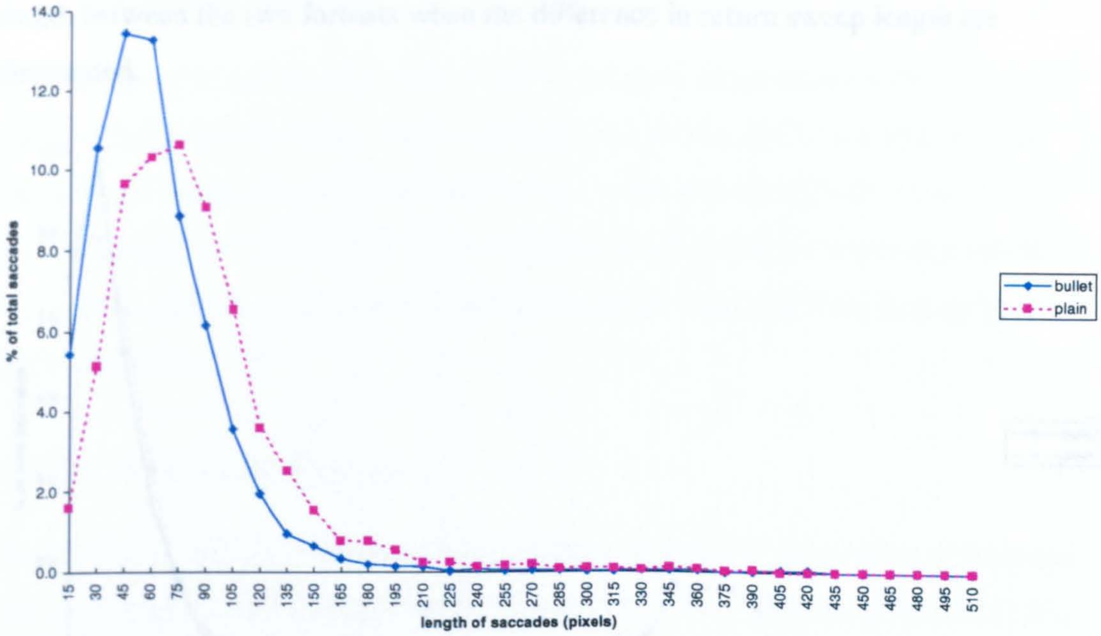

Figure 10: The proportion of occurrences of each saccade length for left to right fixations. No difference were found between the two formats in the proportion of forward saccades of each length.

5.3.2.5. Right to Left Saccades

A further analysis was conducted investigating the saccades made from right to left, again using the same ANOVA. Significant differences were found between the two formats for lengths:

- 330 pixels (≅48.5 characters), $F(1,11)=3.933$, $p=0.075$; (approaching significance)
- 345 pixels (≅50.7 characters), $F(1,11)=8.227$, $p<0.05$;
- 360 pixels (≅52.9 characters), $F(1,11)=4.753$, $p<0.05$;
- 375 pixels (≅55.1 characters), $F(1,11)=3.709$, $p=0.083$; (approaching significance);
- 390 pixels (≅57.4 characters), $F(1,11)=5.327$, $p<0.05$.

In each case, plain text resulted in proportionally more saccades than bulleted test (see Figure 11). The reason for this can be seen by looking at the materials. Because of the standard paragraph format for the plain text, it would be expected that there are more longer return sweeps than would be found with bulleted text, where the last word in a bulleted sentence, before a return sweep, can be at any point in the line, and not just at the very end of the line. Therefore there seems to be a parity in saccade length between the two formats when the difference in return sweep length are discounted.

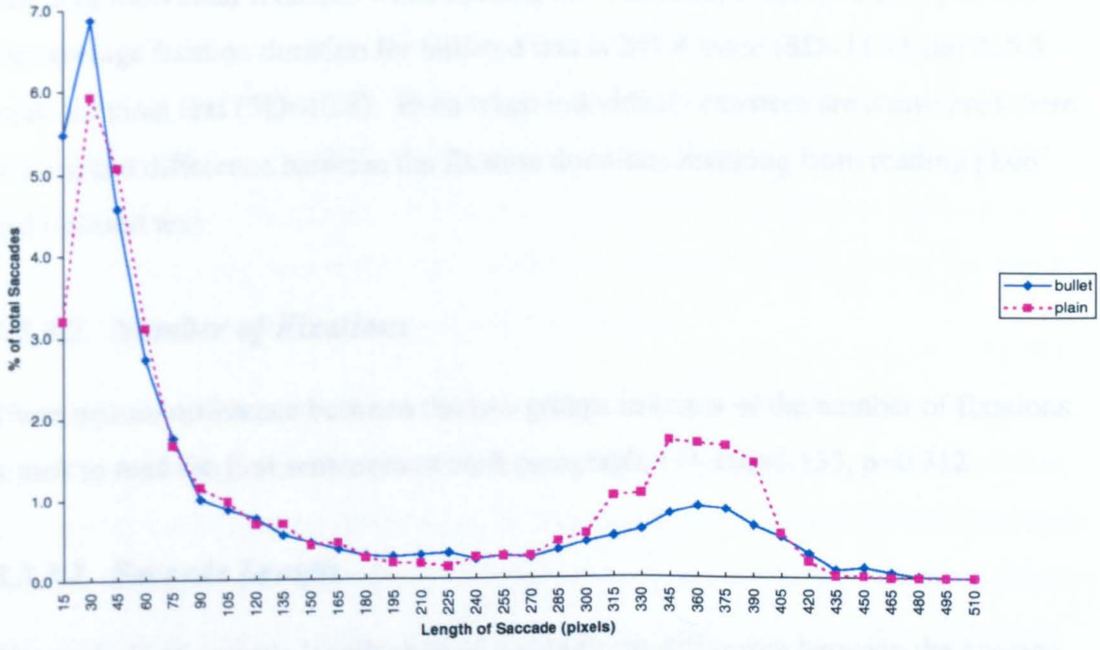

Figure 11: Proportion of each saccade length for left to right fixations. The second peak of the graphs around the 330-400 pixel mark resulted in a higher proportion of saccades while reading the plain formatted text. This is most likely due to the larger number of return sweeps while reading this types of formatting.

5.3.3. Sentence Analyses

As can be seen from the saccade length analysis, the large number of fixations per page (226.5 fixations on average) can introduce some unnecessary noise to the data. In order to overcome any masking of the data that may have been caused by excess noise, individual sentences were extracted from the data to see if the effects could be singled out here. The first sentence in each paragraph was taken and analysed individually to see if there were differences between the formats. These sentences were identical. These sentences were analysed in the same was as the global analyses just discussed.

5.3.3.1. Fixation Duration

In the analysis of individual sentences there was again a significant difference in the length of individual fixations while reading that sentence, $F(1,10)=6.825$, $p<0.05$. The average fixation duration for bulleted text is 241.4 msec (SD=11.4) and 215.5 msec for plain text (SD=10.8). Even when individual sentences are considered there is a marked difference between the fixation durations resulting from reading plain and bulleted text.

5.3.3.2. Number of Fixations

There was no difference between the two groups in terms of the number of fixations it took to read the first sentences of each paragraph, $F(1,10)=1.133$, $p=0.312$.

5.3.3.3. Saccade Length

The analysis of saccade length showed a significant difference between the average saccade length of plain and bulleted text, $F(1,10)=10.474$, $p<0.05$. The average saccade length was 62.6 pixels (≅9.2 characters) for bulleted text (SD=12.5) and 89.9 pixels (≅13.2 characters) for plain text (SD=14.6). When only left to right saccades were considered, no significant results was obtained, $F(1,10)=2.937$, $p=0.117$. However, this may be due to the small number of saccades obtained that filled all the criteria. The mean saccade lengths are 54.0 pixels (≅6.6 characters), and 76.1 pixels (≅11.2 characters) for bulleted text and plain text respectively.

5.4. DISCUSSION - READING

There was a marked difference between the two formatting manipulations when participants were simply asked to read for comprehension. The reading time differences between the two formats suggest that a reader encounters difficulty while reading bullet formatted text. The average reading time for a single page of bulleted text was 1 minute 30 seconds (harmonic mean), whereas the corresponding average reading time for plain formatted text was only 45 seconds; half the time. These reading time differences resulted despite the fact that there is identical information on each page of bullet and plain formatted text, presented in an identical typeface and point size. The only distinction between the two formats is simply due to the way the sentences of each paragraph are laid out over the page.

The reading times differences were directly reflected in the eye movement pattern observed while the participant was reading. All eye movement measures used were affected by the formatting manipulations. While a participant read bulleted text their fixation durations were significantly longer than during the reading of plain formatted text, they made more fixations, and there were alterations in the pattern of saccades. The difference in the saccade lengths can be partly attributed to the different proportion of line lengths between the two formats: plain text can be seen to result in an increased number of longer right to left saccades, due to the fact the most return sweeps are from the end of the line. In contrast, return sweeps while reading bulleted text can be from any point on the line where that particular bulleted sentence happens to end.

In order to overcome issues such as saccade length variability, individual identically presented sentences were compared between the two formats, and a clear pattern of results emerged. As in the global eye movement analysis, there were significantly longer fixations when bulleted text was being read. However with this analysis a clear difference can be seen between saccade lengths. Bullet formatted text resulted in shorter saccades, even when right to left saccades (that is regressions and return sweeps) were removed. All these measures collectively indicate that there is definitely some difference in the way these two formats are being read. Commonly, all these factors - an increase in the fixation duration, a decrease in the average saccade length, and an increase in the time it takes to read the document - are associated with a disruption to the reading process, or the reader having some difficulty reading the text, (Frazier & Rayner, 1982; Rayner & Pollatsek, 1989). It can therefore be assumed that there is something about presenting a document of text in a bulletted format that is impeding fluent reading.

However, simply noting that presenting a document by bulleting individual items impedes fluent reading does not indicate to us what it is about the text that is disrupting the reading process. The difference in the eye movements and reading times between the two formats could be the result of a number of different causes. First, it is possible that the layout of the text is distracting the reader during the reading of bullet formatted text. In particular the reader may be distracted by the bullets themselves, which alters the reading pattern. However, this explanation does not explain why the entire pattern of eye movements, that is the saccade lengths, the number of fixations, and the fixation durations are also affected. Also, if the bullet was distracting the reader, more fixations may be expected, particularly near to the bullet, whereas this was the only eye movement measure (number of fixations) to show no difference when individual sentences were investigated. This distraction hypothesis will again be explored in more detail in later studies.

A second possibility is that participants find the perceptual features of the document presented in the bulleted format more difficult to encode than if it was presented in the plain format. The relatively homogenous nature of the text presented in this way may lead to the reader to take more time to encode the spatial references of particular pieces of information during reading. We can be confident participants encode some visual information due to the superior transfer effects when they are searching the same format as they initially read, seen both in Study 2 and in the present study, discussed below. However, this present study does not tell us whether more visual or perceptual information is encoded while reading either of the two formats. The extent of the visual encoding obtained from bullet formatted text, and whether this differs from other formatting manipulations, will be explored in later studies in this thesis.

A final possible explanation for the reading differences is that the different types of formatting manipulations are making participants read the document in a different way, depending on which of the two formats they are reading. It could be that while reading bulleted text, each individual sentence, as it is picked out with a bullet, is treated like a separate paragraph, and read in more depth as such. If this were the case, there would be a number of different outcomes. First, the reader would then have more difficulty integrating the present sentence into their representation of the text as a whole, as there would be less reason to consider each sentence in the paragraph as a related idea. Second, more time would be taken to read each sentence because less could be predicted about the content on the sentence based on previous sentences if they were thought of as individual, unrelated ideas. Although these theories are difficult to test empirically, the response accuracy, response times and eye movement patterns from the second, search part of the task may give an indication as to whether more perceptual information or more detailed semantic information was taken in when the participant read either of the two formats.

5.5. SEARCHING RESULTS

5.5.1. Response Times

Search latencies were analysed by materials, resulting in a 2 (format read, plain or bulleted text, within items), x 2 (format searched, same or different, within items) x 2 (answer, yes or no, between items). The time it took the participants to respond "yes the answer is on the page" or "no, the answer is not on the page" was measured and analysed using reciprocal transformations, see Table 9.

	Plain(same)	Plain(different)	Bullet(same)	Bullet(different)	average
YES	3,135	4,079	2,794	3,387	3,349
NO	3,021	3,153	4,918	6,907	4,500
average	3,077	3,557	3,563	4,545	

Table 9: The average response latencies (harmonic means) for positive and negative questions. Participants were faster searching the same, as opposed to a different, format. An advantage was also found for first reading plain formatted text. However, this only manifested itself when the answer was not located on the page, and therefore required a "no" response.

There was a significant main effect for which format was initially read, $F(1,22)=8.828$, $p<0.05$. Participants were faster searching the texts if they had first read the document presented in a plain, unformatted layout. However, this was qualified by a format initially read x answer interaction, $F(1,22)=30.031$, $p<0.05$.

Post-hoc Tukey tests of this interaction revealed a difference between the bullet "no" response and all the other latencies ($p<0.05$). There were no other significant differences. These results indicate that there is no difference in the response latencies between the formatting manipulations when the answer is located on the page. When the answer is not present, however, and an exhaustive search is required, participants behaved in a very different manner depending on which of the two formats was initially read. If a participant had first read plain, unformatted text, they were able to respond in a similar amount of time as they did when the answer was located on the page. If the participant had first read bulleted text, however, there was a strong disadvantage to then searching for an answer that is not present on the page, see Table 10.

	PLAIN	BULLET	average
yes	3,545	3,062	3,303
no	3,086	5,745	4,415
average	3,315	4,403	

Table 10: The interaction between which format was initially read and the required answer. Response times are measured in milliseconds (harmonic means). Participant's response times were equivalent if the answer was located on the page. If it was not, there was a significant advantage for fist reading plain formatted text.

Thus participants are performing particularly badly in the bullet-no condition. The extreme nature of this results can be highlighted in the context of experimentation that will be discussed later in this thesis: the figure of 5,745 msec is comparable to response times seen when participants have not had to the opportunity to pre-read the document at all (see Study 4, Chapter 6). The significance of this will be discussed below.

All other interactions were non-significant: search x answer, $F(1,22)=0.342$, $p=0.565$; format x search, $F(1,22)=0.302$, $p=0.588$; and format x search x answer, $F(1,22)=0.841$, $p=0.369$.

There was also a significant main effect for whether the format searched was the same or a different format to the one initially read, $F(1,22)=4.789$, $p<0.05$. As in the previous study, participants are faster searching a format with which they are already familiar through reading than a different format.

Finally, a 2 (format searched, within subjects) x 2 (answer, between subjects) revealed no difference between the formats when their search latencies were compared directly, $F(1,22)=0.302$, $p=0.588$. There was no format searched x answer interaction, $F(1,22)=0.841$, $p=0.369$.

5.5.2. Eye Movement Analyses

All eye movement data was analysed using the same 2x2x2 ANOVA used for the latency analyses.

5.5.2.1. Fixation Duration

There was a significant effect for format read, $F(1,22)=13.75$, $p<0.05$, with the mean fixation for bulleted text being 206.6 msec and 190.1 msec for plain text. All other results were non-significant, Table 11.

	degrees of freedom	**F**	**significance**
Format read	1,22	13.75	<0.05
Format searched	1,22	0.879	0.359
Answer	1,22	0.009	0.926
Format read x format searched	1,22	0.227	0.280
Format read x answer	1,22	0.267	0.120
Format searched x answer	1,22	0.464	0.503
Format read x format searched x answer	1,22	0.092	0.765

Table 11: F values for fixation duration analyses.

5.5.2.2. Number of Fixations

The was a significant main effect for which format was initially read, $F(1,22)=29.039$, $p<0.05$, which was qualified by an interaction between which format was initially read and the answer given, ($F(1,22)=26.340$, $p<0.05$, see Table 12. This corresponds to the response latency findings. There was little difference between the two formats when the answer was located on the page, but when the answer was not there, participants took far more fixations to locate information when they had first read bullet formatted text.

	PLAIN	BULLET	average
yes	14.2	14.6	14.4
no	10.9	28.5	19.7
average	12.6	21.6	

Table 12: The average number of fixations made on answering a question. As in the response time analysis, it can be seen that the number of fixations required to respond to a question is equivalent if the answer is located on the page. If the answer is not present, there is a clear advantage for plain formatted text.

The difference between whether the same or a different format was searched to that initially read which was evident in the response time analysis was not evident in the number of fixations made per page, $F(1,22)=1.552$, $p=0.266$. All other main effects and interactions were non-significant. Answer, $F(1,22)=0.675$, $p=0.421$; format read x format searched, $F(1,22)=0.751$, $p=0.396$; format searched x answer, $F(1,22)=0.435$, $p=0.517$; format read x format searched x answer, $F(1,22)=0.208$, $p=0.633$.

5.5.2.3. Saccade Length

There were no significant results for saccade length. This is probably the result of the fact that participants were making large jumps from one part of the page to another while searching the document, so there would be a great deal of variability in the length of saccades during this process, see Table 13.

	degrees of freedom	F	significance
Format read	1,22	0.008	0.930
Format searched	1,22	0.003	0.956
Answer	1,22	0.506	0.485
Format read x format searched	1,22	2.885	0.104
Format read x answer	1,22	0.397	0.556
Format searched x answer	1,22	0.464	0.503
Format read x format searched x answer	1,22	2.065	0.165

Table 13: F table for saccade length.

5.5.2.4. Accuracy of the First Fixation

Comparisons were made between the two formats in the number of fixations it took for them to reach the sentence which contained the answer to the question during text search. The was conducted using a 2 (format read, bullet or plain text, within subjects) x 2 (format searched, bullet or plain text, within subjects) ANOVA. No significant differences were found between the two formats, see Table 14 and Table 15. A comparison was also made in the same way between the two formats in relation to the number of fixations that were made on the target sentence. Again there were no significant differences between the two formats.

	degrees of freedom	F	significance
Format read	1,11	0.070	0.797
Format searched	1,11	0.296	0.597
Format read x format searched	1,11	0.115	0.741

(a) The number of fixations made to get to the target sentence.

	degrees of freedom	F	significance
Format read	1,11	0.766	0.400
Format searched	1,11	0.058	0.815
Format read x format searched	1,11	1.670	0.222

Table 14: F tables for (a) the number of fixations made to the target sentence and (b) the number of fixations on the target sentence.

Format Read	**PLAIN**	**BULLET**
Format Searched		
Plain	10.6	10.4
Bullet	11.4	10.0

Table 15: The average number of fixations made before fixating on the target sentence. No difference was found between the two formats in participants' speed at first locating the relevant information.

5.5.3. Error Analysis

The analysis of the pattern of errors made in the course of the experiment (analysed in the same way as the latency and eye movement analysis) revealed a significant effect for answer, $F(1,22)=12.437$, $p<0.05$. Participants made fewer errors if the answer was not on the page and the required response was "no". The average number of errors per trial are 0.05 for "no", and 0.08 for "yes" responses.

	degrees of freedom	F	significance
Format read	1,22	0.107	
Format searched	1,22	0.961	
Answer	1,22	0.388	
Format read x format searched	1,22	2.494	
Format read x answer	1,22	2.313	
Format searched x answer	1,22	2.313	
Format read x format searched x answer	1,22		

5.6. DISCUSSION - SEARCHING

This study was designed to investigate whether the differences in search times found in Study 2 due to various formatting manipulations also held when the document being searched was presented on a computer screen. As discussed above, the reading data indicates quite dramatic differences between the formats in the way they are read. Despite identical information being presented on each page of text, participants took on average twice the amount of time to read each page of the bullet formatted text. The eye movement records provided additional support to illustrate the difficulty participants reading bullet formatted text were experiencing, with all measures being affected. The response latencies for the participants' search task must therefore be examined in the context of the less fluent reading associated with bulleted text.

5.6.1. The Effect of Repetition of Format

Differences were found between the two formats in many of the search measures which replicate the results found in the previous study. Primarily, there was again an advantage for searching the same format as the one in which the document was first read. Again this implies that there is more to the encoding of a textual document than simply remembering what the semantic content of the document was: additional information from the layout of the text must also be encoded at the time of reading. However, this present investigation comes closer than Study 2 to indicating what it is about the repetition of the layout of a document that is aiding the search task. Because of the differences in page length in Study 2, it was not possible to propose where the repetition benefit for a specifically formatted page originated from. In this study, each individual page of text was identical between formats in the information it contained. This seem to lead to no other conclusion than it is the repetition of the specific formatting and visual features of the page that is creating the advantage for searching the same format. Participants searching a different format were encountering the same information, only presented in a slightly different way, but were still less able to locate information and make content decisions based on the page in front of them. Therefore it can be concluded that visual features associated with pieces of information within a participant's representation in memory of a document facilitate the participants ability to quickly locate the information they are searching for within the same format.

5.6.2. The Effect of Different Formats

There was also a difference in the amount of facilitation brought by each of the two formats from the initial reading experience to the later search task. Despite the fact that participants spent a lot longer reading a document when it was presented in a bulleted format, they remained at a disadvantage when it came to searching both the same and a different format in the text search task. As in the previous study, there are a number of possible explanations for this disadvantage. First, however, it must be stated that the increased reading times associated with the bullet formatted text in the first stage of this study obviously do not relate to the fact that the bulleted text was read in more depth than the plain formatted text. If this were the case then we would expect that bullet formatting would then result in faster search times, which of course did not happen. Although the accuracy of participants' responses were equivalent across the two formats, response latencies were far longer after bulleted text was read, indicating again that there were problems that stem from the encoding (reading) stage of the task.

The advantage for plain formatted text seems to be most evident during the exhaustive searches of the text which required a "no" response. In this case the response latency was on average over 2,500 msec slower for first having read bullet formatted text. When the answer was on the page, and the required response from the participant was "yes", there was no significant difference between the two formats. These results relate to those from Study 2, in that the task in Study 2 can be thought of as similar to the "no" responses in this current experiment because each trial had a strong likelihood of involving an exhaustive search of a page at some stage of the search process. The advantage for first reading plain formatted text under both these circumstances indicates that the participant can more readily sum up what information is contained within a page of text and therefore make a decision on the information content of such a page after reading the plain format.

If we examine the difference in the search times between plain and bulleted formats we can get an idea of the facilitation brought about by the repetition of perceptual features. As discussed earlier, there is an advantage for both formats if the same format as was initially read is then searched. However, the size of the difference between the same and different searches are quite different between the two formats. Of most interest is the fact that there is quite a small difference between plain-same and plain-different when the answer is not on the page (the search latencies are 3,021 msec and 3,153 msec). Both of these latencies are very fast, especially in comparison to the latencies for bulleted text, which were 4,918 msec and 6,907 msec respectively. These data suggest that the amount of content or semantic information brought from first reading plain formatted text is great, and can then facilitate the search of both the same and a different format very quickly. Bullet formatted text, in contrast, seems to be at a severe loss (almost 2 seconds) in the absence of a repetition of format. This implies that reading the bulleted format allows for the creation of a perceptual representation, but hinders the creation of a semantic representation. When the participant then searches the same format, they can utilise the visual information they have stored to aid text search. However, when a different format is being searched, they can no longer rely on this information, and do not have a detailed semantic representation with which to compensate, resulting in extended search latencies. The fact that there is less content information available if bulleted text is first read is also consistent with the fact that participants' reading fluency was disrupted with this format: they found it difficult to encode the information.

5.6.3. Eye Movements During Text Search

The difference in the average fixation duration between the two formats (fixation durations are longer if the participant first read bullet formatted text) is more difficult to interpret. However, what this clearly shows is the difference in fixation durations between text search and reading. When participants were involved in reading the text, the average fixation duration for bullet and plain formatted text were 236.0 msec and 216.9 msec respectively. However, when participants were searching the same texts, the average fixation durations fell to 206.6 msec if the participant had first read bulleted text and 190.1 msec if they had first read plain formatted text. Rayner & Fischer (1996) demonstrated that during the scanning of a text, fixation durations decrease because less lexical processing is necessary. If all that the participant is required to do is scan a sentence for a certain target word, then the average fixation duration while searching that sentence would be lower. Rayner & Fischer also showed that participants are not sensitive to any word frequency effect while scanning or searching a text for a target word. They concluded from this lack of a word frequency effect that the trigger which signals the eye movement control system to programme a saccade is different during reading and text search. During reading the trigger is thought to be lexical access, hence the sensitivity to word frequency. However during text search, the trigger is thought to be something of less depth, such as a simple pattern matching. Under these circumstances, the lexical meaning of the word is not accessed, and therefore there is no word frequency effect. The results of this present study, however, suggests that there is something more than simple pattern matching occurring during the search stage of this experiment.

As discussed earlier, a text presented in bullet format is more difficult to read and encode, and results in longer search latencies. The difference in the fixation durations may be a reflection of this. As has been stated earlier, eye movement measures are sensitive to the rereading benefit (Hyona & Niemi, 1990; Inhoff, Topolski, Vitu & O'Regan, 1993, Raney & Rayner, 1995). During a second reading of a text, fixation durations decrease, saccade lengths increase and few fixation are required to read the page. Texts that are found easier to read than others also demonstrate a similar pattern of eye movements (Rayner & Pollatsek, 1989). Therefore, the difference between first reading plain formatted text and first reading bullet formatted text may reflect different representations of the semantic content of the document stored in memory as a result of reading one of the two formats. Because participants had difficulty encoding the bullet formatted text, and therefore formed a poorer representation of the text, longer fixations are needed in order to read sample pieces of text during the search task.

An equivalent interpretation cannot be made about the saccade lengths, because the pattern of fixations during the search is much more random than in reading. What seems to occur during the search process is that participants sample a piece of text, read for about 3 or 4 fixations and then jump to another place on the page. The location of the landing site of the fixation is not predictable from the layout of information on the page. Participants did not search the page in a systematic fashion. For example, they did not begin at the top of the page and then sample various pieces of text at seemingly salient locations, or from top to bottom, left to right. Instead what seemed to happen during most text searches is that participants first fixated quite close to where the fixation cross was (in the middle of the screen), read for a few fixations, and then jump to another part of the screen. Therefore the pattern of saccade movements are difficult to interpret in the present study.

5.7. CONCLUSION

The results of Study 3 add to the findings of Study 2 in a number of ways. First we have clearly demonstrated the detrimental effect the bullet presentation technique has both on reading and document search. It can be concluded that this type of formatting results in participants having severe difficulties in reading and encoding the text, leading to a poorer representation of that information with which to aid a later search. The results also give further support for the conclusion that participants encode and utilise perceptual information about the text. The advantage of searching a document presented identically on both encounters can be seen across all formatting manipulations, supporting the conclusion that perceptual information is contained within the representation created of the text. The severe loss of facilitation between first reading bullet formatted text and then searching plain formatted text indicates that participants can compensate for a lack of semantic information through remembering the layout of a passage. However, when their is a disruption to the perceptual features of the text, there is a major disruption to the search process, as there is no semantic information to rely on.

Study 3 also replicated the results found in Study 2 while using a different medium of presentation. The tested formats which demonstrated an advantage when participants searched a paper document are also advantageous when the same document is presented on screen. Thus, proposals by some researchers for example Nygren (1996), which recommend that the ideal presentation techniques for computer and paper may be different are not borne out in this present study.

Finally, these results suggest a much stronger relationship between the visual layout of a document and the ability of participants to re-read it than previously found. Re-reading studies using weaker manipulations between conditions such as typeface or point size have tended to only see an effect comparable to the same/different comparison in the present study. Researchers have tended to find support for keeping the formatting consistent during certain tasks (Levy & Kirsner, 1989; Levy & Kirsner, 1989; Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992) but when presentation techniques are compared directly, for example in participants' reading speeds, little difference can be seen between formats (Tinker, cf Morrison & Inhoff, 1981) . This study, however, illustrates differences between the two presentation mediums during each of the tasks, even the direct reading task. Participants read plain formatted text with greater ease, and respond to the search task in a shorter latency.

These conclusions lead to the suggestion that there is something about the way bulleted documents are presented that leads to an impairment of fluent reading and an impoverished representation. It is possible that it is the bullets themselves that are distracting the reader, resulting in difficulty reading the document. Alternatively, presenting the document using bullets may simply disrupt the reading process by making the document harder to understand and therefore encode, specifically with regard to semantic information. It is these suggestions that will be explored in the following experiment.

CHAPTER 6

6. STUDY 4: PAPER AND SCREEN SEARCH OF STEM BULLETING

Study 3 indicated that bulleted text interferes in some way with the normal reading process. This interference during reading in turn seems to have an effect on the representation of the text that is created during that first reading encounter, which then influences the way the document is searched in subsequent information retrieval tasks. Various possible explanations were given in the previous chapter as to the cause of the interference to both fluent reading and efficient text search. However, another possibility is that interference is exacerbated by the unnatural way the bullets were laid out in Studies 2 and 3. Despite the fact that the BBC Audience Lines do arrange some documents as long lists of bullets, this may not be the most efficient use of this type of formatting.

Another use of bullets is in collaboration with a "stem sentence". A stem sentence is a sentence that is left unformatted and unindented at the beginning of each paragraph; in all respects the same way the first sentence of a plain formatted paragraph would be presented. This stem sentence is used as an introduction to the paragraph: the bulleted items that follow can be seen as expansions on the original idea that was set up in the stem sentence. Thus the stem sentence is used in much the same way as a title or an introduction to each paragraph. For example, a paragraph taken from the experimental document used in Studies 2 and 3 and presented in plain format reads:

> Permanent cures for psoriasis are not yet possible although many people are helped by treatment. Medical treatments involve creams and ointments, which can be applied locally to the affected area. Oral treatments can also be used as a treatment for psoriasis, although they are only prescribed by, or under the supervision of, a consultant dermatologist. Phototherapy and photochemotherapy can also be used, although again this will only be used under specialist dermatological supervision and for severe resistant psoriasis. Many psoriasis sufferers find that their condition improves when exposed to sunlight and some doctors may recommend the use of artificial sunlight. Artificial sunlight should only be used if the condition is severe, as there is a possible risk of skin cancer from exposure to ultraviolet rays.

Alternatively, if this was to be presented using a stem bulleted formatting type, it would look like this:

> Permanent cures for psoriasis are not yet possible although many people are helped by treatment.
> - Medical treatments involve creams and ointments, which can be applied locally to the affected area.
> - Oral treatments can also be used as a treatment for psoriasis, although they are only prescribed by, or under the supervision of, a consultant dermatologist.
> - Phototherapy and photochemotherapy can also be used, although again this will only be used under specialist dermatological supervision and for severe resistant psoriasis.
> - Many psoriasis sufferers find that their condition improves when exposed to sunlight and some doctors may recommend the use of artificial sunlight.
> - Artificial sunlight should only be used if the condition is severe, as there is a possible risk of skin cancer from exposure to ultraviolet rays.

The stem sentence introduces the paragraph in much the same way as a title of a chapter might. In the example used above, the stem sentence gives a clear indication of the content of the rest of the paragraph; information on what treatments are available for psoriasis. Each separate bullet that follows can be thought of as an individual point that relate to the subject of treatments which was identified in the stem sentence. This type of layout uses bullets in what many would consider a more conventional way; as a list of points that all relate to one idea, with the stem sentence giving the reader information about the way each bulleted point is related to the others.

Research into schemas and schemata as far back as the early 70's indicated the importance of signalling to a reader the topic of the text they are reading. Bransford & Johnson (1972) presented a passage to participants which was very hard to interpret without knowing what schema to employ. However, if a title was given to the passage, participants had little difficulty reading and encoding the passage as a coherent piece of text. Much has been written on the importance of the macrostructure in understanding and remembering longer texts, (for example, Kintsch, 1994). Kintsch suggested that the macrostructure of text can be signalled by various means, but most importantly for this current discussion by summarising the main points of the paragraph in the first sentence. Thorndyke (1977) suggested that traditionally the theme of a passage is made explicit in an introductory sentence, so information read after this point can be understood in relation to this central theme.

Thorndyke found large impairments in comprehension and recall if participants were not given a theme with which to comprehend the passage, in much the same way as was found in the Bransford & Johnson (1972) study. This type of evidence indicates that knowing how different points relate to each other or relate to a participants' prior knowledge of the world can affect the way a document is encoded. Thus if the spatial layout of the text could inform the reader as to what the content of the passage may be, and how different points in the passage relate to each other, then an advantage would be expected over a document format that did not serve these functions. As suggested in earlier chapters, bulleting every point may lead to participants not relating individual bullet points together to form a coherent idea and therefore producing a representation lacking in semantic structure. Stem bulleting, however, may be able to overcome this.

Stem bulleting may also serve another function, in that there is a far clearer spatial or perceptual structure than can be seen in the previous form of bulleting, which will now be referred to as blanket bulleting. Intuitively, a page of blanket bulleted text seems to create much less of a memorable structure than a page of stem bulleted text (Appendixes 3 and 6 can be compared to test this point). It may be that the spatial structure of the text is more easily encoded in memory with stem bulleted text, and therefore may be easier to read and search. As discussed earlier, the work of Lovelace & Southall (1983) in which they removed all absolute spatial cues from a document demonstrated severe disruptions to the documents memorability. In taking away page demarcations from a scroll of continuous text, participants lost both their ability to remember *where* in the text information could be found and also *what* information was contained within the document. Thus, the presentation of a document can also be seen to affect encoding.

The present study replicates the previous two studies discussed in this thesis to investigate whether the same disadvantages found when blanket bulleted text was read and searched is found with this new formatting manipulation. By investigating eye movements during the reading and searching of this modified bullet format, an indication of the effect of bullets on the reading and search process can be explored. Discussions of the first two studies suggested that it may be the bullets themselves that are distracting the reader and searcher, drawing their eye to uninformative areas of the text. Observing the way stem bullets are read will help test this theory. A comparison between formats will also be made while searching unread documents. Masson (1983) proposed that people are not particularly good at selecting informative or important pieces of text while they are scanning or searching a document. It seems likely, therefore, that informative formatting, that can direct participants towards relevant or important information, would aid the searchers task. The blanket bulleted formatting used in the previous studies may be signalling that every sentence is equally important, with none being highlighted as being particularly informative. The use of stem bulleting in the present study may overcome the homogenous nature of the previous text by signalling that the first sentence of the paragraph is more important that any of the other sentences in the paragraph, and so decisions as to the content of a paragraph can be made though considering these sentences only.

There are, therefore a number of different issues to be investigated. The main questions addressed by this study are the following:

1. Is there a difference to the pattern of results found in earlier studies when blanket bulleted text is replaced with stem bulleted text?
2. When directly compared, are the search latencies in response to the question answering task of a similar duration for both paper and computer screen search?
3. What difference is there to the pattern of results when the participant is not allowed to pre-read the document?
4. Do the previously found formatting differences generalise over a number of different materials?

To investigate these points, a number of different tasks were used on the same participants. Many of the tasks replicate those of Studies 2 & 3, substituting stem bullet for blanket bullet formatting. By altering the presentation of the bulleted format, the suggestion that it is the bullets themselves that are distracting readers can be explored. We also gave participants an identical task during the reading and search of a paper document and a computer screen, in order to compare these two mediums directly. As was discussed in Chapter 5, there is substantial evidence to support the conclusion that there is a disadvantage to a number of tasks including reading, proof-reading and searching when they are conducted from a computer monitor. From this evidence it is expected that a disadvantage for computer screen would be expected during both reading and text search. The previous studies in this thesis have also all supported the importance of formatting during an initial reading encounter, but do not seem to indicate any difference between formats when their search times are compared directly. This study will investigate this difference directly, by giving participants an unread document to search. Finally, a number of different materials will be used (6 per participant) in order to investigate whether the formatting effects generalise over a number of documents.

6.2. METHOD

6.2.1. Materials and Design

Six materials were prepared. These were on the subjects of: adoption, asthma, the financial consequences of divorce, homelessness, how to organise protests and campaigns, and tinnitus. Again, each of these documents were based on material produced for use within the BBC Audience Lines. Each document was prepared in both plain format, and the new modified bulleted format, "stem bulleting" as discussed earlier. These documents were prepared for both paper presentation and presentation on a computer screen. See Appendix 6 & 7 for samples of these documents, in both formats.

These new documents were shorter than the previously used document, with an average of 792 words per document (range 773 to 816 words), 157 words per page (range 108 to 203 words). Each took up 5 pages of screen or paper and consisted of ten paragraphs. The documents were chosen in an attempt to cover some of the different competencies that are covered in the BBC Audience Lines; finance, health, social action and general information.

When prepared, each page of the document started at the same point at the top left hand corner of the page/screen. Each page contained exactly the same information for both formats, including all punctuation marks.

Twenty questions were prepared for each of the documents (see Appendix 8). The questions prepared were all based on the experimental text. Every question had a corresponding answer within the text, which could be answered in a single word or a short phrase. The wording of the sentence in the text which contained the answer was used to phrase the question where possible.

During each encounter with the material, the participant was asked all twenty questions. Their task was to indicate whether the answer to the question they were asked by the experimenter was on the page of text in front of them or not. Ten of the answers required an answer of "yes", ten "no". The same "yes" "no" combinations of answers were used each time the same material was used.

6.2.2. Experiment

Three different tasks were used.

6.2.2.1. Task 1

The first task was a variation of Study 3, in which the experimental participants first read and then searched a document on a computer screen. Participants were presented with one of the six documents laid out in one of the two formats. Their task was to simply read the text as carefully as possible and to advanced to the next page at their own pace. After this initial reading experience, they were then asked questions relating to the text. Once the question was asked, a page from the text, presented in the same format, was displayed on the computer screen. The participant's task was to answer as quickly and as accurately as possible whether the answer to that question was located on the page in front of them or not. This was accomplished by pressing one of two assigned keys on the keyboard. Their responses, response times, and a record of their eye movements were monitored during both the reading and the search tasks.

6.2.2.2. Task 2

The second task was a variation on Study 2. Participants read a document prepared in the form of a paper booklet in their own time and stopped the millisecond timer when they finished reading the document. They were then given a booklet containing pages from the document, with each page separated by a filler page which indicated the trial number (see Appendix 9 for examples). Participants were asked questions in a similar fashion to Task 1. They sat with the appropriate filler page in front of them (equivalent to the fixation cross in Task 1), and were then asked a question relating to the text. At the end of the question the experimenter started the millisecond timer, which was the participant's cue to turn the page. Their task was to indicate as quickly and as accurately as possible whether the answer to the question was located on the page they had in front of them or not. When they had an answer they responded by hitting the millisecond timer's response button which was in their hand, and simultaneously calling out their answer ("yes" or "no"). The time and answer was logged by the experimenter. The participant then turned to the next filler page.

6.2.2.3. Task 3

The third task was similar to Task 1. In this task, however, the participants did not read the document first. The pages that were presented on screen were new to the participant, although they were still pages taken from a coherent document on a single subject area. Their task was again to indicate whether the answer to the question asked by the experimenter was present or not. Latencies, responses and eye movements were again monitored.

These three different experiments were always presented to participants in the same order: Task 1 (the reading then searching experiment) was always first; the paper experiment (Task 2) was always in the middle to break up the eye tracking work; and the search of an unread text (Task 3) was presented last after the participant was very familiar with the task. Each task was presented twice, once for each format, using a different material each time. Participants only searched one format per material.

Corneal eye fixations were again monitored using the SMI Eyelink head mounted eye tracker for Tasks One and Three. In most cases binocular fixations were recorded, although only right eye fixations were analysed.

6.2.3. Participants

Twenty-four Glasgow University undergraduates voluntarily participated in the study. All of the participants were native English speakers with uncorrected vision. They were paid for their participation in the experiment. There were 11 male and 13 female participants. All were between the ages of 18 and 26. Participants who responded incorrectly on more than 5 questions in any one trial (i.e. 25%) were eliminated from the experiment, and replaced by another participant. This occurred on 6 occasions.

6.2.4. Procedure

Participants took part in individual experimental sessions. These were split into two one hour sessions. The first hour consisted of both trials from Task 1, and one trial from Task 2. The remaining trials were completed in the second experimental session. This was never more than 4 days later, and never less than a day. The order of the format within each trial was randomised, resulting in each material and each type of format being read and searched equally often in the six conditions through the appropriate counterbalancing. Consequently, no material differences existed across the main experimental contrasts (see Table 16).

TASK	PARTICIPANT	MATERIAL	FORMAT
1	1	Adoption	bullet
1	1	Asthma	plain
2	1	Divorce	plain
2	1	Homelessness	bullet
3	1	Protests and Campaigns	plain
3	1	Tinnitus	bullet
1	2	Homelessness	plain
1	2	Adoption	bullet
2	2	Tinnitus	bullet
2	2	Protests and Campaigns	plain
3	2	Asthma	bullet
3	2	Divorce	plain

Table 16: An example of the test format for two participants.

Participants first read an introduction to the experiment, (Appendix 10), which described it as a reading experiment, and gave a rough outline of the format and listed the issues they would be reading about. The participants were asked to indicate if any of the subject matters were particularly salient to them. Participants who had particular indepth knowledge of any of the topic areas, or found any of the areas particularly emotive were removed from the study. In practice, this only involved removing one participant who worked for a Homeless charity, and who disagreed with the slant of the document on Homelessness. The accuracy and speed required during the experiment was stressed at this stage. It was made clear to the participants that any incorrect answers were unusable, and therefore to be avoided at all costs, but that speed was very important.

The participants were then set up on the eye tracker. They were calibrated, and allowed to proceed only when the calibration was "good". They then were allowed to practice searching and answering using a practice document ("Becoming a Writer"), which was formatted in the same way as their first Task 1 document. Once participants were clear about what the test consisted of, they were re-calibrated.

The test consisted of the participants reading the test document in their own time, advancing onto the next page by pressing the space bar. They were instructed to read the document carefully, because they would be tested on it later, but not to reread any of the text. A re-calibration was conducted after the document was read. Participants were then asked questions on the text. Once the experimenter had finished asking the question, they pressed the appropriate key to present a page of text to the participant. The participant then had to indicate whether the answer to this question was present or not. Reading and response times were measured, along with eye movement events. Participants were given 10 questions before the next re-calibration, and then a further 10 questions before the end of the trial.

Before each subsequent Material/Format participants were given the opportunity to practice with the neutral document presented in the same formats as the subsequent task document. This gave them the chance to see the new format and refresh themselves as to the task.

Task 3 proceeded in an identical manner to this, except the participant was not given the opportunity to pre-read the document. Task 2 involved the use of a prepared booklet. Participants first read the document, printed with the same number of words on a page, and number of pages as in the computer presentation. A millisecond timer was started when the participant turned over the first page. The participant stopped the timer when they had completed reading the document. A second booklet was then given to the participant. This had filler pages that stated the question number. The experimenter asked a question, and then started the millisecond timer. This was the participants cue to turn over the page and search for the answer to the experimenter's question. When they felt they had an answer (either "yes, the answer is on the page" or "no, the answer is not on the page"), they pressed the millisecond timer in their hand, and called out the appropriate answer ("yes" or "no"). As soon as they had responded, they were instructed to turn the page onto the next filler page. The experimenter logged the time and the answer, re-set the timer then asked the next question. The booklets were prepared so that there were two booklets of ten question for each document.

6.2.5. Analysis

The three task were initially analysed as three separate experiments to explore the effect of the formatting under the three task conditions.

Reading times were analysed using paired sample t-tests, comparing the reading times for each participant while they read plain and bulleted text. A similar analysis was also conducted using the number of words read per minute as the measure of reading speed. Global eye movement measures of reading were also analysed using paired sample t-tests, with the format read analysed as a within-subject measure. The measures investigated were:

- mean number of fixations;
- mean fixation duration;
- mean saccade length (an analysis was also conducted into the mean saccade length of forward saccades, and the mean saccade length of right to left saccades);
- mean number of left to right saccades;
- mean number of right to left saccades;
- the proportion of forward and regressive saccades made.

The distribution of saccade lengths were also compared between the two formats. These were analysed using a One-Way ANOVA, as in Study 3.

Search response times were analysed using a 2 (format: bullet or plain, within subjects), x2 (answer: yes or no, within subjects) ANOVA. Global eye movement measures were also submitted to this analysis. The measures investigated were:

- mean saccade length;
- mean number of fixations;
- mean fixation duration.

However, many of these measures, when used to explain search patterns, are vague and difficult to decipher because of the high degree of variability in the measures, and the difficulty of understanding what is motivating the direction and length of any saccade and the duration of any fixation. Therefore, in order to obtain an insight into the actual patterns that occur during a search of the text, a number of alternative analyses were conducted. These consisted of paired-sample t-tests to investigate:

- the number of fixations made on the page before the target sentence was fixated. The target sentence is defined as the sentence or phrase which contains the answer to the experimenter's question. An area to the bottom of the line above and to the top of the line below the target sentence was used, to account for any error in the eye tracking measures.
- the number of fixations made on the target sentence;

In order to investigate whether it was the stem sentence per se that was causing any differences in search times between plain and stem bulleted text, two analyses were conducted.

- the number of fixations made on the stem/first sentence was looked into. If the participant had fixated the stem sentence, the mean number of fixations was taken for both the "yes" responses, and the "no" responses and submitted to the 2 x 2 ANOVA detailed above.

Finally, analyses were conducted to compare the three different tasks. First the response times for Tasks 1, 2 and 3 were submitted to a 3 (task: Task1, Task 2 or Task 3, within subjects), x 2 (format: plain or bullet, within subjects), x 2 (answer: yes or no, within subjects) ANOVA. This analysis (omitting Task 2) was also conducted on the fixation durations, the number of fixations and the average saccade length.

Erroneous responses were removed and replaced by subject and series means.

- 87 responses were removed from Task 1, making up 9.06% of the total responses.
- 80 responses were removed from Task 2 making up 8.33% of the total responses.
- 61 responses were removed from Task 3 making up 6.63% of the total responses.

The pattern of errors were analysed again using a 2 (format, within subjects) x 2 (answer, within subjects) ANOVA for each of the three individual tasks, and a 3x2x2 ANOVA for joint analyses.

6.3. RESULTS

6.3.1. TASK ONE: Pre-Reading a Document on Screen

6.3.1.1. READING DATA

Reading data was analysed using paired sample t-tests for each of the dependent variables: reading latency, fixation duration, number of fixations and saccade length.

6.3.1.1.1. Reading Time

No difference was found between the two formats when the logs of the time it took participants to read the document were compared, t(23)=0.469, p=0.644. The antilogs are 214.6 seconds for plain text and 211.1 seconds for stem bulleted text. There was also no difference between the formats when the number of words read per minute was measured, t(23)=0.551, p=0.587. The average number of words read per minute is 234 for plain text and 238 for stem bullet formatted text, standard deviations are 59.3 and 61.9 msec respectively.

6.3.1.1.2. Fixation Duration

There were no differences between the two formats in the average fixation durations obtained while reading the documents, t(23)=-0.778, p=0.444. The average fixation duration for stem bulleted text was 215 msec and the average for plain text was 217 msec. The standard deviations are 25.6 and 26.0 msec respectively.

6.3.1.1.3. Number of Fixations

Log transformations were used. Again, no significant results were found for the number of fixations used to read the document, t(23)=-1.120, p=0.274. The average number of fixations are 139.1 for stem bulleted text (SD=47.4),and 146.2 for plain text (SD=49.0).

6.3.1.1.4. Saccade Length

Differences were found between the two formats when the average saccade length was compared, $t(23)=5.245$, $p<0.05$. Average saccade lengths are 82.7 pixels long for stem bulleted text, (≅12.2 characters), and 90.4 pixels long for plain text, (13.3 characters). However, the variation in saccade lengths is great, (the standard deviations are 11.6 and 14.2 pixels for stem bulleted and plain text respectively). It may be that differences between the two formats are an artefact of the different line lengths, as in Study 3. Therefore, saccades were divided into those made in a forward direction (left to right) and those made in a backward direction (right to left, which will include all return sweeps and regressions). These forward and regressive saccades were compared between the two formats, to see if there were any differences in the average saccade lengths in each of these situation.

Forward saccade lengths revealed no significant differences between the two formats, $t(23)=-1.036$, $p=0.311$. However, when the backward saccades were analysed (right to left saccades), a significant difference was found, $t(23)=-4.539$, $p<0.05$. The average right to left saccade length is 128 pixels (≅18.8 characters) for bulleted text, and 146 pixels (≅21.4 characters) for plain, unformatted text.

6.3.1.1.5. Distribution of Saccade Lengths

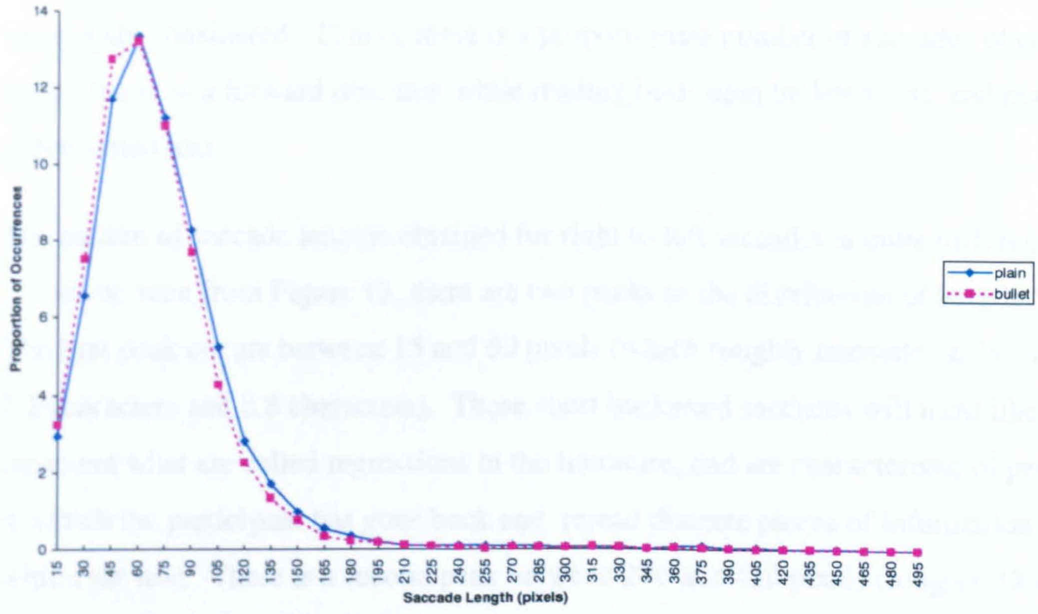

Figure 12: Saccade length distribution for forward saccades made during reading. No difference can be seen between the two formats in the proportion of saccades of each length made during reading.

The distribution of saccade lengths were compared using a One-Way ANOVA with one between subjects factor, format read. These are illustrated in Figure 12 and Figure 13.

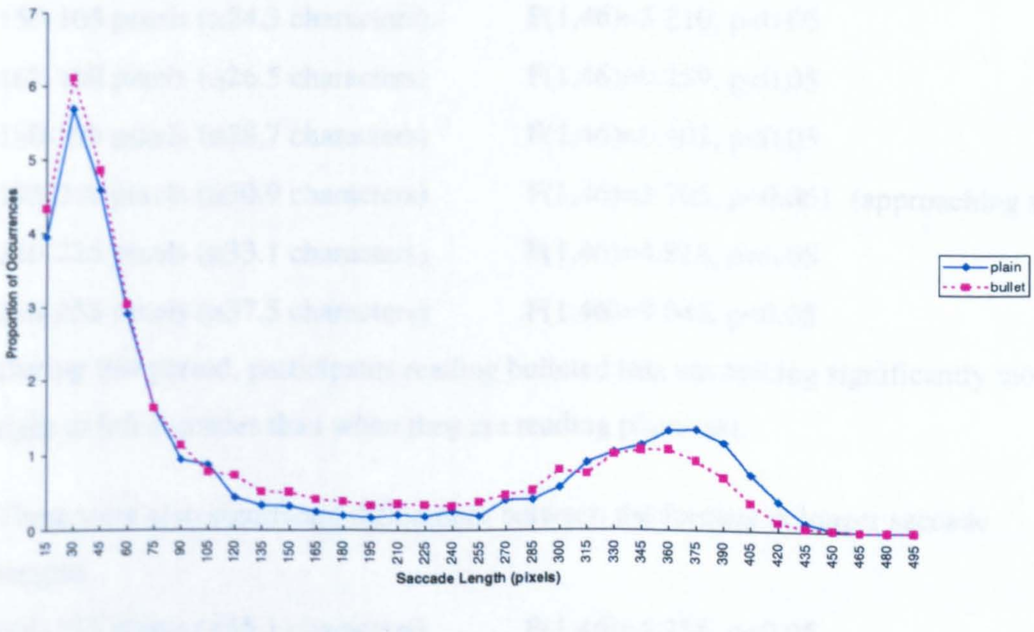

Figure 13: Saccade length distribution for regressive saccades made during reading. Differences can be seen between the formats at a number of different points. Bulleted formatting results in proportionately more medium length saccades, whereas plain formatted text results in proportionately more long saccades.

There was no difference between the two types of format when forward saccades were again considered. That is, there is a proportionate number of saccades of each length made in a forward direction while reading both stem bulleted text, and plain, unformatted text.

The pattern of saccade lengths obtained for right to left saccades is quite different. As can be seen from Figure 13, there are two peaks to the distribution of lengths. The first peak occurs between 15 and 60 pixels (which roughly translates as between 2.2 characters and 8.8 characters). These short backward saccades will most likely represent what are called regressions in the literature, and are characteristic of periods in which the participant has gone back and reread discrete pieces of information within the text. There is a second peak between 270 and 420 pixels (roughly 39.4 to 61.8 characters). This most likely represents the return sweep that is made at the end of the line.

Differences were found between the two formats at the following saccade lengths:

105-120 pixels (≅17.6 characters)	$F(1,46)=8.541$, $p<0.05$
120-135 pixels (≅19.8 characters)	$F(1,46)=4.888$, $p<0.05$
135-150 pixels (≅22.0 characters)	$F(1,46)=4.569$, $p<0.05$
150-165 pixels (≅24.3 characters)	$F(1,46)=5.210$, $p<0.05$
165-180 pixels (≅26.5 characters)	$F(1,46)=9.259$, $p<0.05$
180-195 pixels (≅28.7 characters)	$F(1,46)=6.402$, $p<0.05$
195-210 pixels (≅30.9 characters)	$F(1,46)=3.705$, $p=0.061$ (approaching sig)
210-225 pixels (≅33.1 characters)	$F(1,46)=4.818$, $p<0.05$
240-255 pixels (≅37.5 characters)	$F(1,46)=9.045$, $p<0.05$

During this period, participants reading bulleted text are making significantly more right to left saccades than when they are reading plain text.

There were also significant differences between the formats at longer saccade lengths.

360-375 pixels (≅55.1 characters)	$F(1,46)=4.258$, $p<0.05$
375-390 pixels (≅57.4 characters)	$F(1,46)=4.952$, $p<0.05$
390-405 pixels (≅59.6 characters)	$F(1,46)=4.349$, $p<0.05$

405-420 pixels ($\cong$61.8 characters) $F(1,46)=6.846$, $p<0.05$

Among these saccade lengths, plain text has proportionally more right to left saccades than bulleted text. It can safely be assumed that this is due to plain text resulting in more full return sweeps, as there are proportionally more complete lines than in the bulleted presentation.

A final way of examining the differences in the number of saccades between the two formats is to compare the number of forward and regressive saccades made during reading for both plain and bulleted text. A t-test revealed that there was, in fact, a different number of regressive saccades made when reading the two different formats, ($t(23)=-4.539$, $p<0.05$). However, this difference is small; the number of saccades per document are 249 and 252 saccades for bulleted and plain text respectively.

6.3.1.2. DISCUSSION: TASK 1 - READING

The reading latencies and eye movement behaviour of participants reading each of the two formats revealed no differences between plain and stem bullet formatted text. Reading latencies, the number of words read per minute, the number of fixations made per page and the average fixation duration remained comparable across the formatting manipulations. Participants seem to be reading both the stem bulleted format and the plain format in a similar manner. This may support the conclusions made in the previous chapter that formatting can affect the coherence of a passage. Coherence lost through the blanket bulleting of text may be replaced through the use of stem bulleted text, therefore making the passage easier to comprehend and therefore easier to read. The richness of the resulting representation held in memory of the text will be explored through the analysis of the search task.

The only reading measure difference between the two formats was in the saccade length. However, as in the previous experiment (Study 3) this seems to be an artefact of the layout of bulleted text. There was a greater number of longer regressive saccades made when the participant was reading plain formatted text. When the participant read stem bulleted text, there were fewer long saccades and more middle length regressive saccades, representing the larger proportion of return sweeps that were made from the middle as opposed to the end of the line. There were also more regressive saccades made in general when the participant was reading stem bulleted text. However, again this is most likely to be an artefact of stem bulleting consisting of more lines of text per page, and therefore requiring more return sweeps. If we look at the proportion of saccade lengths around the range for normal reading, excluding return sweeps, (1 to 15 characters, which translates as between 6.8 and 102.0 pixels) then we can see that there is little difference in the proportion of saccades of each length made.

If we consider fixation durations, it is interesting to note that the average fixation durations during reading found in this present study (215 msec for stem bulleted text and 217 msec for plain text) are almost equivalent to the average fixation durations found during the reading of plain text in Study 3 (217 msec), which seems to suggest that the level of difficulty and the fluency of reading between these two experiments are equivalent. What is very clear in this present analysis is that stem bulleting does not impede text search in the way blanket bulleting did in Study 3. Thus the disruption to the reading process cannot be the result of the bullets themselves distracting the reader or altering the way the text is read.

6.3.1.3. SEARCHING DATA

Search data was analysed using a 2 (format read: plain or bulleted, within subjects), x 2 (answer: yes or no, within subjects) ANOVA for both response latency and all eye movement measures.

6.3.1.3.1. Search Times

Response times were submitted to a logarithmic transformation to minimise the skew of the data. There was a significant main effect for format, $F(1,23)=6.919$, $p<0.05$, with plain, unformatted text resulting in longer search times than stem bulleted text, Table 17.

The length of time it took participants to make a response also revealed a significant effect for whether the answer was "yes, the answer is on the page", or "no, the answer is not on the page", $F(1,23)=45.404$, $p<0.05$. When the answer is present on the page, participants are much faster at responding compared to when the answer is not present on the page, Table 17. There were no interactions, $F(1,23)=0.003$, $p=0.956$.

	STEM	PLAIN	average
yes	2933	3593	3263
no	3922	4826	4374
average	3428	4210	

Table 17: The antilogs of the average response times. Stem bulleted formatting resulted in faster response times that the plain formatted document. Participants were also far faster responding "yes, the answer is on the page", than, "no, the answer is not on the page".

6.3.1.3.2. Fixation Duration

During the search process, the average fixation duration was significantly shorter when participants were searching stem bulleted text, $F(1,23)=5.894$, $p<0.05$. The values are 189 msec and 193 msec respectively. There was no significant difference between formats for answer, $F(1,23)=0.076$, $p=0.785$, or for the format x answer interaction, $F(1,23)=0.009$, $p=0.927$.

6.3.1.3.3. Number of Fixations

An analysis of the number of fixations it took to respond also revealed a significant main effect for format searched, $F(1,23)=4.3$, $p<0.05$. Stem bulleted text had an average of 17 fixations, plain text, 20. There was also a main effect for answer, $F(1,23)=8.724$, $p<0.05$. "Yes" answers took significantly less fixation (17) than "no" answers, (20). There was no significant interactions, $F(1,23)=0.004$, $p=0.951$.

Because of the strong relationship between fixations and reading times, with fixations accounting for the majority of the time taken to read the document, the pattern of search times would be expected to be repeated in the number of fixations made on the page.

6.3.1.3.4. Saccade Length

There was a difference between the two formats in their average saccade length which is approaching significance, $F(1,23)=3.207$, $p=0.086$. Stem bulleted text results in slightly shorter saccades when searching (98 vs 101 pixels). However, this is less than a characters in length. (1 character = roughly 6.8 pixels). Both the analysis for answer ($F(1,23)=0.751$, $p=0.395$) and for the interaction ($F(1,23)=0.057$, $p=0.813$) failed to reach significance.

6.3.1.3.5. Target Sentence Analyses

Paired sample t-test were conducted on the search fixations; that is the number of fixations made before the target sentence was fixated and the number of fixations made on the target sentence. However, this failed to reach significance for both analyses, ($t(23)=1.69$, $p=0.105$, $t(23)=0.821$, $p=0.421$).

6.3.1.3.6. Stem Sentence Analyses

When the average number of fixations made on the stem sentences were compared using the same ANOVA as discussed above, there was again no difference between the two formats, $F(1,23)=0.803$, $p=0.379$. The difference between the two answer types is marginal, $F(1,23)=3.068$, $p=0.093$. "Yes" responses result in a fewer number of fixations being made on the stem sentence before a response is made. The average number of fixations made in each case can be seen in Table 18.

	STEM	PLAIN	average
Yes	4.17	4.66	4.41
no	4.80	5.19	4.99
average	4.48	4.92	

Table 18: The average number of fixations made on the stem or introductory sentence of each paragraph.

There was no interaction, F(1,23)=0.008, p=0.932.

6.3.1.4. DISCUSSION: TASK 1 - SEARCHING

The representation created in memory for each of the formats was tested by the question answering task to investigate whether either of the formats resulted in a greater transfer of information to facilitate text search. The response times indicated converse results to previous studies: whereas blanket bulleting hindered both reading and text search in Studies 2 & 3, in this study the stem bulleting resulted in no difference in reading measures, and an advantage in search times.

A possible explanation for the response latency advantage associated with stem bulleted text is that the stem sentence itself provides the searcher with all the information required in order to make the appropriate yes/no decision. However, an analysis of the likelihood of fixating either the stem sentence or the first sentence in the paragraph indicated that there was no difference between the two formats. It therefore seems not to be the case that participants use the stem sentence more than the first sentence in a paragraph under more conventional formatting manipulations.

The analysis conducted on the search patterns also revealed no difference between the two formats. Because of the seemingly random nature of the search process, it is difficult to quantify what is happening during the search of the text. However, it can be seen that participants seem to reach the target sentence (that is the sentence containing the answer to the experimenter's question) in an equal number of fixations when searching both stem bulleted and plain formatted text. There are also a comparable number of fixations made on the target sentence with each format, and an equal likelihood of fixating the target sentence with either format. Thus the only quantifiable difference between the two formats is that participants can make a yes/no decision about stem bulleted text faster than with plain formatted text.

In summary, Task 1 demonstrated there is an advantage for stem bulleted text that is not related to an increased encoding time, and seems not to relate to how the document is being searched, certainly not in the use of the stem-sentence. It therefore seems that there is information attained from reading this type of bulleting, while not increasing the reading latencies, can facilitate text search to a greater degree than if the original document read was plain formatted text.

6.3.2. TASK TWO: Paper Reading and Search Task

Task 2 was analysed in the same way as Task 1. In this case there were no eye movement measures to analyse.

6.3.2.1.1. Reading Times

No difference was found between the two formats when the time it took to read the documents was compared, $t(22)=0.630$, $p=0.53$. The average total reading times for each of the two formats is 198.5 seconds for stem bulleted text (SD=52.4), and 201.8 seconds for plain formatted text (SD=50.1).

6.3.2.1.2. Search Times

There was a significant main effect for format when the logs of each of the formats were compared ($F(1,22)=5.301$, $p<0.05$). The average response times were 3,935 msec for stem bulleted text, and 4,506 msec for plain text (antilogs). There was also an answer effect, $F(1,22)=27.311$, $p<0.05$. Again "yes" answers resulted in much faster response times than "no" answers, the response times are 3,790 msec and 4,486 msec respectively (antilogs). There was no interaction, $F(1,22)=0.013$, $p=0.910$.

6.3.2.3. DISCUSSION - TASK 2

Task 2 revealed very similar results to Task 1. There was no difference between the two formats in the time it took to read the documents. The search latencies also revealed similar results to the computer search task: participants were faster searching the stem bulleted format by on average 500 msec. An advantage was also seen for participants searching for answers that were located on the page they were searching.

These results support the conclusion discussed in Chapter 5, that the advantages seen for the experimental formatting manipulations replicate across the two mediums tested. Despite a different formatting manipulation being used in this present study, the pattern of results again replicated. With both mediums, there is a search latency advantage for stem bulleted text, despite equivalent encoding times across the two formats.

6.3.3. TASK THREE: Searching an Unread Text

Task 3 was analysed in the same manner as the search data for Tasks 1 and 2.

6.3.3.1.1. Search Times

An ANOVA of the logs of the search times in Task 3 revealed a strong response time difference between the positive "yes" answers, and the negative "no" answers ($F(1,23)=61.371$, $p<0.05$). Participants answered the "yes" question much faster than the "no" questions. Average response latencies were 3,928 msec and 5,833 msec (antologs).

There was no statistical difference between the two formats, $F(1,23)=0.449$, $p=0.509$. However, the format x answer interaction was close to significance, $F(1,23)=4.009$, $p=0.057$. The "yes" responses resulted in plain text having a slight advantage over the stem bulleted format. However, when the answer is not on the page, the pattern seems to be reversed, with stem formatted text having a response time advantage, see Table 19.

	STEM	PLAIN	average
yes	4289	3938	4113
no	6077	6235	6156
average	5183	5087	

Table 19: Response times to both positive and negative questions (antilogs). Pain and stem bullet formatted text seem to facilitate text search differently depending on what type of search is required.

6.3.3.1.2. Fixation Durations

There is a significant main effect for format, $F(1,23)=5.730$, $p<0.05$. Bulleted text resulted in a longer average fixation duration than did the plain formatted text, (192 msec and 188 msec respectively). There is also a significant difference between the two different answers with respect to fixation duration, $F(1,23)=11.997$, $p<0.05$. "Yes" responses result in an average fixation duration of 188msec, "no" responses 192msec. The interaction was non-significant, $F(1,23)=0.723$, $p=0.404$.

6.3.3.1.3. Number of Fixations

There is a significant difference between the two response types with respect to the average number of fixations that occurred before making a response. $F(1,23)=39.485$, $p<0.05$. "Yes" resulted in an average of 18 fixations per page, "no" resulted in 26 fixations per page.

There is also an interaction between what format was read, and what answer was required, $F(1,23)=9.428$, $p<0.05$, this can be seen in Table 20.

Answer \ Format	STEM	PLAIN
Yes	18	17
No	26	27

Table 20: The average number of fixations made while searching each format

Again this reflects the same pattern of results seen in the response time analysis. Participants seem to be able to locate answers to the question with more ease when they are searching plain formatted text. However, when the answer is not on the page, participants seem to be able to search stem bullet formatted text faster.

6.3.3.1.4. Saccade Length

There was a main effect for format in relation to saccade length ($F(1,23)=8.497$, $p<0.05$). The average saccade lengths were 101 pixels for stem bulleted text (≅14.9 characters), and 106 pixels for plain text (≅15.6 characters). The difference between answers was non significant, $F(1,23)=0.573$, $p=0.457$, as was the interaction, $F(1,23)=1.360$, $p=0.255$.

6.3.3.2. DISCUSSION: TASK 3

Studies 2 & 3 revealed no difference between formats when their search latencies were compared directly, and the format in which they were initially read was disregarded. From this, it was concluded that it is not the participant's direct interaction with the format that accounts for differences in response latencies, but the information that is encoded as a result of reading the specifically formatted documents. Task 3 in the present study supports these conclusions. No significant difference can be seen between the formats when participants search a page that they are not already familiar with. The fact that the interaction between format and answer is close to significance suggests that participants are more able to locate a correct answer in plain formatted text, rather than stem bullet formatted text if the answer is on the page. However, if the answer is not located on the page, participants seem to be at an advantage if they are searching stem bulleted text. The marginal nature of these results make it difficult to make conclusive statements about them, but does seem to suggest that depending on the length of time a document will be searched for could influence the appropriate format to use to present that document.

The difference between the two formats with respect to fixation duration may be thought of as relating to the depth of processing that is occurring during the search of each of the two formats. Rayner & Fischer (1996) found that fixation durations during text search are far shorter than fixation durations during reading, as discussed in Chapter 5. Participants therefore may be scanning stem bulleted text in more depth than plain formatted text, or are involved in more reading-like behaviour. Therefore, the borderline advantage for stem bulleted formatting during exhaustive searches of the text may relate to the fact that participants are engaging in different types of search strategies. However, the difference between the two formats in search latencies and eye movement measures are small, leading to the general conclusion that there is very little difference between formats in the way that they are searched.

A possible explanation for the lack of difference between the formats during directly tested search tasks may relate to the participants' understanding of what the format they are searching does[3]. As we acquire the skill of reading, we also require a number of related skills and knowledge at the same time. Many of these cannot be stated overtly, and can be better understood if we think of them as conventions that we understand and adhere to which were assimilated along with our ability to read. Examples of these conventions are the placing of capital letters at the beginning of sentences or on proper nouns. In earlier studies in describing stem bullet formatting, I discussed what function it was meant to perform: the stem sentence summarises and introduces the paragraph of bullets that follow it. However, if this function of stem bulleted formatting is unknown to the reader, then they may not be able to attain full advantage from it, especially during the search of unfamiliar documents.

In order to investigate whether participants were simply unaware of the conventions associated with stem bullet formatting, a pilot was conducted which overtly stated the purpose of this type of formatting. This replicated Task 3 in every way, except more elaborate instructions were given to participants before commencing the study which described the formatting type and what function it served. The stem bulleted description stated the important summary qualities of the stem sentence itself. The results of this pilot, however, again revealed no difference between the formats searched. This suggests that it is not purely a lack of experience with the formatting type or lack of awareness of its purpose that is causing parallel results between formats.

In summary, as discussed in the earlier studies in this thesis, there is little difference between formats when their search latencies are directly tested. Participants seems equally able to search both formats, although there may be an advantage for the plain format when the answer is located on the page and stem bulleted format when the answer is not present. The reason for stem bulleted text failing to produce a search advantage has been shown not to be attributable to participants not knowing what the benefit the formatting technique is meant to give. We can therefore be confident that the advantages found in the other two task, and in the earlier studies are not the result of participants' direct interaction with the document, but are the result of the representation formed of the text during the initial reading encounter.

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[3] Thanks to Dr S. Draper for this suggestion.

6.3.4. JOINT ANALYSIS (Tasks 1, 2 & 3)

An analysis was conducted to determine whether there were any interactions between the three tasks. This was conducted using a 3 (which task was used: 1, 2 or 3, within subjects) x 2 (which format was used: plain or bulleted, within subjects) x 2 (which answer was given: yes or no, within subjects) ANOVA for each of the latency measures. For eye movement measures this was a 2 x 2 x 2 ANOVA because data was only available for Tasks 1 and 3.

6.3.4.1. Reading Data

The average reading times for the two formats was compared between Task 1, in which the participant read the document from a computer screen, and Task 2, in which the participant read the document on paper, see Table 21. This resulted in a 2 (task 1 or task 2: within subjects) x 2 (format, plain or bullet, within subjects) ANOVA.

	Computer	**Paper**
Stem	215.2	198.6
Plain	219.6	201.8
Average	108.7	100

Table 21: The average reading times for plain and stem bulleted text when the document is read on either a computer screen or in the form of a paper booklet (measured in seconds). Participants are faster reading a document when it is presented on paper rather than on a computer screen.

A significant effect was found for whether the documents were read on paper or read on a computer screen, $F(1,22)=10.964$, $p<0.05$. Participants were faster reading a document if it was presented on paper rather than on a computer screen. Participants were on average roughly 17 seconds slower when they read from a screen.

6.3.4.2. Searching data

6.3.4.2.1. Response Times

Log transformations were made on the response latencies for the question answering trials for all three of the tasks. A 3 x 2 x 2 ANOVA was conducted on the response latencies, (Factor 1 relates to which of the three Tasks is being conducted, Factor 2 relates to which of the formats is being searched, and Factors 3 is the answer of the experimenter's question, yes or no). Each factor was a within-subjects variable. The results obtained are presented in Table 22.

	Degrees of freedom	F	significance
Task	2	13.075	<0.05
Format	1	118.747	<0.05
Answer	1	6.321	<0.05
Task x Format	2	7.177	<0.05
Task x Answer	2	4.982	<0.05
Format x Answer	1	1.102	0.490
Task x Format x Answer	2	0.829	0.310

Table 22: The significance of all response time analyses.

A comparison of the response times for the three studies revealed a main effect for which of the three tasks the participant was responding to, $F(2,46)=13.075$, $p<0.05$. Participants searched the text fastest when they had previously read the document, regardless of whether this was on paper or on a computer screen. Both these searches were significantly faster than if the document had not been read before it was searched. The average response times (antilogs) can be seen in Figure 14.

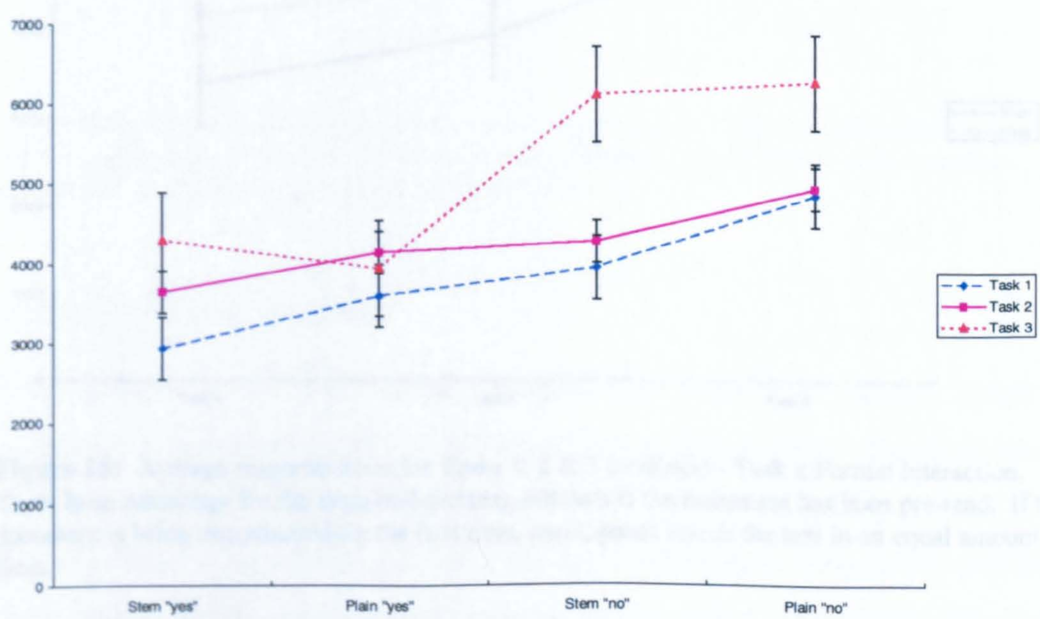

Figure 14: Response times for each of the three tasks (antilogs). Participants were faster searching the document if they had first read it (Tasks 1 & 2). There was no significant difference between the search times when a participant was searching the document on paper or on a screen, as long as the document has first been read. Participants were also consistently faster making "yes" responses.

There was also a main effect for answer. “Yes” questions were answered significantly faster than “no” questions for all three of the tasks, $F(1,23)=118.747$, $p<0.05$. The average response times are 3,732 msec and 4,977 msec respectively (antilogs). This is most striking in the case of Task 3, in which “yes” and “no” responses differ by an average of 2.042 msec. This difference strongly illustrates the advantage brought to exhaustive searches during Tasks 1 & 2 from pre-reading the document. The difference between pre-reading and not pre-reading on a computer screen is an average of 850 msec for “yes”, self terminating searches, and an average of 1,782 for “no”, exhaustive searches. Thus the difficulty associated with a lack of familiarity with a document can most clearly be seen during exhaustive searches.

There was a task x format interaction, $P(2,46)=7.177$, $p<0.05$. This is illustrated in Figure 15. This simply demonstrates what was shown in the individual analyses. There is a significant difference between the two formats when a document has been pre-read. However, when the participant does not have the opportunity to first read the document, there is no formatting effect.

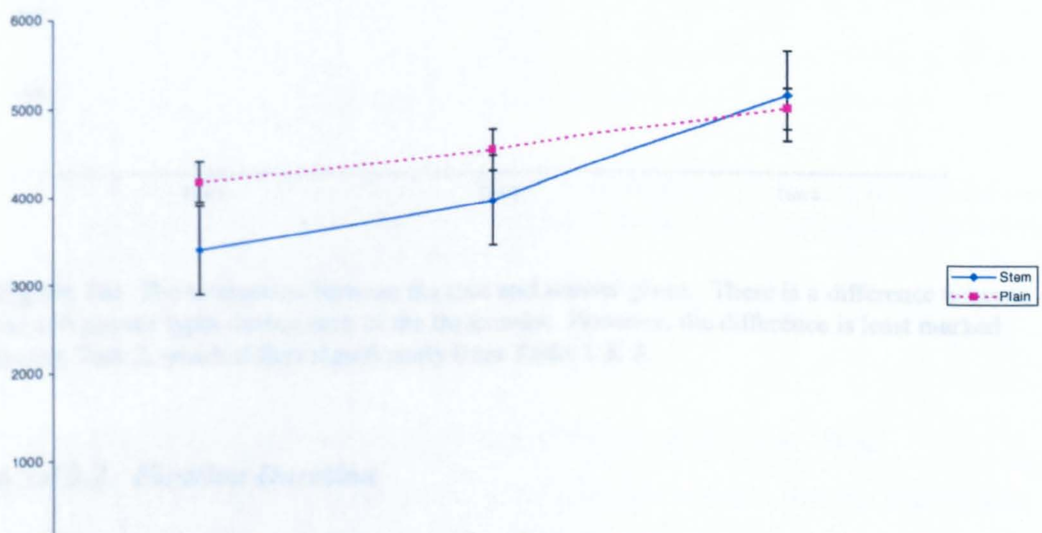

Figure 15: Average response times for Tasks 1, 2 & 3 (antilogs) - Task x Format interaction. There is an advantage for the stem bulleted text, but only if the document has been pre-read. If the document is being encountered for the first time, participants search the text in an equal amount of time.

There is also an interaction between the task and the answer given, $F(2,46)=6.961$, $p<0.05$. This illustrates the strength of the answer effect is not consistent across the three manipulations of the task. A series of paired comparisons revealed that there is a significant task x answer interaction between Task 1 and Task 2, $F(1,23)=4.545$, $p<0.05$, and between Task 2 and Task 3, $F(1,23)=14.270$, $p<0.05$. There is no significant difference between Task 1 and Task 3, $F(1,23)=2.754$, $p=0.111$. Thus, although there is a significant difference between "yes" and "no" responses during each of the tasks, this is least marked during the paper search of a document, which differs significantly from the other two tasks. The search of a computer screen seems to emphasise the difference between exhaustive and self terminating searches. These data can be seen in Figure 16.

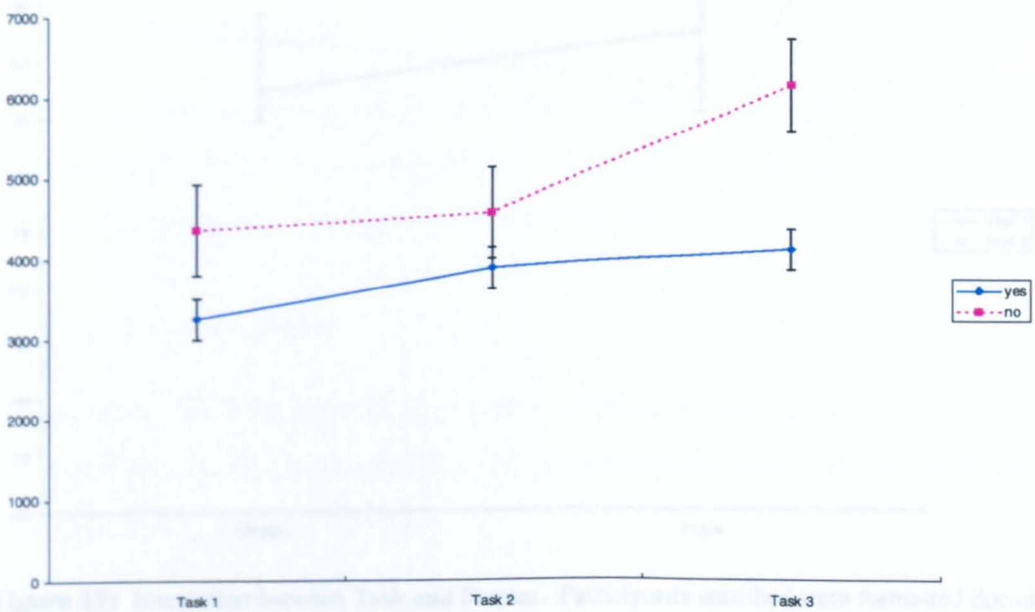

Figure 16: The interaction between the task and answer given. There is a difference between the two answer types during each of the three tasks. However, the difference is least marked during Task 2, which differs significantly from Tasks 1 & 3.

6.3.4.2.2. Fixation Duration

When fixation durations were compared across Task 1 and Task 3 using a 2 (task 1, task3: within subjects) x 2 (format, bullet or plain: within subject) x 2 (answer yes or no: within subjects) ANOVA, a main effect for answer was found, $F(1,23)=6.212$, $p=0.020$. The was qualified by a task x answer interaction, $F(2,46)=6.050$, $p<0.05$. There was no difference between the two answers in Task 1, resulting in a mean of 190 msec for both "yes" and "no" answers. Task 3, as was shown earlier, resulted in shorter fixation durations for "yes" answers (186 msec) than for "no" answers (193 msec). Finally there was also a task x format interaction, $F(2,46)=6.644$, $p<0.05$. This interaction is illustrated in Figure 17.

Figure 17 illustrates that plain text results in longer fixation durations during Task 1 (193 msec compared with 187 msec). However, during Task 3, the opposite is the case, with stem bulleted text resulting in the longer fixation durations than plain text.

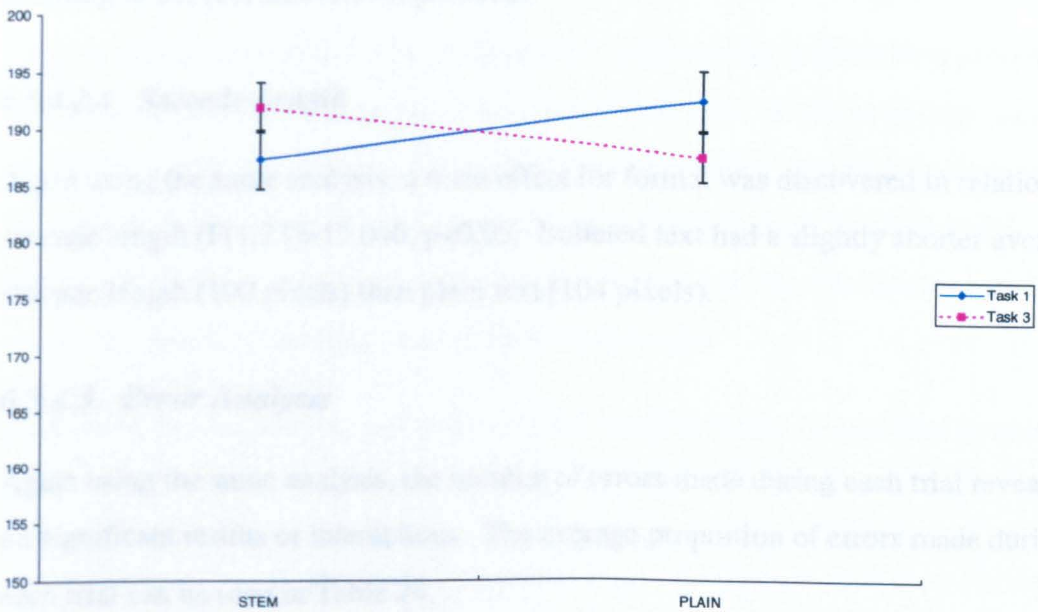

Figure 17: Interaction between Task and Format. Participants searched stem formatted documents with shorter fixation durations during Task1. However, during Task 3, participants searched plain formatted documents with shorter fixation durations.

6.3.4.2.3. Number of Fixations

Using the same analysis as above, a main effect for answer was found ($F(1,23)=42.231$, $p<0.05$). However, there was also a task x answer interaction, $F(2,26)=13.928$, $p<0.05$. This illustrates that the difference between "yes" and "no" responses are far more extreme when the participant has not had the opportunity to pre-read the document. When the participant is searching for an answer that is present on the page, then there is little difference between the two tasks, however, when the answer is not on the page, there is a much greater difference between the two tasks, see Table 23.

	Yes	No
Task 1	17	20
Task 3	18	26

Table 23: The number of fixations made on the page for positive and negative answers.

The difference in number of fixations for format was approaching significance, with bulleted text resulting in an average of 19 fixations during text search, and plain text resulting in 21, ($F(1,23)=3.570$, $p=0.072$.

6.3.4.2.4. Saccade Length

Again using the same analysis, a main effect for format was discovered in relation to saccade length ($F(1,23)=13.040$, $p<0.05$. Bulleted text had a slightly shorter average saccade length (100 pixels) than plain text (104 pixels).

6.3.4.3. Error Analysis

Again using the same analysis, the number of errors made during each trial revealed no significant results or interactions. The average proportion of errors made during each trial can be seen in Table 24.

	BULLET		PLAIN	
	Yes	No	Yes	No
Task 1	0.12	0.07	0.09	0.11
Task 2	0.09	0.06	0.07	0.04
Task 3	0.09	0.09	0.09	0.07

Table 24: The average proportion of errors made per trial. No difference was found between format, answer or trial.

6.4. GENERAL DISCUSSION

Participants were at no disadvantage while reading stem bulleted text, either on paper of on a computer screen. The eye movement record obtained from the reading of the documents on screen also revealed no difference between the formatting manipulations. Thus there seems to be an equivalence in the reading fluency between stem bulleted and plain formatted text in all possible reading measures.

Another way of examining what occurred during the reading process is to examine participant's behaviour during the search stage of the task. This can give an idea of what information was acquired and encoded during reading. Stem bulleting is again seen to behave in a different manner to the blanket bulleting in Studies 2 & 3. Whereas blanket bulleting was seen to impede text search, stem bulleting actually results in faster reaction times than plain formatted text.

Each of the factors investigated in this current study will now be explored in more detail, with particular consideration being paid to the interactions between the three tasks which manipulated medium and familiarity in turn.

6.4.1. The Effect of Medium

The reading speed differences revealed when participants are reading from paper and from a computer screen support the previously discussed findings which indicate that indicate that reading is rarely as fluent from a screen as it is from paper (Muter, Latremouille, Treurniet & Beam, 1982; Gould & Grischkowsky, 1984; 1986; Gould, Alfaro, Barnes, Finn, Grischkowsky & Minuto, 1987a; Kruk & Muter, 1984; Muter & Maurutto, 1991). In the present study, the differences in reading speed are not great: the computer screen presented document is read only 7.88% slower than the paper document, but the differences are still significant. Participants read from a computer screen slower than if they were reading from paper.

The reason for this difference in reading rate due to medium of presentation most likely relate to some of the possible explanations raised by researchers over the years and discussed in Chapter 3. What is of particular interest, however, is the fact that this difference in reading speed is not mirrored in the search task findings. This finding is in opposition to many of the studies of reading, proof reading and searching conducted before, in particular the findings of Muter & Maurutto (1991) who found that skimming from a computer screen in 40% slower than skimming from paper. Therefore we can see that it is possible, in this case when the participant was familiar with the document, to obtain an equivalence in searching speed between the two mediums.

It must also be noted that although reading speed differences were found between mediums, the *pattern* of results across these two mediums was the same. In both cases participants had equivalent reading speed for both stem bulleted and plain formatted text, and a search time advantage for stem bulleted text. Indicating again that formats that seem to facilitate text search do so for both paper and computer screen searches.

6.4.2. The effect of Familiarity

An insight into what causes the advantage for stem bulleted text in Task 1 & 2 can be seen be examining the results of Task 3. Task 3 was almost identical to Task 1, and only differed in the fact that participants were not given the opportunity to pre-read the document. However, the results were very different. There was no main effect for format, with both formats resulting in similar response times. There was an interaction with the answer that approached significance. When the answer was "yes", there was a slight advantage for plain, unformatted text and when the answer was no, there was an advantage in turn for stem bulleted text. However, this was a very small effect. Therefore, it can be seen here that the advantage found in Task 1 for stem bulleted text seems not to be due to any cues found in the layout of the text which helps participants navigate round the text. If this was the case it would be expected to be found in Task 3 as well. As in the previous studies in this thesis, the advantage found between formats seems to be due to something that is happening at the encoding stage of the process when the text is being read rather than at the search stage, during the actual interaction with the document.

The difference in the eye movement measures during text search are difficult to interpret. The number of fixations analysis, as would be expected, mirrored the response time findings. However, the fact that significant differences were found between conditions with respect to the fixation duration and the saccade lengths are more difficult to explain. Task 1 revealed that the average fixation duration during text search was significantly shorter while searching stem bulleted text than plain formatted text. Task 3 also reveals differences between the two formats, but in an opposite direction. In Task 3, fixation duration in the stem sentence condition were significantly longer than in the plain formatting condition.

A difference in the average fixation duration could also be seen when the "yes" answers were compared to the "no" answers. "Yes" answers resulted in a shorter average fixation duration than "no" answers. Shorter fixation durations have been associated with easier processing (Rayner & Pollatsek, 1989) and also less detailed processing (Rayner & Fischer, 1996). When readers do not have to read the text in depth, for example during the target word search in the study by Rayner & Fischer (1996) no word frequency effects were found, presumably because there was no need to lexically process the words that were being scanned. In addition, although statistical tests were not conducted in the Rayner *et al* paper, the average fixation duration during text search were shorter than the average fixation durations during reading. Thus, along with other research on fixation durations decreasing with increasing ease of reading (Hyona & Niemi, 1990; Inhoff, Topolski, Vitu & O'Regan, 1993, Raney & Rayner, 1995), it can be assumed that a shorter average fixation duration can be associated with a greater ease of reading, or a greater proportion of text search or word matching. The fact that the "yes" response is associated with shorter fixation durations in Task 3 may relate to the strategy used during the text search. Participants could be first scanning the text hoping for a pattern match during this stage, if they find a match, then they respond and the search ends. If, however, they do not find the required information from this, they may have to alter their technique and read some of the data.

In turn, assuming that shorter average fixation durations are associated with fluent reading, shallower processing can be seen to also affect the interpretation of the fixation durations seen during the searching of each of the formats. Participants can be thought to being involved in shallower processing of the stem bulleted text when they have first read the document. However, if they have not first read the document, participants searching stem bulleted text tend to be involved in a behaviour which involves longer fixation durations than with plain formatted documents.

6.5. CONCLUSIONS

It can be seen that there is a distinct advantage for first searching a document that has been pre-read. If a document is pre-read, subsequent search of that same document will then be faster. However, the facilitation that is brought to the secondary search task can be altered depending on the formatting of the document that was initially read. There was no difference between the two documents in *how* they were read, but there was an advantage in the ability of participants to make judgements on the content of a sample page from that document. Stem bulleted text resulted in participants being able to make faster decisions.

The advantage for searching stem bulleted text in this present study is not related to the participant spending longer reading such a formatted document, or in any difference in the *way* they read the document, as measured by the eye movements during reading. The facilitation also does not seem to come from the way the formatted document itself is being searched: participants are equally able to search either format if they did not first read the document. It can also be seen that participants do not seem to use the stem sentence itself any more than if it was the first sentence of a standard paragraph. The reason for the facilitation must, therefore, be due to some other factor. Existing research (Rothkopf, 1971; Zeichmeister & McKillip, 1972; Zeichmeister, McKillip, Pasko, Bespalec, 1975; Chrisite & Just, 1976; Lovelace & Southall, 1983) has shown that some sort of visual/locative information is encoded with the semantic information encoded in memory. Other research has also shown that this can be manipulated depending on the spatial cues given to the participants (Lovelace & Southall, 1983). Therefore, the reason for the differences found in participants' abilities to search different formats (already muted in previous chapters) could be that certain formats form a clearer visual representation of the text which them goes on to facilitate a secondary search task. This is a proposition that will be tested in the following experiment.

CHAPTER 7

7. STUDY 5: BLURRED IMAGE SEARCH

A possible explanation for the difference in reading and response latencies between the format manipulations in Studies 2 to 4 is the visual memorability of the different formats. Different layouts may alter how the text is read, how it is represented in memory and therefore how a participant then goes on to search the text. As was suggested in the previous chapters, certain formatting manipulations could encourage visual encoding during reading more than others. This more detailed perceptual information could then be responsible for the increased transfer benefit that can be seen between certain formats. Therefore, if the representation held in memory of a previously read text presented in a certain format differs in the amount of perceptual information that is available to aid subsequent encounters with that text, then it could be predicted that participants' performances on tasks that probe the visual layout memory for the text would differ depending on which format had been read initially.

As previously stated, it is possible for the appearance of a document to alter how it is read and also how it is remembered. Lovelace & Southall (1983) altered the ability of participants to remember the location of information within a document, and also to remember the content of the passage by removing any within-page cues from the document. The removal of these cues prohibited the reader from encoding spatial and location information, which in turn was seen to create a distinct loss in the representation held of that text. Another case where spatial information has influenced text representation is when the page advancement was either page-by-page or by scrolling (Piolat, Roussey & Thunin, 1997). Piolat *et al* found that in a reading task, participants were better at locating relevant information and remembering the main ideas from the text if they had advanced through the document a page at a time, rather than scrolling through the document. Piolat *et al* concluded that paging allowed for the participants to create a stronger mental representation of the text as a whole. In particular this method of page advancement allows participants to spatially encode the document using the corners of the screen as absolute references with which the location of specific pieces of information could be encoded. Scrolling allows for participants to encode information with internal reference, that is with reference to other pieces of information on the page, but does not permit the reader to encode information with any absolute reference, as in the case of paging. As can be seen with both the Lovelace & Southall and the Piolat *et al* studies, this inability to create any absolute references results in a disadvantage both for encoding the location of information on the page, and the content of the passage.

However, both these studies discussed above manipulated the means by which participants could make absolute references for pieces of information within the text. There are other studies which can demonstrate the importance of spatial information encoding under different circumstances. Nygren (1996) proposed that if a document or a document type in the case of tabular data, is repeatedly used, participants then search that document in a different way. During case study analyses, Nygren noted that novices looking up a table of information will locate the appropriate columns and rows from the column and row titles, and calculate the required information that way. However, expert users, who were very familiar with certain types of tabulated information were able to look at the table and directly locate the information they required. In order to test the extent of any pattern or perceptual knowledge attained from tables of information, Nygren presented doctors with commonly used charts, and replaced the actual figures from each of the table's cells with crosses. The doctors' task was to see if they could still identify the patient's condition. The findings for this study were surprising. Despite the doctors themselves reporting using the numbers and the table in a conventional way, during this study doctors were still as accurate in diagnosing the condition of the patient on the basis of the pattern of filled in and blank cells in the table. Thus Nygren demonstrated that expert, frequent users of certain pieces of information can become so familiar with a piece of information, in her case a table, that they can then use the document in a different way to naïve users: they can now use the perceptual information that is available and constant in the table to quickly "read" what information the table contains.

Our own studies, discussed earlier in this thesis, also support the suggestion that the visual layout of the document can affect how that document is encoded. Evidence found in Study 2, the first paper search study, indicated that there is certainly a difference between the three formats tested in their ability to facilitate subsequent searches from an initial reading task. Plain formatted text resulted in faster searches than both the blanket bullet formatted text and the separate formatted text. Separate formatted text was seen to result in a very small difference between whether the same or a different format was then searched. Together these results illustrate a difference in the way the representation held in memory of these formatted texts can facilitate text search. This pattern of results was also seen in the subsequent experiments. Study 3 illustrated an advantage for searching the same format as was initially read, and also an advantage for plain formatted text. Study 4 illustrated a difference in the ability of participants to search a different type of bulleted text. When stem bulleted text was used, the plain formatting advantage disappeared, implying that there is something very different happening between blanket bulleted text and stem bulleted text: one seems to have a strong advantage over the other.

This present study was designed to investigate whether the differences between formats in the ability of participants to indicate whether an answer was present on the page found in the previous studies had a spatial component. If a reader was able to form a strong spatial representation of certain formats but not others, it could be concluded that the difference in the ability of participants to locate information on the screen was due, at least in part, to a visual representation of the text that they formed while reading the text. In order to test this hypothesis, pages of text used in Study 4 were passed through a spatial frequency filter to blur the text, so no individual words were recognisable. Participants were then asked to indicate where they thought the answer to the experimenter's questions were located. If there was still a response time advantage, or an accuracy advantage, for stem bulleted text, then it would be shown that the spatial representation of the text was causing the response time differences: it could not be due to any semantic information within the text, as this was not available to the participant.

7.2. METHOD

7.2.1. Materials and Design

Three of the materials and related questions used in Experiment IV were again prepared for this current study, namely the texts on Adoption, Homelessness and Tinnitus. These were chosen as they again represented a spread of subject matter used by the BBC Audience Lines (How To?, Social Action, and Health), and were quite homogenous in their reading and response times in Experiment IV.

The three five page documents were presented in three different ways. First there was plain, unformatted text, in which there were no special formatting techniques applied. Second, the two different types of bulleting were applied. Blanket bulleting applied a bullet to every sentence in the paragraph, as in Studies 2 & 3. Stem bulleting was almost identical, except the first sentence in each paragraph (the "stem" sentence), was left unformatted, with no bullet point at the start of the sentence and no indentation, as in Study 4.

All the documents were subjected to a spatial frequency filter. This resulted in blurred pages of each document in which no individual words could be made out (see Appendix 12 for an example). These were the texts used in the response stage of the study.

The aim of the study was to investigate whether formatting could influence the within-page memory and search ability, of participants about a page of text. Each participant read one of the texts, and were then tested on their ability to identify where on the blurred page they thought the answer to the question asked by the experimenter was located. Their response time was measured along with their accuracy of response and their confidence in the answer given.

All materials were presented and timed using PsyScope, version 2.1.

7.2.3. Participants

Eighteen students at Glasgow University participated in the study. All participants were under the age of thirty and native English speakers. Each volunteer was paid for their participation. The experimental sessions took on average around 45 minutes.

7.2.2. Procedure

Participants took part in individual experimental sessions. The order of presentation and the combination of Materials and Format were completely randomised.

Participants initially read an introduction to the Experiment (Appendix 11), which detailed each aspect of the study. It described the study as a memory study and emphasised the importance of both accuracy and speed of response, without compromising each for the other. The instructions also emphasised the importance of trying to remember the "look" of each page, which was reiterated in the verbal instructions given to each participant. Before beginning the study each participant was taken through a practice session on a trial document ("How to Become a Writer") to allow them to practice and give them a familiarity with the blurred texts. Only once the participant was happy with the task and the responses that were required of them were they allowed to proceed to the experimental trials.

Each participant read the five page document presented in one of the three formats in their own time. They could take as long as they wanted reading the document, but were encouraged not to re-read the page, and were not allowed to go back to previously read pages. Once the document was read, a fixation cross was presented on screen. Participants were required to look at this cross and make sure the cursor (as controlled from a standard Macintosh mouse) was located on this cross. At this point the experimenter read a question based on the text just read as in previous studies. At the end of the question, the experimenter presented a blurred page from the previously read document on screen. The answer to the experimenter's question was always located on this page. The participant's task was to indicate, using the cursor, where they though the answer was located within the page of text. When they felt they were pointing at the correct sentence they pressed the mouse button. At this point their response time was measured by the programme, and an array of numbers appeared on the left hand side of the text. The participant was then to read out the number that most closely corresponded to their cursor position, and also give an indication of their confidence in their response, on a scale of 1 (very sure of the response) to 5 (very unsure of response). A visual representation of this scale was placed beside the participant during the study to help them make these confidence responses. The number scale at the side of the text was deliberately left imprecise, so that each number did not exactly correspond to each line of text. This was to encourage participants to indicate *roughly* where they though the answer was located, and not to waste time finding the precise location of the target words or try to "read" the blurred text. This was reinforced by the experimenter's verbal instructions that some leeway was given with respect to the precise location of the answers, so the participants were to locate the appropriate sentence. Once both the location and confidence responses were given, the page was replaced by the fixation cross, which the participant was again to place the cursor on top of. This pattern of response/location/confidence continued until all of the fifteen questions corresponding to that document were asked. (5 questions were rejected from the 20 questions used in Study 4 in order to speed up Study5).

Each participant was tested on all three documents and formats.

7.2.4. Analysis

The reading times, as measured by the reading time for the document and by the average number of words per minute, were compared for each of the three formats using a repeated measure ANOVA with one factor, type of format (three levels: stem, blanket or plain). In order to test that there were no order or material effects, this same analysis was conducted for material and for order (was the document read first second or third).

Response times were also analysed using a within-subject's ANOVA with three levels (type of format). The response times were analysed in three ways. Firstly, all the response latencies were analysed together. Then the correct responses only were compared, and then the erroneous answers only. The number of erroneous responses (out of a possible 810 for each format) were:
156 from plain text (19.3%),
137 from blanket bulleted text (16.9%), and
156 from stem bulleted text (19.3%).

The method of scoring for accuracy involved giving a margin or error of four lines around the target word. As can be seen from the example of the blurred text in Appendix 12, the numbers at the side of the passage do not directly correspond to the line numbers. When the participant called out the appropriate number, they were aware that this was an approximation and a margin of error would be allowed. Therefore, for every question's answer, the two lines surrounding that question which most corresponded to the location of the words of the answer, and the body of the sentence which included the answer, were logged as the "correct" response. One line on either side of these correct lines were also categorised as the correct answer. In this way there was a degree of error allowed, while still remaining close to the answer's location. The different number of line numbers between the two bulleted formats and the plain formats resulted in a different margin of error for each of the formats. The average number of lines per page for plain formatting is 16, and for the bulleted formats (both of which naturally have identical line lengths) 20. Therefore the chance probability for plain text is 24%, and for the bulleted formats 20%. Thus, out of the 15 questions asked, the chance level of accuracy for plain formatted text is 3.6 questions correct out of 15, and 3 questions correct out of 15 for the bulleted formats. As all three formats resulted in an accuracy rate far above this level (8.7, 8.1 and 7.3 for stem bulleted, blanket bulleted and plain formatted text respectively) a direct comparison between the three formats was thought suitable, without altering the results.

The accuracy of the participant's responses were analysed in one of two ways. Firstly, the number of correct responses were analysed for each format and each material. The second analysis consisted of looking at the number of lines away from the correct answer each participant's response was. In this way the magnitude of the error between the three formats could be investigated. In this case, only the two lines which marked the location of the correct answer were taken as "correct", and the number of lines away from this correct location was measures. An ANOVA was used for this analysis, as above. The analysis of each participant's confidence in their response was also submitted to the same analyses. Correlations between the confidence of each participants response and their accuracy were calculated, in order to see if participants were more aware of their accuracy during the interaction with certain types of formatting.

In order to investigate any within-subject consistencies in their pattern of responses, their accuracy while making location judgements with one type of format was correlated with their accuracy locating information in another. This was conducted for each of the accuracy measures: the accuracy of the response; the number of lines away from the correct response; and the response latency. Finally, to ensure that participants who were more accurate were not taking more time responding, correlations were made between the accuracy of the response and the response latency.

7.3. RESULTS

7.3.1. Response Times

As in previous studies, an analysis was conducted on the time it took each participant to read and respond to the document they were presented with in each format, this time using a repeated measures ANOVA with one factor (format, plain, blanket bullet or stem bullet). There was no significant difference between the three formats, $F(2,34)=1.16$, $p=0.325$, see Table 25. The number of words read per minute was also calculated and analysed in the same way, but again revealed no significant differences between formats, ($F(2,34)=0.687$, $p=0.510$). The average number of words per minute can also be seen in Table 25.

There were no differences between the groups in relation to the speed of responding overall $F(2,34)=1.741$, $p=0.191$. This was broken down into correct responses and incorrect response. Again, however, there was no difference between the three groups for correct responses, $F(2,34)=1.59$, $p=0.219$, or for incorrect responses, $F(2,34)=1.27$, $p=0.293$. Again, response times can be seen in Table 25.

Analysis \ Format	Stem bulleting	Blanket bulleting	Plain formatting
Reading Time	295,504	299,283	278,665
Words per minute	171.6	173.1	182.0
Response time (all responses)	4,674	5,125	4,362
Response time (correct answers)	3,946	4,478	4,151
Response time(incorrect answers)	5,992	6,053	5,255

Table 25: The average reading speed and response time for each of the three formats. Reading and response latencies are measured in milliseconds. No differences were found between the formats in any of the above measures.

Analyses of the same design were also conducted on each material, to investigate whether there were any major differences that may be masking the any formatting effect. However, again these revealed no difference between the three materials either in reading times, $F(2,34)=2.06$, $p=0.143$, or in response times, $F(2,34)=1.12$, $p=0.338$. Finally, to ensure participants read each document in a similar manner, a comparison of reading speed (as measured by words per minute) was analysed according to the order of presentation, that is whether the document was read first, second or third, regardless of format or material read. Again there was no difference found, F(2,34)=0.650, p=0.528. Participants read each document without speeding up on the later readings.

7.3.2. Accuracy of response

Using an ANOVA of the same design, the number of correct answers obtained for each of the three formatting manipulations revealed no significant difference between any of the three formats, F(2,34)=2.14, p=0.133. In case the lack of difference between the formats was due to a strong difference between the materials, an analysis was again conducted to investigate whether this was the case. No significant difference between the three groups was found, F(2,34)=1.31, p=0.282. See Table 26.

Format / Material	Stem Bulleting	Blanket Bulleting	Plain Formatting	Average
Adoption	8.7	6.8	7.3	**7.6**
Homelessness	8.7	7.5	7.3	**7.8**
Tinnitus	8.8	9.8	7.3	**7.3**
Average	**8.7**	**8.1**	**7.3**	

Table 26: The number of correct responses per participant (maximum correct =15) for both format searched and material searched. Again no difference were found between formats or between materials. Participants searched each of the documents with comparable accuracy.

A second analysis was conducted which examined the number of lines away from the target sentence the participant's actual response was. However, again this revealed no effect for either format read (F(2,34)=3.06, p=0.060), or for material read (F(2,34)=1.03, p=0.368). The format comparison, however, approached significance, which is due to the fact that responses for stem bulleting are more accurate than the other two formats, see Table 27.

Material \ Format	Stem Bulleting	Blanket Bulleting	Plain formatting	Average
Adoption	2.6	3.6	3.0	**3.1**
Homelessness	2.3	3.3	3.0	**2.8**
Tinnitus	2.4	2.1	3.4	**2.6**
Average	**2.4**	**3.0**	**3.1**	

Table 27: The average number of lines away from the target location for format searched and material. The analysis again failed to find a significant difference between either the formats or the materials in the participant's ability to locate the correct information within the document. However, the format manipulation did approach significance, which results from the stem bulleted text having more accurate responses.

7.3.3. Confidence Ratings

A comparison of the confidence ratings attained for the three different formats revealed a marginally significant difference between the three groups, $F(2,34)=3.175$, $p=0.054$. As can be seen from Table 28 participants are significantly more confident in their location judgements for plain formatting than they are for either of the bulleted formats, which do not differ significantly from each other. An analysis of the material used in the study revealed no differences in confidence ratings, ($F(2,34)=1.764$, $p=0.187$). The summary figures can be seen in Table 28.

Material \ Format	Stem Bulleting	Blanket Bulleting	Plain Formatting	Average
Adoption	2.6	2.9	2.8	**2.76**
Homelessness	2.7	2.8	2.4	**2.62**
Tinnitus	2.8	2.7	2.5	**2.66**
Average	**2.80**	**2.69**	**2.56**	

Table 28: The average confidence rating for each of the three formats and for each of the three materials. Participant locating information with plain formatted text were significantly more confidence than during the search of the other two formats.

How closely the confidence ratings match the accuracy of the participants' response was measured by correlating the accuracy of the response as measured by the number of lines away from the target sentence the response was, with the participants noted confidence in their response. Table 29 illustrates that all three formats and all three materials resulted in a significant correlation between these two measures.

	Correlation	N
Stem Bulleting	0.409	270
Blanket Bulleting	0.394	270
Plain Formatting	0.375	270
Adoption	0.282	270
Homelessness	0.427	270
Tinnitus	0.462	270

Table 29: Pearsons correlation comparing the accuracy of each response (measured by the number of lines away from the target location) with the participant's confidence in that response. Participant's accuracy in their response and their confidence in it were correlated for all formats and materials. The Adoption format, however, did seem to result in a lower correlation than the other formats.

7.3.4. Correlations

There was a very large difference between participants in their speed of responding to the questions, and also in the accuracy of their responses. For this reason, a series of correlations for each participant's responses were analysed, to investigate individual differences in each participant's ability to retain a spatial memory of the material they had read.

When the number of correct answers per format were compared, significant correlations were found between all three formats. If someone performed well at the task in one format, they would perform well with while searching the other formats, see Table 30a.

Significant correlations were also seen between the number of lines away from the target sentence each participant was while locating information in each of the three formats, Table 30b. If a participant was accurate while locating information in one format, they tended to be accurate searching another. There was less of a correlation between the stem bulleted formatting and the plain formatting, however. Finally, the response latencies again illustrated how consistently participants performed across latencies, Table 30c.

Format \ Format	Stem Bulleting	Blanket Bulleting	Plain Formatting
Stem Bulleting		0.642**	0.441*
Blanket Bulleting			0.627**
Plain Formatting			

(a): Pearsons correlations between the number of correct responses made for each format by each participant. Correct responses are measured by whether the participant located the answer to the experimenter's question within 4 lines.

Format \ Format	Stem Bulleting	Blanket Bulleting	Plain Formatting
Stem Bulleting		0.498*	0.279
Blanket Bulleting			0.635**
Plain Formatting			

(b): Pearsons Correlation between the average number of lines away from the correct location responses for each format were.

Format \ Format	Stem Bulleting	Blanket Bulleting	Plain Formatting
Stem Bulleting		0.827**	0.867**
Blanket Bulleting			0.786**
Plain Formatting			

(c): Pearsons correlation between the average response times for each participant locating information in different layouts.

Table 30: Series of correlations investigating the consistency of a participant's responses across formats. N=18. In each analysis, participants can be seen to perform consistently across formats.

** signifies correlation is significant at the 0.01 level (1-tailed)
* signifies correlation is significant at the 0.05 level (1-tailed)

A possible reason for the lack of any difference between the three formats in the accuracy of their responses or their response latencies could be that participants who achieved a higher accuracy rate may also have been taking longer to answer the questions than if they were trying to respond quickly, and therefore making more mistakes. In order to investigate this a series of correlations were conducted plotting either the number of correct responses made against their response latency, or the number of lines the response was away from the target sentence against the response latency. However, no correlation was found between the accuracy of the response and the latency of the response for any of the three formats, see Table 31.

	Stem Bulleting	Blanket Bulleting	Plain Formatting
Number of correct responses	0.064	0.034	0.139
Number of lines out	-0.030	0.034	0.168

Table 31: The correlations between the accuracy of the responses (as measured by the number of correct response or by the number of lines away from the correct location the target response was) and the time it took to arrive at a response. No correlation was found.

7.4. DISCUSSION

This study was designed to investigate whether participants who had read stem bulleted text formed a stronger visual representation of the information layout than if they had read either blanket bulleted formatting or plain formatting. Previous studies in this thesis have led towards the suggestion that because participants searching familiar formats have a response latency advantage, and because differences between the experimental formatting manipulations can be seen with respect to both reading and response latency, that perceptual or location information is encoded at the time of reading. This encoded perceptual information has been suggested to then facilitate text search to a greater or lesser degree depending on which of the three formats was originally read. However, this present study failed to reveal any advantages, in reading time, or response latency for any of the three formatting manipulations. This implies that, during this study anyway, there is no difference between the formats in the way they were read or in the ability of participants to indicate the location of pieces of information within that document. The two borderline significant results will be discussed below.

7.4.1. Reading Data

Study 3 demonstrated some gross differences between the way blanket bulleted text and plain formatted text were read, which were reflected in both reading time and in eye movement measures. In this present study, however, the reading latency analysis revealed no significant differences between the three formats. There are a number of factors which could have influenced these reading times. First, participants were aware of the fact that they had to read and then locate information within three documents in quick succession. Therefore, participants may have not made as much effort with later documents, and thus confounded any format difference. However, an analysis of any order effects failed to reveal any systematic difference in the way the first document was read compared with the way the third document was. Therefore concluding that the participants read the first document in more detail than the last seems not to be an adequate explanation for why no differences in reading speeds were found between the three format types.

A second possible explanation is that the participants in this study were aware from the outset that this was a spatial memory task, and therefore read the documents in a different way than in previous studies. By looking at the reading times attained for stem bullet formatting and plain bullet formatting in Study 4 it can be seen that the average reading latencies in this current study are far longer than in the previous experiment. Plain formatted text resulted in a reading rate of 234 wmp in Study 4 (which used the same materials), and 182 wpm in the present study, stem bulleted text was read at a rate of 238 wmp in Study 4, and 172 wmp in this study. Therefore it can be seen than in this present study, where participants were aware that there was a spatial memory component and were overtly trying to remember such information, reading rates are greatly inflated.

As discussed earlier in this thesis, Zwann (1994) investigated whether a persons expectations about a text can affect how they read and remember that document. Readers who thought they were reading a piece of literature had longer reading times and what Zwann described as a better memory for surface information than if they were reading what they thought was a news item, in which case they had a stronger memory for situational information and faster reading times, but a poorer memory for the surface features of the text. Although Zwann, like Kintsch, (Kintsch, 1971; van Dijk & Kintsch, 1983; Kintsch, 1992) uses the term "surface features" to denote the exact wording and syntactic structure of the text, his study does demonstrate that the expectation a reader brings to a piece of text can strongly influence how it is read (as measured by reading times) and what representation is created in memory of that text. Thus the fact that participants in this present study took longer to read the documents than in Study 4 may relate to the readers expectations about the forthcoming task. These inflated reading times in turn seem to have masked the reading differences that have been seen to occur in the previous experiments in this thesis.

Other researchers have suggested that depending on what task participants are asked to perform, participants can divide their cognitive resources in different ways. Reading as the focal task in an experiment results in a limited transfer of perceptual features from one reading encounter to another, (Carr, Brown & Charalambous, 1989; Levy & Kirsner, 1989; Carr & Brown, 1990; Carlson, Alejano & Carr, 1991). Reading as a secondary task, on the other hand, for example secondary to comprehension, demonstrates a greater reliance on perceptual features (Levy & Kirsner, 1989; Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992). Together these studies indicate that the task given to a reader can also strongly influence how the text is read and also what information is acquired from the text to be then stored in memory. Therefore it can reasonably be concluded that the nature of the task in this present study results in participants reading the document in a different way than they had in previous studies. In the earlier studies, although spatial memory was being tested for, participants were not explicitly aware of the fact, and therefore treated the experiment in much the same way as they would have treated a high school English interpretation. Any spatial encoding of the documents was incidental to the task at hand and outside the participant's conscious control. In this way, any difference in the amount of perceptual information that was then part of the representation in memory of the text can be thought of as purely a results of the different formatting manipulations. The instructions for this study, however, made it clear that it was perceptual information that was being tested for, and therefore needed encoded. Judging from reading times, participants seem to have spent an increased amount of time reading the documents in order to encode such information. The lack of any difference between the three formats, therefore, may be due to the inflated reading times masking any true differences between the formats as would be found in reading for comprehension tasks.

7.4.2. Response Accuracy

There was also little difference found between the three formats when the accuracy of the responses were investigated; there were no more correct location responses made with any of the formats. Therefore, none of the formats used in this study can be claimed to result in a stronger visual memory for the material that was read in the first instance that could later aid their navigation round a blurred page from that document. There was a borderline significant advantage for stem bulleted text, when the number of lines away from the correct location response were analysed. This seems to imply, as was expected, that a stronger perceptual representation is created in memory for this type of formatting, which is obviously aiding the search for information within the document as in previous studies. However, from the previous studies, we would have expected a stronger effect than was found during this study.

We will now discuss the reasons why a stronger effect, especially between the blanket bulleted and the plain formatting was not seen.

First, the inflated reading times for all three of the documents, suggests that the readers were taking more time to encode the spatial information that would be needed later. If this was the case, then this may have resulted in the readers of all three formatting manipulations having a stronger visual representation of the text than if they had been reading purely for comprehension, as in earlier tasks. This conscious remembering of visual information could then have masked any difference between what perceptual information is usually encoded under more common reading situations in which no conscious effort is made.

Second, when the nature of the transfer of what is known of the perceptual information is considered it has been shown to only be seen under certain circumstances, (Carr, Brown & Charalambous, 1989; Levy & Kirsner, 1989; Carr & Brown, 1990; Carlson, Alejano & Carr, 1991; Levy & Kirsner, 1989; Jacoby, Levy & Steinbach, 1992; Levy, Di Persio & Hollingshead, 1992). Therefore, depending on the task given to participants, perceptual features seem to have more or less of an influence on their ability to use this information on a subsequent task. This evidence has led to the conclusion that there is a greater reliance on perceptual characteristics when the text is being processes in a more automatic fashion in the service of a meaning-based task.

The previous studies in this thesis have illustrated many of the perceptual feature repetition benefits found in the rereading literature, but with a different task; the task of text search as opposed to rereading. This current study modified the search task so that the use of the percpetual information from the page was foregrounded, and any search strategy which involved reading was not possible. Instead of the search task being subsumed to the participant's main aim of indicating the presence or absence of the required information, in this study the participants only goal was to locate the answer to the experimenter's question. Participants were asked to focus on perceptual information within the task. Therefore, the difference found between the earlier noted experiments and this present one may be solely due to task differences. As in the rereading literature, if a participant is asked to focus on more superficial levels of analysis, they are less likely to use the perceptual features that have been encoded during the first reading of the text.

A third explanation for the lack of the expected difference between formatting manipulations can relate to other findings in the rereading literature. There is evidence that the entire representation of the text needs to be reinstated in order for the entire episodic representation of the text to be used in any transfer benefit. No transfer benefit can be seen if a single word which was originally read in the context of a coherent passage is then read in isolation (Jacoby 1983b). It is possible that in the same way, because the semantic information has been removed from the text, then the perceptual information alone cannot conjure up the episodic whole. However, the experimentation by Lovelace & Southall (1983) has indicated that if the location information as a whole can be repeated (in their case by blacking out the individual words by hand), then both location and content information is more easily recalled, and therefore cannot be the appropriate explanation for the lack of a difference between format. This current study supports the findings of Lovelace & Southall, in that participants reliably located information on the page in the absence of semantic content. Therefore it is not the case that difference between formatting manipulations cannot be seen because participants are failing to reinstate the representation created from the first reading encounter. Participants are reliably remembering information from the initial reading encounter.

Finally, the lack of any difference between the response times may be, at least in part, due to the inflated reading latencies during the initial stage of the experiment. If more time was taken to consciously encode visual information about the document than in previous studies, then it could be accepted that this then evens off any perceptual advantage one format has over another through the incidental encoding of perceptual information during the alternative tasks used in pervious experiments.

7.4.3. Confidence

A marginally significant difference was found between the formats in the participant's confidence in their response. When the format read and searched was the plain format, participants were more confident in their responses than if they has read either of the bulleted formats. Participants were equally confident in their responses to these bulleted formats, which did not differ from each other. However, this is a small difference, and may be due to the increased familiarity participants have with the plain type of formatting, and are therefore more experienced in locating information within this type of document. Because the plain formatted document also has fewer lines than the bullet formatted documents, this may also lead to the participants being more confident in their judgements.

7.4.4. Individual Differences

An interesting finding from this study is revealed by examining the pattern of results obtained from each participant. Each participant was given all three formats and all three materials to read and locate information within. Although no reliable difference was found within participants in their ability to more accurately or more quickly locate information in one type of format over another, differences were found *between* participants in their ability or otherwise to perform the task. The poorest performing participant resulted in a near chance level of accuracy for all three of the formats (with an accuracy of 4/15 for the bulleted formats, and 4/15 for the plain format) whereas the most accurate participant achieved near perfect accuracy for all three of the formats (13/15 for the bullet formats, 14/15 for the plain format). In order to test for the consistency of participants in their ability to perform this task, a correlation compared their scores across all of the formatting manipulations. There was a strong correlation found between all the formatting manipulations (see Table 30), which demonstrates that if participants are particularly able at this task they will be good, *regardless of format.* If they are bad at this, the converse will be true.

Thus, although this study failed to demonstrate a clear difference between formats in the ability of participants to locate information within the page, it has demonstrated the difference *between participants* in their ability to locate information on a page of text in general. We can see here that some people are good at this task, and seem to easily encode spatial information as it related to content information. Others do not have this ability, and perform badly across formats. However, in each of these situations, the participant was *trying* to encode spatial information, and even in this case we cannot say whether these individual differences relate to the day to day encoding of perceptual information during reading for comprehension.

7.5. CONCLUSION

There are a few important conclusion that can be made from this present study. First, it is essential to note that participants were able to successfully and accurately complete this task. This adds support to the conclusions made in previous chapters that participants can and do acquire visual information from a page of text that they can utilise during a later search task. In the case of this present study, although all semantic information was removed from the page, participants remained able to make accurate decisions about what information the document contained. This leads to a second important finding which relates to the difference between participants in their ability to perform this task. A participant able to make location decisions about one format has been shown to also be able to make the same kind of decisions about another. However, the range of abilities between participants ran from almost chance to almost perfect, suggesting that some participants have the ability to acquire and use perceptual information from text, whereas others are not as able.

The aim of differentiating between formats with respect to their visual memorability, however, was not borne out. Even with respect to participants' readings speeds, the difference between formats seen in earlier studies was not replicated. However, through examining the reading times in this current study we can safely conclude that participants read the document in a different way than previous studies. The task prepared participants for the need for spatial knowledge, and their reading speeds were slowed to compensate. The search latencies were equally poor at differentiating between formats. Participants performed in a similar manner across formatting manipulations. There was a slight advantage for stem bulleted text when the number of lines away from the correct response was considered. However, this was not reflected in the number of correct answers analysis or in the response time analysis, and may be due to a more simple explanation.

We can therefore conclude from this study that participants encode and use perceptual features of the text to locate information within it. Even without access to the semantic content of the text, participants are able to reliably indicate the location of information within a familiar document. However it is not possible to differentiate between formatting manipulations on the basis of their spatial memorability. It must be considered, however, that this could be an artefact of the inflated reading times and the conscious attempts of participants to encode such information. The ability of participants to encode perceptual information, on the other hand, varies quite dramatically between people, with some attaining far more accurate scores than others.

CHAPTER 8

8.1. GENERAL DISCUSSION

8.1.1. Introduction

The series of experiments detailed in this thesis have explored a number of different facets of participants' ability to read, encode and search textual documents. Although the majority of psycholinguistic research has tended to focus on the semantic content encoded during reading, I have clearly demonstrated the importance of perceptual features on any transfer of information benefit. I have also demonstrated the severe detrimental effects simple formatting manipulations can have on both the reading and search of a text, predominantly influencing the way the semantic content of the passage is encoded.

This chapter will now discuss the findings contained within this thesis as a whole. I will argue that the pattern of results obtained provides support for the conclusion that both visual and semantic encoding occurs during a reading encounter with text, which is reflected both in the way a participant reads and later searches a textual document. Different formatting manipulations can impinge on these factors and can dramatically alter how a document is encoded. I will also discuss the implication these data and conclusions will have on the work at the BBC Audience Lines, and the implications for future academic research.

8.1.2. The Encoding of Perceptual Information

Studies 2 & 3 demonstrated that participants are better able to search a page of text if they have already seen that page presented in the same format. Even when the semantic information contained within each page was identical across formats, as in Study 3, participants remained at an advantage if the presentation of information remained consistent across encounters.

Psycholinguists have tended to suppose that readers do not retain a verbatim representation in memory of a text they have read. Instead many researchers have argued that readers typically retain the gist of that text, and discard the surface structure (for example, van Dijk & Kintsch, 1983). This theory can be easily accepted if we consider what is remembered from reading an entire book: we do not remember every sentence or even every detail that occurred throughout the book, but we do remember the gist of the story and the main events. There is a lot of support within psycholinguistics for the conclusion that the precise surface form of the text (as defined by remembering the exact form of the passage - the words, grammar and punctuation) is stored in short term memory only until its meaning is understood, at which time it is discarded to be replaced by the surface form of the next sentence (Jarvella, 1971; Bransford & Franks, 1971; Sachs, 1967). However, although it is intuitively appealing to suppose than we simply remember the gist of a passage and do not retain the word by word structure, it can be equally appealing to assume than we also retain a visual representation of the passage. It has commonly been reported that after reading a document, a reader can easily re-find information within that document, (Rothkopf, 1971; Zeichmeister & McKillip, 1972; Zeichmeister, McKillip, Pasko, Bespalec, 1975). For example, a reader may remember that the information they are looking for is located near the beginning of the book; or that it was on the left hand page, near the bottom; or that it was on a page with a picture; or even that there was a lot of information on that page. From this anecdotal evidence it seems natural to assume that at least some visual information is retained along with the gist of a passage in memory.

The fact that perceptual information is encoded during reading has been given strong support throughout this thesis. Studies 2 & 3 demonstrated that participants were able to search a document with greater ease if it was presented in the same layout as when it was first read. Study 5 was able to demonstrate that participants are actually able to locate information within a page of text to a degree far exceeding chance even without recourse to reading, and without access to the semantic content of the page. By simply reinstating the overall structure of the text, participants can locate information that cannot be discerned through any other means other than a visual memory. Thus there seems to be a simple visual match occurring, in which the visual representation held in memory is matched with the pattern of information as it is presented on the page.

The advantage for searching a document in the same format in which it was initially read was shown in Studies 2 & 3 to hold across a number of formatting manipulations. Plain, blanket bullet and separated text all showed an advantage when the formats were kept constant across encounters. Study 5 also demonstrated the encoding of perceptual information when stem bulleting was used. We can therefore conclude that, at least within the present range of formatting manipulations, perceptual information is encoded irrespective of formatting manipulation. Study 5 attempted to discover whether any of the three primary formatting manipulations tested resulted in more perceptual encoding that any other. However, when the encoded perceptual representation was directly tested, no reliable difference could be seen between formats. As discussed in Chapter 7, directly testing the perceptual representation may have altered the way in which it was encoded and used. Inflated reading and search times seem to support this. Nonetheless, the results from Study 5 lead us to conclude that the substantial differences between formats found in Studies 2 & 3 are not the results of difference in the encoding of perceptual information. Study 5 supports the fact participants can reliably encode perceptual information, but does not support the conclusion that there is any difference between formats in the amount of perceptual information that is encoded during reading.

We can therefore conclude that participants form a perceptual representation of a text during reading that aids later tasks. This representation can be seen to be used across a number of formatting manipulations, but cannot distinguish between manipulations.

8.1.3. The Encoding of Semantic Information

The information attained during reading is of course more than just visual information. Psycholinguists have long discussed what information is retained after the reading of a page of text.

The experimental evidence from Studies 2 & 3 indicates an advantage for plain over blanket bullet formatted text. Study 3 clearly demonstrates the difficulty participants are experiencing during the reading of blanket bullet format. As discussed in Chapter 5 & 6, the disruption to the reading process cannot be attributed to the bullets themselves. If this was the case, a comparable disruption would be seen during the stem-bullet reading in Study 4. Alternatively, it is proposed that the difficulty experienced during the reading of blanket bulleted text relates to the lack of coherence in the text. Bulleted sentences are treated as isolated pieces of information, making them more difficult to integrate and understand, which therefore leads to a poorer semantic memory representation of the text. This proposal is given support by the pattern of results seen in the search tasks of Studies 2 & 3. Participants who first read blanket bulleted text are then at a distinct disadvantage when it comes to the search of *any* format. This is particularly salient when we consider Study 3: despite participants taking far longer to read blanket bulleted text they remain at a disadvantage when it comes to searching the document.

Insight into the representation formed after reading blanket bulleted text can be seen in the search data of Study 3. Participants are able to successfully locate information within blanket bullet formatting when this is the format they have initially read. However if participants first read blanket bullet formatting and then searched a different format, they were at a distinct disadvantage, with response times comparable to a search of a previously unread document (compare Table 10 with Figure 14: the exhaustive search time average for blanket bulleted text in Study 3 is 5,745 msec, whereas in Task 3, Study 4 the average exhaustive search time is 6,156 msec). This can be interpreted as follows. Participants reading blanket bulleted text fail to form a detailed representation of the document because the document presented in this format lacks coherence. However, as with the other formats, participants are able to acquire information about the visual layout of the text. During the search task, the visual information can aid text search if the same format is presented. However, if a different format is presented, the impoverished semantic representation is not able to facilitate the text search to the same degree as the plain format. To summarise, therefore, the plain formatted text results in a superior semantic representation of the text. There is therefore an advantage brought from this type of formatting to *any* subsequent search, as seen in Studies 2 &3. Blanket bulleted text results in an adequate perceptual representation, that can aid text search when the format is repeated. However, due to an impoverished semantic representation, when no perceptual information is available, participants have little to facilitate text search, resulting in longer response times.

The fact that stem bullet formatting produces a pattern of results very similar to plain formatting suggests that participants regain some of the coherence of the passage through this type of formatting. Unlike blanket bulleting, participants are able to fluently read stem bulleting, so much so that equivalent reading rates and eye movement measures can be seen across the two formats. This fluent reading is due to the stem sentence giving coherence to each passage. As with plain formatted text, participants are aware of how each sentence in the paragraph relates to the others and to the overall topic of the passage. Through this coherence in the passage, readers then create a strong semantic representation in memory of the text. Support for this position can be seen in the ability for this representation to facilitate a search task. During Study 4 the search latencies for stem bulleted text were, in fact, superior to that of plain formatted text, both during paper and computer search. Thus stem bulleted text, like plain text, does not produce any problems during reading, and helps form a representation that can facilitate later tasks.

The amount of semantic information encoded, therefore, can be altered depending on the format of the document being read, which can either enhance or disrupt the coherence of the passage. Blanket bulleted text disrupted fluent reading and semantic encoding of the passage, resulting in a poorer semantic representation of the text in comparison to plain formatted text. Introducing a stem sentence to the bulleted text, however, returned the coherence of the text, resulting in fluent reading and a coherent representation of the text.

8.1.4. The Difference Between Formatting Manipulations

I discussed earlier how the formatting manipulations discussed in this thesis do not seem to differ in their ability to create a visual representation in memory of that text. In a direct perceptual information task, participants were equally able to locate information within a piece of blurred text irrespective of the format being searched.

The distinct advantages for some formats in the earlier studies, therefore, would seem to be the results of the formats altering the way the semantic content of the document was encoded. Plain formatted text, as discussed above, can be seen to be superior to blanket bullet formatted text due to the blanket bulleted formatting disrupting the coherence of the passage. Stem bulleted text, conversely, creates a stronger representation of the text than the plain format, allowing participants to locate information within the document faster than if they were reading and searching the plain format.

8.1.5. Differences between Mediums

The difficulties experienced by users of computer terminals are well known (Muter, Latremouille, Treurniet & Beam, 1982; Gould & Grischkowsky, 1984; 1986; Gould, Alfaro, Barnes, Finn, Grischkowsky & Minuto, 1987a; Kruk & Muter, 1984). Disruptions have been seen in the ability of participants to read, proof-read, and scan texts when they are presented on a computer screen as compared to a paper document. A direct comparison was made between both reading and searching latencies across mediums in Study 4. The much reported reading time difference was again evident in this study. Participants are slower reading a document when that document is presented on a computer screen. This is understandable, as many of the techniques cited as improving the readability of a page of text such as anti-aliasing the letters, were not used in the computer reading studies. The reading time difference, however, was not great between the mediums, resulting in an average difference of just 17 seconds, which is just 7.9% slower from a computer screen.

What is of particular interest in the present context is that there was no difference in the search times between the two mediums: the computer presented documents were searched equally as fast as the paper document. Even taking into consideration that there may have been slightly more time taken in the paper condition to turn the page of the booklet in order to see the target page, there is no obvious difference between the two mediums in the time it took to search them. This is in contrast to Muter & Maurutto (1991) who found differences of as much as 41% when they compared skimming rates between paper and computer screens.

The lack of difference in the two mediums in this thesis suggests that there is no particular advantage for using paper documents over screen presentation, for within page search of a familiar document anyway. The lack of a difference also has procedural implications for the BBC Audience Lines. The fact that the BBC Audience Lines still use paper documents for "difficult" issues is given no support in this context. There is no search time advantage for the Helpliners to locate information within paper documents, so the only basis to continue using paper documents would be because of a subjective preference on behalf of the Helpliners. There is no empirical advantage in the ability to search one medium over another.

A final point to be made about the medium of presentation used relates to the work of Nygren. Nygren (1996) suggested that there was an advantage for the presentation of doctors records to be presented in paper form because of all the "extra" cues that can be ascertained from the paper documentation that cannot be seen when the same information was presented in the standard computerised form. For example, doctors can tell instantly the extent of a patient's history purely by the thickness of a patient's medical record. They can also get an idea of the severity of the complaint simply through the handwriting of the person completing the form (if a nurse completed the form it can be assumed that the patient was in a less severe condition than if a consultant had completed it). Nyren also suggested that the ideal way to present documents on paper is not necessarily the way to present documents on screen, although in stating this she was referring to the presentation of tabular information. We have illustrated that there is no difference between the search speed across mediums when much of the "extra" information that may be obtained from the paper documentation is removed. By presenting an isolated page of pre-read text in Study 4, we demonstrated that participants could search a page presented on paper or on a computer screen equally as fast. We also demonstrated that the effect of different formatting manipulations, in Study 4's case the difference between stem bulleted formatting and plain formatting, are the same for both mediums. Thus, participants are faster reading from paper than from a computer screen, but the pattern of results obtained from formatting manipulations and the search times can be seen to be comparable across mediums.

8.1.6. The Impact on the BBC Audience Lines

Through the work conducted in this thesis it has been possible to pass back to the BBC Audience Lines some information on how they present their documentation. The findings have implications both now for use by Helpliners, and in the future for the possible general consumption of written information produced by the BBC Audience Lines over the Internet.

First we have been able to stress the importance of keeping the formatting of a document constant from one encounter to another. Although this may seem an obvious statement, documents are commonly reused and reedited on a daily basis. For example, if a briefing sheet is produced on the subject of asthma, this may be used by a number of Helpliners over the course of a day or a week, during which time Helpliners can become very familiar with that document. However, for each programme broadcast that the Audience Lines supports, a new briefing sheet is produced. Each programme will necessarily have a different slant depending on what the programme was talking about, and also on what network it was broadcast. Commonly if a similar topic is being discussed the previously created briefing sheet is simply reedited to incorporate this new slant, and perhaps alter or delete certain aspects of the original document. However, it can be seen here that altering the presentation of a document between encounters can result in a loss in the ability of the previously created representation of the text to facilitate the text search. Therefore it was recommended to the BBC Audience Lines that as far as possible, documents should remain unedited. For example, there will always be large topics, such as asthma, covered on a regular basis. If these topics could be kept as independent briefing sheets, irrespective of programme, then it is likely that they would remain largely unedited unless there was a change in thinking on the subject. This way a briefing sheet for a certain programme need only refer to this larger, more familiar document, or even have a hypertext link to it with updated technology. The Helpliner would then have the advantage of searching a familiar document in which search is made easier.

We have also been able to advise the BBC Audience Lines on their use of certain formatting techniques. Long lists of bulleted items, without a structuring initial sentence can impede both reading and also encoding. Lists of individual sentences, as in the separate text of Study 2 can also disrupt the search process.

Another important finding in relation to the BBC Audience Lines' work is that there is a strong difference between self terminating searches of a page ("yes" responses), and exhaustive searches of a page ("no" responses). When a page alone is considered, differences of on average 1,111 msec are seen between response types (taken from Task 1, Study4). This difference is even larger if participants have not first read the document they are searching, 2,042 msec (taken from Task 3, Study 4). Therefore, the temptation of Helpliners producing a briefing sheet to enter more information than is necessary should be strongly discouraged. Although a wide range of information on a certain topic should be available, the presence of unwanted information can extend search times considerably. For this reason clear hypertext links may also be of benefit, in that a page could be searched for the desired information quickly and clearly. If more information was needed on a certain issue, links could be followed for greater depth while not disrupting a fluent search of the page for other information.

Finally, there are strong individual differences in the ability of participants to encode perceptual information. This implies that despite attempts, it may not be possible to design a perceptually memorable text for all users. For this reason it is all the more important to keep the semantic structure of the passage clear as well. Participants will use what information is available to them, and therefore every source of information should be presented in the clearest way.

8.1.7. The Impact for Future Research

There are a number of issues raised throughout this current research which may warrant further investigation. First the experimentation from Study 4 onwards used a number of documents on different subjects in an attempt to investigate the generality of the findings across materials. Illustrating that a formatting difference occurs using one document, although interesting, does not show what will happen in the majority of cases. For this reason, expanding the current research across more materials and tasks will help support the findings of this present thesis.

Second, we uncovered a strong advantage for the repetition of perceptual features across reading and searching encounter. The length of time this effect remains would be of considerable interest both as a factor of how long perceptual information is available to facilitate subsequent tasks, and also in comparison with the decay of information relating to the semantic content of the text. Kintsch (1993) asserted that memory for surface features of text are only retained in working memory and are soon discarded. However, researchers who have investigated the representation held in memory of a text by examining the rereading benefit have claimed that perceptual feature information is retained for as long as a year after an initial reading encounter (Kolers, 1975). The decay of perceptual information over time, and the ability of differently formatted text to facilitate subsequent tasks over time would be of interest and relevance, especially in the context of the BBC Audience Lines producing semi-permanent documents on a single subject that will be reused over a period of time.

A third way of expanding the current research would be to look at other commonly used formatting manipulations in the same way. Authors commonly use columns to present textual information, which some researchers have claimed will facilitate skimming better than plain formatted text (Kolers, Duchnicky & Ferguson, 1981; Muter & Maurutto, 1991). Other authors commonly indent information or enclose pieces of text with a box, again in an attempt to make the information within the box more salient. It may be of interest, therefore, to see if any of these other formatting manipulations result in either a reading or a search task benefit for a pre-read document or a greater facilitation than was found here with stem bulleted text.

Attempting to find a format that aids text search of a previously unseen document may also be of interest and have applications in skimming and searching tasks in general. The Internet has created a huge information resource with the result that vast amounts of information will be accessed and searched through in an attempt to quickly and accurately retrieve information. The studies in this thesis failed to find a reliable formatting effect when the participant had not had the opportunity to pre-read a document. This is not to say that formatting does not have an effect on simple information retrieval. Research on the design of tables has indicated that a well structured page, with easily navigable columns is easier to navigate than the same information was presented in the form of text or without a regular structure (Nygren, 1996) - think of what happens when the formatting of information is lost within an Email message. Therefore, the way information is presented *can* alter the ability of people to find information within it when the information is presented as part of a table of regular display. It is therefore feasible to suppose that the way a textual document is presented may alter our ability to find information within it. The search for this type of formatting will be of interest to future researchers.

Finally, it was found that perceptual information is encoded and retained from an initial reading encounter which then aids subsequent text searches. Does any formatting manipulation, including manipulations not investigated in this thesis, result in more perceptual encoding than another? (under more naturalistic tasks than that of Study 5).

8.2. CONCLUSIONS

In conclusion, this thesis has demonstrated three primary points. First, I have shown evidence of perceptual encoding of text across a number of format manipulations. The extent of this perceptual information was demonstrated in Study 5, resulting in participants having enough information to locate information within a page of blurred text. Second, I have shown the power of various formatting manipulations to alter how a document is read, and therefore how it is encoded. Interfering with the ability of participants to encode the text was seen to be able to alter the representation in memory for that text, and therefore the benefit that could be brought to later tasks. Thus, altering the layout of a page was seen to be able to alter the semantic encoding of the text. Finally, I have shown that the formatting manipulations hold across mediums, with the same pattern of results being evident in the reading and search of both paper and computer screens.

These studies, therefore have demonstrated that both visual and semantic information combine to form a representation of a textual document that has been read, with both factors playing a role within that representation. I have argued that blanket bulleting disrupts the coherence of the document and therefore how it is read and represented in memory, whereas plain formatted text allows for a coherent representation of the semantic content of the text to be created. Altering the blanket bulleted format to incorporate a stem sentence resulted in participants reading and searching the document in much the same way as plain formatted text: participants are able to form a coherent semantic representation of the text. Therefore in the case of both plain and stem bulleted formatting, a strong semantic representation is formed that can then facilitate later searches of any format. However, the perceptual representation created from reading each of the formatting manipulations has not been shown to differ between formatting manipulations.

Through these investigations, the BBC Audience Lines has been able to improve and standardise the information layout of their documentation, as well as remain confident in their formatting consistencies across mediums. The importance of presenting only informative material has also been emphasised, to avoid exhaustive searches of the text.

CHAPTER 9

9. REFERENCES

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APPENDIX 1

A Time Stamped and Coded Transcript

PS1

Turn 1:	**0.00**	**Hello Radio One Helpline**	
		orient	0:04
Turn 2:	**0:04**	**Uhuh**	
		align	0:04.5
Turn 3:	**0:13**	**Uhuh**	
		align	
		Are you still taking it?	
		elicit	0:14
Turn 4:	**0:15**	**And how long did you say you've been taking it?**	
		elicit	
Turn 5:	**For three years?**		
		elicit	0:17
Turn 6:	**0:17**	**Right**	
		align	0:17:5
Turn 7:	**0:20**	**Em**	
		unknown	0:20.5
Turn 8:	**0:24**	**I'm just looking**	
		fr info	0:24.5
Turn 9:	**0:25**	**The effects, em...**	
		br info	0:25.5
Turn 10:	**0:30**	**Some users report a phenomenon of head rushes which feels to the user like blanking out, of sight or hearing**	
		br info	0:37
Turn 11:	**0:40**	**You get it**	
		align	0:40.5
Turn 12:	**0:44**	**How do you know you are getting it when you are asleep?**	
		elicit	0:45
Turn 13:	**0:49**	**Are you disorientated?**	
		elicit	0:50
Turn 14:	**0:52**	**Yeh, and you feel a rush to the head**	
		align	0:53
Turn 15:	**0:54**	**Yes**	
		align	0:54.5
Turn 16:	**0:58**	**Uhuh**	
		align	0:58.5
Turn 17:	**0:59**	**Have you thought about reducing the amount you are taking?**	
		elicit	1:01
Turn 18:	**1:04**	**But what?**	
		elicit	1:04.5

Turn 19:	**1:05**	**Pardon?**	
		elicit	1:05.5
Turn 20:	**1:09**	**Well, is it not better to maybe stop taking it and not having the symptoms?**	
		elicit	1:13
Turn 21:	**1:18**	**But what?**	
		elicit	1:18.5
Turn 22:	**1:22**	**Sorry, I didn't hear you**	
		align	1:22.5
Turn 23:	**1:25**	**Yes, and how often do you take it?**	
		elicit	
		Every day or every weekend?	
		elicit	1:29
Turn 24:	**1:31**	**And do you get these rushes actually at the weekends after you've taken it or do you get them, you know, during the week when you haven't been taking it?**	
		elicit	1:37
Turn 25:	**1:45**	**Mhmm**	
		align	1:45.5
Turn 26:	**1:47**	**Have you been to anybody, eh, you know, your G.P. or anything about it?**	
		elicit	1:51
Turn 27:	**1:55**	**I think you should, em, I, I mean obviously the best thing would be for you, if you could stop taking it because you are obviously getting symptoms that are really quite worrying. If you're going to get it when you're not. You're getting these symptoms when you're not actually taking the drug**	
		fr info	2:11
Turn 28:	**2:15**	**It's not when you're on it**	
		align	2:16
Turn 29:	**2:18**	**Oh, I see**	
		align	2:18.5
Turn 30:	**2:22**	**How about, would you?**	
		fr info 2	2:22.5
Turn 31:	**2:25**	**I'm just looking to see w, wha, if there is anywhere you could go**	
		fr info	2:29
Turn 32:	**2:38**	**I think you really need to talk to somebody about this, you know, em.**	
		fr info	
		There is a drugline freeline.	
		br info	
		Can you take that number?	
		elicit	2:46
Turn 33:	**2:48**	**It's oh eight hundred, double seven, double six, double zero**	
		br info	2:52

Turn 34:	**2:53**	**Em, I mean obviously I, I would imagine they'd probably tell you the same thing but...**	
		fr info	2:57
Turn 35:	**2:59**	**Eh, I mean obviously because you are phoning you, you are worried about it, aren't you?**	
		elicit	3:04
Turn 36:	**3:05**	**Do you take the ecstasy every weekend?**	
		elicit	3:07
Turn 37:	**3:16**	**Sometimes you take it what?**	
		align	3:17
Turn 38:	**3:18**	**Oh, I see**	
		align	3:18.5
Turn 39:	**3:22**	**And are these rushes to the head the same, during the week as they are when you are actually taking the drug?**	
		elicit	3:28
Turn 40:	**3:30**	**That's right**	
		align	3:30.5
Turn 41:	**3:32**	**I think you need to go and see somebody, speak to somebody about it. Em, if you 'phone that number and, em, hopefully they'll be able to give you some information and some help.**	
		fr info	3:42
Turn 42:	**3:44**	**Okay?**	
		align	3:44.5
Turn 43:	**3:45**	**Right, can I ask you which part of the country you're 'phoning from?**	
		elicit	3:47
Turn 44:	**3:48**	**The north.**	
		align	
		And you're age group?	
		elicit	3:50
Turn 45:	**3:51**	**Mmm, you're 19**	
		align	3:51.5
Turn 46:	**3:53**	**Okay**	
		align	3:53.5
Turn 47:	**3:56**	**Okay then?**	
		align	3:56.5
Turn 48:	**3:57**	**Right, bye**	
		orient	3:58

APPENDIX 2

The Plain Formatted Text Document Used in Study 2

SKIN CONDITIONS

Skin is a sensitive and flexible organ that protects the rest of the body from: physical damage; attack by microscopic organisms; chemical pollution; and from damage by the sun. It also plays a key role in keeping the body's temperature within the narrow range needed for healthy working, and in making vitamin D which plays a vital part in maintaining sturdy bones.

The skin is made up of two main layers: the epidermis, or outer layer, and the dermis, the inner layer. The epidermis, like the hair and nails, is dead and millions of cells are shed from it every day. As newly formed cells are pushed to the surface, they gradually flatten and harden. Many modern cosmetics are aimed at the actively growing layer, and advertise themselves as such, but whether any of them reach the cells and have any effect is doubtful because the skin forms an efficient barrier against the entry of many chemicals.

Acne is commonly regarded as a teenage complaint but, while it affects sixty percent of teenagers between fourteen and twenty, it can also affect people with no previous history of the problem in their twenties or thirties. Even over the age of forty, one percent of men and five percent of women still have significant problems. The incidence of acne amongst over twenty-five's, especially women, appears to be on the increase. There are various different types of acne. The first form is called acne vulgaris. Acne vulgaris is characterised by spots on the skin, usually the face, but they can also occur on the back and chest as well. These spots may be red and inflamed, have pus-filled tops, or they may have blackheads and whiteheads.

A more serious type of acne is acne rosacea. Acne rosacea is a long term inflammatory skin disorder affecting the centre part of the face, the cheeks and nose, although the central chin and forehead areas can be affected too. It causes redness on the skin, which is initially intermittent and then permanent. Inflamed pustules and spots might also develop. The blood vessels under the skin may enlarge and show through as thin red lines. In severe cases, the nose may thicken, so it becomes permanently reddened, enlarged, and bulbous especially around the tip. This is most common in male sufferers.

Maturing bodies go through many changes. Oil producing glands in the skin become much more active during puberty, making hair and skin more greasy. At this time it is likely to be more prone to blackheads, whiteheads and acne, especially on the face and back. If a pore gets blocked, bacteria can breed in the trapped oil causing inflamed, red spots. More boys than girls get acne as a result of different hormone levels. Girls periods can bring on acne and spots, and fluid retention can clog pores. Contraceptive pills that contain oestrogen can help acne but progesterone only, or mini pills, can make acne worse.

Acne is not caused by: eating rich or fatty foods; not washing thoroughly; by drinking too much; or by leading a slovenly life. There does, however, seem to be a tendency for acne to run in families. Too much chocolate or certain fatty foods might not help acne, but scientists have found no direct link between diet and the eruption of spots. The excess oil in the skin is caused by the secretions of the sebaceous glands not by the fat in fried food.

Psoriasis is a disease of the skin in which raised, rough, reddened areas appear, covered with fine silvery scales. These areas of skin are known as lesions and they mainly occur in areas such as the knees, elbows, back or scalp, but almost any area of the body may be involved. Although the lesions are unsightly and may sometimes be embarrassing, the disorder is not catching and with care and proper treatment the condition can be brought under control. Psoriasis usually occurs in early adulthood and, like all skin conditions, stress and emotional upsets can make it worse. Small patches of psoriasis often clear up relatively easily when exposed to the sun. Psoriasis affects about two to three percent of the population and can occur equally in men and women and at any age. A far more chronic form is erythrodermic psoriasis. This form of the condition can be life threatening. The symptoms include the entire surface of the skin becoming hot, dry and red. If this happens medical advice should be sought immediately. The widespread ignorance about psoriasis, and the real or imagined reactions of non-sufferers to the condition, may also lead to the psychological suffering of an individual with psoriasis. This may lead to the sufferer's withdrawal from society and to feelings of isolation and depression.

The exact cause of psoriasis is still unknown but there are some factors that seem to affect it. It is often a family disease, but it is thought that other factors have also to come into play to start it off. Stress can bring on psoriasis for the first time and, can also be responsible for a relapse. Children with a family history may well develop the condition at puberty. Women are more prone to psoriasis at or after the menopause.

Permanent cures for psoriasis are not yet possible although many people are helped by treatment. Medical treatments involve creams and ointments, which can be applied locally to the affected area. Oral treatments can also be used as a treatment for psoriasis, although they are only prescribed by, or under the supervision of, a consultant dermatologist. Phototherapy and photochemotherapy can also be used, although again this will only be used under specialist dermatological supervision and for severe resistant psoriasis. Many psoriasis sufferers find that their condition improves when exposed to sunlight and some doctors may recommend the use of artificial sunlight. Artificial sunlight should only be used if the condition is severe, as there is a possible risk of skin cancer from exposure to ultraviolet rays.

Vitiligo is a common disorder of skin pigmentation in which pigment disappears from the skin in patches. These patches are due to a loss of the pigment cells, melanocytes, which create melanin. Depigmented white patches are particularly obvious in dark skinned people, occurring most commonly on the face, hands, armpits and groin. When vitiligo becomes obvious and affects the face or hands, the sufferer can feel isolated and insecure. Hair may become white. The affected skin is particularly sensitive to sunlight. The condition of vitiligo may occur at any age but usually develops in early adulthood. Vitiligo affects about one in two-hundred people, with spontaneous re-pigmentation occurring in about thirty percent of cases. Vitiligo is not contagious, infectious or harmful. The sufferer should be cautious when exposed to the sun as the affected skin does not have the same means to filter the harmful rays which can cause skin cancer.

Vitiligo is thought to be an auto-immune disorder that causes an absence of melanocytes. It is a disease that can be triggered by a wide range of physical and psychological events, including surgery, skin damage, accidents and even stress. There is often a family history of this condition.

Make-up may be used to disguise the affected areas in mild cases and the sufferer may feel that no further treatment is necessary. Phototherapy induces significant repigmentation in more than half of cases of vitiligo, but many treatments are required. Creams containing corticosteroid drugs may also help vitiligo sufferers. If the areas of vitiligo are extensive, chemicals may be used to remove the pigment from remaining areas of normal skin. There is no guaranteed cure, but children tend to improve much more than adults.

APPENDIX 3

The Bullet Formatted Text Document Used in Study 2

SKIN CONDITIONS

- Skin is a sensitive and flexible organ that protects the rest of the body from:
    - physical damage;
    - attack by microscopic organisms;
    - chemical pollution;
    - and from damage by the sun.
- It also plays a key role in keeping the body's temperature within the narrow range needed for healthy working, and in making vitamin D which plays a vital part in maintaining sturdy bones.

- The skin is made up of two main layers:
    - the epidermis, or outer layer;
    - and the dermis, the inner layer.
- The epidermis, like the hair and nails, is dead and millions of cells are shed from it every day.
- As newly formed cells are pushed to the surface, they gradually flatten and harden.

- Many modern cosmetics are aimed at the actively growing layer, and advertise themselves as such, but whether any of them reach the cells and have any effect is doubtful because the skin forms an efficient barrier against the entry of many chemicals.

- Acne is commonly regarded as a teenage complaint but, while it affects sixty percent of teenagers between fourteen and twenty, it can also affect people with no previous history of the problem in their twenties or thirties
- Even over the age of forty, one percent of men and five percent of women still have significant problems.
- The incidence of acne amongst over twenty-five's, especially women, appears to be on the increase.
- There are various different types of acne.
- The first form is called acne vulgaris.
- Acne vulgaris is characterised by spots on the skin, usually the face, but they can also occur on the back and chest as well.
- These spots may be red and inflamed, have pus-filled tops, or they may have blackheads and whiteheads.

- Amore serious type of acne is acne rosacea.
- Acne rosacea is a long term inflammatory skin disorder affecting

the centre part of the face, the cheeks and nose, although the central chin and forehead areas can be affected too.

- It causes redness on the skin, which is initially intermittent and then permanent.
- Inflamed pustules and spots might also develop.
- The blood vessels under the skin may enlarge and show through as thin red lines.
- In severe cases, the nose may thicken, so it becomes permanently reddened, enlarged, and bulbous especially around the tip.
- This is most common in male sufferers.

- Maturing bodies go through many changes.
- Oil producing glands in the skin become much more active during puberty, making hair and skin more greasy.
- At this time it is likely to be more prone to blackheads, whiteheads and acne, especially on the face and back.
- If a pore gets blocked, bacteria can breed in the trapped oil causing inflamed, red spots.
- More boys than girls get acne as a result of different hormone levels.
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- Contraceptive pills that contain oestrogen can help acne but progesterone only, or mini pills, can make acne worse.

- Acne is not caused by:
    - eating rich or fatty foods;
    - not washing thoroughly;
    - by drinking too much;
    - or by leading a slovenly life.
- There does, however, seem to be a tendency for acne to run in families.
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- The excess oil in the skin is caused by the secretions of the sebaceous glands not by the fat in fried food.

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- These areas of skin are known as lesions and they mainly occur

in areas such as the knees, elbows, back or scalp, but almost any area of the body may be involved.

- Although the lesions are unsightly and may sometimes be embarrassing, the disorder is not catching and with care and proper treatment the condition can be brought under control.
- Psoriasis usually occurs in early adulthood and, like all skin conditions, stress and emotional upsets can make it worse.
- Small patches of psoriasis often clear up relatively easily when exposed to the sun.
- Psoriasis affects about two to three percent of the population and can occur equally in men and women and at any age.
- A far more chronic form is erythrodermic psoriasis.
- This form of the condition can be life threatening.
- The symptoms include the entire surface of the skin becoming hot, dry and red.
- If this happens medical advice should be sought immediately.
- The widespread ignorance about psoriasis, and the real or imagined reactions of non-sufferers to the condition, may also lead to the psychological suffering of an individual with psoriasis.
- This may lead to the sufferer's withdrawal from society and to feelings of isolation and depression.

- The exact cause of psoriasis is still unknown but there are some factors that seem to affect it.
- It is often a family disease, but it is thought that other factors have also to come into play to start it off.
- Stress can bring on psoriasis for the first time and, can also be responsible for a relapse.
- Children with a family history may well develop the condition at puberty.
- Women are more prone to psoriasis at or after the menopause.

- Permanent cures for psoriasis are not yet possible although many people are helped by treatment.
- Medical treatments involve creams and ointments, which can be applied locally to the affected area.
- Oral treatments can also be used as a treatment for psoriasis, although they are only prescribed by, or under the supervision of, a consultant dermatologist.
- Phototherapy and photochemotherapy can also be used, although again this will only be used under specialist dermatological supervision and for severe resistant psoriasis.

- Many psoriasis sufferers find that their condition improves when exposed to sunlight and some doctors may recommend the use of artificial sunlight.
- Artificial sunlight should only be used if the condition is severe, as there is a possible risk of skin cancer from exposure to ultraviolet rays.

- Vitiligo is a common disorder of skin pigmentation in which pigment disappears from the skin in patches.
- These patches are due to a loss of the pigment cells, melanocytes, which create melanin.
- Depigmented white patches are particularly obvious in dark skinned people, occurring most commonly on the face, hands, armpits and groin.
- When vitiligo becomes obvious and affects the face or hands, the sufferer can feel isolated and insecure.
- Hair may become white.
- The affected skin is particularly sensitive to sunlight.
- The condition of vitiligo may occur at any age but usually develops in early adulthood.
- Vitiligo affects about one in two- hundred people, with spontaneous re-pigmentation occurring in about thirty percent of cases.
- Vitiligo is not contagious, infectious or harmful.
- The sufferer should be cautious when exposed to the sun as the affected skin does not have the same means to filter the harmful rays which can cause skin cancer.

- Vitiligo is thought to be an auto-immune disorder that causes an absence of melanocytes.
- It is a disease that can be triggered by a wide range of physical and psychological events, including surgery, skin damage, accidents and even stress.
- There is often a family history of this condition.

- Make-up may be used to disguise the affected areas in mild cases and the sufferer may feel that no further treatment is necessary.
- Phototherapy induces significant repigmentation in more than half of cases of vitiligo, but many treatments are required.
- Creams containing corticosteroid drugs may also help vitiligo sufferers.

- If the areas of vitiligo are extensive, chemicals may be used to remove the pigment from remaining areas of normal skin.
- There is no guaranteed cure, but children tend to improve much more than adults.

APPENDIX 4

The Separate Formatted Text Document Used in Study 2

SKIN CONDITIONS

Skin is a sensitive and flexible organ that protects the rest of the body from: physical damage; attack by microscopic organisms; chemical pollution; and from damage by the sun.

It also plays a key role in keeping the body's temperature within the narrow range needed for healthy working, and in making vitamin D which plays a vital part in maintaining sturdy bones.

The skin is made up of two main layers: the epidermis, or outer layer; and the dermis, the inner layer.

The epidermis, like the hair and nails, is dead and millions of cells are shed from it every day.

As newly formed cells are pushed to the surface, they gradually flatten and harden.

Many modern cosmetics are aimed at the actively growing layer, and advertise themselves as such, but whether any of them reach the cells and have any effect is doubtful because the skin forms an efficient barrier against the entry of many chemicals.

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Even over the age of forty, one percent of men and five percent of women still have significant problems.

The incidence of acne amongst over twenty-five's, especially women, appears to be on the increase.

There are various different types of acne.

The first form is called acne vulgaris.

Acne vulgaris is characterised by spots on the skin, usually the face, but they can also occur on the back and chest as well.

These spots may be red and inflamed, have pus-filled tops, or they may have blackheads and whiteheads.

A more serious type of acne is acne rosacea.

Acne rosacea is a long term inflammatory skin disorder affecting the centre part of the face, the cheeks and nose, although the central chin and forehead areas can be affected too.

It causes redness on the skin, which is initially intermittent and then permanent.

Inflamed pustules and spots might also develop.

The blood vessels under the skin may enlarge and show through as thin red lines.

In severe cases, the nose may thicken, so it becomes permanently reddened, enlarged, and bulbous especially around the tip.

This is most common in male sufferers.

Maturing bodies go through many changes.

Oil producing glands in the skin become much more active during puberty, making hair and skin more greasy.

At this time it is likely to be more prone to blackheads, whiteheads and acne, especially on the face and back.

If a pore gets blocked, bacteria can breed in the trapped oil causing inflamed, red spots.

More boys than girls get acne as a result of different hormone levels.

Girls periods can bring on acne and spots, and fluid retention can clog pores.

Contraceptive pills that contain oestrogen can help acne but progesterone only, or mini pills, can make acne worse.

Acne is not caused by: eating rich or fatty foods; not washing thoroughly; by drinking too much; or by leading a slovenly life.

There does, however, seem to be a tendency for acne to run in families.

Too much chocolate or certain fatty foods might not help acne, but scientists have found no direct link between diet and the eruption of spots.

The excess oil in the skin is caused by the secretions of the sebaceous glands not by the fat in fried food.

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These areas of skin are known as lesions and they mainly occur in areas such as the knees, elbows, back or scalp, but almost any area of the body may be involved.

Although the lesions are unsightly and may sometimes be embarrassing, the disorder is not catching and with care and proper treatment the condition can be brought under control.

Psoriasis usually occurs in early adulthood and, like all skin conditions, stress and emotional upsets can make it worse.

Small patches of psoriasis often clear up relatively easily when exposed to the sun.

Psoriasis affects about two to three percent of the population and can occur equally in men and women and at any age.

A far more chronic form is erythrodermic psoriasis.

This form of the condition can be life threatening.

The symptoms include the entire surface of the skin becoming hot, dry and red.

If this happens medical advice should be sought immediately.

The widespread ignorance about psoriasis, and the real or imagined reactions of non-sufferers to the condition, may also lead to the psychological suffering of an individual with psoriasis.

This may lead to the sufferer's withdrawal from society and to feelings of isolation and depression.

The exact cause of psoriasis is still unknown but there are some factors that seem to affect it.

It is often a family disease, but it is thought that other factors have also to come into play to start it off.

Stress can bring on psoriasis for the first time and, can also be responsible for a relapse.

Children with a family history may well develop the condition at puberty.

Women are more prone to psoriasis at or after the menopause.

Permanent cures for psoriasis are not yet possible although many people are helped by treatment.

Medical treatments involve creams and ointments, which can be applied locally to the affected area.

Oral treatments can also be used as a treatment for psoriasis, although they are only prescribed by, or under the supervision of, a consultant dermatologist.

Phototherapy and photochemotherapy can also be used, although again this will only be used under specialist dermatological supervision and for severe resistant psoriasis.

Many psoriasis sufferers find that their condition improves when exposed to sunlight and some doctors may recommend the use of artificial sunlight.

Artificial sunlight should only be used if the condition is severe, as there is a possible risk of skin cancer from exposure to ultraviolet rays.

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These patches are due to a loss of the pigment cells, melanocytes, which create melanin.

Depigmented white patches are particularly obvious in dark skinned people, occurring most commonly on the face, hands, armpits and groin.

When vitiligo becomes obvious and affects the face or hands, the sufferer can feel isolated and insecure.

Hair may become white.

The affected skin is particularly sensitive to sunlight.

The condition of vitiligo may occur at any age but usually develops in early adulthood.

Vitiligo affects about one in two- hundred people, with spontaneous re-pigmentation occurring in about thirty percent of cases.

Vitiligo is not contagious, infectious or harmful.

The sufferer should be cautious when exposed to the sun as the affected skin does not have the same means to filter the harmful rays which can cause skin cancer.

Vitiligo is thought to be an auto-immune disorder that causes an absence of melanocytes.

It is a disease that can be triggered by a wide range of physical and psychological events, including surgery, skin damage, accidents and even stress.

There is often a family history of this condition.

Make-up may be used to disguise the affected areas in mild cases and the sufferer may feel that no further treatment is necessary.

Phototherapy induces significant repigmentation in more than half of cases of vitiligo, but many treatments are required.

Creams containing corticosteroid drugs may also help vitiligo sufferers.

If the areas of vitiligo are extensive, chemicals may be used to remove the pigment from remaining areas of normal skin.

There is no guaranteed cure, but children tend to improve much more than adults.

APPENDIX 5

The 24 Questions for the Skin Document Used in Studies 2 & 3

Questions that required an answer of "yes" in Study 3 are printed in italics and bold.

1. What is a far more chronic form of psoriasis, which can be life threatening?
   Erythrodermic psoriasis.

2. ***In what percentage of people with vitiligo does spontaneous repigmentation occur in?***
   30%

3. If a pore gets blocked, what can breed in the trapped oil causing inflamed, red spots?
   Bacteria.

4. ***What layer of the skin, like the hair and nails, is dead and millions of cells are shed from it every day?***
   The epidermis.

5. ***What are the raised, rough, reddened areas covered with fine silvery scales in psoriasis known as?***
   Lesions.

6. ***Artificial sunlight should only be used if the psoriasis is severe, because what is there a risk of from exposure to ultraviolet rays?***
   Skin cancer.

7. What have scientists found not direct link between and the eruption of spots?
   Diet.

8. When may children with a family history of psoriasis develop the condition?
   Puberty.

9. Where are the spots usually located in people suffering from acne vulgaris?
   The face.

10. ***What are the pigment cells in skin, which create melanin called?***
    Melanocytes.

11. What other kind of suffering may be caused by widespread ignorance about psoriasis, and the real or imagined reactions of non-sufferers?
    Psychological.

12. ***What percentage of teenagers between fourteen and twenty are affected by acne?***
    60%.

13. ***More boys than girls get acne as a result of different levels of what?***
Hormones.

14. What may happen to the nose in severe cases of acne rosacea?
May thicken.

15. ***What does vitamin D play a vital part in maintaining?***
Sturdy bones.

16. When does the condition of vitiligo usually develop?
Early adulthood.

17. With acne rosacea, what may enlarge and show through the skin as thin red lines?
Blood vessels.

18. ***What type of disorder is vitiligo thought to be?***
An auto-immune disorder.

19. ***What percentage of the population are affected by psoriasis?***
2-3%

20. ***What is the excess oil in the skin caused by, if not the fat in fried food?***
The secretions of the sebaceous glands.

21. Who are oral treatments for psoriasis only prescribed by, or used under the supervision of?
A consultant dermatologist.

22. What does the skin form and efficient barrier against?
An effective barrier.

23. ***What can bring on psoriasis for the first time, and can also be responsible for a relapse?***
Stress.

24. What gradually happens to newly formed cells as they are pushed to the surface?
Flatten and harden.

APPENDIX 6

An Example of the Stem Bulleted Format, for Documents Discussing Asthma and Homelessness

Asthma

Asthma is a chronic condition which is due to the narrowing of the air passages in the lung.

- The narrowing is due to a swelling of the airway wall, an increase in secretions in the lungs and a tightening of the muscles around the airway.
- The main symptoms caused by asthma are coughs, wheezes, breathlessness, and chest tightness.

Asthma is the most common chronic condition of children and adults.

- It affects approximately five percent of adults in Britain, and between ten to twenty percent of children.
- The number of individuals suffering from asthma is between two and three million.
- Asthma is becoming more common although the reasons for this are unknown.
- It has been suggested that possible reasons may include:
    - an increased exposure to allergens such as house dust mites and pollen;
    - smoking during pregnancy;
    - dietary factors; and
    - possibly air pollution.

If an individual's asthma involves being allergic to house dust mites there are various precautions that can be taken.

- Bedding can be a problem for sufferers.
- Special non-fabric mattress covers can be used to provide a barrier against dust mite droppings.
- Unfortunately these can be expensive.
- Synthetic pillows and duvets can also help.
- Bedding should be washed every week at sixty degrees centigrade.
- Soft toys can be put in the freezer regularly to destroy any dust mites present.
- Short pile synthetic carpets and vinyl are the best floor coverings to use, and if possible others should be left to vacuum.

If the asthma involves being allergic to grass pollens other precautions can be taken.

- On hot, dry days there may be a lot of grass pollen so spending too much time out of doors should be avoided.
- Long grasses should also be avoided in summer.
- Many weather forecasts give pollen warnings during the summer, and so particularly bad days can be noted and precautions taken.

There are two main types of treatment for asthma.

- There are preventers, which guard against asthma happening at all, and
- there are relievers, which controls breathing difficulty as it happens.

Preventers and relievers work in different ways.

- Preventers work by building up a protective shield in the lining of the airways that make them less likely to narrow when triggered.
- They do not bring on instant relief from symptoms, and will not work unless they are used regularly, but they can save lives and restore quality of life to sufferers.
- Relievers, or bronchodilators, rescue sufferers from breathing difficulties as they happen.
- The reliever is designed to relax the muscles surrounding the airways by opening them and allowing ease of breathing again.
- They do not reduce the inflammation in the airways.

Along with preventers and relievers, there are other devices that can be used to ease the life of an asthma sufferer.

- A peak flow meter is a mechanism whereby an asthmatic can obtain a reading which indicates how open their airways are.
- The more open the airways are, the higher the rate at which air can be blown out of the lungs, and the higher the peak flow reading.
- During episodes of asthma, the airways become narrowed, and the peak flow reading falls.
- Measuring the peak flow reading can help indicate when an attack is on the way.
- Often there will be a drop in readings a few days before symptoms develop.

The typical symptoms that can be seen young children suffering from asthma are wheezing or troublesome coughing.

- This occurs particularly at night, with colds, or with exercise.
- It is the pattern and severity of symptoms over time which shows whether a child has asthma or not.
- Children benefit once everyone knows they have asthma because they will then receive regular monitoring and proper treatment.
- Children under two are most likely to suffer from the type of asthma which is set off by virus infections such as colds and a runny nose.

Spotting asthma in children can still be difficult.

- This is due to the fact that at least thirty percent of all children will have wheezing during their first five years of life, and most of these children will never have breathing problems again so doctors may not want to use the term asthma.

Doctors often classify children's asthma into mild, moderate and severe forms.

- Mild asthma involves coughs and or wheezes, but the child may play happily, feed well, and sleep undisturbed by their symptoms.
- Moderate asthma involves waking at night, not being able to run and play without wheezing or coughing.
- Severe asthma is when the child is too restless to sleep, unwilling to play at all, and too breathless to talk or feed.
- If very severe the child's lips may go blue.

Homelessness

According to the Housing Act, a person is homeless if they have no accommodation in England, Wales or Scotland that they can reasonably occupy, together with anyone else who lives with them, as a member of the family.

- The law has different terms in Scotland and Northern Ireland, but the definition is basically the same.
- It is possible to be legally homeless even if the person has a place to live.
- For example if the occupier is subjected to violence, racial harassment, or if the accommodation is unfit to live in.

It is not an offence to sleep rough in the street in Britain, as long as the general public is not obstructed.

- However, depending on the area, there may be local by-laws which prevent people from sleeping rough and the police may move people on if local residents complain.

It is usually possible to claim income support whilst in temporary accommodation and it may also be possible to claim housing benefit.

- It must be remembered, however, that the local authority may charge for meals and other bills that will have to be paid for using the income support money.
- A person who is sleeping rough can still claim income support but they will not be entitled to any premiums.
- A homeless couple will receive a couple's personal allowance.

Each local authority has certain duties to homeless people.

- Local authorities have an obligation to take notice of the code of guidance to the housing act when dealing with a case of homelessness.
- This code of guidance is issued by the Department of the Environment in England and Wales, or in Scotland, the Scottish Office.
- How far they act on these guidelines varies amongst authorities.
- A homeless person does not have to prove they are homeless.
- The onus is on the local authority to prove that a person is not homeless.
- Whilst it investigates a case, the local authority must provide the person concerned with temporary accommodation.

If a parent wishes their child to leave home, then the child must do so, given reasonable notice.
- Many local authorities will then recognise the child as legally homeless, but some may ask the parents to get a court order first.
- If a child is under eighteen and has left home for whatever reason, the social services have a responsibility towards them.

Sixteen and seventeen year olds who are due to leave accommodation provided by the local authority can expect the local authority to help them plan how to live independently.
- A continuing care plan should be drawn up.
- This plan sets out:
  - where the young person is to live;
  - how they will support themselves financially; and
  - what support there will be if these arrangements break down.

Another form of homeless accommodation is squatting.

- Squatting is when people occupy an empty house or flat without the consent of the owner.
- The term squatter can be used to cover two different groups of occupiers:
  - people who entered premises without permission and occupy those premises. In law, these people are trespassers; and
  - people who previously entered a property as squatters but have now been given permission to occupy.
- Usually, a squatter who is entering premises will only be prosecuted if they have caused criminal damage, for example by breaking a window or a door.

A squatter who uses an illegal supply of gas or electricity risks being disconnected and charged with theft of gas or electricity.

- Squatters may have problems obtaining a supply of gas and electricity and a deposit will often be required.
- Water Companies must provide a water supply to an occupied property.
- If the supply is disconnected, a squatter should contact the water company to get it reconnected.
- Squatters will be billed for connection and water charges.

A squatter who is occupying premises which are their sole or main residence, is liable to pay council tax.

- The squatter should be aware that contact with the local authority council tax section will alert the local authority to their presence.
- A squatter should not be refused benefit merely because they are a squatter, and should claim any benefits in the normal way.
- Since squatters do not have accommodation that they have a legal right to occupy, they are considered homeless.

Common law landlords have the right to evict squatters themselves without getting a possession order.

- However, landlords risk committing an offence under the criminal law act if they do evict without a court order.
- It is an offence if any person without lawful authority uses or threatens violence for the purpose of securing entry to premises when there is someone present on those premises who is opposed to the entry.

APPENDIX 7

An Example of the Plain Bulleted Format, for Documents Discussing Adoption and Protests and Campaigns

Adoption

Adoption is a formal legal process in which all rights, powers duties and responsibilities relating to a child are transferred to the adoptive parent. There are various bodies through which adoptions can be arranged. These include: the social services department or an approved agency; voluntary adoption agencies which are approved by the secretary of state for health; and a local authority. Once the adoption order is made, the child's birth parents lose all rights in relation to the child. Adoption is a permanent court order.

For a baby to be adopted by a blood relative the child must be at least nineteen weeks old. They must also have been living with the relative for at least thirteen weeks before an adoption order can be made. Once an adoption order has been made it cannot be reversed. Where a child is born as the result of a surrogate arrangement, a parental order can be made so that the child is treated in law as the child of the commissioning couple. A parental order will be made only where the couple are married and one is the genetic parent of the child.

In Britain the state pays for most of the expenses involved in adoption. The actual legal process of adoption does not require the services of a lawyer, providing the adoption is a straightforward case. Child allowance is the entitlement of the adoptive parents from the moment the child comes to live with them. This would not apply if the parents were fostering a child and already receiving a fostering allowance.

In certain circumstances the local authority may pay something called an adoption allowance, although not all local authorities provide this allowance. The actual amount available will vary from area to area. Legislation for an adoption allowance was developed in order to permit children to be adopted who might not otherwise have been adopted because of financial reasons.

Before an individual contacts their birth parents there are a number of points to consider. These includes: considering what will be felt if the birth parents refuse to meet them; what it is that is motivating them to try and find their birth parents; and what effect contacting their birth parents may have on their adoptive family.

Counselling is usually required before information can be given from adoption records. The counsellor is usually a social worker who will give the adopted person the opportunity to discuss their expectations and consider some of the issues that will enable them to be prepared for their search. In England, adopted adults over eighteen years old, are able to apply for access to their original birth records. Using the information on the birth certificate, some adopted people have been able to trace and make contact with their birth parents or other relatives.

In England there is also an adoption contact register which is held by the general register office, and is in two parts. The first part is a register of adopted persons, the second part is a register of birth relatives who want to contact an adopted person. The purpose of the adoption contact register is to put adopted people and their birth parents or other relatives in touch with each other where this is what they both want to do.

Until the introduction of the adoption contact register there was no way of knowing whether contact would be welcome. Now, if an individual is interested in making contact with their adopted child they can place their name on the adoption contact register. To put a name on the Birth Link Register, the adoption must have taken place in England or Wales. Birth parents and other relatives who have decided that they would rather not have contact with an adopted person do not have to worry. The register cannot help an adopted person learn the whereabouts of a birth parent or other relative unless that person has chosen to be entered on the register.

Protests and Campaigns

Before organising a protest, there are a number of issues to be addressed. One of the major considerations is to ensure that the protest does not break the law. There are many different organisations with experience in arranging campaigns and protests. It may be possible that they will have similar aims and can offer their experience and facilities in the preparation of the protest.

Although the police have been given very wide powers under the criminal justice and public order act, the actual exercise of these powers has been rare since the act came into force. Only a handful of the hundreds of thousands of prosecutions brought under the act have been for offences connected with: organising marches or assemblies; defying banning orders; or even breaching conditions imposed by the police. However, it is worthwhile understanding the main provisos of these acts before organising a protest.

An efficient stewarding operation avoids many of the interactions between protesters and police that create potential for conflict. Protesters are usually quite happy to follow sensible instructions from stewards; as long as it is known that they are part of the organisers' plan, rather than some arbitrary decision made on the spot by a police officer. Stewarding can give confidence to protesters, while allowing information about particular difficulties to reach the organisation room, or chief stewards at the protest, very quickly.

Stewards should be briefed prior to the protest on exactly what they should be doing, and who they should report to in the event of difficulty. The stewards are an integral part of the organisation of the event and should be easily identifiable to police and protesters. This can be achieved by the use of: bibs; arm bands; special T- shirts; or badges. At the protest, the stewards should always have a map of the proposed route and the telephone number of the organisation room.

Some organisations have groups of legal observers who are prepared to attend demonstrations and make an independent note of numbers and movements of police and protesters. In the event of arrests legal observers will make an immediate notes of witnesses' names and addresses. In this way, legal observers can be of help if there is any trouble. In general, however, the presence of legal observers at a demonstration is reassuring to both the protesters and to the police.

It is important for the legal observers to perceive themselves as independent of both the protest and its organisation. They may therefore wish to be identified in a way that distinguishes them from other people on the march, including the stewards. Often law students or lecturers from local colleges are prepared to be legal observers. Inexperienced legal observers should be briefed by a solicitor before attending the protest.

Stewards and legal observers should know where to meet immediately after the event for a debriefing. In the debriefing any feedback or information from both the stewards and the legal observers can be retrieved. Both the stewards and the legal observers should be available to come to a defendants' meeting, in case anyone at the demonstration is arrested. This meeting should be planned for two or three days after the event. Arranging the defendants' meeting provides a safety net which allows for all the resources available to be drawn up should there be a defendants' group that needs these resources.

Prior to the actual event itself, the advance publicity should include a clear statement of: the venue for assembly; the time of departure for the march; and the time and place of the eventual rally. Any venues advertised, as a matter of good practice, should be agreed in advance with the owners, local authority and police.

On the day of the protest there should be a reference point, an organisation room. The organisation room should be away from the demonstration itself, with at least two separate phone lines. One of the telephone numbers should be circulated widely, so that anyone arrested is likely to have a leaflet with the number written on it in the police station. This will also be the number used by the stewards or legal observers if they want to contact the organisation room during the protest. The second phone line can be kept for outgoing calls, for example to the police station; the standby lawyer; or the press.

Well in advance of the actual protest, it is advisable to arrange a standby lawyer who is prepared to be contacted during the demonstration itself, and to follow through with representation for any arrested demonstrators if they require it. The standby lawyer should be a criminal solicitor with particular experience of dealing with demonstrations. There are organisations which can help find such a solicitor in any area. If difficulties are experienced negotiating with the police in advance, the standby lawyer may be prepared to help.

Under Scots Law an adopted person born in Scotland has the right of access to their original birth entry from the age of seventeen. A person adopted in Scotland also has the right of access to court documentation about their adoption. Family care adoption society in Edinburgh operates the birth link register for Scotland. The birth link register has been in existence since and was specifically set up at the request of birth parents who wished information on the child they placed for adoption. Unlike the adopted person, the birth parent or relative does not have any statutory rights to assist them in tracing the child placed for adoption. The birth parent or relative does not therefore have the right of access to the court papers.

APPENDIX 8

The 20 Questions Prepared for Each Material

The questions which required an answer of "yes" are printed in italic and bold.

ADOPTION

1. Who are voluntary adoption agencies approved by?
   The secretary of state.

2. ***From what age does a person born in Scotland have the right to access their original birth entry?***
   17.

3. ***How old must a child be to be adopted by relatives?***
   At least 19 weeks old.

4. What must a couple be, in order to have a parental order of surrogacy made?
   Married.

5. Who is registered on the second part of the adoption contact register?
   Birth relatives.

6. What documentation about their adoption does a person in adopted Scotland have the right to access?
   Court Documentation.

7. ***What office holds the adoption contact register in England?***
   The general register office.

8. ***What job does the councillor of adopted individuals who want to see their birth certificate usually have?***
   A social worker.

9. Before an individual contacts their birth parents, one of the points they must consider is what will be felt if their birth parents do what?
   Refuse to meet them.

10. ***What benefit is the entitlement of the adoptive parents from the moment the child comes to live with them?***
    Child allowance.

11. ***Where must the adoption have taken place if an individual wants to place their name on the adoption contact register?***
    England or Wales.

12. What allowance may the local authority pay in some circumstances, although not all local authorities provide this allowance?
    An adoption allowance.

13. Until the introduction of what in England and Wales, was there no way of knowing whether contact would be welcome?
    The adoption contact register.

14. ***What department can arrange adoptions?***
    The social service dep.

15. ***Some adopted people have been able to trace and make contact with their birth parents using the information on what?***
    The birth certificate.

16. ***Where a child is born as the result of a surrogate agreement, what can be made so that the child is treated in law as the child of the commissioning couple?***
    A parental order.

17. How old must adopted adults in England be before they can apply for access to their original birth records?
    18.

18. What group of people specifically requested the setting up of the Birth Link Register?
    Birth parents.

19. ***Who operates the Birth link Register in Edinburgh?***
    Family care adoption society.

20. Who does the actual legal process for adoption not require the services of, providing the adoption is a straightforward case?
    A lawyer.

ASTHMA

1. ***What are the best floor coverings for dust mite affected asthmatics to use?***
   Short pile, synthetic and vinyl.

2. ***What percentage of all children will have wheezing during their first five years of life?***
   30%

3. Smoking during what time has been suggested as a possible reason for asthma?
   Pregnancy.

4. ***The narrowing of the air passages in the lung is due to a tightening of what, around the airway?***
   The muscles.

5. ***What treatment works by building up a protective shield in the lining of the airways that make them less likely to narrow when triggered.***
   Preventers.

6. The more open the airways are, the higher the rate at which what can happen?
   Air can be blown out of the lungs.

7. ***Children under what age are the most likely to suffer from the type of asthma which is set off by virus infections such as colds and a runny nose?***
   Two.

8. What percent of adults in Britain are affected by asthma?
   5%.

9. What treatment controls breathing difficulty as it happens?
   Relievers.

10. What treatment does not bring instant relief from symptoms, and will not work unless regularly used?
    Preventer.

11. ***What does the reading obtained from a peak flow meter indicate?***
How open the airways are.

12. What type of child asthma is characterised by waking at night, and not being able to run or play without wheezing or coughing?
Moderate Asthma.

13. ***What are bronchodilators also known as?***
Relievers.

14. ***What type of mattress covers can be used to provide a barrier against dust mite droppings?***
Special non-fabric.

15. What should be avoided in summer for individuals who are allergic to grass pollen?
Long grasses.

16. How often should the bedding of dust-mite affected asthma sufferers be washed?
Every week.

17. What may happen to a child's lips if the asthma is very severe?
They may go blue.

18. What happens to the peak flow reading during an episode of asthma?
It falls.

19. ***How many individuals suffer from asthma?***
Between 2 and 3 million.

20. ***Sever asthma can result in the child being too restless to do what?***
Sleep.

DIVORCE

1. ***If there are significant sums involved in a divorce, what kind of advice can a solicitor be asked to get?***
   Actuarial advice.

2. ***If each partner has worked throughout their life, what will they probably be entitled to in their own right?***
   A full retirement pension.

3. What agency has the right to review child support in the future, and can raise the level of maintenance?
   The child support agency.

4. ***A clean break divorce is a once and for all order that deals with what type of issues between spouses?***
   Financial issues.

5. ***What can a divorcee apply for if she is on income support?***
   A community care grant.

6. A partner will be responsible for the other's debt if one partner acted as what for the other?
   Guarantor.

7. ***What is it important that a partner pursuing a pension gives their ex-partner's employer, so as to receive any pension she is entitled to?***
   Her address.

8. What does a clean break divorce provide for the dismissal of?
   Maintenance claims.

9. When a relationship end, what will a divorcee often need to meet the costs arising out of the separation?
   A lump sum.

10. When children are involved in a divorce, what may it be possible to obtain from the social services department?
    A section 17 payment.

11. ***A partner will be responsible for the other's debt if the debt is for what?***
    Community charge or council tax.

12. What may a divorced woman who does not have a full contribution record and who has not remarried be able to claim a retirement pension on?
    Her x-husband's record.

13. ***What has each local authority the power to provide in order to safeguard and promote the welfare of children in need in their area?***
    Financial assistance.

14. ***A court will be unwilling to provide for a clean break divorce in circumstances when what is the wife's only means of support?***
    Income support.

15. What is a spouse who is in receipt of maintenance considered, and as such can make a claim against the husband's estate under the family and inheritance act?
    A dependant.

16. A clean break divorce can extend only to the parties in the marriage and not to what?
    The provision for the children.

17. If a married woman is paying reduced contributions, what must she start paying as soon as she is divorced?
    Full contributions.

18. What will the way an occupational pension scheme is treated after divorce depend on?
    The rules of that particular scheme.

19. ***What does a clean break divorce encourage both parties to create?***
    Independent lives.

20. ***If a woman remarries before retirement age, who's contributions can she <u>not</u> claim a pension on?***
    Her former husband's.

HOMELESSNESS

1. If a person is subjected to what kind of harassment would they be considered legally homeless, despite having a place to live?
   Racial harassment.

2. ***What is a squatter who is occupying premises which are their sole or main residence liable to pay?***
   Council tax.

3. ***What is it not an offence to do in the streets of Britain, as long as the general public are not obstructed?***
   Sleep rough.

4. Depending on the area, what may there be which prevent people from sleeping rough?
   Local by-laws.

5. Usually, a squatter who is entering a premises will only be prosecuted if they have caused what?
   Criminal damage.

6. What should a squatter not be refused, merely because they are a squatter?
   Benefit.

7. ***In law, what are people who enter premises without permission and still occupy these premises?***
   Trespassers.

8. ***Who has a responsibility towards a child who is under the age of eighteen and has left home for whatever reason?***
   The social services.

9. If a parent wishes their child to leave home, then the child must do so, given what?
   Reasonable notice.

10. ***In Scotland, who issues the code of guidance to the housing act?***
    Scottish office.

11. ***What must Water Companies provide a water supply to?***
Occupied property.

12. While investigating a case of homelessness, what must the local authority provide the person concerned?
Temporary accommodation.

13. What does a squatter who uses an illegal supply of gas or electricity risk being charged with?
Theft.

14. ***What is it possible to be, even if the person has a place to live?***
Legally homeless.

15. ***A Continuing Care Plan will set out how a young person will support themselves in what way?***
Financially.

16. ***What benefit can a person who is sleeping rough still claim?***
Income support.

17. What type of plan should be drawn up for sixteen and seventeen year olds due to leave care provided by the Local Authority?
A Continuing Care Plan.

18. Who have the right to evict squatters themselves without getting a possession order?
Common Law Landlords.

19. ***Since squatters do not have accommodation that they have a legal right to occupy, what are they considered?***
Homeless.

20. What code do local authorities have an obligation to take notice of when dealing with a case of homelessness?
The code of guidance to the housing act.

PROTESTS AND CAMPAIGNS

1. What is it possible that an organisation with experience in arranging campaigns and protests will have?
   Similar aims.

2. ***What should be away from the demonstration itself, with at least two separate phone lines?***
   The organisation room.

3. ***What act have the police been given very wide powers under?***
   The criminal justice and public order act.

4. Only a handful of the hundreds of thousands of prosecutions brought under the criminal justice and public order act have been for offences connected with organising what?
   Marches or assemblies.

5. What should both the stewards an legal observers be available to come to in case anyone at the demonstration is arrested?
   A defendant's meeting.

6. What should the second phone line in the organisation room be kept for?
   Outgoing calls.

7. ***What should stewards and legal observers meet after the event for?***
   A debriefing.

8. ***What is it important for legal observers to perceive themselves as independent of?***
   The protest and its organisation.

9. What do legal observers make an independent note of during the demonstration?
   Numbers and movements of police and protesters.

10. ***Who are an integral part of the organisation of the event and should be easily identifiable to police and protesters?***
    The stewards.

11. Who should any venues advertised be agreed in advance with, as a matter of good practice?
The owners, local authority and the police.

12. What, along with the telephone number of the organisation room, should a steward always have at the protest?
A map of the proposed route.

13. Prior to the event, what should include a statement of the venue for assembly, the time of departure and the time and place of the rally?
The advance publicity.

14. What is one of the major considerations to be addressed before organising a protest?
That it does not break the law.

15. Who should inexperienced legal observers be briefed by before attending the protest?
A solicitor.

16. Who are usually quite happy to follow sensible instructions from stewards, as long as they know it is part of the organisers plan?
Protesters.

17. Who are often prepared to be legal observers?
Law students or lecturers from local colleges.

18. Who may be prepared to help if difficulties are experienced negotiating with the police in advance?
The standby lawyer.

19. What should the standby lawyer be, with particular experience with dealing with demonstrations?
A criminal solicitor.

20. What can stewarding give to protesters, while allowing information about particular difficulties to reach the organisation room?
Confidence.

TINNITUS

1. ***Tinnitus is related to high blood pressure associated with what?***
   Stress

2. ***Specialists may recommend or arrange a variety of treatments depending on what?***
   An individual's situation and needs.

3. Who appear to be more affected by tinnitus, men or women?
   Women.

4. ***What is it possible to have a very marked loss of, without any tinnitus at all?***
   Hearing.

5. ***When someone sees no end to the tinnitus what may they even start to have?***
   A nervous breakdown.

6. What can, for some people, night of broken sleep develop into?
   A habit which is difficult to break.

7. ***What hospital departments now have a special interest in tinnitus, with some having their own tinnitus clinic?***
   Ear nose and throat departments.

8. What proportion of the adult population are affected by tinnitus?
   Up to one in ten.

9. What is a very common emotional response amongst tinnitus sufferers?
   A fear of the tinnitus becoming worse.

10. What have some tinnitus sufferers reported contemplating, because tinnitus can sometimes produce extreme states of despair?
    Suicide.

11. ***What is one of the most common responses to tinnitus, affecting over half of sufferers to some extent?***
Insomnia.

12. What is also known as a white noise generator?
A tinnitus masker.

13. ***It is not always clear whether it is the tinnitus which is causing the emotions experienced by tinnitus sufferers or whether it is combining with what?***
An existing stress.

14. ***If tinnitus is not a disease, what is it?***
A symptom.

15. If the tinnitus has a treatable cause, what can antibiotics clear up?
An infection in the middle ear.

16. Tinnitus can develop following what type of upset?
An emotional upset.

17. What secondary benefit may complementary therapies have, making the sufferer feel a lot better?
Allowing the sufferer to have a better sleep.

18. What is the initial step that should be taken by tinnitus sufferers?
To contact their doctor.

19. ***Every day, how many people in Britain experience the onset of tinnitus?***
Two hundred.

20. ***What is it probable that complementary therapies have no direct effect on?***
The ears.

APPENDIX 9

Examples of the Booklets Used in Task 2, Study 4 for the Materials on the Financial Consequences of Divorce and Tinnitus

Divorce 1

Question 1

The disadvantages of a clean break divorce include: the fact that the capital award is unlikely to produce as high an annual income if it is invested at standard rates as any maintenance provision; a court will be unwilling to provide for a clean break in circumstances where the wife's only means of support is income support; a clean break order should include a provision to prevent one spouse from having to claim on the estate of the other spouse after death under the family and inheritance act; and the clean break approach can extend only to the parties in the marriage, and can not extend to the provision for the children.

It is important to get details of all pension entitlement, insurance policies, shares and other assets of a spouse. If there are significant sums involved, a solicitor can be asked to get actuarial advice. On a straightforward case this will cost roughly three-hundred to five hundred pounds. A clean break settlement should not be accepted, unless the terms are irresistible. A spouse who is receipt of maintenance is considered a dependent, and as such can make a claim against the husband's estate on his death under the family and inheritance act.

Question 2

If a couple are divorcing this may have consequences for each partner's future retirement pension. If each partner has worked throughout their life, or had breaks only for child rearing, they will probably be entitled to a full retirement pension in their own right. Remarriage will not affect this pension.

A divorced woman who does not have a full contribution record and does not remarry may be able to claim a retirement pension on her ex-husbands record. If a woman remarries before retirement age, she cannot claim a pension on her former husband's contribution but can benefit from her new husband's entitlement. If she does not remarry before retirement age, but her former husband has remarried, she remains entitled to a pension based on her ex- husband's contributions. If a married woman is paying reduced contributions, she must start paying full contributions as soon as she is divorced.

Question 3

When a couple have joint insurance policies, they will need to weight up the implications of joint financial commitments against the possible loss from terminating a policy early. For married, cohabiting, and divorcing couples, neither partner is responsible for the other's debts. There are certain exceptions to this rule, however. A partner will be responsible for the other's debt if: the debt is for community charge or council tax; the debt was incurred jointly; or one partner acted as guarantor for the other.

After divorce, the way in which an occupational pension is treated will depend on the rules of that particular scheme. Some occupational pension schemes will assess the degree of dependency of the partner, others will not. The partner has no access to the rules of her partner's occupational pension scheme and therefore must wait until her ex-partner retires before knowing if she will receive a pension. It is important that a partner pursuing the pension gives her address to her ex-partner's employer so she will receive any pension to which she is entitled.

Question 4

A clean break divorce is a once and for all order that deals with all financial issues between spouses. It provides for the dismissal of maintenance claims and is not capable of subsequent variations even if circumstances change.

The advantages of a clean break settlement include: the husband knows that his maintenance obligations to his wife will end; the wife knows she will receive a specific sum of money; and it encourages both parties to create independent lives. However, following the implementation of the child support act, the child support agency has the right to review child support in the future and can raise the level of maintenance.

Question 5

When a relationship ends, a divorcee will often need a lump sum to meet costs arising out of the separation. There are many expenses involved in a separation and especially in setting up a separate home. The divorcee may be able to apply for a community care grant if she is on income support. This can cover the cost of furniture; removal expenses; and for fuel connection charges. If a spouse is trying to obtain money to set up a separate home and children are involved, it may be possible to obtain a section seventeen payment from the social services department.

Each local authority has the power to provide financial assistance in order to safeguard and promote the welfare of children in need in their area. To obtain this assistance the family must have a child who is assessed by the local authority as being in need. This will be assessed by a social worker.

Tinnitus 1

Question 1

Tinnitus is a symptom, not a disease, and there can be many different causes.

- Tinnitus can develop following an emotional upset;
- an illness;
- an injury; or an infection which may or may not be related to the hearing mechanism.
- It can also appear as a reaction to, or side effect of, a drug, and
- is related to high blood pressure associated with stress.

Occasionally, the cause of tinnitus is treatable.

- For example,
    - antibiotics can clear up an infection of the middle ear,
    - syringing can remove the wax from a blocked ear, and
    - changing or ending a course of medication may put an end to the noise.
- However, where there is permanent damage to the function of the inner ear hair cells, there is currently no wonder-drug or operation which will immediately get rid of the tinnitus.

Question 2

Specialists may recommend and arrange a variety of treatments depending on an individual's situation and needs.

- Treatments may include a hearing aid, because even if there is only a slight hearing loss the use of a hearing aid may reduce or mask tinnitus.
- There is also something called a tinnitus masker, which is also known as a white noise generator.
- A tinnitus masker looks like a hearing aid and generates a quiet, gentle sound of its own, which gives the ear something to listen to and diverts the attention of the listener from the tinnitus so that it moves into the background.

Some people with tinnitus have reported that acupuncture, hypnotherapy, homeopathy and other complementary therapies have been of benefit.

- Although they probably have no direct effect on the ears, they may result in the reduction of tension and anxiety that the tinnitus sufferer may be experiencing.
- It may also have the secondary benefit of allowing the sufferer to have a better sleep, and in that way too, making the sufferer feel a lot better.
- Most alternative treatments are only available privately, although some are available on the national health service.

Question 3

One of the most common responses to tinnitus, affecting over half of sufferers to some extent, is insomnia.

- Insomnia can take the form of difficulty in getting to sleep, of waking in the night, of early morning wakening, or all three.
- For some people, these nights of broken sleep can develop into a habit which is difficult to break.
- This inability to sleep can result in a dependence on sleeping tablets, a secondary concern resulting from the initial problem of tinnitus.
- Other methods of trying to get to sleep should be tried before resorting to sleeping tablets.

The initial step that should be taken by tinnitus sufferers is to contact their doctor.

- A doctor can carry out an initial examination to check for problems such as wax and infections, and may also be able to advise on some basic ways of dealing with the tinnitus.
- A number of hospital ear, nose and throat departments now have a special interest in tinnitus and some have their own tinnitus clinic.

Question 4

Tinnitus is the term for noises which are heard in the ears or in the head.

- These are buzzing, ringing, whistling, hissing and other sounds which do not come from an external source.
- The noises heard vary from person to person, ranging from a mild hiss to a pneumatic drill or a jet plane.
- It can happen to those with normal hearing as well as to deaf or hard of hearing people.
- It is also possible to have a very marked hearing loss without any tinnitus at all.

Tinnitus is very common, affecting up to one in ten of the adult population.

- More than four million British adults have it.
- Every day, two hundred people in Britain experience the onset of tinnitus.
- Women of all ages appear to be more affected by tinnitus than men.
- There are some ways to get significant relief from tinnitus, and it is nearly always possible with appropriate treatment to reduce the stress that tinnitus causes.

Question 5

The range of emotional responses provoked by tinnitus is large.

- A very common emotional response amongst tinnitus sufferers is a fear of the tinnitus becoming worse, sometimes even fear that it will become so loud that it will drive them mad.
- Where someone sees tinnitus as calamitous then they may experience fear and anxiety.
- Where someone sees no end to the tinnitus, they may even start to have a nervous breakdown or suffer from other depressive conditions.

Tinnitus can sometimes produce extreme states of despair and some sufferers have reported contemplating suicide.

- The emotions experienced by tinnitus sufferers can sometimes be very confusing because it is not always clear whether it is the tinnitus which is causing the feelings or whether it is combining with an existing stress or difficulty and making it worse.

APPENDIX 10

The Written Introduction Given to Participants of Study 4

Reading Experiment

1. This is a reading experiment.
2. You will read four documents.
3. After each document you will be asked a question about the document, and then be shown a page and asked whether the answer to the question is located on the page.
4. For the first 2 documents, your eye movements will be monitored, as well as your reaction times.
5. For the second 2 documents, you will read a paper copy of a document and only reaction times will be logged.
6. FOR EVERY EXPERIMENT IT IS IMPORTANT TO BE AS QUICK <u>AND</u> AS ACCURATE AS POSSIBLE.
7. There will be a final 2 trials where you will search a document on screen without first reading the document.

The documents that you will read and search are on the following subjects:

- Adoption/tracing a birth relative.
- Asthma.
- Divorce - financial matters.
- Homelessness.
- Protests and Campaigns.
- Tinnitus.

Please tell me in advance if you have a problem with any of these issues, as this may affect the experiment.

Before each experiment you will be allowed some practice trials on a neutral document (how to become a writer).

Trials 1 & 2

1. This uses the head-mounted eye-tracker. Once this is put on your head, the experimenter will make sure than it is set up to monitor your eyes, and then you will be calibrated. Basically this is ensuring that the computer knows where about you are looking on screen.
2. After this there will be a validation. This is a final confirmation. Do not be worried if this does not happen first time round, as it may take a while to get good calibration/validation results.
3. You will then be able to practice being asked questions, and then making a yes/no decision as to whether the page is on screen or not.
4. You will then be presented with a 5 page document. You are to read through this at your own pace for comprehension. Remember this is the document you will be tested on later.
5. You can get from one page to the next by pressing the space bar.
6. You cannot go back to a previously read page.
7. The final part of the trial is to be asked questions. Once the question has been asked, the experimenter will present the page, and you are to answer as quickly and as accurately as possible.
8. There will be 20 of these questions.
9. During this process you will probably be re-calibrated two or three times, again this is normal.
10. After the trial you will have time to rest, and then you will be given a similar document and go through the same process.

Trials 3 & 4

1. For these trials you will be tested using a paper document.
2. Again you will be given some practice trials to get a feel for the task.
3. You will then be give a 5 page paper document to read through, again for comprehension. Your reading will be timed, but please do not let this affect your reading speed as your comprehension of the document is paramount.
4. Once you have read the document you will be give a booklet. You will open the first page and see "Question 1" written. This is the page the document is to be open at while the question is asked.
5. As soon as the experimenter has finished reading the question, she will start the timer. You will then turn over to the next page and give an answer out loud as quickly and as accurately as possible as to whether the answer to the question is on that page. The experimenter will then note down the times.
6. The same process happens again for question 2 etc.
7. Again there are 20 questions.
8. You will then be given an opportunity to rest and you will go through the same process again on a similar document.

Trials 5 & 6

1. Trials 5 and 6 resemble trials 1 and 2, only this time you will not be give an opportunity to read the document before answering the yes/no questions.
2. For this reason it should not take as long as the other 2 trials.

APPENDIX 11

The Written Introduction Given to Participants of Study 5

Phase #1

1. Read the document fully for comprehension. You will later be tested on both the content and the "look" of the document.
2. When you begin the experiment, you will see a cross in the middle of the computer screen ("+"). Look at this cross.
3. The experimenter will begin the experiment by presenting the first page of text on the screen.
4. Read silently for comprehension. Your reading speed will be monitored, but your comprehension of the document is of primary importance.
5. To advance onto the next screen, press the mouse button. You cannot re-read any previous pages.
6. All documents are five pages long.

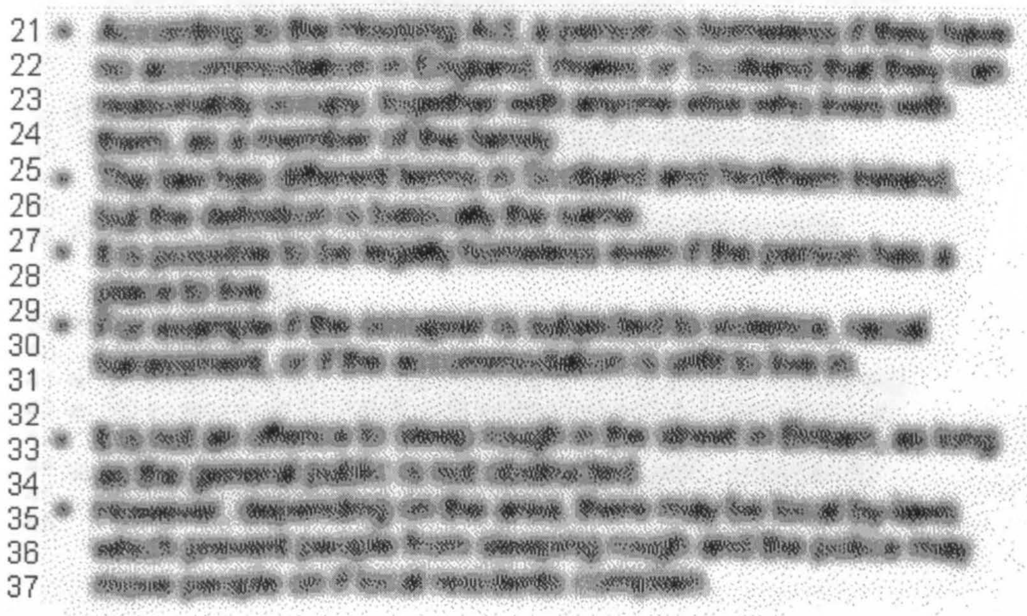
Phase #2

1. The same pages as were initially read in phase #1 will be re-presented on screen. However, they have been blurred so individual words are no longer recognisable.
2. Again there will be a cross on screen that should be looked at ("+").
3. While you are looking at the cross, the experimenter will read out a question based on the text that you have just read.
4. At the end of the question, one of the blurred pages will be shown on screen. The answer to the question is contained within the page somewhere. Your task is indicate with the mouse as quickly as possible, <u>what line on the page the answer is located on</u>. When you think you are approximately on the line, PRESS THE MOUSE BUTTON.
5. Once the mouse button has been pressed a line of numbers will appear at the side of the page. Please read out the approximate line number that corresponds to the location of the cursor.
6. Also give the experimenter an indication of the confidence you have in your response, from 1 to 5: 1 is very confident. 2 is very unsure.
7. You will not be able to read the blurred text, so your response will be largely based on your memory of the document you initially read.
8. This pattern of <mouse response/line number/confidence> will be repeated 15 times until all the questions are exhausted.
9. Keep in mind that the time to make the initial mouse-click response is being measured, but both speed and accuracy are important.

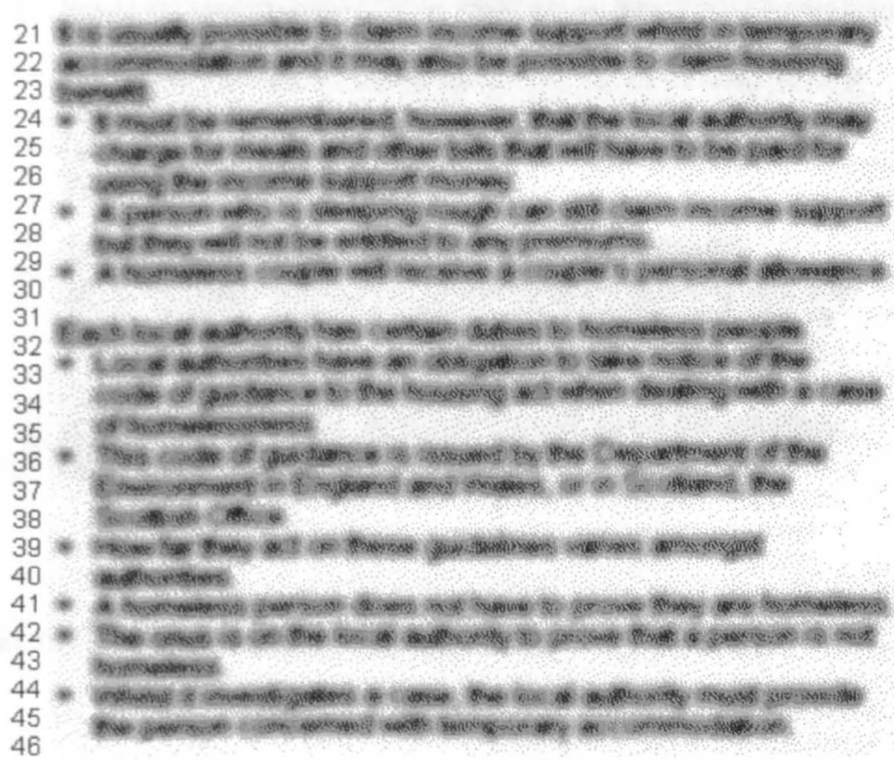
Phase #1 and #2 represent an entire test.
Through the course of the experimental session you will be tested on three similar tests. These will all be formatted slightly differently. Each individual test session should take under 20 minutes.

APPENDIX 12

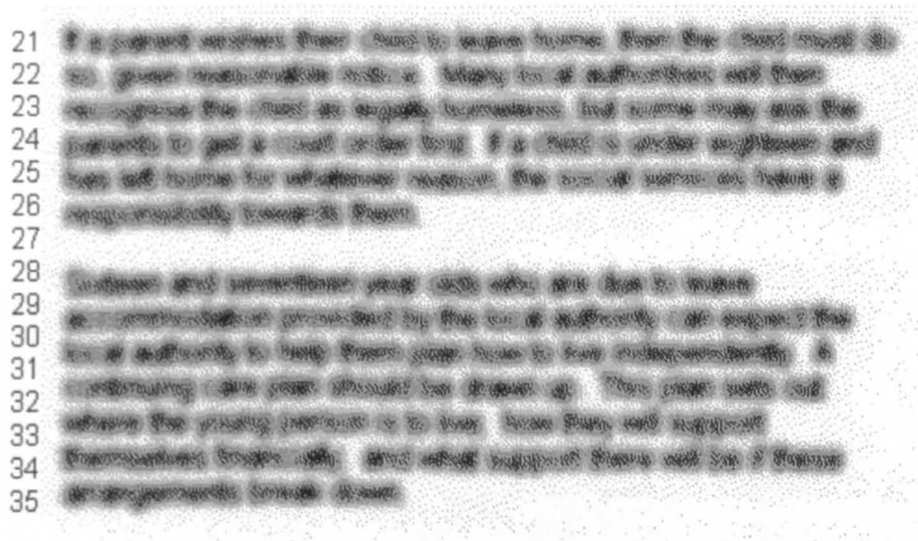
An Example of the Blurring of the Adoption Document



Page 1 of the homelessness document presented with blanket bullets



Page 2 of the homelessness document presented in stem bulleted formatting



Page 3 of the homelessness document presented in plain formatting