"Text comprehension - the influence of temporal information on processing and reading rate"

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DEDICATION

To the memory of my mother Jane Thomson.

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CONTENTS

ABSTRACT

The research described in this thesis investigated some aspects of the process of text comprehension. A variety of experimental techniques were used including readers' decisions on paragraphing continuous prose, a self paced reading paradigm where a computer timed the speed of reading each sentence in a text, the time taken by readers to answer questions about a previously read text, and the nature of readers' continuations of short unfinished narratives.

From the results of the initial experiments on paragraphing continuous prose one feature emerged as an important predictor of the points in a text where readers' chose to begin a new paragraph. This was the presence in a sentence of an explicit statement of temporal information, such as "In 1961 . . ." or "Eighteen years later . . .". Subsequent experiments investigated the role of such statements in text processing. It was thought that the time statements were used as cues that a new temporal setting had begun in the text and that the preceding information in the text might be perceived by the reader as less relevant following these cues. Reading time and question answering time experiments were designed to test if such changes were reflected in the time taken to read time change statements and to process the following sentences and questions. The results of these experiments were inconclusive.

The literature on text processing was studied and

several potentially relevant concepts were incorporated into subsequent experiments. The concept of the 'script' or 'scenario' devised by Minsky (1975) Schank and Abelson (1977) and Sanford and Garrod (1980) seemed particularly pertinent. In the later experiments on the role of temporal information, it was hypothesized that one element of the readers' knowledge unit or scenario concerning particular stereotyped events, was the normal time course for these events. If a time change in a text exceeded this predicted range, then the readers would interpret the standard events as being completed, and the current scenario and its associated information would be considered as no longer relevant-this latter state being termed "out of focus" following, Grosz (1977).

The results of the experiments in which readers continued unfinished narratives supported this hypthesis. Following a time change which was beyond the predicted range for the particular events described in the text, the characters in the text which were bound to the scenario were less liable to feature in continuations of the text. These experiments also highlighted more general features of status or relevance in a text. The characters who were not dependent on the scenario were always more liable to be mentioned in the continuations and were also the only characters liable to be referred to by pronouns. This privileged status in the text was termed foregrounding, after Chafe (1972).

Reading time experiments were conducted to investigate the effect of time change statements during the

comprehension process. The results of these experiments were similar to the continuation studies. Following beyond-range time changes readers took longer to retrieve information concerning the scenario dependent characters. If these scenario dependent characters were not highly predictable from the scenario title, then resolving pronoun references to them also took longer following such time changes. The foregrounded status of the scenario-independent characters was confirmed as these characters were readily accessible for reference resolution and information retrieval in all conditions.

A scenario-based model of comprehension is proposed following these results, with time range information as a useful test of the relevance of the current scenario. The results also highlight general features of comprehension such as the status of entities in the text and how the readers apportion processing capacity accordingly. The role of time change information is suggested as one device which readers use in more general processing strategies.

CHAPTER 1

The Process Involved in Text Comprehension

The research described in this thesis is concerned with text comprehension. The process by which readers understand complete texts must obviously be a complex multifaceted phenomenon, involving many constituent processes from the basic perception and recognition of letters and words, to high level cognitive processes such as the interpretation and evaluation of the ideas presented by the author. No one course of research can hope to investigate all or even many of the aspects of such a diverse topic as text comprehension. The investigation of comprehension described in this thesis focuses on only limited aspects of the processing of text.

Three features of comprehension were considered to be of interest first because they seemed intuitively to be fairly basic to the whole process of comprehension, secondly they had been considered important to previous researchers in the field and third they were amenable to empirical investigation. The three facets of comprehension chosen for study in the current research were segmentation, integration and interpretation. It was considered intuitively reasonable that when presented with a text, whatever other comprehension processes may occur, a reader has to divide or segment the continuous stream of information contained in the complete text into some kind of smaller units to prevent the processing

system being swamped. Second the reader has to integrate all the individual items of information into some kind of meaningful whole and third the reader has to interpret the meaning of both the segments of the text and the whole text itself in terms of previously stored knowledge.

(1) Segmentation

The division of a text into component parts can be conceived in many different ways. For example, there are the conventions in the presentation of a text; the subdivision of books into chapters, chapters into sections, sections into paragraphs, paragraphs into sentences. These subdivisions may be intended to make the task of comprehension easier for the reader. They signal which elements of the text form some kind of conceptual unit and thus have to be related to one another by the reader. So the meaning of two sentences in the same paragraph can be interpreted by the reader as being more related in some way than two sentences in different chapters of the same book.

This kind of segmentation, is presented in a formal way by the author of a text, possibly as an aid to comprehension.

Other types of segmentation have been considered by linguists and psycholinguists as originating with the reader during the process of comprehension. For example, the concept of the sequential parsing of sentences

obviously involves the breaking down of a continuous word string into meaningfully related components. The concept of parsing involves the reader dividing the elements of a sentence in terms of abstract categories which are external to the actual sentence but which elucidate the semantic relationships within it.

This notion of segmenting a word string into predefined categories has been extended from the sentence to the text. Narrative texts are said to have a particular structure which allows their component sections to be categorized in a manner analogous to the division of a sentence into its grammatical parts. These narrative structures are known as story grammars. Several psychologists have developed story grammars, for example Thorndyke (1977) Rumelhart (1975) Mandler & Johnson (1977). Although these grammars may differ in their details, the general principle of story grammar is that stories have several unique parts that are conceptually separable, which are identified by the reader from their past experiences of stories and these are used by the reader to comprehend and encode the information in a particular text. Stories are segmented by readers into such subparts as setting, theme, plot and resolution, which again as in sentence grammars, are abstract categories external to the actual text but used by the reader to aid comprehension of it.

Another reader-based view of segmentation is more directly focused on the contents of the text. A text can

be seen as a connected string of pieces of information or propositions. One account of comprehension is based on the segmentation of a sentence or a text into its constituent propositions. The psychologist Kintsch (1974) has developed his account of comprehension in this way. The division of the text is in terms of the propositions stated in the text and these are seen as being arranged into a hierarchical structure called a text base. This text base is seen as representing the interconnections between, and relative importance of, the items of information presented in the text, and to have implications for how easily and well the reader will comprehend certain elements or texts.

Thus segmentation is an aid to comprehension and may be conceived as involving the presentation of the text or the readers' knowledge about types of texts, in general, or the relationship between the elements in a given text. The common ground is that the text cannot be comprehended as a continuous string of pieces of information. It must be divided into smaller units and this must involve some kind of conceptual grouping of the elements in the text.

The accounts of segmentation considered above are based either on the behaviour of the author in the presentation of a text, or are concerned with readers postulated use of theoretically derived segments. The experimental studies of segmentation described in Chapter 2 of this thesis focus on how readers choose to segment a continuous text and the possible implications for the

process of comprehension of this experimentally derived segmentation.

One feature which was found to consistently affect reader's segmenting of a narrative text, was the presence of explicitly stated temporal information. In Chapter 3, previous research on the role of temporal information in language is examined for any supporting evidence for the role of temporal information in the segmentation process of comprehension.

Following this review of the literature, expressions of temporal information in texts were manipulated experimentally in some initial experiments on the possible role of such statements not only in the process of segmentation but also in other aspects of comprehension such as integration. These studies are described in Chapter 4. The aim of the research was to assess both the role of temporal information in text and to examine how segmentation, integration and inter pretation might interrelate during the process of comprehension.

(2) Integration

The complementary problem to segmentation when considering the comprehension of an entire text is the problem of integration. The reader of a text has not only to cope with a continuous string of information but also to relate the information contained in one string with the information contained in previous and subsequent ones. If this cannot be done because the information is

not related in any way, then this would not properly be considered as a text, and if the reader was not able to relate the information in the word strings of any given text this could not properly be considered as comprehension.

The task of reference resolution is the process which seems to be most directly involved in this aspect of comprehension. In the following short text for example:

"The ants were in the kitchen. *
The ants ate the jelly.
The jelly was sweet.
The jelly was on the table".

the reader must deduce that the 'ants' mentioned in the first and second sentences refer to the same entity and that the jelly which was sweet is the same jelly which was on the table. If these references are not resolved in this way then the reader cannot comprehend the text because the information in the five simple sentences cannot be integrated into a meaningful whole.

The case where a text contains repeated noun phrases in adjoining sentences provides the reader with a very simple type of reference resolution.

Perhaps a more natural type of simple reference resolution is where a noun phrase referent is repeated

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* [illegible]e taken from . . . . Kieras (1978)

after several lines of intervening text, and this is one kind of integration of referent and antecedent which was investigated in the present research. Another very simple kind of reference is an unambiguous pronoun, that is a pronoun used where there is only one possible antecedent of the correct number and gender in the preceding text. These simple kinds of integration of referent and antecedent were examined in the reading experiments described in Chapter 4, where the effect of different temporal expressions intervening between anaphor and antecedent, and the resulting ease of processing was examined.

However the integration of elements in a text can involve the resolution of much less obvious references, one example of the flexibility in the use of reference involves a reference to an antecedent mentioned over a hundred pages earlier in a book from Koestler's "The Case of the Midwife Toad" cited by Chafe (1976).

The wide scope of the readers ability in reference resolution which these examples demonstrate, plus the importance of the process to comprehension in general, have led to much consideration of the topic by linguists, psychologists and computer scientists working in artificial intelligence. Some of the concepts and theories they have developed which are of particular relevance to the research described in this thesis will be discussed in Chapter 5.

The process of integrating the information in a text

involves the reader in considerably more than merely resolving all the references to previously stated antecedents which a text contains. One of the other aspects of reference resolution, namely the ability to refer to entities not stated but implied in the text highlights another aspect of integration in the comprehension process. This topic of implied objects has been considered by several theorists. Reference to implied objects can occur to the subparts of an entity which has been explicitly stated. For example in a text concerning a car, the subpart 'engine' may be referred to as though it had been explicitly mentioned and this would involve the reader linking the 'engine' to 'the car' and the information connected to 'the engine' would be integrated with the previously stated information about the 'car'.

This ability to resolve references to implied entities extends beyond objects and their subparts. More interesting examples occur when the entities are implied by concepts or situations occuring in the text. Several accounts of comprehension feature this ability to resolve such references(Minsky (1975) Charniak (1972) Rumelhart (1976)). A particularly well developed account is given by Schank & Abelson (1977) who describe how an artificial intelligence system can 'comprehend' sentences which refer to entities implied by the situation described in the text, through the use of 'Script'. A script is a packet of stored information based on the processors knowledge of

the described events. It allows the processor to fill in the details of a narrative, with all the obvious stereotypical information which it would be tedious to describe in the text. When a text involves such a stereotyped situation about which the system has a script for example a restaurant, the known entities involved in such a situation, such as waiters, can have references made to them as though they had been explicitly introduced in the text, as they have implicitly been introduced by the script. Every script has a number of roles associated with it. When a script is instantiated by a story the characters in the story assume these roles within the instantiated script. If no character is explicitly mentioned in the text when a script is instantiated these roles are still activated by default and unnamed actors are assumed to fill these through the script. So in the short narrative below:

John went to a restaurant.
He asked the waitress for coq au vin.
He paid the check and left.

A definite reference can be made to 'the waitress' as if she has been explicitly mentioned previously in the text because the instantiation of the restaurant script implicitly introduces the character. The script also makes all the corrections between the stated items by filling in the 'missing' information and makes the apparently disconnected sentences into a meaningful

narrative. The artificial intelligence system devised by Schank & Abelson (1977) called SAM can use these prestored information packets or scripts to comprehend such texts, translate from one language to another and answer questions about the text.

Garrod & Sanford (1980) describe the process of resolving implied references in human comprehesion using knowledge structures similar to scripts. They illustrate the equal ease of resolving references to entities which are implied by the topic of a discourse or explicitly introduced in the text. So for a passage like:

"Learning to Ski"
Harry fell several times (in the snow)
He didn't like skiing at all.
The snow was wet and cold.

the ease of resolving the reference in the third sentence is equally speedy whether 'the snow' was or was not stated in the first sentence as it is so strongly implied by the title of the passage. The reader's knowledge of skiing introduced the entity.

The point about 'implied' references as regards integration is that these references can be resolved by the reader because of the conceptual framework of the text. It is because certain elements of a text are known to belong together under a heading of 'restaurant' or 'Learning to Ski' that references to implied antecedents

can be made and resolved.

These references occur within a setion or segment of text which can have its separate items of information integrated into a complete unit and these items of information come not only from what is stated in the text but from the readers stored knowledge of the kind of events being described. The integration process involved is the bringing together of the two sortsof information to enable the text to be interpreted by the reader.

The experiments described in Chapters 6 and 7 utilize these concepts of integrating the information stated in the text, such as temporal information, with the readers stored knowledge of the described events, such as the time normally spent for example having a meal in a restaurant. The experiments investigate the role of the temporal expression itself and its effect on the use and comprehension of subsequent referential expressions.

When integration involves not only the linking of appropriate information in the text itself but also includes the interaction of the readers' real world knowledge and the information in the text then the process of interpretation is involved.

(3) Interpretation

So far the reader has been considered as having to divide the incoming stream of information into some kind of smaller units, and integrating the presented

information into some kind of conceptual whole by resolving all the references within the text and thus linking together the level of information both explicitly stated in the text and stored in the readers' memory of similar events. When readers have to use their knowledge of past events to expand the information stated in a text they are involved in a higher level cognitive process than integrating repeated noun phrases or resolving pronoun references by number and gender checks. As this higher level process seems much less constrained and may involve the reader in selecting whole domains of possibly relevant prior knowledge it appears to involve not merely integration of the information presented in a text but the interpretation of it.

For example, Schank & Abelson (1977) have used their computer story understander (SAM) with short stories about restaurants, the outline they provide of the kind of prestored information which can be used to interpret such stories is extensive. One element of the pre-stored knowledge about restaurants, the 'ordering scene' in the restaurant script lists twenty constituent parts to which the system has access in order to expand and interpret any 'ordering' information stated or implied in the text. If human readers' text processing operates on similar principles, then many high level processes concerning how to access particular packets of pre-stored knowledge and how much of their constituent information is required and relevant, must occur during comprehension. The process

of activating prior knowledge and utilising it to expand and hence comprehend information presented in a text can be considered as a process of interpretation. This is one aspect of comprehension investigated in the current research.

In Chapters 6 and 7 the interpretation of stated temporal information in the light of prior knowledge about the normal time course of the described events was studied. The effect of such interpretations on the readers' perceptions of the status of different characters in the text was examined by observing how references to different characters were made. First by the readers themselves who were asked to continue the stories concerned, and second by measuring the speed with which references to the different characters were resolved when a complete text was presented to the readers.

Thus the approach of the current research was to postulate that one of the basic processes involved in the comprehension of text is the division of the continuous string of information into a series of smaller units. If readers were allowed to choose how to segment a text and their decisions were found to be consistent across a group of different readers, it was thought that the critical feature in their segmentation decisions was likely to have more general processing implications in comprehension.

The critical feature observed in the present research was found to be temporal information. This empirically

derived feature was then manipulated in further experiments to investigate two further related aspects of comprehension, integration as demonstrated by the ease of reference resolution, and interpretation using the theoretically interesting concept of the readers use of stored knowledge structures during comprehension. It was hoped that by studying one particular feature of text processing, the function of temporal information in narratives, that the experimental results would provide insight into the general process of text comprehension.

CHAPTER 2

Experiments on Paragraphing

In the study of text comprehension, the focus of research interest has been largely those features of text which have been considered of a priori interest and importance. These have then been manipulated and the readers' responses noted. Little work, however, has investigated the textual features to which the readers themselves attend. The research described in this Chapter attempts to discover which features of text the reader uses in one particular process of text comprehension; namely the division of a continuous passage of prose into units.

The idea of the segmentation of texts into units appears in many studies of comprehension. The whole development of story grammars is based on the analysis of complete stories into their constituent elements. The studies of Kintsch and his co-workers are founded on the segmentation of texts into propositions and hierarchical levels. The theories of Schank, Minsky and Rumelhart do not specifically describe the subdivision of texts, but as the knowledge based structures which they describe as being utilized during comprehension are essentially modular packets of information, a full psychological theory of comprehension based on these, would have to detail how such structures are divided one from another during reading.

Segmentation thus appears to be one of the basic

features of theories of text comprehension. The segmentation task used in the present research to investigate the readers own analysis of text was the task of paragraphing continuous narrative prose. This task was chosen as it provided the reader with a fairly free framework within which to make decisions about length, number and content of the segments. The results it was hoped, would reveal subjective assessments of which elements in text the reader uses in making divisions of incoming information during text processing.

Before describing the experiments there are several questions to be asked about paragraphs and paragraphing. The first is obvious what is a paragraph? Is there an agreed definition to be found in the literature? The second question is what function if any does the paragraph serve? Is the paragraph a stylistic device of the writer or does it help or hinder the reader's comprehension of a text? Are there agreed methods of dividing a text into paragraphs which help text processing?

These questions concerning the paragraph, or process of paragraphing have received little attention in psycho-linguistics. One paper which does deal with paragraph structure and processing, however, is that of Kieras (1978).

Kieras states that conventional paragraph structure requires that the topic sentence of a paragraph should be presented first, followed by connected coherent sentences. The processing role of these rules was investigated by

comparing readers' performances on reading simple passages that conformed to or violated conventional paragraph organization. In three experiments, subjects read such passages presented one sentence at a time. The data collected were the subjects' choice of best title which provided a measure of apparent theme, the reading time for each sentence, and the amount of the gist of the story the subjects could recall.

Bad paragraph structure produced fewer choices of the topical proposition as the best title, longer reading times on the initial incoherent sentences which cannot be immediately integrated, and lower recall of the content of the passage, especially of the initially unintegratable sentences. These results, it is suggested, show that unintegratable input must be held in immediate memory pending integration, leading to a greater processing load. The role of the paragraph structure conventions is thus to minimize memory load.

For Kieras, then, an efficient paragraph is defined as a coherent collection of sentences starting with a topic sentence to which the other sentences are connected. The function of the paragraph is to enable the reader to readily assimilate incoming information into memory by conventionally structuring information in a way that makes these processes possible.

Kieras assumes that the 'conventional' paragraph structure which he manipulates is conventional i.e. is the structure of paragraphs commonly found in simple prose. Other researchers mainly in linguistics have studied

paragraphs and their structures in some detail and their findings are relevant to the question of the definition and function of the paragraph in comprehension.

Gutwinski (1976) makes several comments on the linguistic conception of the paragraph. A well constructed paragraph is said to be characterized by unity and coherence. Unity is achieved when all the sentences in the paragraph relate to a single point represented by a topic sentence. Coherence is achieved when the sentences follow each other in a logical order and are linked together by transitions.

From his own studies of cohesion in literary texts, features such as anaphora which provide textual connectivity between clauses and sentences, Gutwinski comes to question the nature of the paragraph. He found breaks in cohesion in a sequence of adjacent sentences more likely to occur inside a single paragraph rather than acting as a division between one paragraph and the next as the above conceptions of the paragraph might lead us to expect. Gutwinski quotes the linguist Halliday (1966) as stating that the paragraph division coincides in some writers with the troughs and in some with the peaks of cohesion.

Gutwinski suggests that the paragraph is an arbitrary convention in English composition, that it is seldom that a paragraph begins with a topic sentence and that all its other sentences develop the theme of the topic sentence. Some paragraphs it is claimed do not contain a topic sentence at all. Writer's often include in a paragraph sentences which otherwise would be unconnected and the

reader generally assumes that what is inside a paragraph represents a connected whole. It is claimed that the attention of the reader usually focuses on the transitions between paragraphs.

Gutwinski finds that in literary texts there is no clear definition of a paragraph. In texts by James and Hemmingway the paragraph does not seem to serve the same function of an orderly arrangement of information that Kieras found. This difference highlights one aspect of text comprehension to which little attention has been paid. The reader of Kieras's simple experimental passages, which are little more than lists of connected propositions is probably using more idiosyncratic processes of comprehension due to the task demands, than the reader of "Portrait of a Lady". The task here is not one of memory but interest in and appreciation of the content. The paragraph here may well serve stylistic functions unrelated to topic-comment integration and may well be arbitrary in that stylistic considerations probably do not produce recognizable rules about structure and function.

Further investigation of paragraph structure is found in a symposium on the paragraph held in 1965. Several papers described studies of paragraph structure in a detailed and systematic way.

Becker (1965) studied the structure of paragraphs using the concept of tagmemes, which are defined as the class of grammatical forms that function in a particular grammatical relationship. For example the grammatical

function subject can be manifested by a limited number of grammatical forms or constructions including noun phrases, pronouns, nominalized verb phrases, clauses etc. Tagmemes then are slots in a system where substitution is possible, and they include both the functional slot and the set of substitutable forms. Meaning cannot be separated from form, or form from meaning. In terms of partitioning this means that the whole is not the sum of the isolated segments but only the segments plus their relationships.

Although Becker's work describes the structure of paragraphs in terms of these functional terms and their relationships, he emphasizes that this is only one aspect of their structure. The other aspects are the continuity or concord between the parts and the system of semantic relationships in which the reader's expectations are aroused and fulfilled. Each of these three perspectives on the paragraph is necessary for a complete description.

Becker describes the structural analysis of paragraphs in expository texts. He states that narrative, descriptive and argumentative paragraphs have quite different structures from those he discusses although the grammatical markers of paragraph slots are nearly identical for all types of paragraphs. In expository writing he finds two major patterns of paragraphing. These two patterns are derived experimentally by giving subjects samples of expository paragraphs and asking them to partition them in ways that seem significant. There were disagreements about how

particular paragraphs ought to be partitioned, but a striking percentage of agreement, especially it is claimed after subjects have partitioned enough paragraphs to recognize recurring patterns.

The first expository pattern has three functional slots, which Becker labels T (topic) R (restriction) and I (illustration). In the T slot the topic is stated, in the R slot the topic is narrowed down or defined and in the I slot, the topic restricted in R, is illustrated or described at a lower level of generality. These slots seem to reflect a natural way of talking or writing about something. Each of the slots in a TRI paragraph can be filled in various ways in, other, with certain types of sentences typically occuring in certain slots.

The second major pattern of expository paragraphs has two slots which are labelled P (problem) and S (solution). The P slot often in question form, is the statement of a problem or an effect which is to be explained, and the S slot states the solution or cause of P. Although these categories are not exhaustive Becker claims the majority of expository writing is covered by these patterns as described or varied by four kinds of operations: deletion, reordering, addition and combination.

Becker also describes the formal markers of paragraph structure. These signals he says are rather indeterminant and redundant. The simplest marker is graphic, namely indentation. The lexical markers of paragraphs are of two sorts, equivalence classes and lexical transitions. Equivalence classes include

synonyms, substitute words or phrases, pronouns and demonstratives. These have certain grammatical roles e.g. subject, object or locative which are maintained throughout the paragraph. Major changes in the grammatical roles of equivalence classes, especially in the head class signal new slots or new paragraphs, or changes in location, time or shift to a new topic.

Lexical transitions are words and phrases which mark the semantic concord of the paragraph words like "but" and "then". Certain of these words are closely associated with particular slots: slot I is often marked by "for example", slot R by "in other words". Lexical transitions may also signal continuation of a slot e.g. such words as "furthermore", "likewise" or "then".

It is claimed by Becker that verb sequences are also important markers of paragraph structure. A shift in verb form frequently marks a slot in a paragraph. Expanded verb forms such as the progressive and perfect forms seem particularly important in marking major shifts in focus in a discourse and shifts in tense usually mark new paragraphs.

These conceptualizations of paragraph structure are based on the evidence that readers can partition paragraphs in a consistent and predictable way. There are shared conventions of grouping sentences into higher level units and that there are structural cues which signal these patterns beyond the sentence.

Rogers (1965) in the same symposium on the paragraph has pointed out some of the problems of Becker's account

of paragraphing. Firstly there is a problem of lack of definition both of the paragraph itself, and of what a topic or topic sentence might be, however an accurate definition of topic might overcome some of the problems in deciding whether a paragraph begins with such a sentence.

Secondly Rogers queries the use of terms such as 'slot' and 'filler' as he claims it is unclear whether the process of filling slots refer to the authors writing of a text or to the comprehension done by the reader, as a text itself cannot be considered as filling slots.

Becker has indeed provided no clear definition of a paragraph but his whole paper provides quite a complete description of his concept of a paragraph. The paragraph is a structure of related functional slots: topic, restriction and illustration or problem and solution. It is also a continuous system of semantic relations in which the reader's expectations are aroused and fulfilled.

This description obviously also involves a concept of the function of the paragraph. The structures described seem aimed at making the topic of a paragraph clear and easily assimilated by the reader. This more complex structural description compared to the Kieras study reflects the more complex texts examined. The pattern of paragraph structure in expository texts seems to be appropriate in that it aims to make the exposition clear and unambiguous.

This underlines the point made about Gutwinski's literary texts; paragraphs probably serve functions appropriate to, and defined by, the nature of the complete

text in which they are contained.

For the psychologist this account is interesting but frustrating to evaluate because Becker provides no details of the task or texts which his subjects were required to segment nor is any actual data given from these tasks. Therefore although claiming to be empirically based due to these shortcomings it becomes a largely theoretical account which requires accurate experimental validation. This could be in the form of a survey by groups of judges of paragraphs to see if the paragraphs of expository writing do match the described patterns. Experimental manipulation of features such as verb tense and its effect on subsequent partitioning by readers would also be a useful test. Becker's description however does provide many interesting comments on structures within and between paragraphs. His ability to secure consistent and predictable responses from readers in partitioning text provides the psychologist with another technique to test the effect of any chosen variable on text processing.

In the same symposium on the paragraph, Christensen (1965) attempts to show that the paragraph has or may have a structure as defineable and traceable as that of the sentence and that it may be analysed in the same way.

Christensen describes the traditional conception of paragraphs as having the topic sentence either at the beginning or the end, in the middle or only implied. He also mentions the concept of "paragraph movement" which is used in the development of the paragraph by the writer. This is said to have different basis depending on the type

of writing involved. In narratives the movement is chronological, in descriptions it is spatial and in discursive writing it is logical.

Christensen describes structures of paragraphs he has found in discursive writing. Firstly he defines the paragraph as a sequence of structurally related sentences. This means that a paragraph is a group of sentences related by co-ordination and subordination. Thus if the first sentence of a paragraph is the topic sentence, the second is quite likely to be a comment on it or a development of it and therefore subordinate to it. A sentence that is not co-ordinate with any sentence above it or subordinate to the next above it breaks the sequence and the writer has unwittingly begun a new paragraph.

Secondly Christensen states that he has found from analyzing many paragraphs that the topic sentence is nearly always the first sentence of the sequence.

Christenen goes on to illustrate the structuring of paragraphs using co-ordination, subordination and a mixture of the two. In a co-ordinate structure the sentences are alike in structure, particularly at their beginning. Subordinate paragraphs have sentences unlike in structures which are linked by semantically develoing the ideas in the topic sentence. The most commonly found paragraphs mix these two types.

Christensen also describes a few paragraphs which either lack a topic sentence or have their topic in a preceding sequence. He concludes that a paragraph is both a logical entity and a sequence of structurally

related sentences as well as being a visual unit formed by identation of the first line and incompleteness of the last.

Roger's criticizes Christensen's paper again on the grounds of lack of clear definitions of such concepts as topic, subordination and co-ordination, pointing out that the last two terms are not easily distinguishable from Christensen's description. He also suggets that to talk of combining two paragraphs or 'having unwittingly begun a new paragraph' is to take an odd view of the paragarph which he claims is a complete unit of discourse not a component unit of another paragraph. The paragraph Rogers points out is a device or strategy used by an author and is not merely a linguistic structure, thus there are psychological as well as linguistic features involved.

Christensen's account is interesting in that it provides a detailed description and definition of the paragraph and its structure, even if the notion of a properly constructed paragraph appears to override in some cases the actual paragraph indented by the author. Unfortunately it is limited to one kind of text; discursive prose and Christensen does not consider how such structures would generalize to different types of text. The account is purely descriptive and does not consider the function of the paragraph for the reader and how the different structures he observed might affect the readers processing of the text.

Rogers (1965) takes rather a different view of the

definition of the paragraph from the preceding writers. He returns to basics and explicitly defines the paragaph as that unit of a text that a writer has indented. He states that structure plainly does not determine the point at which a paragaph must begin or end and the concept of stadia of discourse are offered as a redefinition of the textual units described by Becker and Christensen.

On the question of the function of the paragraph, Rogers makes no explicit statement but he remarks on the strategy of the author and the psychological as well as linguistic aspects of paragaph development, showing that for him the paragraph is a unit which can be manipulated to aid the purpose of the prose.

From the various studies of the paragraph what can be concluded about the definition and function of the paragraph? The definition of a paragraph must be that unit of discourse which has been indented. From these papers it appears however that the paragraph has several more characteristic if not defining features. In studies of expository writing a topic sentence is usually found at the start of the paragraph and subsequent sentences are linked to this in a logical way. The Experiments of Kieras (1978) suggest that this pattern described by linguists in expository texts, can be demonstrated in short simple narrative texts, to enable the reader to integrate information easily and remember the passage more accurately.

This evidence supports Rogers view stated above that the paragarph is a unit which can be manipulated to aid

the purpose of the prose. If a piece of expository prose aims to make the readers task of information assimilation and recall as easy as possible this is a suitable structure of paragraphing to adopt.

In different types of prose it has been sugested, different patterns of paragraph will emerge. If these different types of text have different functions for the author and reader this is not surprising. For example in Gutwinski's descriptions of literary texts he found no logical constraints in the divisions between paragraphs but purely stylistic ones. If the 'function' of literature is not merely to inform the reader concerning a set of facts which have to be remembered but rather to entertain by an imaginative use of language, then this paragraphing pattern is to be expected. It is of no advantage to the writer to follow logical topic-comment-easy recall models if this is less interesting or pleasing to the reader when the function of the text is explicitly pleasure oriented.

The problem for the psychologist is that although the paragraph seems an interesting textual unit to which readers are consistently sensitive, in the ease with which they process certain paragraph structures and the agreement with which they divide texts, these processes depend on the function of the text being considered. Psychological models of comprehension such as propositional accounts, Kintsch (1974) story grammars, Bower (1976) and schema based account Schank and Abelson (1977) have mainly considered narrative texts. Narrative

texts have not been explicitly studied in terms of paragaphing in the above accounts. Becker states the structure will be chronological and Christensen does not mention whether his description of expository texts would generalize to naratives but this does not seem likely. One problem may be that a concept of the function of a narrative text may be required before an adequate account of paragraphing could be made. The function of a narrative has not been explicitly considered by psychologists. Intuitively it would seem to involve the presentation of a number of items of information usually concerning a character or characters in a chronologically ordered sequence of events in such a way that the reader can clearly understand the identity of the characters involved and the sequence of the described events. The narrative usually aims to present this information as clearly as possible to the reader whilst also retaining the readers' interest. This balance between explicitness and interest might suggest that the topic-sentence-first model which Kieras demonstrated in simple texts involving strings of simple sentences, as increasing ease of processing, may have to be tempered with the type of stylistic considerations found by Gutwinski in the texts of James and Hemmingway. Most narrative texts on which psychological models of comprehension have been based fall between the 'unnatural' explicitness of Kieras and the stylistic elaboration of Henry James. In the type of narratives considered by psychological theories, the normal but nonliterary narrative, it might be suggested

that the function of the paragraph would be to make the readers' task easier; the task in such narratives being the comprehension o characters of events in sequence. The function of the paragraph has been consistently linked to the function of the text, empirical investigation of the paragraphing of such narratives is required to test if the paragraph is used to ease the readers' processing load either by dividing units into topic-comments structures or by segmenting the continuous string of information according to another type of organization.

The research described in the rest of this Chapter attempts to use the task of paragraphing prose to discover how the readers themselves use paragraphs. Do readers paragraph in a consistent and predictable way as Becker describes? Do they use certain features of text as paragraph cues more than others? What features do they use? What function does the paragraph serve in a narrative text? Can paragraphing provide insight into general features of text comprehension by demonstrating the link between the function of the paragraph and the information processing of the reader?

The experiments described in this Chapter attempt to provide data on paragraph choice by readers to answer some of these questions.

Experiment I

Introduction

It was decided to test the nature of readers' paragraphing of continuous narrative prose. The first study described below was designed to discover which features of text readers would use in this task. Becker (1965) had used a similar task and claimed that in expository prose the readers paragraphed in a predictable and consistent way using topic sentences as the starting point for paragraphs. The present study tested this hypothesis with narrative prose.

Method

Materials and Procedure

The material used was a narrative passage seventy-five sentences long describing the career and ideas of one man (In Appendix A). It was typed without the normal paragraph indentations but with each new sentence starting a new line of text.

The passage was given to fifty undergraduate subjects with the following instructions.

"The passage in this booklet has been typed without the normal changes of paragraphs. Your task is to read through the passage and then reread it, marking where you would expect each new paragraph to begin. There are no right or wrong answers, your decisions are what is important. Please start reading when you are ready and read at your normal pace".

Results and Discussion

The number of times each of the seventy-five sentences was chosen by subjects as a starting point of a new paragraph as calculated. From this it was noted that eight sentences were chosen by more than fifty percent of the subjects. Of these eight sentences, five contained information about the time events in the passage (see Table 1). The passage was then checked for all sentences containing explicit temporal information other than verb tenses. There were twelve sentences in this category. These sentences were compared with the remaining sentences in the passage for frequency of choice by subjects, using the Mann Whitney U Test.

The sentences containing explicit temporal information were chosen significantly more often ($U = 3.11$, $p < 0.01$) than the sentences not containing such information. The mean % of subjects choosing sentences containing temporal information as the start of paragraphs was 41% compared to a mean of 6% of subjects who chose sentences not containing such information.

From this data it appears that one cue used by subjects when segmenting this passage of prose into paragraphs is temporal information. However in this experiment there is still the possibility that these sentences are chosen for reasons other than the temporal information they contain.

To test this possibility a second experiment was conducted.

Table 1

Sentences chosen frequently to begin paragraphs

Number of Choices (out of 50)	Sentence	Sentence No.
25	It was then when Toch was eighteen that de Gaulle first came to the attention of the young Toch.	13
26	At the time the strongest dictator in Europe was the Portuguese General, Salazar.	25
37	By 1961, it was clear that de Gaulle intended to put an end to the Algerian war, which he felt was destroying France.	31
34	This was not for Toch a radical decision for he was drawn to simple violent solutions.	38
42	Toch's clandestine activities were interrupted in June 1961.	41
35	Toch was in an appartment not far from the prison.	52
36	In May and June there were a dozen abortive attempts.	68
30	A feeling that it would never work began to be felt.	30

Experiment II

The aim of this experiment was to test the hypothesis that the presence or absence of explicit temporal information in a sentence affects the probability of that sentence being chosen by subjects as the starting point of a paragraph.

Materials and Procedure

The material used was a modified version of the narrative passage used in Experiment I. The passage was modified by removing the statements of temporal information from the original sentence and inserting the statement in the following sentence. For example, the following pair of sentences appear in the passage in Experiment I.

> "By 1961, it was clear that de Gaulle intended to put an end to the Algerian war which he felt was destroying France. A coup was staged by four generals in Algeria".

These were modified to appear in Experiment II.

> "It became clear that de Gaulle intended to put an end to the Algerian war which he felt was destroying France. By 1961, a coup was staged by four generals in Algeria".

Six such modifications were made to the passage, and these are shown in Table 2.

Table 2

Sentences with and without explicit temporal information

Sentence with Temporal Information	Sentence without Temporal Information	No.
By 1961 it was clear that de Gaulle intended to put an end to the war which he felt was destroying France.	It became clear that de Gaulle intended to put an end to the war which he felt was destroying France.	32
By 1961, a coup was staged by four Generals in Algeria	A coup was staged by four Generals in Algeria.	
Toch's clandstine activities were interrupted in June 1961	Toch's clandestine activities were interrupted.	
His hiding place was given away to the police in June 1961.	His hiding place was given away to the police by rivals.	
In May and June Toch was compelled to steal cars for the operation because he could not afford to keep renting them.	In addition Toch was compelled to steal cars for the operation because he could not afford to keep renting them.	
In May and June there were about a dozen abortive attempts.	There were about a dozen abortive attempts in all.	

The rest of the sentences in the passage including six other sentences containing temporal information remained unchanged (See Table 3).

The passage was presented to a group of fifty undergraduates subjects using the same procedure and instructions as in Experiment I.

Results and Discussion

The number of times each sentence was chosen by subjects as the starting point for a new paragraph was noted.

The comparisons of interest are the frequency with which subjects chose the same sentence in Experiment I and II when temporal information was present or absent.

The sentence containing the explicit temporal information was chosen significantly more often than the same sentence without this information 46% vs. 12% of subjects ($T(6) = 13.2$, $p < .01$).

The other comparison of interest was the consistency of choice of unchanged sentences containing temporal information. There is no significant difference between the two experiments in the frequency of choice of these sentences ($T(8) = 0.9$ n.s.).

Table 3

Sentences with Unchanged Temporal Information

Sentence	Sentence No.
Toch feared the idea of a French defeat in 1940	2
Toch's attempt to assassinate de Gaulle twenty one years after the 1940 humiliation resulted in a very near miss.	9
Perhaps the most disconcerting aspect of the French defeat in 1940 for Toch was the manner in which de Gaulle acted.	10
It was then when Toch was eighteen that de Gaulle first came to the attention of the young Toch.	13
The General in his celebrated June 18th appeal said "France has lost a battle but not the war".	14
At the time the strongest dictator in Europe was the Portuguese General Salazar.	25
The coup failed two days later and three of the four were arrested.	37
Pierre visited Toch on 31st January, 1962.	62
A dozen volunteers were recruited at the end of May.	64

From these two experiments it seems that subjects do use temporal information as an important cue in paragraphing narrative prose. Sentences which have explicit temporal information inserted are subsequently chosen more frequently than the same sentence without this information.

Why does a statement of temporal information have this effect? From the literature the paragraph was seen as a cohesive unit of sentences following on a topic sentence. Does the reader then assume that a sentence containing temporal information is a topic sentence which the following sentences elaborate? This model from expository writing and simple prose seems unlikely. The reader of the experimental passages has the same sentences following on a given test sentence whether this contains temporal information or not. The subsequent sentences in any part of the passage do not contain information or elaboration of the temporal statement itself, and this would be unlikely in most narratives. Sentences following from "In May and June there were a dozen abortive attempts" go on to describe the attempts not "May and June". Readers from experience of reading narratives would find this the normal pattern of writing.

The insertion of the statement "In May and June" must cause the reader to choose this sentence as the start of a new paragraph for other reasons. One possible explanation is that a temporal statement highlights the following information as being of some importance and thus the reader is more likely to consider the sentence as a

topic and so mark this as a new paragraph. The temporal statement may act as an introduction which provides context information for a sentence of importance. Consider the following pair of sentences:

A "In 1975 I bought a house".

B "In 1975 I bought a book".

Sentence A seems very reasonable, but sentence B seems less so unless following sentences inform the reader why this book was important to the writer. Thus sentence C seems a reasonable continuation where D appears rather odd, given the temporal statement.

C It changed my whole way of life.

D It was a good thriller.

The position of the temporal statement intuitively seems to be important in this explanation. A temporal statement at the start of the sentence may be an introduction to some important information, a temporal statement at the end seems more like just another item of information.

Consider the following sentences:

A I travelled to London on a coach.

B I travelled to London on May 1st.

C On May 1st, I travelled to London.

Sentences A and B seem equivalent in the importance travelling appears to have. The date is a piece of information about the journey as is the mode of travel.

In C as already noted the journey seems highlighted by the date.

Temporal information can be conceived as having at least three possible roles in a text. As noted above temporal information could act as just another item of information as suggested from sentences above. The results of Experiment I however would suggest that there must be something about temporal information in a sentence which draws the readers' attention.

Another view of temporal information from Grimes (1975) suggests that features such as time in a text act as a "setting", that is provide a frame of reference to help the reader interpret subsequent information in the text without the information itself being of particular importance. The 'setting' role of temporal information could be a plausible explanation for the results of Experiments I and II if readers use the time statements as cues that a new setting has begun and are thus more likely to divide settings by marking a new paragraph at that point in the text. The position of temporal information in a particular sentence intuitively does not seem to be a critical factor to a setting explanation. Thus from a setting explanation no effect of sentence position on paragraphing would be expected.

The third view of the role of time information that suggested above, is that of highlighting the importance of following information. This is a more localised function than the 'setting' view as it seems to relate to the position of a temporal statement in a

particular sentence preceding a particular item of information as sentence C above illustrates.

The manipulation of the position of the temporal information would be predicted to effect the influence of this function of temporal highlighting. An attempt to distinguish these possible explanations of the function of temporal information in influencing the readers choice of paragraph was made by manipulating the sentence position of the time statement.

Experiment III investigates the effect of sentence position on paragraphing, and the prediction is that if an introduction/highlighting function is the crucial factor then temporal information in the initial sentence position will produce more new paragraph choices. If sentence position does not affect the number of paragraph choices then a 'setting' explanation seems a more likely explanation, of the previous results.

Experiment III

Temporal Information and Sentence Position

Aim

To test the hypothesis that the position in the sentence of temporal information affects paragraph choice by subjects.

Procedure and Materials

The material used was a modified version of the narrative passage used in Experiment I. The passage was modified as

follows. In seven sentences from the original passage the position of the temporal statement was changed (see Table 4).

Table 4

Experiment I	Experiment III
Toch's attempt to assassinate de Gaulle 21 years after the 1940 humiliation resulted in a very near miss.	Twenty one years after the 1940 humiliation, Toch's attempt to assassinate de Gaulle resulted in a very near miss.
The General in his celebrated June 18th appearance said "France has lost a battle but not the war".	On June 18th, the General in his celebrated appeal said "Freance has lost a battle but not the war".
The coup failed two days later and three of the four were arrested.	Two days later the coup failed and three of the four were arrested.
Toch's clandestine activities were interrupted in June 1961.	In June 1961 Toch's clandestine activities were interrupted.
Pierre visited Toch on January 31st, 1962.	On January 31st, 1962 Pierre visited Toch.
A dozen volunteers were recruited at the end of May.	At the end of May a dozen volunteers were recruited.
In May and June there were a dozen abortive attempts.	There were a dozen abortive attempts in May and June.

The passage was presented to a group of fifty undergraduate subjects using the same procedure and instructions as in Experiment I.

Results and Discussion

The number of times each sentence was chosen by subjects as the starting point for a new paragraph was noted.

The comparison of interest was the frequency with which subjects chose the same sentence in Experiment I and III when temporal information was at the start of the sentence in question or not.

This result was tested and the difference found to be insignificant (T-test for correlated samples $t(6) = 1.68$ n.s.). The other interesting analysis comes from a combination of the results of the three experiments. The comparison was made of the number of choices for sentences containing temporal information from the remainder of sentences in the passage. The data for one hundred and fifty subjects is included, the mean % of subjects in the three experiments choosing sentences containing temporal information was 42% compared to 12% of subjects choosing sentences without such information.

This difference in the number of choices was tested using the Mann-Whitney U test ($U = 3.32$, $p < .01$) and showed a significantly greater number of paragraph choices where sentences contained explicit temporal information.

Discussion

From these results it can be seen that the position of the temporal component of a given statement seems relatively unimportant in the frequency of subjects' paragraph choice.

The hypothesis that the experiment tests is not confirmed, the initial position of the temporal statement does not lead to more paragraph choices. The concept of temporal information acting in an introductory

highlighting function does not seem therefore to be an appropriate explanation of the earlier results.

What alternative explanations for the effect of temporal information can be proffered for the effect found in the analysis of all three experiments?

Temporal information may affect the process of segmenting text into paragraphs by altering the readers perception of which elements of the text cohere together. This may operate as a cue of a change within the text which suggests to the reader that some of the preceding information is no longer relevant. Thus the time information may intimate a new setting for the subsequent sentences. In a narrative passage such as this the temporal information divides the events described into units similar to scenes in a play. An explicit statement of temporal information indicates a change of setting and scene and the reader marks this with a new paragraph.

The function of the paragraph then would be to segment a continuous string of information into units sharing a common setting. The temporal statements acting as cues for each setting, indicate which elements are part of an integrated segment.

The reader's task may be made easier because instead of having to link each new story element with every previous piece of information, the temporal setting marks which elements of the story go together and which elements are no longer relevant.

In the experimental passage for example, an expression such as "By 1961" would indicate to the reader

that the 1940's setting was over and that some of the previous information may no longer be relevant. The statement also links the following information together by providing a temporal setting and reference point.

Conclusions

The research in this Chapter was conducted to answer several questions about text comprehension.

Firstly do readers paragraph prose in a consistent and predictable way? From these three studies the answer appears to be yes. Readers in the three experiments consistently chose certain sentences more often than others as appropriate starting points for new paragraphs. Readers also chose certain sentences equally often, thus showing consistency of paragraph choice. Readers' behaviour was predictable in that altering certain features of the passage led to the predicted changes in paragraph choice. The task of paragraphing prose this seems a viable one in producing consistent and predictable responses from subjects.

The features which subjects use as paragraph cues, were found in one particular narrative to be statements of explicit temporal information. Temporal information was found to lead to more choices of sentences as starting points for paragraphs even in sentences which initially did not contain this information. The same sentence with temporal information was chosen more often than when it lacked this information. Sentences containing such statements were chosen more often than the remainder of

sentences in the passage.

On the question of the function of the paragraph the answer is not as clear. The concept of a paragraph being a topic with coherent added sentences which makes the information easy for the reader to understand or remember, gains no support from these studies. In this narrative the temporal statements which affected paragraphing do not appear to be topic statements or explanation of topics. As Becker and others mentioned the topic paragraph does not seem an appropriate explanation of how narrative texts are organized.

The function of highlighting important information by providing an introduction was considered. This concept was undermined by the lack of difference in the number of paragraph choices when temporal statements were placed at the start of sentences.

It appears that the concept of paragraphs as cueing the reader to recognize and understand important information such as topics is not how the experimental passage was processed by subjects.

The alternative explanation offered, is that temporal information divides continuous narratives into contextual units sharing a common temporal setting. It is suggested that this aids the reader by providing a reference point for which story elements are no longer relevant because they belong in a previous temporal setting and which story elements have to be integrated as they share a temporal setting.

The paragraph may reduce the amount of information

that the reader has to actively process at any one point in the narrative and thus make processing of such a text easier.

This explanation is merely consistent with the studies described in this Chapter. However it does seem one plausible explanation of the findings and has implications for other processes involved in text comprehension which can be tested.

The explanation is derived from an interest in the general process of text comprehension and from suggestions in the literature on this general process. In the next Chapter the literature on temporal information as a topic of interest in itself will be considered. The aim is to discover the details of how temporal information is considered to function in language and to determine whether there is any supporting evidence for the explanation postulated from the paragraph data. In general the current research is aimed at discovering how readers process text, and the paragraph studies have suggested one technique to derive features which are salient to the readers of a text. From the feature discovered here, namely time statements, an explanation of how temporal information is processed by readers is required. The literature on time in language may provide such an explanation or suggestions towards how such an explanation could be developed.

CHAPTER 3

Time in Language

Introduction

In the experiments on paragraphing prose, readers were influenced by the occurrence of expressions of temporal information. In this Chapter the functions of temporal information, as described in the literature, will be considered and an attempt made to relate these findings to the paragraphing results.

Temporal information is conveyed by every sentence of a language through the verb tense at the least, although nouns, adjectives, adverbs, prepositions and conjunctions can all also be used as indicators of time. The variety of these sources of information has resulted in a wide divergence of approaches to the study of temporal information in language; psychologists, linguists, anthropologists, educationalists and researchers in artificial intelligence have all considered how temporal indicators function in language. The concepts discussed in these various accounts of temporal information can be broadly categorized under three general headings. The first of these headings is the consideration of the linguistic aspects of temporal expressions compared to or contrasted with cognitive aspects of time. A related issue considered in the literature is the sequencing of events in time as processed by the language user.

The third heading is the use of temporal information

as reference points in a language. All three of these issues seem of possible relevance to the findings of the paragraph experiments. Readers may be influenced by some aspect of the linguistic prominence of the temporal expressions, or they may use the time information to sequence the described events or the information may be used as reference points for the other information contained in the passage.

The literature on time in language should provide clues as to which aspects of time seem to be generally most pertinent for the reader or listener.

Linguistic vs. Cognitive Aspects of Temporal Information

An expression of temporal information in a sentence of a text, whether it is the use of a particular verb tense or a phrase describing a time or date is a linguistic event which represents a particular chronological event or state. The reader or listener has to process correctly both aspects to comprehend the temporal information conveyed by the text. Several psychological experiments on language have been designed to determine the ease or difficulty of this process. For example, Clark and Stafford (1969) tested the ease of recall of sentences with different verb tenses. Subjects were asked to recall sentences which contained one of eight verb forms. The verbs were either past or present, progressive or nonprogressive, perfect or nonperfect. In recall verbs underwent semantic simplification. Perfect

verbs were often recalled as nonperfect, progressive as nonprogressive, present perfect verbs were often recalled as simple past tenses and present perfect progressive as past progressive. Each change entails the loss of one semantic feature i.e. a simplification in the interpretation of the verb. Subjects' protocols also showed evidence of semantic bias, in that they reported trying to picture the situation described or relate it to personal experience. None memorized the sentences word for word.

Another interesting finding was that subjects preferred past to present tense in recall. This does not show syntactic simplification but seems to have a cognitive origin, based on the time course of the experiment. Presented with a sentence such as "The cowboy is branding the cattle", and then later asked to recall it, the time of the action has changed from present to past and the sentence is thus recalled by the subject as "The cowboy was branding the cattle". Subjects' recall of temporal information, as conveyed by the different verb tenses in this experiment is influenced by the pragmatic features of a verb's usage rather than the linguistic complexity of a given tense. Moreover even in the recall of isolated sentences subjects were influenced by general cognitive factors such as the real temporal framework of the experiment itself.

This distinction between cognitive and linguistic factors in the processing of time in language has been demonstrated in a study by Cromer (1971). Cromer was

interested in the ability of children to conceive of temporal events from an objective viewpoint not centred on the child's own body or actions, i.e. the Piagetian notion of decentering related to time.

Children between mental ages 4 years 11 months and 5 years 11 months were presented with stories in picture form and were asked to identify the picture in the story in which the pictured figure could make certain utterances or the children were asked to take the view of the figure in one of the pictures and identify other points in time relative to that point.

Where the children had to pick the appropriate picture there were significant age differences in the number of decentred responses. The youngest age group make hardly any decentred responses, 83% make none, whilst the oldest children are nearly all able to decenter.

The interesting feature of the results for the contrast between linguistic and cognitive aspects of time, is that Cromer found that decentering did not seem to depend on specific linguistic forms of the verbal directions although name forms, e.g. perfect tenses did cause trouble even to the oldest children.

Children who did not decenter could nevertheless perfectly repeat the sentences involved. Cromer suggets that the cognitive ability to decenter develops independently of specific linguistic skills in handling particular verb forms.

Thus for children the development of the ability to process the language of time is very much a general

cognitive progress rather than a specifically linguistic one. Other aspects of children's use of, and problems with, the language of time will be discussed later in this Chapter.

A further study of adult recall of temporal information was conducted by Harris and Brewer (1973). They presented subjects with sentences to recall which contained present, past, future, present perfect, past perfect or future perfect tenses. They found that 45% of the sentences were recalled with shifts in the verb tenses.

In the second part of the experiment, temporal adverbs were added to half the sentences to provide a partial temporal framework. When the recall of these sentences was tested there was a significant reduction in the amount of tense shifting. It seems that what is important is a temporal context for the accurate recall of verb tenses. If this is lacking the differing tenses are relatively meaningless.

Brewer and Harris (1974) conducted another experiment on a slightly different aspect of context and recall of time expressions. Subjects were presented with sentences to recall which included deictic elements of time but no context, for example

"The driver's license expired last week".

The second part of the study tested the recall of sentences with deictic elements and context, for example.

"John Dean testified at the Watergate hearings last week".

Recall was tested first for no context sentences, comparing deictic and nondeictic elements in the sentences. Deictic elements such as temporal adverbs were recalled significantly less well. Where context was included the recall of deictic elements rose significantly to comparable levels with non deictic words. It appears that deictic elements of time were not difficult to recall where they could be fitted into a temporal context which relates to the subjects' general knowledge of events in real time in the real world.

From these studies of the processing of temporal information in language it seems that cognitive factors are more influential than purely linguistic ones. Adults have problems with the recall of linguistic forms where they cannot relate the temporal information provided to a wider temporal context. Where a temporal framework is provided linguistic forms of the information do not pose particular problems. Children's ability to comprehend temporal information also seems to depend more on a cognitive ability rather than a purely linguistic competence.

One particular aspect of the problem of balancing the linguistic and the cognitive or pragmatic aspect of time information in language is the question of order of presentation or sequence. Clark and Clark (1968) found that adult subjects were overdependent on the order of presentation when recalling two events in a sentence irrespective of the actual linguistic description of the

chronological relationship. Thus when two events S_1 and S_2 were presented as"S_2 after S_1" the subjects would incorrectly recall the order of the event as $S_2 - S_1$, not because they could not recall the details of the events S_1 and S_2 but because they confused the chronological order as described by linguistic expressions such as 'after' with the actual order of presentation in the experiment.

The salience of this non linguistic feature, the order of presentation has also been noted in children. An early study of children's comprehension of the temporal relationship of events by Oakden and Start (1922) found that children often confused chronological sequence of historical events with the order in which they had learned about them. Jarvella and Lubinsky (1975) in a study of deaf and hearing children's description of events presented in a series of pictures and sentences found that both groups tended to assume the order of presentation corresponded to chronological sequence with deaf children and young children being particularly dependent on order.

The psychological research on temporal information suggests that the purely linguistic features such as the particular verb tense or conjunction used, are less important in the reader's or hearer's comprehension of the chronology of the described events, than such non linguistic features as a knowledge of the time course of events in the real world and the order of presentation of the events.

Linguistic studies of temporal information might be expected to focus on the importance of the actual lexical

or syntactic form of the sentence or text.

Linguistic Studies of Time

Verb tenses have been one area of interest for linguists studying temporal information in language. Crystal (1965) has considered the use of verb tenses and adverbial phrases in English. Crystal examined a corpus of 250,000 words of spoken and written English for temporal adverbials and their co-occurrence with verb tenses. He found that the relationship of temporal information and verb tenses is not always straightforward. For example the following types of sentences were found, "I live in London, as from next week". In this sentence a present verb tense is used to refer to a future event. Crystal found that it is not the verb tense alone which causes the change of temporal emphasis but the present tense in collaboration with an adverbial phrase of time. Extra information is essential to convey the appropriate temporal relationship of the sentence.

In the corpus the first striking feature was the frequency of clauses overtly connected with temporal adverbials, sixty-five per cent of all clauses were found to contain such phrases. The materials contained forty eight defineably distinct time situations of which seventy-five per cent require explicit adverbial specification of some kind. Temporal adverbials are defined as all adverbials which could be elicited as possible answers to the question "when".

Crystal also examined the co-occurrence of various

adverbials and tense forms. The predictability of co-occurrence varied greatly from 100% for 'before' and past tense verbs to only 12% co-occurrence of 'already' with present tense verbs.

The conclusion to be drawn from this study of tense is that verbs alone do not directly reflect the temporal situaton of the described events within a sentence, and that temporal adverbials are frequently used to qualify the verb tense used. These phrases are probably one major way of establishing the wider temporal framework which the psychological studies demonstrated the listener or reader uses in comprehending temporal statements.

Diver (1963) attempted to analyze the chronology of the complete English tense system. Each verb form was analyzed and the exact meaning described in terms of five variables: the mutually exclusive categories of past, present and future; the category of definite or indefinite; repeated or nonrepeated; extended or not; and remote or not. For example, "He was walking" indicates an event which took place on a definite occasion in the past. "We would go swimming" indicates a past repeated occurrence, "He used to walk" indicates an event over an extended period of time within an occasion in the remote past.

Even such a detailed account of tense however is not sufficient to characterize temporal information. Diver incorporates the complete sentence in his chronology. All the temporal features of a sentence have to agree for the sentence to be meaningful. Thus a sentence such as

"I have played golf last Tuesday" cannot occur because the event described is definite whilst the verb tense is not. Diver extends his account to a continuous narrative passage and again highlights how the chronology must be consistent throughout both by verb tenses and other temporal indicators.

These linguistic studies of time confirm the finding of the previous psychological studies that although verb tense is the ever present temporal indicator in language, it is not used alone to convey information about time. The work of Crystal and Diver illustrates the linguistic devices which supplement the verb in actual usage. The adverbial phrases and the temporal information within and beyond the single sentence must all be synthesized by the reader or listener and related to the real world time scale.

These studies were all considered under the general heading of linguistic versus cognitive factors in the expression of time in language. The most obvious linguistic feature of temporal information is the use of various verb tenses. The various tenses have been shown in psychological and linguistic research to be supplemented by other sources of information when describing and comprehending events. The way in which extra information, which enables the reader to relate the described event to the passage of time in the real world, is used has underlined the importance of the cognitive aspect of time. If a reader lacks contextual information or cognitive has not sufficient development, or if there

is other information compatible with the purely linguistic expressions of time in a text or sentence the temporal information causes difficulty. Although the linguistic aspect, namely the actual words used to express a temporal relation must be vital as the means by which the information is presented to the reader, the cognitive interpretation of this and the integration of the described event with previous knowledge of temporal information in the text and the real world is at least as important.

Relating the temporal relations expressed in a sentence or text to the time course of events in the real world is an example of using real world time as a reference point for the events described in the text.

This use of temporal information in establishing reference points will be considered in more detail in the next section.

Time and Reference in Language

One way in which temporal information is used as reference points is the system of common temporal descriptions or names which are applied to various periods of time. These agreed descriptions in any language range from cyclic systems of expressions such as 'morning' 'afternoon' and 'evening' or names such as 'January' 'February' etc. to strictly sequential descriptions such as "16th century" or "3rd September 1939". The point about these temporal descriptions is that they provide the speaker or writer with a convenient way to define the

particular period or moment to which they wish to refer; and which the reader or listener can use to locate the event with respect to real world time including the present moment. As has been noted in studies by Oakden and Sturt (1922) children have difficulty with this conventional time scheme. Bradley (1948) replicated this study and found children had a definite developmental order in their ability to use and comprehend the time names which are used to refer to the time of events. As in Oakden and Sturt, personal experience affects this progress, so that time references which have meaningful associations such as the names of seasons with their characteristic weather and dates of birthdays are learned earliest. Thereafter the most frequently occurring cycles such as days of the week are understood before longer cycle such as months. Bradley claims that the ability to comprehend the system of conventional time references is later in developing that is generally believed.

Farrell (1952) studied the ability of high IQ children to use the conventional time references. Again a developmental trend emerged in the responses, with six and seven year olds performing better than the five year olds. Farrell was interested in what cues the children used to answer time questions. Younger children tended to rely on asking other people, whilst older children used the conventional records and measurements of time such as clocks and calenders, and known time sequences such as the order of days of the week.

For children, the ability to comprehend and use time names as meaningful reference points has to develop through their experience of meaningful events in the world, which have corresponding conventional names for their time of occurrence. Again this highlights the multiple sources of information which an adult language user brings to bear in the use and comprehension of even very simple temporal expressions. These can be used as reference points only because adults share a common world view and experience which allows the expression 'morning' or '10th century" or '1945' to be used as shorthand for a whole range of shared expectancies related both to the order of the events described, so adults know the '10th century' event was earlier in time than an event described in the text '19th century' and we have a range of predictions about that time point based on real world knowledge as well as knowledge gleaned from the text.

The complexities of adults' use of a variety of temporal expressions as reference points for events in a text or sentence has been investigated by several researchers.

One concept which has been widely applied in temporal reference schemes is the concept of a time line or axis. Time lines have been used to describe the temporal relationships of events described by verb tenses, sentences and complete texts.

Clifford (1975) reviews attempts to systematically characterize the temporal relations expressed by verb tenses, by the use of reference points on one or more time

lines. The earliest and simplest time line system of tenses was proposed by Jesperson (1924). This scheme starts with a time line stretching from past to future. At a point in time a sentence is uttered which establishes a point B, in the time line which divides the line into two segments A and C. The event referred to in the sentence uttered at B can be placed at B or at some point in A or C the earlier or later segments of the line. When this event is placed on the time line it provides a further subdivision and reference points. A simple example, in English "he was running" places the event of running at a point in the anterior segment A with respect to the point B defined by the utterance of the sentence.

Jesperson's system was designed to explain the systematic tense markers in English and thus to define how tenses convey the temporal relations between the described events.

This simple scheme however did not account for all the systematic tense forms of English. Later schemes proposed by Reichenbach and Bull [illegible] described by Clifford attempted to amend the shortcomings of Jesperson's model. Reichenbach introduced a sytem of directions from the reference points, time of speech, time of event and moment of speech which enabled a simpler and fuller description of verb tenses, although this scheme too failed to cover all verb tenses adequately. The system devised by Bull was comprehensive and complex involving four axes instead of one time line, and many vectors and response points.

From the earlier review of psychological studies of

the effect of verb tenses on readers and listeners, it seems unlikely that the particular details of a time line account based on tenses alone will be critical in a general account of the influence of time in text comprehension. However the concept of a time line has wider applicability than verb tense alone for example one account of time relations which goes beyond the verb tense and includes a system of time lines or vectors is provided by Miller and Johnson Laird (1976). They attempt to provide a system of logical descriptions of the full range of time expressions in English from tenses, adverbs to conjunctions, which allow events, processes and states to be mapped onto a time line in the order of their occurrence the time line, extending from past to future and with a privilege moment now is considered as the conceptual core of the system of temporal relations.

As psychologists, they consider that the reader or listener has to interpret time information in language by constructing this serial representaton of events and mapping these on to the real time line or to imaginery alternatives to it. They state that as the time line is mainly used to represent ordinal relations between events it is unimportant whether equal extents on the time line represent equal intervals of time.

Although the range of logical descriptions of time expressions which they discuss are taken from individual sentences they are not intended as purely logical formulations but are the definitions, in terms of common elements, which allow different types of temporal

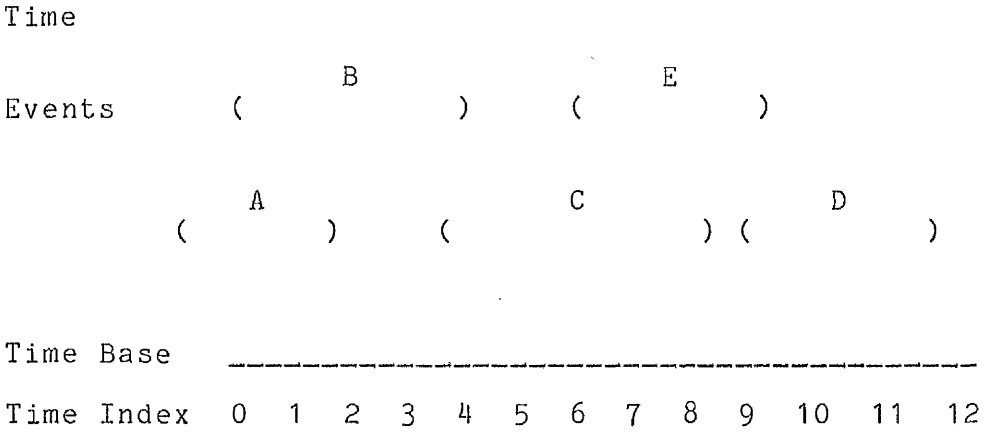
expressions to indicate how the events to which they are attached, can be mapped on to a common conceptual time line and they claim that this mapping is not necessarily limited to individual sentences.

They state that many texts are a description of a sequence of events and that the temporal relations which are described in any one sentence must be related to the temporal information in the rest of the text. This temporal organisation represents part of the context in which any particular sentence is interpreted.

This highly technical logical description of temporal relations in English goes beyond the consideration of verb tenses alone and provides a common conceptual scheme covering the full range of time expressions within sentences and suggests how this might generalize to the readers' processing of texts.

A linguistic account of temporal reference based on a time line which considers complete narrative texts was proposed by Litteral (1972). He was interested in developing a system to explain the universal cognitive aspects of time which would also enable cognitive time to be mapped on to a metric scale when speakers of a language talk about units of time such as minutes, days or centuries.

Using narrative texts which he had collected from Anggor, a New Guinea language and a topological indexing system Litteral illustrates his system in the diagram below.



Time is represented by a topology on the real number line. The time line is infinite, it goes from $-\infty$ to $+\infty$. As it is organised topologically and not metrically it is the boundaries of events but not their length which is important. To provide a fixed reference point, 0 is arbritarily assigned to the boundary at the start of the narrator's activity. For each event i, there is a function Fi (0, I) which maps the arbritary unit interval (0, I) to an open interval on the time line, F i (0, I) therefore represents the time interval taken by the event. Nonevents, such as generalizations are represented on the time line as extending infinitely, states and processes have the same type of representation as events except that they usually take longer which is unimportant in this topological indexing.

The diagram above shows how the system operates. There are five events shown, A, B, C, D, and E, some of which are simultaneous and some which partially overlap in time. The base for the index as shown, is a sequence of intervals, integers are mapped onto these to correspond to the intervals and the boundaries between them. The index

for a particular event is the ordered pair that identifies the beginning and ending segments or boundaries of that event in the time chain.

Litteral introduces some topological concepts to argue for the appropriateness of his referential system for modelling the temporal information in texts. The 'neighbourhood' of a point is the set of points that surround it. The 'Hausdorff' spaces' for any two points are the corresponding neighbourhoods that have no points in common. Linguistically the Hausdorff property asserts that two events may be in sequence with no reason for isolating a point in time which the events share. For example in the sentence "He went to the jungle and cut down a tree", the topological indices for these two intervals as a sequence, implies that there is a time when the agent is going to the jungle but not cutting down a tree, and there is a time when he is cutting down a tree but not going to the jungle but when one stops and the other begins may either be considered as a boundary point or ignored.

Two intervals may even overlap in fact yet be viewed linguistically as distinct intervals. The Hausdorff property of time indexing copes with this by excluding overlap but indicating that nonoverlapping neighbourhoods also exist. For example, in "He cut the tree and it fell down" there is a period of cutting when the tree has not begun falling, and another period when he is still cutting and falling has begun and a final period when cutting is finished and the tree is falling. Yet linguistically

these events are treated as separate in time and the overlap period is ignored.

The other main advantage which Litteral proposes for this topological system of time indexing is the way in which the metric duration of time intervals is usually ignored in texts. For example in the sentence "He went to Amanab and bought some shorts", the two events are treated as temporally equivalent yet the journey has a duration of three hours, the purchase only a few minutes. Topologically this metric difference is irrelevant as each event occupies just one interval on the time base.

Litteral claims that his system can clearly and systematically describe all temporal relations in his Anggor narratives, and allows linking temporal information in the text to extralinguistic or real world time. All the sources of temporal information, phrases, such as "at that time", temporal relations such as 'before' and 'after', deictics like 'now' and 'then' and not merely tense can be included in the indexing.

This account is interesting because it goes beyond analysing the linguistic forms used to express temporal information and attempts to model the semantic relations of the events described. Litteral uses topological concepts to distinguish the rather subtle temporal relations involved in many events which appear to involve straightforward overlap or sequence. Another useful aspect of this account is the concern with these relations in terms of complete model narratives and not merely events described within single sentences.

This model seems a very promising description of temporal referencing in text. However it does not involve any account of how the listener or reader processes temporal information to index events described in a narrative. This is what is required by the psychologist interested in the use of such information by readers during the process of comprehension. The wide range of time line schemes suggest that adopting such an approach to the processing of texts might well be fruitful.

The results of the experiments on paragraphing by readers could be conceived in terms of a time line model. Readers may mark the boundaries of paragraphs where event boundaries occur, the presence of explicit temporal information making the start of a new episode more salient, and use these temporally marked paragraphs to make clear the order and relationship of events in the text. For as several writers have pointed out temporal reference schemes can be seen as serving to make the meaning of a text more comprehensible to the reader or listener. This concern with the function of temporal reference schemes is found in accounts of such as Grimes (1972).

Grimes in a study of oral narratives in some of the languages of Brazil and New Guinea, found a type of narrative organization termed an overlay structure in which a narrative has sections called planes, in which whole stretches of the narrative are repeated with only a few new items of information in each. Time references

may jump back to an earlier point in time and establish that a new plane has begun. Each change of time or place is marked by a new plane.

Grimes suggests that such an apparently complex narrative structure is actually helpful to the listener by controlling the rate at which new information is introduced. Each plane after the first having a certain amount of already given information. The new information is also made more predictable in that it will share the same setting and time that has been established previously. Time references are used to provide a more restricted setting and to make new information more predictable and therefore to make the whole narrative easier for the listener.

Again the parallels with the paragraph results, and the tentative conclusions concerning comprehension processes which were drawn from them, are striking. It was suggested that in the written text, the paragraph was used as a device to segment the flow of information into more manageable chunks and to indicate which items of information were closely related and had to be integrated. Time expressions were suggested as cues to a shared temporal setting and hence cues as to which items of information were to be treated and processed as a conceptual unit.

In this Chapter several aspects of temporal information in language have been considered, linguistic factors compared to cognitive factors in the comprehension of time, the sequence of events in time and in texts and

the use of temporal information to establish reference points and order events. These aspects are obviously interrelated where a reader is processing temporal information. The literature suggests that in spite of the variety of linguistic forms used to convey temporal information, cognitive factors, such as having a meaningful temporal framework to which the presented information may be related, have more influence on the reader. Cognitive factors superceding linguistic ones seem also to be involved in the perceived sequence of events, where the order of presentation was an often too influential cue in the subjects' interpretation of order.

In considering reference systems for events in texts, the accounts which are based on the complex system of reference points established by the verb tense seem unlikely models for the readers' use of temporal information in the light of their relative insensitivity to linguistic cues of time when these are not related to a wider temporal framework. A model of temporal reference which focuses on ordering events described in complete narratives seems more useful for developing a psychological account which will have to involve readers' knowledge of events and expectancies about events in the world, their normal order and durations, and the implications of any temporal expressions in the text.

A psychological model would require a description of how such knowledge and expectancies about events in the world interacts with temporal information stated in the text, to allow the reader to determine the order of

events, their relations to one another and their relation to real world time. The literature suggets various factors which might be involved in such a model, such as temporal context, the mapping of events onto a time line, and the preference for descriptions of events in sequence. How the reader might use all these to aid comprehension of texts is not yet known. As the readers' interest when presented with a text is not the construction of a time model but the comprehension of the text itself, the use made of temporal information may best be understood within a general model of comprehension.

From the experiments on paragraphing decisions, it was suggested that temporal information might be used as a cue to the reader that a change of scene had occurred and hence the subsequent events belonged in a new conceptual grouping or paragraph. This is an explanation which features cognitive decisions by the reader rather than linguistic analyses.

The manipulation of the position in the sentence of the temporal information had no effect on paragraphing decisions which again supports the view that the effect of temporal information is not due to detailed syntactic or stylistic analysis within the sentence.

The experimental findings thus support the suggestions in the literature that temporal information has its effect at a cognitive rather than a purely linguistic level.

A general model of comprehension which could incorporate the pertinent features involved in

interpreting temporal information would be particularly useful, as it is the role of temporal information in text processing which is of greatest general interest.

The research described in the remaining Chapters of this thesis is an attempt to include the role of temporal information in a model of comprehension. It is hoped that the experimental results will throw light both on the processing of time itself and that the role of time information can be used to investigate text comprehension in general.

CHAPTER 4

Simple Experiments on the Processing of Temporal Information

Introduction

This Chapter describes some experiments using techniques other than paragraphing, to test the effects of temporal information on text processing. Following the results of the paragraph studies it was suggested that the function of temporal information was to divide a continuous text into smaller integrated units with a shared temporal setting. The time statements in the text acted as a cue to the reader that a new setting has begun and that some preceding information may no longer be relevant.

The literature on time in language illustrates a wide variety of ways in which temporal information can be used as reference points by which described events can be ordered, in relation both to other events in a text, and real world time. The notion of a shared temporal setting can be incorporated in this view by considering the time statement as a reference point for all the events in that setting or paragraph. The temporal information indicates to the reader not only that the following events have a shared setting and therefore form a cohesive unit but it also indicates how the setting relates to other described events and to the readers' own real world time scale.

In the last Chapter it was emphasized that this sequencing and interpreting of events involved information processing from a variety of sources, both in the text and in the readers' knowledge of the world. It was suggested that the function of temporal information in text would be most usefully considered as part of the preceding information and may no longer be relevant.

The literature on temporal information suggests that temporal information is involved in defining the sequence of described events in particular acting as reference points for general cognitive process of comprehension.

The experiments described in this Chapter were an initial attempt to investigate the role of temporal information in the process of text comprehension. Text comprehension was described in Chapter 1 as involving three basic processes, segmentation, integration and interpretation. The paragraph studies suggest the role of time statements in segmentation. The following experiments investigate the possible segmentation function of temporal information <u>during</u> the comprehension process by observing the time readers take to process lines of text containing such temporal cues. Later experiments investigate the effect of temporal information on integration by observing the ease and speed of reference resolution when temporal cues indicate that anaphor and antecedent do not share a temporal setting.

The first experimental hypothesis is that if a new setting is generated as a result of encountering an explicit temporal statement, and preceding information

which is no longer relevant may be dropped from active processing following such a cue. These Processes are predicted to be time consuming for the reader and so lines of text which contain such statements are expected to be read more slowly than lines of text which do not contain such cues.

To test this hypothesis an experimental technique known as the self-paced reading paradigm, (described by Garrod and Sanford (1977)), was used in the following experiments. This allows measurements of line by line reading times and has several advantages in this kind of psycholinguistic research. First it allows measurements to be made during the comprehension process itself, and as the hypothesis to be tested is concerned with the encoding and processing aspects of comprehension this seems particularly appropriate. Second as the technique allows reading times to be measured to the nearest millisecond it allows very subtle differences in processing speed to be observed. The sensitivity of the task has been noted in several studies described in Sanford and Garrod (1980).

Experiment I

This experiment aims to test the hypothesis that a statement of temporal information in a text is used by readers as a cue that a new temporal setting is in operation, and that this should result in slower reading times for such lines of text.

This experiment also aims to test the effect of particular temporal statements and the implied magnitude

of the resulting change in temporal setting. If a temporal statement implies a large time change has occurred will this have a more pronounced effect in slowing reading times than if a smaller time change is implied? If a large time change occurs it could be suggested that either more information would be discarded as no longer relevant or that a new setting was even more likely or that any such new setting might be moved further along a time line conceptualization of the text. If any of these hypotheses are correct then a statement which implies a large time change in text would be predicted to result in slower reading times than a statement which implies a smaller time change. Experiment I tests this hypothesis by comparing reading times for lines of text containing statements indicating large time change with the reading times for the same lines of text containing temporal statements indicating that a smaller time change has occurred.

Materials and Design

Five passages were generated each of which contained six time changes. These changes occurred in a large and small version as shown in the example opposite and were arranged so each passage contained three small and three large time changes. The order of presentation was counterbalanced across subjects.

The passages were approximately thirty lines long and were followed by six questions on their content which required a yes/no response from the subjects. The

passages and questions are shown in full in Appendix B.

Procedure

Twenty six undergraduate and postgraduate students at the University of Glasgow acted as subjects in this experiment. They were paid 50 pence for a half hour experimental session.

The subjects were tested individually. They were seated in an experimental booth in front of a visual display unit linked to a NOVA 210 computer. The subjects were given two practice passages to familiarize them with the reading technique. This consists of self paced reading task operated by the subject pressing a space bar on the key board of the VDU which brings one illuminated line of text on to the screen. The subject reads the line quickly and then represses the bar which causes that line of text to disappear and the next line to appear. The computer times the interval between bar presses to the nearest millisecond. The questions appeared after the passage one at a time and the subject responded by pressing a yes or no button in front of them. The subjects were instructed to read the lines of text and answer the questions as quickly as possible.

Example of Materials in Experiment I

The town straddles the river for several miles.
The river begins to widen as it approaches the sea.
On clear days the sea can be seen from high ground in the town.

The town was granted a Charter in [1550/1875] from the King.

From then till the end of the century was a time of growth.

Trade flourished notably with the Low Countries.

The town doubled in size in these years.

The fine buildings of the period reflect its prosperity.

An earlier prosperity was curtailed by the war of [1520].

The merchant fleet was drastically reduced in size.

Many of the inhabitants had to turn to fishing or farming.

Neither was well suited to the area and much hardship was endured.

In [1700/1800] the weaving industry began locally.

The people hoped to become more independent of external events.

The cloth woven was of high quality and became popular.

Soon much of their trade was in this local product.

Locally built ships were also an expanding trade.

This was fortunate as weaving gradually declined.

By [1740/1935] new fabrics began to appear.

The local cloth was no longer in great demand.

Cheap foreign cloth damaged the industry.

Agriculture expanded after the land reforms of [1845/1937].

The increased volume of produce all flowed through the town.

This new trade all helped the town remain properous.

There were no more setbacks and growth was steady.

The population reached half a million in [1850/1977].

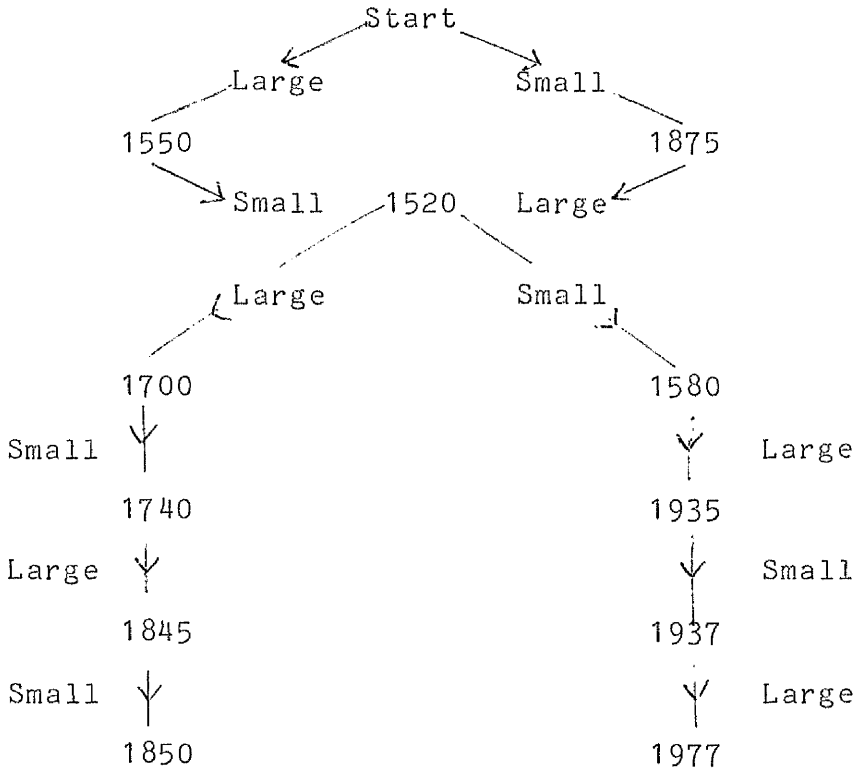
This quadrupled the number of people in the last century.

The town has grown larger to accommodate the increase.
It retains the bustling prosperity it had in earlier times.
This vigour is unchanged from the date of the Charter.

** Questions **

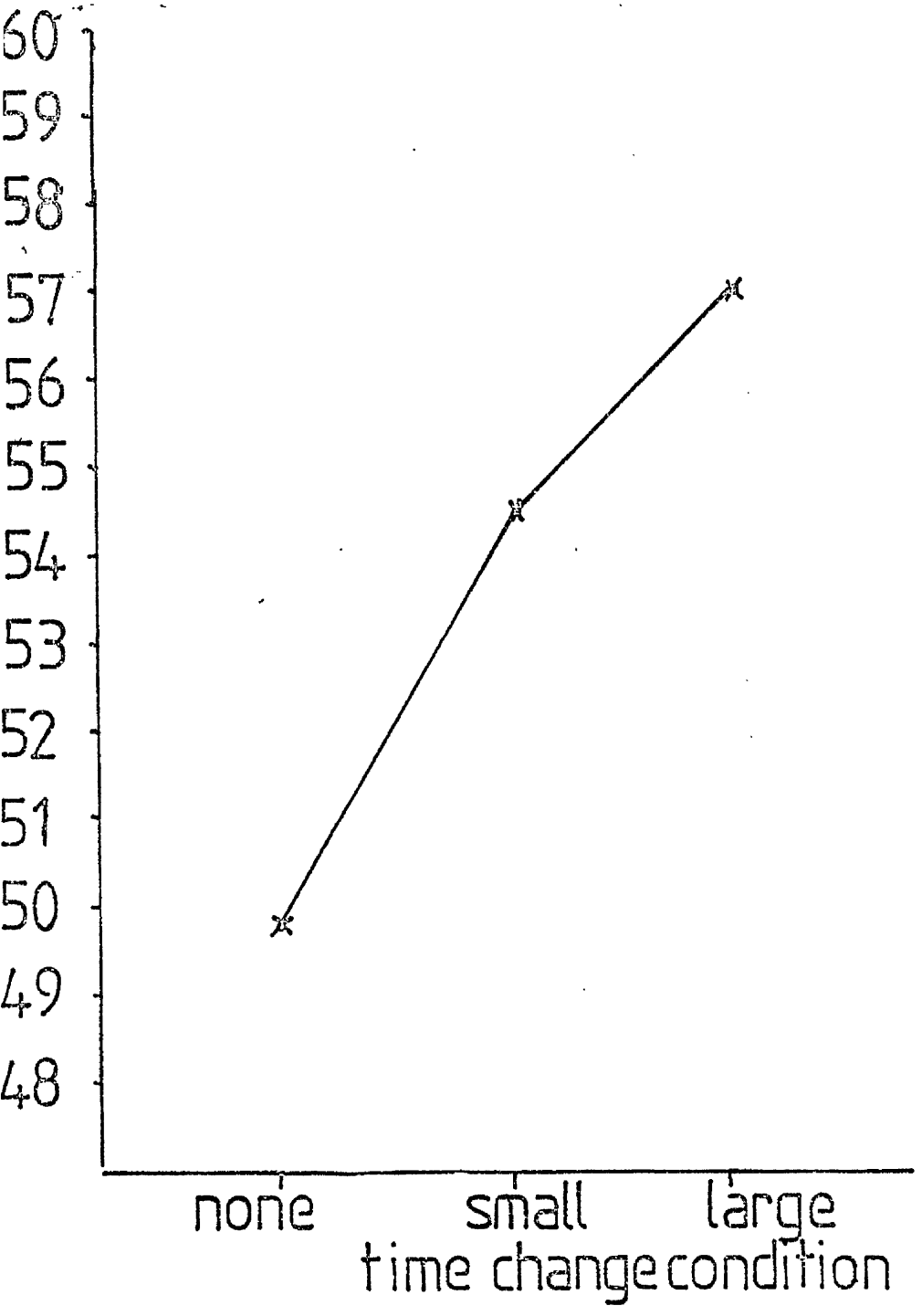
Was the Charter granted over a century ago?
Was the earlier prosperity interrupted?
Did weaving begin in 1700?
Did the demand for local cloth stay constant?
Were there land reforms?
Was the half-million mark reached in 1950?

Time Change Structure of Passage Above



'e 4.1 Reading Rates for sentences in Experiment I:

a comparison of the effect of time changes.



Results

The reading times for lines of text which contained temporal statements implying large and small time changes were compared with the mean reading times for lines of text not containing such information. These comparisons of reading time involved lines of text of slightly different lengths and as a control for any effect of length of line, a rate score for each subject for each line was calculated. The simplest objective measure of length in a reading task appeared to be the number of letters in each line and the total reading time for each line was divided by this. Thus mean rates for each condition of line, i.e. no time change lines, small time change lines and large time change lines were calculated for each subject. A one way analysis of variance was performed on this data first treating subjects as a random effect and collapsing across materials. A second analysis was performed by materials comparing the mean rates reaching for each time change occurrence in the text, when the time change was small or large and contrasting these times with the rate for the intervening lines which did not contain time changes. A one way analysis of variance treating materials as a random effect collapsing across subjects was performed on this data.

The results are shown in Figure 4.1

The analyses yielded a significant effect of sentence condition ($F(2, 50) = 7.24$, $p < .01$ by subjects ; $F(2, 14,) = 19.6$, $p < .01$ by materials, Min $F'(1, 38)$, $= 5.33$, $p < .05$. A Newman-Keuls p test on the differences between

the three means showed both time changes to produce significantly longer reaction times ($p < .05$) but the difference between the two conditions of time change was not statistically significant.

Discussion

The aim of this experiment was to test the hypothesis that temporal statements in a text cue the reader that a new temporal setting has occurred and that previous information may have to be discarded, and that this process would result in longer reading times for lines of text containing time changes. The reading time data confirm this hypothesis, the time change sentences did produce significantly longer time latencies than sentences which did not contain such statements.

The experiment also investigated the effect of the magnitude of the implied time change. It was suggested that a large time change might result in more information being discarded, or make a new temporal setting more likely, or cause any such conceptual setting to be moved further along a time line model of the text. Thus a large time change statement was predicted to produce slower reading times than a smaller time change. The numerical pattern of results showed a trend in the predicted direction but the difference in reading times did not prove statistically significant.

The results support the hypothesis that time changes are cues to the reader that a new temporal setting has begun and that some earlier information may be regarded as

no longer relevant. It appears in these texts that any time change has this effect and that the smaller time changes have just as marked an effect in slowing reading as the larger ones. It may be that in the quasi-historical texts used in this experiment any of the temporal statements, which were in terms of dates or 'x years later' all changes implied new settings and information removal. The numerical trend however was for longer reading times to result from larger time changes, and it may be that some kind of mapping on a time line and movement along this continuum reflecting the size of the time change is involved. A more sensitive examination of this possibility would involve correlating the actual size of the time changes involved and the corresponding reading times. This procedure is described in Chapter 7, Experiment I where a more discriminating categorization of time changes was possible.

The general aim of the present experiment was to test the function of temporal information. The hypothesis was that the reading time data reflected increased processing load caused by the construction of new temporal settings following time change statements in the text. Can alternative models of comprehension account for the data?

The model of comprehension proposed by Kintsch (1974) predicts that sentences which contain a larger number of propositions produce longer reading times. In this experiment the comparisons of the effect of time changes are made are across different sentences and as the propositions were not controlled for in the construction

of passages it is possible that different numbers of propositions are found in the lines of the text. This seems an unlikely explanation of the difference in reading times however, as an examination of the experimental passage on pages 76-77 shows. The time change lines do not seem to differ in the information content from the other lines in the passage, in the way that sentences containing many vs. few propositions described by Kintsch and his coworkers do.

Another counter to a propositional argument is the length control used in the analysis of reading times. The differences found in reading times were found by comparing reading rates per letter in each line of text. When reading rates per letter are calculated it is probable that any differences in the number of propositions would be controlled. The propositional account does not seeem a very probable explanation of the observed differences in reading rates.

The experimental results can be explained by considering either the construction of new temporal setting and associated information updating. The results are also compatible with a time line models such as that proposed by Miller & Johnson Laird described in Chapter 3. In this model, the time line is seen as a conceptual continuum extending from the past through the present, to the future. Temporal information in a sentence, such as verb tenses map the representation of a sentence on to the time line. The reader can conceptually move along the time line where temporal

expressions or information indicate such a move is appropriate.

In the passage shown on pages 76-77 this model would suggest that the first sentence would be mapped on to the time line at some point, probably equivalent to the present time due to the present tense of the verb. This would also be the case for lines two and three. Line four however, contains an explicit temporal statement (either 'in 1550' or 'in 1875') which would cause the representation of this line to be located at an earlier point on the time line. The distance from the initial mapping point would presumably be greater where the date mentioned is more distant in time.

Although Miller and Johnson-Laird do not discuss how such temporal mappings would affect reading times, a plausible extension of their arguement might include predicting an increased reading time where a temporal mapping has to be made at a different location on the time line as is the case in this experiment when the reader comes to those lines with explicit temporal expressions which indicate a time change has occurred. The reading time differences may indicate that any relocation is a time consuming process for the reader as both time change conditions produced increased times. This relocation explanation would account for the difference as would the construction of a new temporal setting which was suggested earlier.

The time line would also explain any increase found in the larger time change condition, for the further along the

continuum a relocation has to be made the longer this process might be expected to take. As the experiment is rather inconclusive on the effect of magnitude of the time changes this explanation cannot be confirmed. As noted above, to separate the time line and temporal setting explanations, further more sensitive manipulation of the size of the time changes and the corresponding reading times would be required.

From this experiment is seems that, as indicated in the study of paragraphing, the presence of temporal information affects text processing. Where time changes occur in a passage reading times increase and there is a trend that this increase is greater where the time changes are large.

This appears to support the hypothesis stated at the start of this Chapter, that the function of temporal information was to divide a section of prose into smaller integrated units sharing a common temporal setting and act as a cue that some of earlier information may no longer be relevant. The experimental results however cannot distinguish this view from an explanation on conceptual mappings of events on to a time line.

A further experiment was conducted which investigated text processing and temporal information. This experiment investigated the role of time statements on the integration of information, as exemplified by the process of reference resolution. The hypothesis is that if time changes cue the reader that a new setting is in operation and earlier information is no longer relevant then references to this earlier information will be less rapid

following such a temporal cue.

The function of temporal statements in comprehension then will be tested by comparing reading times for lines of text containing time changes with lines of text not containing such information. The prediction is that time changes will result in slower reading times. The reading times will be compared where lines of text contain small time changes and where they contain large time changes. The prediction is that large time changes will produce slower reading times. The accessibility of information following small and large time changes will be measured by comparing reading times for sentences containing pronouns which refer to information prior to the time change. The prediction is that reading times will be slower following a large time change. A further test of information accessibility will be made by comparing question answering times in the two time conditions. Questions are predicted to be answered more slowly when a large time change occurs between the pertinent information and the question itself.

Experiment II

Introduction

Experiment I used complex passages in the comprehension task and yielded data which reflected on the general features of text processing and temporal information. In the present experiment the aim was to examine in detail the function and processing of time changes in text.

To do this a number of short simple texts were generated. In simple texts it was hoped that there would be fewer factors extraneous to the experimental variables to affect processing. In particular the passages were non-historical narratives where the time changes were categorized not in terms of centuries but in relation to the everyday events described.

In this experiment the small time changes are predicted to be sufficiently small and so less likely to cue a new temporal setting and hence are expected to have less effect on reading times. The experiment also aims to test the hyothesis that a time change may cause information to be dropped as no longer relevant in the new setting. To test this the accessibility of previous information will be measured by the ease and speed with which references can be made to previous information following a time change and the time taken to retrieve such information to answer questions about the passage following the two time change conditions. Again small time changes are expected to have less effect on information accessibility.

Method

Twenty eight undergradute volunteers acted as subjects in the experiment, and the self-paced reading paradigm, described in Experiment I was used.

Materials and Design

Fourteen short passages were used in the experiment.

These passages were four lines long and contained the following features. In the first line one main character is described. In the third line there is an explicit time change. In the fourth line a pronoun occurs which refers to an entity mentioned before the time change. The passages are each followed by one question which contains information concerned with the first line of the passage.

For example

"The pilot banked the plane out of the clouds.
He checked his instruments to see that all was well.
The fight had begun half an hour ago.
At take-off he had been worried about the weather.

** Questions **

Was the pilot landing the plane?"

The experiment was run in two groups. The first group of fourteen subjects would receive the passage shown above. The second group would receive the same passage with the time change and question modified.

"The pilot banked the plane out of the clouds.
He checked his instruments to see that all was well.
The flight had begun thirty hours ago.
At take-off he had been worried about the weather.

** Questions **

Was the pilot landing the plane?"

Time change condition was counterbalanced across subject groups. A full list of the passages used in the experiment is shown in Appendix B

Results

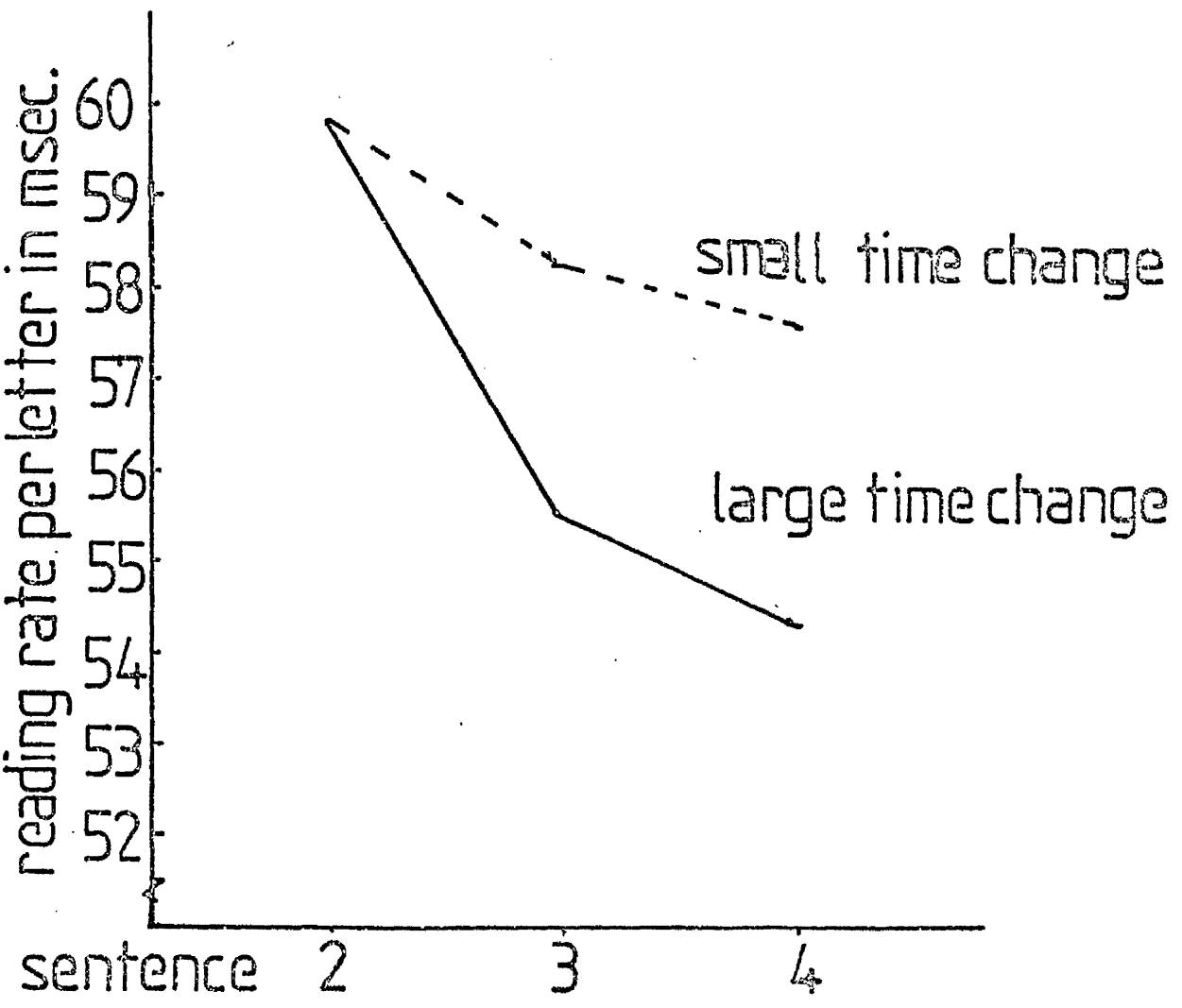
The mean reading rates of reading times for each subject for sentence two, and for sentence three in small and large time change conditions were calculated. These results are shown in Figure 4.2. An analysis of variance was performed on this data treating subject group and time change condition as fixed factors and subjects as a random factor. Neither subject group, time change condition nor the group x time interaction was significant ($F(1, 26) = 1.83$, $p > .05$, $F(1, 26) = .65$, $p > .05$, $F(2, 52) = 0.18$ n.s. respectively).

The data were also analysed by materials collapsing across subjects. A one way analysis of variance treating time change condition, absent, small and large in each of the fourteen passages as the main effect, again showed no significant differences ($F(2, 26) = 0.14$ n.s.).

The mean reading rates were calculated for sentence four containing the pronoun references, for each subject in the two time change conditions. Again subject group and time change were treated as fixed effects with subjects as a random effect; the analysis showed a significant main effect of time change ($F(1, 26) = 8.6$, $p < .01$).
The sentences containing pronoun references were read more slowly following a small time change. The data were also

e 4.2 Reading Rates for sentences in Experiment II:

a comparison of the effect of time changes.



analysed by materials collapsing across subjects for each of the fourteen passages. In this analysis there was no main effect of time change condition ($F(1, 13) = 1.50$, $p = 0.24$).

Mean question answering times following each time change condition in the texts were calculated for each subject and a two way analysis of variance was performed on the data treating subject group and time change condition as fixed treatment factors and subjects as a random factor.

Time change condition was a significant main effect but neither subject group nor the subject group x time interaction was significant ($F(1, 26) = 7.52$, $p < 0.01$, $F(2, 26) = 0.48$ n.s. $F(1, 26) = 0.27$ n.s. time, Subject Group and Time x Group, respectively). The question answering data was also analysed, comparing mean question answering times following the two time change conditions for each passage collapsing across subjects. A one way analysis of variance performed on this data showed a significant main effect of time change condition ($F(1, 13) = 4.16$, $p < .05$) F 2 (Min $F' = 2.69$ n.s.).

Questions were answered more slowly following a passage containing large time changes. The analysis of the results are shown in Appendix B.

Discussion

The results of this experiment do not confirm the predictions made concerning the effects of time changes on text processing. The hypotheses which this

experiment was intended to test will be reconsidered in the light of the results of the experiments.

Reading Time Effects for Time Change Sentence - Methodological Problems

Sentences containing time change information were predicted to cue the reader that a new temporal setting had begun. This process was expected to increase the processing load for the reader and so be reflected in increased reading times for these lines of text. The experiment showed no effect of time change on reading rate. The comparison of sentences with and without time change information, was made between different sentences the contents of which could have unknown effects on reading rate. This may be one explanation of the unexpected result of Experiment II but why a similar comparison in Experiment I should have been effective will be discussed below.

The other interesting comparison of the reading rates for the time change sentences, was between each sentence containing a small time change and the same sentence containing a large time change. The results of the experiment did not confirm the prediction that large time changes would lead to slower reading rates. A second methodological problem, may explain this unexpected result. The time changes in the experimental texts were categorized as small and large on a purely intuitive basis. No systematic categorization of the size of time changes was made, nor was the small/large distinction held

constant across different texts, thus a change such as "thirty hours" represented a 'large' time change in a text concerning flights but this was smaller than many of the 'small' changes in other texts. These problems of categorization may well lead to increased variance and hence obscure the relationship between time change and reading rate.

In Chapter 6 a method was developed to establish time norms for use in experimental texts and this problem of the size of the time changes will be discussed further in that Chapter.

Reading Times for Pronoun Reference Sentences

Experiment II was designed to test the hypothesis that one consequence of the establishment of a new temporal setting is that entities in a text which precede the time change become less accessible. This in turn is predicted to lead to slower reading rates for sentences which contain pronoun references whose antecedents precede the time change sentence. This effect was predicted to be more marked where the time change was large.

The results of the experiment suggested that pronoun references were resolved more slowly following a small rather than a large time change. This was an unexpected finding but not entirely incompatible with the general concepts developed in Chapter 2 where it was suggested that time changes cues a reader both that a new temporal setting has begun and that some of the previous information in a text may be no longer relevant. In the

texts used in Experiment II if the time changes particularly the large time, changes the reader to regard some of the previous information as no longer relevant, the reader may retain only the most important items of information. The only character in the story seems liable to be treated as such a feature but some of the other items of information may be disregarded following the time change.

This in effect may simplify the experimental texts as there is so little information to be retained in the new temporal setting. A pronoun reference may well be resolved very easily and speedily if this process involves checking the pool of retained information for possible antecedents for the pronouns and this pool is smaller where a large time change has reduced the amount of this information.

In Chapter 7 texts were devised which contained more than one character of different degrees of relevance to the text to test these explanations.

Question Answering Times and Time Changes

Experiment II was designed to test the accessibility of information following time changes both by pronoun resolution and question answering times. The question answering data did confirm the hypothesis that a large time change would result in longer question answering times. It was suggested that this would happen because the large time change would either be more liable to initiate a new temporal than a smaller change or that a

large time change would cause the events described to be mapped on to a conceptual time line at a more distant point than a smaller time change. Either explanation could cause information which preceeded the change to be less accessible and hence retrieval times would be longer in this condition.

The question answering times although providing supporting evidence for this model, apparently contradict the results of the reading rates for pronoun reference sentences. One possible explanation which was suggested was that the speed of resolving pronoun references following a large time change resulted in little information apart from the main character remaining relevant. The reduction in information meant that fewer possible antecedents for the pronoun had to be checked and the correct antecedent, the main character, was found more quickly in this time change condition.

In fact, the question answering data is compatible with this account. The questions following each text required the reader to verify information attached to the main character. For example, in answering the question "Was Paul varnishing his boat?", the reader not only has to find the intended antecedent of the referring expression 'Paul' but has to check the predication information attached to this to see if the rest of the question is correct. If this predicate information is the kind of detail which a large time change cues as possibly no longer relevant then this may be less accessible following such a cue whilst the representation

of the main character himself might be very quickly located as it will remain active in the readers' model of the text.

General Discussion

Following the paragraph studies described in Chapter 2 and experiment I in this Chapter it was suggested that temporal information might function as boundaries which divide continuous prose into smaller units sharing a temporal setting. An explicit statement of temporal information could act as a cue that a new temporal setting was in operation and that some of the previous information in the text may no longer be relevant.

The results of the last experiment appear at first to refute this suggested role of time information. Is there any reason which would explain the different pattern of results between these experiments and which would suggest how investigation might clarify the role of temporal information in text comprehension?

One obvious difference between the experimental materials is the length of the passage presented to the subjects. In the paragraphing studies the passage was long and of quite complex structure. The temporal statements could be very useful to the reader in dividing this into separate units which share a common setting. The temporal information could be used to help simplify the processing of the text by dividing into smaller and more manageable units.

Similarly in the first reading time experiment the

temporal statements in the passage can be used by the reader to divide long passages containing a continuous flow of information into smaller units with a common setting and fewer items of information to integrate at once.

In these experiments the temporal information can act as previously described by dividing a complex passage containing a large amount of information into different temporal settings and cueing some of the numerous items of information preceding each time statement as no longer relevant.

In Experiment II in this Chapter the passages were only four lines long and contained only one character, and were thus much shorter and simpler than the earlier experimental texts. It seems plausible that in such a passage, although some information may be cued as possibly no longer relevant following a time change, the identity of the main character will be retained as the most important element of the narrative. The continual ease of referencing this character therefore does not necessarily contradict the temporal cue-information reassessment suggestion. All the important information cannot be disregarded by the reader following a time change or temporal statements would not act as aids to the reader during comprehension but as complete breaks in processing. Further investigation of the effect of time changes should examine ease of reference resolution and accessibility of information where more than one character is involved particularly characters who have

different perceived relevance or importance in the text.

Another important aspect of the influence of temporal information highlighted by the unexpected results of Experiment II, is the question of the magnitude of the time changes involved. In the paragraph studies the time changes were those originally contained in the narrative. These differed in size as they related to the important events in the story. In constructing a model of time changes in comprehension, however it is important to establish if any time change is significant or if the magnitude of the time change is important. It has been suggested for a variety of theoretical reasons, in this Chapter that a large time change, is expected to have a more pronounced effect or text processing. In Experiment I, an insignificant trend in the reading times in this direction was observed. In Expriment II, small time changes resulted in slower reference resolution times but large time changes resulted in longer question answering times.

The problem is that the different sizes of time changes, both in the quasi historical passages and the short narratives are defined intuitively. If the effect of the magnitude of the time change is not clear and simple then a more sensitive categorization of time changes may be required. For example Litteral (1972) has suggested in his account of time in New Guinea narratives, described in Chapter 3 that the length of the relative times in unimportant but the boundaries of the time periods is critical. It may be that in devising small and large

time changes for narrative texts, the perceived time boundaries for each narrative event will have to be established from groups of readers.

The experiments described in Chapter 6 and 7 aim to test these possibilities, and thus to clarify the apparent contradictions in the results of the experiments described in this Chapter.

CHAPTER 5

A Review of Some Models of Text Processing

In Chapter 1, comprehension was considered in a general way with reference to the types of processes such as segmentation, integration and interpre tation which may well be involved. Following the experiments described in Chapter 2, the research focused on the role of time change information during the process of comprehension. The experiments described in Chapter 4 produced rather inconclusive results with a very simple test of the effect of time changes on text processing. It now seems appropriate to consider rather more detailed accounts of text processing in an attempt to plan more sensitive experiments on the effect of time change information.

In general, psychological accounts of comprehension have not concentrated on the actual processing of the text, but have been more concerned with descriptive accounts of the texts and the influence of the structure of the text on recall. For example Kintsch (1974) has explicitly stated that his propositional model is not concerned with text processing. The story grammar theorists such as Bower (1976) and Thorndyke (1977) have concentrated mainly on the effect of story structure on recall without detailing how the structure might be used during processing.

Researchers in artificial intelligence in their attempts to produce functioning language understanding

systems are forced to consider the actual processing of texts in their comprehension models. It is therefore artificial intelligence models which seem most relevant to the research described in this thesis, particularly as several of these accounts discuss reference resolution as one of the central features in a text processing system.

The Schank and Abelson (1977) system, SAM (Script Applier Mechanism) which can 'comprehend' short texts which was briefly described in Chapter 1, is one relevant account of text processing. The SAM system includes a description of how the script mechanisms are instantiated, namely when certain key concepts called headers are found in certain contexts. Schank and Abelson explain how the system uses the script during processing to supplement the stated information, from its stored knowledge of the appropriate event sequence, and how this implied information is then treated as though it was actually stated in the texts. This allows references to be made to this script or implied information as though it had been previously explicitly mentioned and so definite references can be used to such script based information. As SAM is a functioning if limited story understander these processes can be demonstrated, in that SAM produces paraphrases, expansions, summaries or translations of the texts it processes.

Another artificial intelligence account of language processing which is similar to Schank and Abelson in that it includes the use of preprogrammed knowledge structures is provided by Bullwinkle (1978). (This is of particular

interest to the current research, as it discusses explicitly and in some detail how references are resolved during text or discourse processing). In Schank & Abelson's SAM program the ability to make definite references to entities introduced by scripts seems to be one of the main interactions between the systems prior world knowledge and knowledge gained from the text. In Bullwinkle's account of text processing, the importance of reference resolution disambiguation, as she terms the process, is discussed explicitly. Perhaps because the texts used in Bullwinkle's account resemble casual conversational discourses rather than the stereotyped stories used by SAM, there is even in the shortest example a large number of references, particularly pronoun references to be resolved. Bullwinkle believes that in order to resolve such references the system needs a detailed description of the discourse and its components. She states that discourse organisation centres around the concept of theme and topic. The theme of the discourse is what the whole discourse is about, in the discourses described by Bullwinkle they are generally suggested by the leading sentence. Topic refers to what each speech act or sentence is about, and Bullwinkle states that when a theme of discourse is chosen, the topic of its related sentence becomes the discourse topic. Once a topic is chosen for a discourse, subsequent sentences provide more information about the topic.

A discourse may expand various aspects of a topic then end the discussion of that topic, or it may mention

one aspect of the topic and describe it in detail. In one of Bullwinkle's examples the topic of the discourse is a meeting but several sentences are spent discussing the time of the meeting. This changes the topic to time but the theme should not be forgotten because the discourse may return to it. The meeting has a background role, and is described as 'stacked' so that it can be retrieved for later use, while the time of the meeting becomes the foregrounded topic. These subtopic shifts occur when a sentence has as its topic, a concept which is not identical to the existing discourse topic. In the example below

> "I want to schedule a meeting with George, Jim, Steve and Mike. We can meet in my office. (a) Its kind of small, but the meeting won't last very long anyway. (b) It won't take more than twenty minutes".

In version (a) of this discourse sentence 2 introduces 'office' as a potential anaphoric antecedent, thus the first clause of sentence 3 can be interpreted as referring to 'my office'. The nature of sentence 3 is significant, as semantic knowledge about objects in the discourse is needed to interpret these sentences. In version (b) of the discourse this knowledge is used to reject 'office' and then the discourse topic is available as the referrent of the anaphor. The distinctions used can be fairly subtle such as appropriate tenses as well as the more obvious semantic marker checks.

Potential sub-topics have a short life. In version (b) above, by the end of the third sentence 'my office' is dropped as a potential sub-topic. If after that 'office' is discussed it cannot be referenced by 'it' unless another sentence reintroduces 'office' as a potential anaphoric referent.

Bullwinkle descibes how her artificial intelligence program called PAL utilizes these concepts to comprehend short discourses. Like SAM, PAL also uses knowledge based structures to supplement the stated information and interpret the discourse. Bullwinkle provides an example of how PAL operates on the short discourse given below.

> "I want to schedule a meeting with Ira. It should be at 3 p.m. tomorrow. We can meet in Bruce's office".

The referent for 'Ira' is chosen from the instances of people via a program that knows the syntax and semantics of proper names. Following the interpretation of sentence 1, the theme is set to the frame of 'schedule' and the topic to 'meeting'. A referent for 'I' is assumed to be the speaker while the referent of 'it' is chosen to be the topic because the topic passes gender, number, and simple semantic agreement checks. In general, the discourse topic is used to determine anaphoric references either because it is the referent of pronouns like 'it' or because it's structure contains referents for pronouns like 'we' 'she' 'he' or 'they'.

Bullwinkle's account of processing is interesting

because not only does it involve the use of knowledge structures in processing text but it also underlines how central reference resolution is to this interaction between text and knowledge. The other feature of this account which differs from the SAM program is the attention Bullwinkle pays to the description of the text and the status of the entities such as topic, subtopic, theme etc. and how these affect the processing of the text in general and the resolution of references in particular.

The main conclusions from Schank and Abelson is the importance of the knowledge structure in processing and reference resolution. Bullwinkle's account adds to this the importance of the discourse structure, in particular the discourse topic as a source of information and antecedents for referents. The third artificial intelligence model of comprehension which seems pertinent, highlights another feature of comprehension, namely the dynamic aspects of text or discourse processing and the effects of this on reference resolution.

Grosz (1977) introduces the concept of focus in her discussion of comprehension which uses spoken discourse and like Bullwinkle's account prominently features reference resolution as a central aspect of the processing of dialogues.

Grosz discusses reference resolution in terms of focus. Focus refers to focus of attention, which influences the interpretation of an utterance and this results from a combination of contextual factors, both the preceding linguistic context, that is the previous

utterances, and the nonlinguistic environment. Focus attempts to differentiate the items in the knowledge base on the basis of relevance by highlighting those items that are relevant to the current discourse. The use of focus enables the sytem to access more important information first during its retrieval and deduction operations.

The representation of focus proposed by Grosz is based on segmenting the knowledge base into subunits. Each subunit called a focus space, contains those items which are in focus during a particular part of a dialogue. This segmentation is structured by ordering the focus spaces in a hierarchy that corresponds to the structure of the dialogue.

Grosz discusses the resolution of references in terms of focus but makes distinctions between the resolution of pronoun and noun phrase references. The resolution of definite noun phrases references is said to reflect the use of focus representation in discourse processing. Definite noun phrases both affect and are affected by the focus of attention. The use of a definite noun phrase can indicate a change in focus. Focus is always a factor in the resolution of definite noun phrases. It provides the set of objects from which the item being referred to must be selected. The successful use of a definite noun phrase depends on the object to which reference is made being in focus. When a subunit of dialogue is complete, a change of focus occurs, and definite noun phrases can be used to refer to objects at higher

levels of the dialogue.

Pronoun references are considered to be affected by focus in a somewhat different manner. As they carry so little information, pronouns generally depend on the sentential context of the preceding utterances to provide candidates for referents. An exception occurs when a shift of focus occurs which establishes a different set of items as given. This use of focus allows pronoun references to be made over long sections of dialogue. Grosz uses an example from a fairly long dialogue concerning an assembly task for two speakers. A pronoun reference is successfully used to refer back to an item mentioned in the first remark of the dialogue after 30 minutes and 60 utterances have occurred. This is possible because, preceding the pronoun, a focus shift has occurred because a subtask has been completed Grosz says this then allows references to be made to higher levels of a dialogue. It is not clear whether this kind of large shift can only be made to the highest level of the dialogue hierarchy, or whether it can occur at the end of all subunits, or if as in the illustrated example this only or mainly occurs when a sub task is complete this was the last subunit, is not clear. Perhaps when all subunits or four spaces are closed the topic or top level of the hierarchy is left as the only possible antecedent.

What may be more important is to note the potential for even large leaps over dialogue in reference resolution where the discourse is appropriately structured.

Grosz's account underlines the importance of the

dynamic aspects of comprehension and reference resolution. There are several aspects about the status of the evidence she provides for her account which are open to question but this is the main contribution of her model.

Her examples of reference resolution highlight how shifts in the dialogue which relate to pragmatic aspects of the task being discussed rather than the actual dialogue structure affect the resolution of referential expressions. It is the relevance of an entity in the task structure which affects its accessibility for the speaker and listener and this relevance changes as the tasks under discussion progress. Thus the speakers' and listeners' shared knowledge of which stage in a task dialogue they have reached and which stages they have completed enables them to use and resolve referentially expressions which appear hopelessly ambiguous. The shifts in focus as described by Grosz seem useful models of how possible referents become and cease to become accessible.

A psychological model which utilised such concepts would require to be able to predict how and when such changes in focus occur and not merely describe past instances of the phenomenon. Psychologists would also wish to know how frequent and typical of her dialogues are Grosz examples of these shifts. The dialogues which are described are also very highly structured by the nature of the tasks set to the speakers and whether these clear shifts of focus can be generalized to more loosely organized discourses has yet to be demonstrated. However although

the quality of the evidence cited by Grosz may not be as detailed or comprehensive as the psychologist might wish the ideas put forward are of great interest. It is obvious that in any discourse the availability of antecedents must vary over time and place in the dialogue. Grosz at least suggests how such availability might operate. The constraints imposed by the open and closed focus spaces suggest a way in which real world knowledge of the task under discussion and the resulting dialogue structure are incorporated in order to resolve potentially ambiguous references.

This model indicates how a full psychological account might involve the concept of the readers' knowledge of the current and changing relevance of information in reference resolution.

Schank and Abelson (1977) and other artificial intelligence language theorists highlighted the importance of knowledge in language processing. Bullwinkle (1978) in her AI account of discourse compehension noted that reference resolution is a central feature of comprehension. Grosz (1977) underlined the significance of reference resolution and stressed the dynamic aspects of this process. None of thse models of comprehension however is a psychological account of language processing by the human reader. A psychological account of text comprehension which draws on these earlier accounts, as well as much psychological evidence on language processing, is presented by Sanford and Garrod (1980).

Sanford and Garrod propose a general framework for

text comprehension in terms of memory access and give a detailed account of how reference resolution occurs within this. Reference resolution is seen as a critical feature of comprehension because ultimately the goal in understanding a discourse is to relate it to the real or imagined world, in other words to determine to what it is that the discouse refers.

The comprehension process is viewed as having two parts, firstly a retrieval process which searches for appropriate information and secondly a construction process whereby a unique representation is made of the text.

The retrieval process is specified in terms of three variables; the search domain, the given partial description of the information to be found, and the type of information to be returned.

The construction process similarly has three variables, the domain of memory where the construction is recorded, a description of the information to be incorporated and the type of structure to result.

These two processes of retrieval and construction are seen as taking place within four memory partitions defined by Sanford and Garrod in terms of a static/dynamic distinction and the origins of the information from text or readers' knowledge. The four partitions of memory are shown below.

	Dynamic	Static
Text-based	1) Explicit Focus	3) Long term text memory

Knowledge-based | 2) Implicit Focus | 4) Long term semantic memory

The partitions are described as follows. Explicit focus is a limited capacity partition of memory which contains representations of entities and events mentioned in the text. Implicit focus is the currently selected subset of general knowledge. This subset is termed a scenario and is similar to the scripts described by Schank and Abelson (1977) but refers to human language processing. The partition called long-term text memory is said to be a specific subset of episodic memory. The fourth partion, long-term semantic memory is the readers' whole general knowledge base.

The two partitions of focus are said to share only one aspect, namely that they provide a retrieval domain which incorporates the information most pertinent to understanding the text at any given time. They embody the current subject matter or 'topic' of the text. The focus partitions are held to be useful because they provide a restricted search domain for any given referential expression. Pronouns are restricted to searching explicit focus. Definite noun phrases are said to search both explicit and implicit focus. Referential expressions are regarded as retrieval commands to the processor, specifying the search domain and the type of information to be retrieved.

Sanford and Garrod provide examples to illustrate their model. In the sentence pair;

Mary dressed the baby.

They were made of pink wool.

the pronoun "they" is not possible because although its putative antecedent 'clothes' is implied by the verb dress, it is not stated, and hence is not in explicit focus which is the only domain searched by a pronoun. If the second sentence was "The clothes were made of pink wool", the definite noun phrase could be interpreted because in implicit focus the antecedent clothes would appear. This point is illustrated more fully by another example which Sanford and Garrod provide.

John entered the restaurant.

The waiter brought the menu.

In this example the definite noun phrase "the waiter" can be interpreted because the current scenario of restaurants, which is what constitutes implicit focus in this passage, will provide the antecedent. The antecedent will be located because definite noun phrases search both domains of focus.

This model of comprehension is important because not only does it include the concepts of knowledge units, the mechanics of reference resolution and the dynamic partitioning of focus, but it provides experimental evidence from human language processors to support many of its claims.

For example, to test their hypothesis that definite noun phrases search implicit focus Garrod and Sanford (in press) presented subjects with passages where the current

scenario either was appropriate to a subsequent definite noun phrase reference or was inappropriate. The antecedent of the reference could be stated or unstated in each scenario context. An example of these conditions is given below.

Appropriate Scenario	Inapproprite Scenario
Title: In Court	Telling a lie
Fred was being questioned (by a lawyer)	Fred was being questioned (by a lawyer)
He had been accused of murder	He couldn't tell the truth
Target: The lawyer was trying to prove his innocence	The lawyer was trying to prove his innocence

Where the scenario was appropriate, the reading times for the target sentences were no different in the stated and unstated conditions (but where the scenario was inappropriate the unstated condition took longer to read). This provides evidence that definite noun phrases automatically search implicit focus words where the antecedent was only implied by the context, it was retrieved just as rapidly as where it was actually stated.

Another example of the empirical orientation of Sanford and Garrod's work is the experiment they conducted on the reader's use of scenarios in reading. They hypothesized that when a text suggests a standard event about which the reader has previous knowledge, a scenario is invoked. The entities mentioned in the text will be mapped into appropriate slots in the scenario and hence

any entity will then be understood as playing a particular role. If such a mapping is subsequently found to be inappropriate, comprehension difficulties will arise for the reader. To test these ideas subjects were presented with passages in which a character in a scenario either shifted or did not shift role. An example of their experimental materials is given by the authors.

Condition 1: No Role Change

John was not looking forward to teaching maths.
The bus trundled slowly along the road.
TARGET He hoped he could control the class today.

Condition 2: Role Change on Target

John was on his way to school.
The bus trundled slowly along the road.
TARGET He hoped he could control the class today.

The reading times for target sentences in the role change condition, where a previous mapping of John in a schoolboy slot, is found to have been inappropriate, are longer than the reading times for the same target sentence in the no change condition.

Sanford and Garrod (in press) point out that the role of the character is not made explicit in the text and the brevity of the passages suggest that the role interpretation must take place very rapidly. They suggest that role assignment is part of the process of invoking a scenario to interpret incoming information from the text. The

background information of the scenario is thus linked to the text by the explicitly stated information being used to fill the partly defined slots which the scenario structure provides.

Sanford and Garrod provide a model of comprehension which attempts to outline how human readers process information in a text. They suggest that reference resolution is a central aspect of such processing. Their model indicates how the concept of knowledge based units, called here scenarios, might be involved in the resolution of references, and how changes within these scenario may affect the ease or difficulty of this process. The model also suggets how different types of referential expessions search different domains of reference and how these relate to real world or text based information. The crucial aspect of this account of text processing is it's basis in empirical evidence. The experiments described by the authors provide support for some aspects of the model, others remain to be tested. From this model many predictions about how readers would resolve references in different conditions can readily be made.

As far as the experimental investigation of the role of time change information is concerned several elements emerge as important from these different accounts of text processing.

Firstly the importance of knowledge units based on the readers' previous experience of the described events, allow the stated information in the text to be expanded and interpreted. The time course for any described events

may be one such item of prior knowledge which the reader uses in this way.

Seondly the importance of reference resolution in text processing and how these knowledge units affect the ease or difficulty of this process. The knowledge unit can provide the antecedents for references, as described in the experiment by Sanford and Garrod (1980) where references could be made to entities implied by the scenario as easily as if they had been stated. The knowledge unit can also disambiguate the mass of apparently confusable referential expression in information or conversational discourse as described by Bullwinkle (1978) in her AI system.

The third element which emerges from process models of comprehension is the dynamic aspect of reference resolution. Sanford and Garrod (1980) describe how changes within the current scenario, as in perceived role shifts affect the difficulty of subsequent references to this character. Grosz (1977) descibes how focus spaces open and close and how these shifts affect the manner and ease of reference to entities within the dialogue. Time change information could be seen as playing a role in this process by cueing the reader to maintain or change the current interpretive knowledge structure and this may have similar implications for reference resolution to the shifts described in these accounts.

A review of processing reveals that in a text there are many potential entities to which reference may be made. These may be explicitly stated events or

implicitly made available by the reader's knowledge. To enable references to be quickly and easily resolved all of these potential antecedents cannot be equally available. Time change information may cue which sets of entities are currently relevant and easily accessible.

The experiments described in Chapters 6 and 7 are an attempt to examine the use of temporal information in readers' assessment of the accessibility and prominence of elements in a text and how the factors described in this Chapter can be shown to operate in readers' processing of texts.

CHAPTER 6
Continuation Studies
General Introduction

In the last Chapter where various models of text processing were considered, it became apparent that several predictions about the effect of time change information on the reader, could be made which would incorporate the earlier empirical results described in this thesis in a more general account of comprehension.

One of the most interesting concepts to emerge from the process models of comprehension was that of the knowledge structure, variously termed a script, frame or scenario which a text processor uses to expand and interpret information explicitly stated in a text with information stored in memory about any given standard event.

Bower, Black & Turner (1979) investigated subjects' knowledge of these stereotyped actions or scripts. They found people largely agreed on the characters, actions, props and order of actions in these events. They also agreed on how to segment these scripts into constituent scenes. In studying memory for script based texts, they found that subjects confused actions implied by the script and those actually stated in the text. In really scrambled stories subjects also tended to reorder events into their familiar script sequence. It was suggested that the normal time range for a described event might be another shared item of prestored information which could be used in interpreting texts.

The first study described in this Chapter investigates if readers do have a common preconception about the normal time range for stereotyped events. The knowledge structure models of comprehension however, go beyond stating that a reader merely has stored a particular item of information, Sanford and Garrod (1981) claim for example, that scenario information becomes available to the reader as readily as explicitly stated information in appropriate circumstances. A recognition memory test of script based narratives by Graesser, Gordon & Sawyer (1979) found that in highly typical script activities subjects' memory discrimination was virtually nil. The false recognition rate for these items was as high as subjects' correct recognitions. This demonstrates how readily accessible script based information is for the reader, but the most interesting question is whether the reader can use as well as possess the relevant information during text processing.

To investigate if readers can use temporal information to ease text processing, the studies described in this Chapter examine how readers perceive the prominence of various characters in a text when the temporal information suggests that the stereotyped events are completed. This followed from the concept of focus, described in the work of Grosz, the hypothesis being that a time change can cue a scenario as no longer of relevance, i.e. it can be considered out of focus. This had the implication in Grosz's work that references were no longer made to entities within that particular focus

space, in this Chapter the experiments will test if references will be made to entities within a scenario that has been cued as no longer in focus by an appropriate time change.

Sanford and Garrod (1981) also use the concept of focus in their model of comprehension in a way which is relevant to the experiments which follow. They describe a partitioning of focus, into explicit and implicit focus which they claim has implications for reference resolution. They state that a scenario which is currently active is implicitly focused and its constituent unstated items become available for reference by noun phrases. The information stated in the text is in explicit focus, and this partition alone can be referenced by pronouns.

In the following experiments the use of referential expressions to scenario and non-scenario information will be examined. This suggested difference in referencing between scenario based and other information leads to another aspect of text processing which these experiments will investigate. This is the general prominence or importance that various elements in a text have for the reader, and how this is affected by the readers' previous knowledge, such as the stereotyped information postulated as being contained in a scenario.

A related concept to focus is that of foregrounded elements in a text (Chafe 1972) was discussed in Chapter I. Relevant studies to test effects of foregrounding on the accessibility of items in a text have been conducted

by Lesgold, Roth & Curtis (1979). They manipulated the status of antecedent items in a text, as being foregrounded or backgrounded, by following these items with information which either continued the context of the antecedent or introduced one or more new topics to the text. The speed of reading a target sentence which was coreferential to the antecedent was their measure of retrievability or accessability. Backgrounding an item always increased target reading times, thus a foregrounded item was always more easily referenced.

One characteristic of foregrounded items described by Chafe (1972) is their ability to be accessed by pronouns. The Lesgold et al studies suggest that explicit changes in topic cause previous elements in a text to be backgrounded. The studies described in this Chapter will investigate how implied changes in scenarios may affect the status of elements in a text and how by the number and manner of subjects' subsequent referential expressions will reflect such changes.

It is hoped that by investigating the factors which determine the items readers consider most prominent, relevant and accessible in a narrative text. The studies also investigate how world knowledge as described by the scenario or script models in general, and time change information in particular is used by the reader during comprehension.

Experiment I:

Assessment by Story Continuations

The Task: To determine what factors in a text seem most relevant to the reader, a continuation task was used. This allows readers to expand a short narrative by providing a one line continuation of the story. The general assumption behind the use of this method is that over a number of readers and a number of texts, the entities mentioned most frequently in the continuations are those judged most prominent or relevant by the readers.

Although apparently a very free and unstructured task, the continuation method can be used in a standardised way by scoring merely the number of referencs to a given character in a text and the type of referential expression used. The data from these experiments is both objective and statistically analysable.

Materials. These consisted of twenty short passages based on stereotyped situations.

In a pre-test time norms had been established for these events. One line versions of the twenty passages had been presented to 20 undergraduate subjects who were asked to estimate the expected time range for the described events e.g. "The family were eating a meal in a restaurant".

The time ranges were ranked for each subject from the event expected to have the shortest duration to the event which was expected to last the longest. The time range

rankings were then tested for intersubject agreement using Kendall's coefficient of concordance. The rankings were found to be highly consistent ($W = 0.69$, d.f. 1, 19, $p < 0.001$).

The actual time range durations for the twenty episodes with the upper and lower bounds produced for each event are shown in Table 1.

By inspections of the distribution of time ranges it was possible to select for each episode one elapsed time period which would be clearly beyond the scenario limits and one which was within the predicted range. These are also shown in Table 1. These are the two conditions of time change which are used in the story continuation experiments. The materials used in this experiment were twenty, four line texts. Each text was preceded by a short title, which was the name of the stereotyped event described in the passage. There are two characters or sets of characters mentioned in the text. In the first line, the main character termed the scenario independent character is introduced. This character is described by proper name. In the second line of the text, a character, termed the scenario-dependent charcter is introduced. This character is described by a role description relating to the scenario. The third line of the text contains information relating to the scenario but not referring to either character. The fourth line contains the time change in one of the two conditions described above.

Table 1

Maximum and minimum of durations for events taken from distributions produced by combining the results of all subjects. Columns 3 and 4 show the shifts in narrative present used for the within- and beyond time range conditions of Experiments I and II.

Scenario Title	Range	Within Range Time Change	Beyond Range Time Change
In the restaurant	1/2 - 3 hours	40 minutes	5 hours
Birthday Party	1 - 5 hours	1 hour	12 hours
On the Beach	10 min - 7 hours	10 minutes	8 hours
The Holiday	3 days - 4 weeks	3 days	3 months
Going Shopping	1/2 - 4 hours	1/2 hour	6 hours
At the Cinema	1/2 - 3 hours	10 minutes	7 hours
The Bus Journey	5 min - 6 hours	10 minutes	10 hours
The Country Walk	5 min - 6 hours	1 hour	2 weeks
Car Repairs	5 min - 6 hours	1 hour	9 hours
The Wedding	15 min - 8 hour	10 minutes	10 hours
Spring Cleaning	15 min - 6 hours	1 hour	1 week
The Operation	15 min - 7 hours	7 hours	7 days
The Trial	30 min - 14 days	3 hours	3 months
At the Hairdresser	1/2 - 6 hours	20 minutes	7 hours
The Examination	1/2 - 3 hours	1 hour	1 week
The Race	0 - 20 hours	2 minutes	2 days
At the Concert	1/2 - 5 hours	2 hours	2 days
Changing the Baby	30 sec - 1 hour	5 minutes	1 day
The Tennis Match	20 min - 4 hours	2 hours	8 hours
Going Swimming	1 min - 2 hours	1/2 hour	5 hours

Two sample texts are shown below:

"The Bus Journey"

Miss Grey was travelling by bus from the terminus.
The conductor was collecting the fares.
The bus rattled and jolted as it went.
Ten minutes)
hours) later joints still ached.

"At the Cinema"

Jenny and Tom were finding the film rather boring.
The projectionist had to keep changing reels.
It was supposed to be a silent classic.
Ten minutes)
Seven hours) later the film was forgotten.

Subjects were presented with two blocks of twenty passages. The time change condition of each passage was reversed between the first and second presentations. Full details of the design and materials used in this experiment are shown in Appendix C.

Aim

This experiment attempts to manipulate the perceived relevance of knowledge units through the alteration of the time range or boundary of the events described in the text. It is postulated that these interpretive structures, termed here scenarios, are based on past experiences of stereotyped events, and that one item of this knowledge is the likely time course of the event.

If this time range is exceeded in the text, the scenario will no longer be in focus, and the and the entities contained in the scenario will be less readily accessible to the reader. These differences will be reflected in the way in which subjects continue the given texts.

The aim of this experiment is to test the following hypotheses. Firstly that a time change beyond the expected range for a given stereotyped event will lead to the current scenario being moved out of focus, and that this in turn will lead to fewer references to entities bound to that scenario in subjects' continuations of the text. Secondly, that entities not bound to the current scenario, will not be affected in this way. Thirdly, that the type of references used will reflect the accessability of the chosen antecedent prounouns being used to refer to the main character rather than the scenario dependent character.

Procedure

Forty three undergraduates of the University of Glasgow acted as subjects in this experiment. They were presented with a typed booklet containing the following instructions:

> "Typed below are short passages which have not been completed. Your task is to read a passage then add, in the space provided, a one line continuation of the passage, similar to those shown in the three examples.

a) On the Farm

Farmer Smith was walking through the farmyard.
The milkmaid was comiong out of the byre.
The rain was falling from a heavy sky.
Half an hour later thunder started.
- - - "The farmer was worried about his hay".

b) In the Office

Miss Jones was typing some letters.
The office boy was stamping the envelopes.
Five hours later the office was quiet.
- - - "She was glad to have a coffee".

c) The Wild West

The Sheriff was at his desk.
The saloon girl was crossing the street.
Ten minutes later a shot rang out.
- - - "The girl turned and fled".

Subjects were untimed and instructed not to consult their earlier continuations as they worked through the task.

Results

The continuations were scored according to the identity of the character mentioned and the type of

reference used. If both characters were mentioned, the totals for both were increased. If neither character was mentioned, this passage scored zero. The actual content of the continuations was ignored. Total numbers of continuations by subjects and by materials were calculated, in the two time change conditions for both scenario dependent and scenario independent character continuations. Analyses of variance were performed on these totals, first treating subjects as a random factor and collapsing across materials treating time change condition and character type as fixed factors, secondly treating materials as a random factor collapsing across subjects again treating time change and chracter as fixed effects.

The analysis of variance showed a significant main effect of character, $F(1, 42) = 270.24$, $p < 0.001$ by subjects and $F(1, 19) = 29.12$, $p < 0.001$ by materials, and a significant interaction between character and time change condition, $F(1, 42) = 14.74$, $p < 0.001$ by subjects and $F(1, 19) = 9.71$, $p < .005$ by materials. Min F's were calculated for the effect of character Min F', $(1, 23) = 26.28$ $p < 0.01$ and for the character x time interaction Min $F'(1, 44) = 5.84$, $p < 0.05$.

To consider the types of references used, a different type of analysis of the data was performed. The totals for pronoun and noun phase references were not independent as subjects could not use both type of reference in the one passage to refer to the same character. An analysis of variance therefore was not an appropriate test, and Chi

square comparisons were used.

The total number of continuations and the type of referential expressions used are shown in Table 2.

Table 2

Continuations by Reference Type

Within Time Range

Character	Noun Phrases	Pronouns	Total
Scenario Independent	199 (23.6%)*	108 (12.6%)	(35.6%)
Scenario Dependent	100 (11.6%)	51 (5.9%)	(17.5%)

* Percentages shown in brackets are the number of continuations in each condition as a % of the total possible in each condition.

Beyond Time Range

Character	Noun Phrases	Pronouns	Total
Scenario Independent	186. 21.6%	230 (27.3%)	48.9%
Scenario Dependent	58 6.7%	27 3.1%	9.8%

The comparisons of interest are the number of pronoun and noun phrase references used for each character over both time conditions, the hypothesis being that more pronoun references will be made to the scenario independent or main character. The hypothesis was

confirmed, as there were more pronoun continuations concerning the scenario independent other than the scenario dependent character ($X_{(1)}^2 = 3.86$, $p < 0.05$). The second comparison of interest was between the use of pronouns and noun phrases in the beyond range time condition. The difference between the two character types and reference type is even greater in this condition, with a smaller number of pronoun references being made to scenario dependent characters ($X_{(1)}^2 = 22.7$, $p < 0.001$). In the within range time condition there is no difference in the use of pronoun and noun phrase references between the two character types ($X_{(1)}^2 = 0.22$ not significant).

Discussion

The aim of this experiment was to test hypotheses concerning the dynamic aspects of a scenario based account of discourse processing. In particular it attempted to evaluate the utility of time boundaries in cueing scenario shifts. The hypothesis was that when a time shift cued a scenario as no longer relevant, the information bound to that scenario would no longer be in focus for the reader and thus the reader would be less likely to mention such scenario dependent information when asked to continue the narrative.

The continuation data provides supporting evidence for these hypotheses. When a text contained a time shift beyond the expected range for that scenario then the continuations which the subjects produced were less likely

to mention scenario dependent characters than when the time shift was within the expected range for that stereotyped situation.

The probability of mentioning the scenario independent or main character is not reduced in this way. The data suggests that this character has a privileged status in the discourse, which (after Chafe) is termed foregrounded. This character is most likely to be mentioned in continuations in both time conditions. When the types of reference used were considered this status is confirmed. Pronoun references are used more frequently to refer to the scenario independent character than the scenario dependent one, particularly in the beyond range time condition.

Experiment I provides evidence first that readers do have shared expectancies about the time ranges for familiar events. Second Experiment I provides evidence that time change information can also be used by the reader to decide whether a scenario is currently relevant and hence in focus. The results show that the main character, who is independent of the scenario, has an overwhelmingly priviledged status. This character is chosen between twice and eight times as often as the scenario dependent character in the various experimental conditions.

This result raises some interesting questions about text processing. It suggest that the scenario and its associated information may be a device used by the reader to fill out unimportant background whilst the main focus

is on the nonstandard or novel information. If the information actually stated in the text which links to the scenario is not absolutely stereotyped or previously predicted will there be a shift of attention to the scenario? The results of Experiment I suggest that the scenario can shift in and out of focus. Can it also in Chafe's term, become foregrounded, or in general the centre of processing attention? If this occurs will the time change information still be used as a scenario shift cue in the same way or does a standard event time range only apply to absolutely standard events? The following experiments investigate these possibilities.

Experiment II

If a scenario dependent character is only a default assignment in a preprogrammed information structure, actually stating the character in the text may add little to the character's status. So for example, if a reader encounters a text about restaurants then 'the waiter' slot is already activated by the scenario and actually stating 'the waiter' provides no extra information and hence adds nothing which would cause the reader to pay attention to that character. If the waiter is described as 'clumsy' this is not information provided by the scenario and may have to be specifically encoded from the text as new information by the reader. This may cause this character to appear more prominent and hence be more likely to feature in continuations of the text. This enhanced status however should depend on the character being in

focus as part of a currently active scenario. Time changes which cue the scenario as no longer in focus should also terminate any increased prominence of the scenario dependent character.

Materials

The materials used in this experiment were twenty four-line narratives adapted from those used in Experiment I. The first line again contained the scenario independent character described by proper name. The second line contained the scenario-dependent character who was defined in terms of the role played in the scenario, in one condition of the experiment this description was qualified by an adjective. The rest of the passage was a one-line filler sentence and then the time change sentence either in the beyond expected range or within expectd range condition. An example of the materials is shown below:

"In the Restaurant"

The Browns were eating a meal in a restaurant.
A (clumsy) waiter hovered around the table.
This restaurant was well known for its food.
Forty minutes)
Five hours) later the restaurant was empty.

Two groups of subjects were presented with two blocks of twenty passages. Across the blocks each subject was presented with each passage in the two time change

conditions. Each subject received half the passages with adjectives and half without. Across the two groups of subjects each passaged appeared in all conditions. (See Appendix C for full details of design and materials).

Aim

The aim of this experiment is to manipulate the prominence of the scenario-dependent characters through the use of qualifying adjectives. It is hypothesized that adjectives will lead to more relevant continuations to the scenario dependent character where the time change cues that scenario as currently relevant, and in focus.

Procedure

Fifty undergraduates from the University of Glasgow were subjects in this experiment. The instructions to subjects were the same as Experiment I.

Results

The continuations were scored according to which character was mentioned and the type of reference used. If both characters were mentioned in the same continuation both totals were increased. Continuations which mentioned neither character scored zero. Again the actual content of the continuations was ignored. Total numbers of continuations by subjects and by materials were calculated.

From the continuations in the two blocks of materials, it appeared that subjects' responses between

blocks was highly consistent. It appeared that subjects' responses in the second block were influenced either by recall or consultation to their early response to that particular passage. It was decided therefore only to perform an analysis of variance by subjects collapsing across on the data from block 1. The results are shown in Table 3.

The total number of continuations in each time change condition for each character type mentioned were subjected to analyses of variance. Analyses of variance were performed treating subjects as a random factor, collapsing across materials and treating time change condition and character type a fixed factors.

The results were as follows, there was a significant effect of time, adjective and character by subjects (F 1, 49) = 3.97, $p < .05$, F (1, 49) = 6.87, $p < .01$, F (1, 49) = 3.48, $p < .0001$ respectively). The interaction of time x adjective led to significantly more continuations in the adjective present, within time range condition (F (1, 49) = 4.45, $p < .03$). The simple main effects comparisons within the time x character interaction showed there were significantly fewer continuations to the scenario dependent character in the beyond range time condition than in the within range condition (F (1, 49) = 7.74, $p < .01$). Within the character x adjective interaction adjectives led to significantly more continuations to the scenario independent character (F (1, 49) = 18.18, $p < .01$). Within the triple interaction of character x time x adjective (F (1, 49) = 4.55, $p < .03$) the significant

difference is that there are more continuations in the adjective present, within predicted time range condition which mention the scenario independent character.

The analysis by materials collapsing across subjects, if only data from block 1 is included, does not fill any readily available analysis of variance design.

Table 3

Experiment II

Continuations by Reference Type, Character, Time Change and Adjective

Within Time Range

	Character	Noun Phrases	Pronouns
Adjective Absent	{Scenario Independent	62 (24.8%)*	72 (28.8%%)
	{Scenario Dependent	22 (8.8%%)	10 (4%)
Adjective Present	{Scenario Independent	106 (42.4%)	49 (19.6%)
	{Scenario Dependent	33 (6.4%)	4 (1.6%)

* Percentages shown in brackets are the number of continuations in each condition as a percentage of the total possible for each condition e.g. in the within time range, adjectives absent condition 54% of the continuations featured the scenario independent character, 24.8% noun phrase continuations, 28.8% pronoun continuations, 13% of continuations in this conditioned mentioned scenario dependent chracters 8.8% nouns, 4% pronouns.

Beyond Time Range

	Character	Noun Phrases		Pronouns	
Adjective Absent	{Scenario Independent	61	(24.4%)	107	(43%)
	{Scenario Dependent	27	(5.6%)	4	(1.6%)
Adjective Present	{Scenario Independent	77	(31%)	66	(26.4%)
	{Scenario Dependent	20	(8%)	4	(1.6%)

The most important comparisons of both number of continuations and the type of references used therefore will be examined by chi square tests.

The first comparison was made of the number of continuations to the two characters between within and beyond expected time ranges. There is a smaller proportion of continuations to the scenario dependent character in the beyond range condition ($X_{(1)}^2 = 3.86$, $p < .05$).

Following on the by-subject analysis the next comparison of interest is between the adjective present/absent condition and the continuations to the scenario independent character. In the beyond time range condition there is a significantly greater proportion of noun phrases to pronoun in the adjective present condition ($X_{(1)}^2 = 8.92$ $p < .01$). This difference is even more marked in the within time range condition ($X_{(1)}^2 = 13.35$, $p < .001$).

As in Experiment I, the comparisons of use of pronoun and noun phrases differs between the two characters, over both time change conditions ($X_{(1)}^2$ = 26.92, $p < .001$) in the within range condition ($X_{(1)}^2$ = 26.4, $p < .001$ and in the beyond range condition ($X_{(1)}^2$ = 33.4, p .001). Pronouns represent a smaller proportion of the continuations to scenario dependent characters.

Discussion

The results of this experiment are not conclusive, due to the sacrifice of data because of effects in subjects' behaviour over blocks 1 and 2 of the experiment. The results however do show a highly consistent pattern both within the experiment and between this data and the results of Experiment I and so tentative conclusions can be drawn. First the experiment replicates the most interesting result from Experiment I, namely that following a beyond range time change continuations to the scenario dependent character become less likely. This is further support for the concept of scenarios shifting out of focus when cued as no longer relevant.

This experiment was designed specifically to test the relationship between the foregrounded scenario independent character and the less privileged status of the scenario dependent character and how this would be affected by adding non-scenario based information to this character in the form of adjectives. The hypothesis was that adjectives would lead to more continuations and that this improvement would be dependent on the scenario being in

focus. The experiment does show a significant effect of adjectives and a significant interaction of adjective x time in the predicted directions. The increase in the number of continuations however is to the scenario independent character not to the scenario dependent one.

It seems that the effect of adjectives is to make the scenario based narrative more vivid in some way and this leads to more relevant continuations featuring the main scenario independent character.

The readers appear to be involved in a quite complex decision making process when they decide on what is prominent in these narratives and hence what to mention in their continuations. The increase in the adjective condition is limited to the within time range condition so the readers appear to be affected by the scenario and its associated characters being in focus. The type of references used in this condition are also interesting, the increase consisting almost entirely of noun phrases references. These more specific references have been characterised as generally being used when entities are less readily or obviously accessible. The passages are designed to make pronoun references unambiguous but pronouns seem to be largely restricted to foregrounded characters and the adding of an adjective to the scenario dependent character seems to have its effect, not in making this character specifically more prominent, but by reducing the degree of foregrounding of the contrasting scenario independent character. It is as if instead of a rather boring stereotyped story which appears to have only one

character in a stereotyped situation, the adjective makes the situation less predictable and the reader more aware of the supporting players, however it is still the main character to whom they refer in their continuations, but there are more of these 'relevant' continuations rather than predictable one line endings which mention neither character. This effect still depends on the scenario being perceived as ongoing and so is limited to the within range time condition.

The role of the scenario seems still to be a background one, but as well as having relevance cues attached such as time ranges, it also seems to have some attention focusing features but these are less simple than might be supposed. If there is an addition to, or departure from, the predicted information about a standard event, then the more of the readers attention seems to be required to process the text as a whole.

Experiment III

The scenario as an interpretive detail filling device operating in the background is the view of comprehension emerging from these studies with time changes cueing when even this restricted status is no longer relevant. The results of Experiment II suggest that even information added specifically to the scenario dependent character has its effect on the contrast between scenario independent and dependent characters.

Experiment III continues the investigation of the role of the scenario. It tests if primacy, i.e. the first character

encountered by the reader has an effect on status in the text and if the scenario's status can be enhanced by the scenario dependent character occuring in this position. The experiment also further tests the notion of predictability within a scenario. Two scenario dependent characters for each passage were chosen and categorized as predictable or unpredictable from a pretesting session where subjects were asked the names of characters when presented with a short scenario title. The predictable characters for the passages were those characters most frequently predicted by subjects, the unpredictable characters those characters very infrequently produced by the subjects. For example, given the title "In the restaurant" 46 out of 48 subjects produced "waiter" as an expected role name whilst 1 subject out of 48 produced "dishwasher". See Appendix C for full list of titles and characters generated from them.

Materials

The materials used in this study were twenty four line texts adapted from those used in Experiments I and II. In line one the texts contained a role name description of the scenario dependent character, this character was either predictable from the scenario title or unpredictable. In line two the scenario independent character appeared described by personal name. The descriptions of both characters were modified so that they could be unambiguously identified by pronouns. The rest of the passage was as described in Experiment I and II. Two examples are shown below:

The Tennis Match

The (spectators / ballboys) were very hot.

Sue was playing well in her first match at Wimbeldon.

The match was being closely contested.

(One / Eight) hours later a wind blew up.

Car Repairs

The (mechanic / apprentice) surveyed the scene.

Katy used several spanners as she worked on the car.

Tools and oily rags lay all around.

(One / Nine) hours later frustration set in.

Two groups of subjects were presented with two blocks of twenty passages. Across the two blocks each subject was presented with each passage in the two time change conditions. In each block half the passages appeared with a predictable scenario dependent character half with an unpredictable one. Across the two groups of subject all passages appeared in all conditions. Full details of the design and materials used in this experiment are shown in Appendix C.

Aim

The aim of this experiment is to investigate if the status of scenario dependent information can be boosted by reordering the position in which such information appears in a

text. This is a test of a primacy hypothesis, it might be suggested for example that the foregrounded status of the character termed scenario independent in the previous experiments may be due to their position in the text rather than their relation to the scenario. Secondly this experiment investigates the role of predictability within a scenario. Adding new unpredictable information to the scenario dependent character in the form of adjectives in the last experiment seem to somewhat reduce the foregrounded status of the contrasted scenario independent character when the scenario was in focus. If the dependent characters role within the scenario is compatible but not highly predictable from that scenario then this may act in a similar way. Thus predictable and unpredictable scenario dependent characters may lead to different numbers of continuations either to these chracters or to the corresponding scenario independent characters. All these hypothesized effects should depend on the scenario being in focus, thus the beyond range time change should have the same effect as before in reducing the number of continuations to scenario dependent characters.

Procedure

Thirty six undergraduates at the University of Glasgow acted as subjects in this experiment. The instructions to subjects were as in Experiment I and II. It was stressed that subjects should not consult previous answers when completing any given passage.

Results

The continuations were scored as in Experiments I and II. Total numbers of continuations by subjects and by materials were calculated. The results are shown in Table 4.

The results were analysed as in Experiment II. Analyses of variance were performed on the total number of continuations in each time change condition for each character condition, first treating subjects as a random effect collapsing across materials, treating time change conditon, character mentioned and predictability of scenario dependent characters as fixed effects, then treating materials as a random effect collapsing across subjects with the same fixed effects. The significant effects of interest were as follows: the main effect of character was highly significant, ($F, (1, 35) = 252.3$, $p < .01$ by subjects $F(1, 19) = 3.6$, $p < .01$ by materials Min $F'(1, 24)$ 29.7). Neither time change nor predictability was a significant main effect ($F(1, 35) = 2.66$, $p = .1$ by subjects, $F(1, 19) = .88$ by materials, $F(1, 35) = .1$ by subjects, $F(1, 19) = .52$ by materials respectively).

Within the character x time interaction, the difference reduction in the number of continuations to scenario dependent characters following a beyond range time change was again significant by subjects ($F(1, 35) = 12.22$, $p < .01$) and by materials ($F(1, 19) = 8.02$, $p < .05$), Min $F'(1, 39) = 4.84$ ( ) $p < .05$). Within the character x predictability interaction the reduction in the number of continuations to unpredicted scenario dependent characters is significant (simple main effect $F(1, 35) = 5.1$, $p < .05$ by subjects, $F(1, 19) = 5.37$, $p < .05$ by materials Min $F'(1, 52) = 2.61$ n.s.)

Chi square comparisons were made between the types of referential expressions used in the various experimental conditions. As in Experiments I and II there is a smaller proportion of pronoun references used to scenario dependent than to scenario independent characters ($X_{(1)}^2$ 18.73, $p < .01$ overall $X_{(1)}^2$ 3.82, $p < .05$ in predicted characters, $X_{(1)}^2$ 19.4, $p. < .01$ in unpredicted characters) and within the continuations to scenario dependent characters there is a smaller proportion of pronouns used to the unpredicted character.

Table 4

Experiment III

Continuations by Reference Type, Character, Time Change and Predictability

Within Time Range

	Character	Noun Phrases		Pronouns		Total
Predictable Scenario Dependent	{Scenario Independent	79	(21.9%)	64	(17.7%)	39.6%
	{Scenario Dependent	40	(11.1%)	19	(5.3%)	16.4%
Unpredictable Scenario Dependent	{Scenario Independent	77	(21.4%)	65	(18%)	39.5%
	{Scenario Dependent	37	(10.3%)	6	(1.6%)	11.9%

Table 4 Cont.

Beyond Time Range

Character		Noun Phrases		Pronouns		Total
Predictable Scenario Dependent	{Scenario Independent	80	(22.2%)	63	(17.5%)	39.7%
	{Scenario Dependent	26	(7.2%)	14	(3.9%)	11.1%
Unpredictable Scenario Dependent	{Scenario Independent	78	(21.6%)	70	(19.4%)	41%
	{Scenario Dependent	20	(5.5%)	7	(1.94%)	7.4

To further investigate the effect of position in a text and scenario relationship the results were compared between Experiment I, where the scenario independent character appeared first in the test and Experiment III where the scenario dependent character was in this position. This data is shown in Figure 6.

The use of noun phrases and pronouns was no different in the two experiments. However the actual proportion of continuations to scenario dependent characters was found to differ. In the within range time change condition there was a smaller proportion of continuations to the scenario dependent character in Experiment III, where the dependent character appeared in the initial line of the text ($X_{(1)}^2$ 4.66, $p < .05$). In the beyond range time change the proportion of scenario dependent-independent characters did

proportion of scenario dependent:independent characters did not differ between the two experiments.

Discussion

This experiment tested the effects of text position and predictability on scenario dependent information. The foregrounded status of the scenario independent character was again overwhelmingly marked in the continuations. In fact far from this result in previous experiments being due to a primacy effect, the scenario dependent characters actually received fewer continuations where they appeared in the initial position. This effect was only present where the time change cued the scenario as being in focus. The status of the scenario dependent character seems to result from the relationship to the scenario i.e. being defined in terms of a role within a given scenario and not from its location in the text.

The effect of the dependent character's predictability from the scenario was very slight. Rather than increased status in this condition due to any attention focusing properties of the unexpected, the results suggest that the unpredictable characters were even less prominent in the texts as they receive even fewer pronoun continuations than the predictable dependent characters.

Previous studies of recall of script based information from narratives (Bower, Black & Turner (1979), Grasser, Gordon & Sawyer (1979) found unpredicted script based actions to be recalled better than predicted ones. However Bower et al describe this as an improved recall of goal relevant

but irrelevant information would not show the same improvement. Grasser et al performed multiple regression analysis of their recognition data to determine the relative predictive power of the necessity, typicality and frequency of mention in scripts of their script actions. Subjects ratings of the necessity of an action to a given script was the best predictor of its recognition score. These results suggest that unpredictability in these studies has a strong relation to importance or relevance to the script. In experiment 3 the unpredictability of dependent characters may well not have this relation and from many of the actual pairs e.g. judge - clerk of court, waiter - dishwasher, mechanic - apprentice it appears that the opposite relationship, unpredictability and unimportance may be linked in this experiment. This would accord with the reduced proportion of pronoun references to these characters. Unimportant characters will be even less foregrounded than the corresponding predicted character and hence receive fewer pronoun continuations.

The reading time experiments described in the following chapter, continue the investigation on the influence of predictability in scenario and further discussion of this issue will be found there.

General Discussion

The experiments described in this Chapter investigated the role of time change information and text processing. The initial question was whether readers had shared expectancies about the time ranges for stereotyped events in the way they had been shown to share other information about these events.

had been shown to share other information about these events. The initial study confirmed that readers do have such shared predictions about time.

The continuation studies investigated how exceeding these predicted time changes affected the reader's conception of scenario based texts. It was hypothesized that such time changes might act as cues that the current scenario was no longer in focus and hence the characters within it would be less relevant and so would receive fewer mentions in the continuations of the texts. This was confirmed in all three experiments. Following a beyond range time change scenario dependent characters received fewer continuations than when the time change was within the predicted range for that scenario.

These experiments also investigated the question of relevance on prominence in general. The continuation data showed that subjects have an overwhelming preference for the scenario independent character. These characters were always far more likely to feature in continuations than the scenario dependent characters and far more likely to be referred to by pronoun. Thus these characters can be termed foregrounded. Even measures aimed at boosting the status of the dependent character, such as adding adjectives to the dependent character merely increased the number of continuations to the independent character. Although this increase was restricted to the condition where the scenario was in focus and resulted in more noun phrase references to the independent character. This finding suggests that prominence is perhaps a result of the reader contrasting all the available relevant information in a quite complex manner. This result was rather unexpected but a somewhat similar odd finding is reported by Black and Bower

(1979). In a study of subjects recall of stories containing several episodes they found that when an episode had more subordinate or unimportant actions added to it, recall of the important actions improved. Their study is also of interest because they found that adding more items only increased recall within a particular episode but did not affect other episodes within the text. It may be that adding unimportant information either as adjectives or as actions affects the readers general interest but the increased attention is directed at the important elements. Both studies show this affect to occur only within the current text division, either episode or relevant scenario.

These continuation studies both suggest the role of time changes and knowledge structures in text processing. The results show that time change information can result in quite subtle distinctions of relevance and prominence. The beyond range time changes only reduce the relevance of the characters bound to the scenario in question. The time changes themselves are defined in terms of these same scenarios. A time change such as 'seven hours later' can cause one scenario to be held in focus e.g. the operation at a hospital, and the same change can cue a cinema going scenario as no longer relevant, and result in fewer mentions of projectionists or usherettes in this condition.

These studies show the end result of such processing decisions by the reader. In the next Chapter the aim is to investigate these processes as they occur during reading. The continuation data strongly support the hypothesis concerning time changes and scenario shifts, it is hoped that reading time

measures will show these processes in operation.

CHAPTER 7

Reading Time Studies

In the last Chapter, there was considerable evidence presented from continuation studies on the function and effect of time change information in text processing. It was claimed that the time range for any standard event was one of the shared items of information which formed part of a world knowledge based information package, termed a scenario, which readers use to expand and interpret the information explicitly stated in a text about any such stereotyped event.

In particular, time change information was used by the readers to assess if the particular event was still in progress and hence if the scenario both as an interpretive structure and as a domain of reference was still in focus. The time changes which were beyond the expected range were thought to cue the scenario as no longer relevant and hence the characters bound to it become less accessible for reference.

These conclusions were formed on the basis of the comparisons of the number of mentions of the various characters in subjects' continuations of the narrative texts. In the experiments described in the present Chapter it is hoped to go beyond inferences about text processing based on post comprehension behaviour to actual investigation of the effect of time changes during the reading process itself.

Instead of contrasting the number of mentions each

character receives, the experiments described in this Chapter will measure the accessibility of each character as reflected in the time taken to retrieve information about a given character and the time taken to resolve references to each character in the two time change conditions.

Several experiments have investigated the process of reference resolution in narratives. Clark and Sengul (1979) for example have reported that subjects take less time to resolve referents whose antecedents were in the immediately preceding sentence rather than earlier sentences, and that in particular the immediately preceding clause had a privileged place in ease of reference. They also found pronoun and noun phrases both showed this effect of distance.

Cirilo (1981) investigated the influence of text structure on the resolution of references in stories. He compared three types of reference resolution. The first is where the antecedent is currently active in short term memory and can easily be identified, this is known as an immediate match. Where the antecedent has to be retrieved from inactive propositions, as is said to happen as the distance between it and the referent increases, the reference resolution is said to be more difficult and is known as a reinstatement match. The third type of reference resolution is known as inference matching and is done where the contents of memory are insufficient to establish coreference. This is the most difficult process. The reading time for sentences requiring each

type of matching will increase from immediate to reinstatement and inferencing, this is called by Cirilo the distance effect.

Cirilo also studies the 'height effect' in referencing. This refers to Kintsch and van Dijk's (1978) concepts of macro-structures. In this paper by Cirilo, a reference to a high level macro proposition is expected to be quicker than to a low level macro proposition. This 'height' effect was tested by manipulating the global relevance of the antecedents. As part of this interest in macrostructures Cirilo used three types of reading task, one of which, reading to answer questions, closely resembles one of the tasks in this thesis. A distance effect and a height were obtained in this condition.

In a series of experiments to investigate the role of scripts in readers' memory for text, Bower, Black & Turner (1979) conducted one reading time experiment. They tested whether a line of text was read more quickly if it is preceded in the text by a statement referring to an action which just precedes it in the underlying script. They hypothesized that the target comprehension time should be shorter the closer in the underlying script was the preceding action given as a prime. To test this they compared reading times for target sentences in two different positions in the text which were preceded by priming sentences either within the same scene of the script or one or two scenes previously. Within scene primes produced faster target reading times than beyond

scene primes. This distance effect was found to be small and monotonic.

The experiments described in this Chapter will test if the findings of the continuation studies can be reinforced by on-line processing data. In the continuation studies distance was found to have no main effect on accessibility for reference. The determining factor was whether a character was a foregrounded scenario independent one, this made such a character much more accessible. A smaller accessibility effect depended on whether a scenario dependent character was part of a scenario which was currently in focus, if this was not the case this character was even less accessible. The reading time experiments aim to compare the accessibility of the scenario independent and dependent character in general, and the effect of time changes on the accessibility of the scenario dependent character. Distance is not expected to have as great an effect as the relationship of a character to the currently active scenario.

Experiment I

Aim

This experiment tests three hypotheses concerning text processing. The first is that a time change which cues a scenario shift will be reflected in the time taken by the reader to process such information. Lines of text which contain beyond range time changes will produce slower

reading times than comparable lines containing within range time changes.

Second, when a scenario shift has occurred, information bound to that scenario will be less accessible than when the scenario is still in focus. Information not dependent on the scenario will not be affected in this way. This can be tested by measuring the times taken by readers to retrieve information and answer questions in the two time change conditions. Measuring the time taken to read lines of text containing pronoun references should also reflect the status of the scenario following time changes of the two types.

Third, following the results of the continuation experiments it is expected that scenario independent or main characters will have a privilege status, namely be fore-grounded, in the text, and that this will be reflected in their being readily accessible in all conditions.

Method

Materials and Design

The materials consisted of twenty, five line passages adapted from those used in the continuation experiments. The first four lines were as previously described and the fifth line contained a pronoun reference to either the scenario independent or scenario dependent characters. As these characters differed in number or gender the pronouns were unambiguous. Following the passage there were two questions, one referring to the main character,

one to the scenario dependent character. An example of the passages used in the experiment is given below.

The Bus Journey

Mrs. Grey was travelling by bus from the terminus.

The conductor collected the fares.

The bus rattled and jolted as it went.

After (ten minutes / hours) joints still ached.

(She / He) hated going on this old boneshaker.

* * Questions * *

Was Mrs Grey going by train?

Did the conductor hate the bus?

Subjects were presented with two blocks of twenty texts. Half of each block was in each time change condition. Half of each block was in each reference condition. Full details of the design and materials used in this experiment are shown in Appendix D.

Procedure

Forty undergraduates from the Univeristy of Glasgow were subjects in this experiment. They were paid 50 pence for a thirty minute experimental session.

Each subject was tested individually in an experimental booth where a VDU displayed the text, one line at a time. The task was a self paced reading

paradigm. The subject had to press a bar on the VDU to illuminate a line of text, read the line rapidly, then repress the bar to bring on the next line of the passage. A NOVA 260 computer timed the interval between bar presses. Questions were answered by pressing the appropriate button on a Yes - No answering box attached to the VDU.

Subjects were given three long passages to read as practice with the self-paced reading task and five short passages similar in form to the experimental texts to familiarize them with the actual experimental procedure.

Subjects were instructed to read as rapidly as they were able whilst still understanding the texts and questions, and to pause as often as they wished between but not during passages.

Results

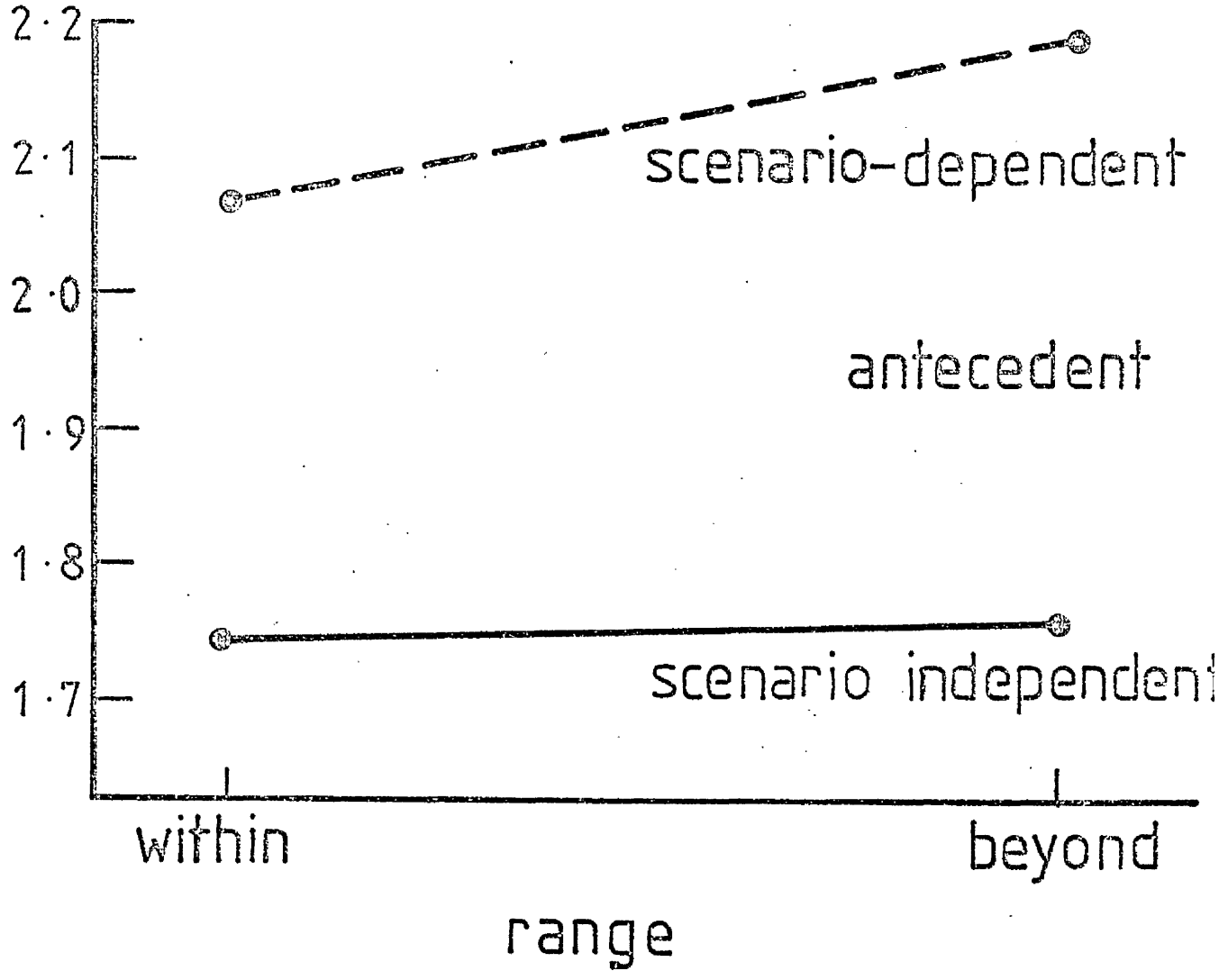
The results are summarized in Figures 7.1 and 7.2. Analyses of variance were performed on mean reading times for each sentence in the two time change conditions first treating subjects as a fixed effect collapsing across materials with character time change as fixed effects and then treating materials as a random factor collapsing across subjects.

Second mean question answering times for all questions answered correctly in the two time change conditions, for all questions to both character types were calculated. Analyses of variance were performed on this data treating subjects as a random effect collapsing

Figure 7.1 Question Response Times for Experiment I :

a comparison of the effect of time change and

antecedent character type.

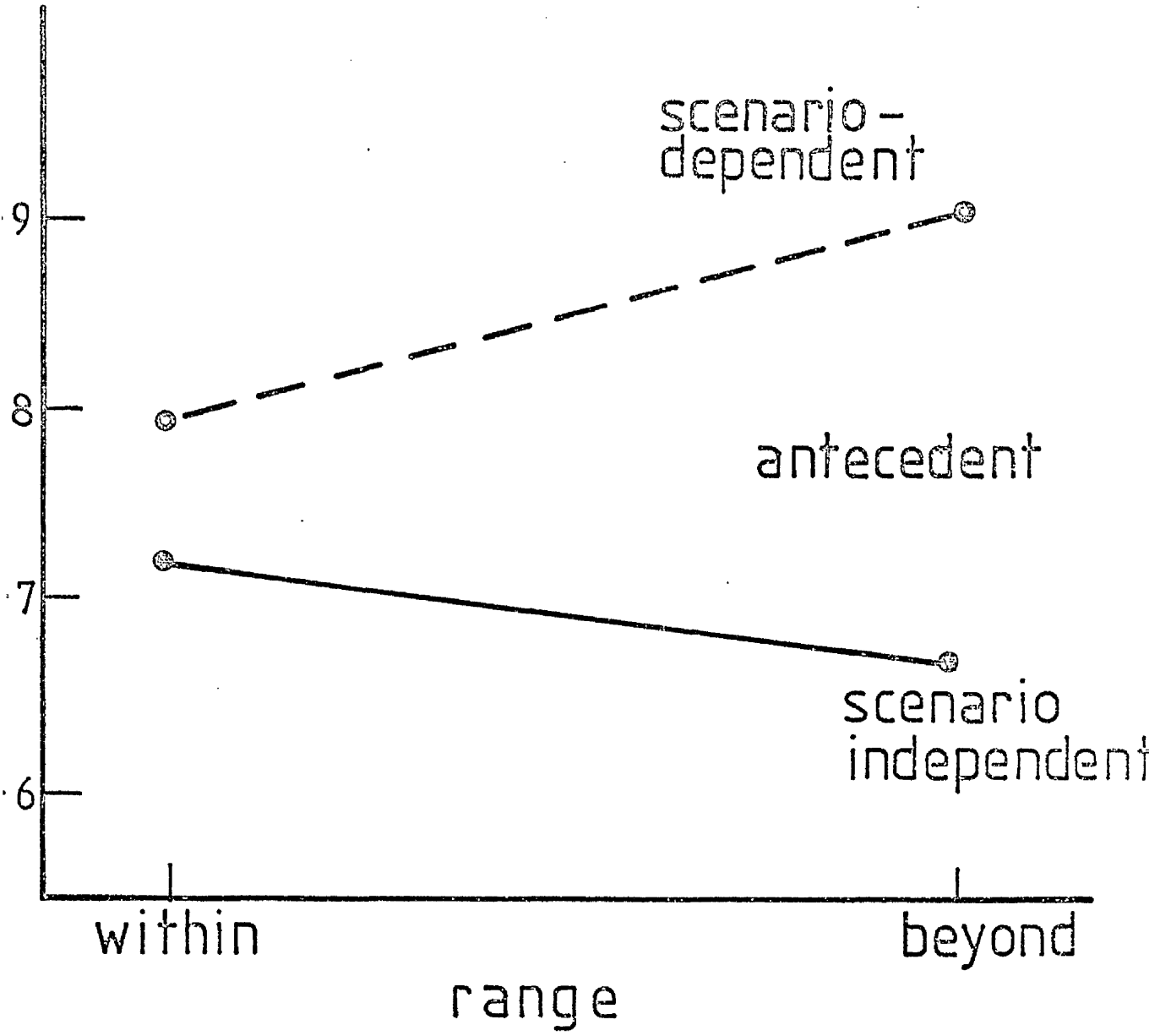


across materials then treating materials as a random effect collapsing across subjects again treating character type and time change condition as fixed factors.

Third, mean reading times were calculated for sentences containing pronoun references to both character types in both time change conditions first treating subjects as a random effect collapsing across materials, secondly treating materials as a random effect collapsing across subjects with character type and time change condition again treated as fixed effects. The analyses of reading times for sentences containing time changes shows a main effect of time change type ($F(1, 39) = 19.85$, $p < 0.0001$ by subjects, $F(1, 19) = 7.11$, $p < 0.05$ by materials Min $F'(1, 33) = 5.23$, $p < 0.01$). The reading times for beyond range time changes were significantly lower, with mean reading times of 1795 msec compared to mean reading times of 1697 msec for within range changes.

The analysis of question answering times, shows a main effect of character type, ($F(1, 39) = 80.87$, $p < 0.00001$ by subjects $F(1, 19) = 106.0$, $p < 0.0001$ by materials, Min $F'(1,55)$ 45.6, $p < 0.01$) a main effect of time ($F(1, 39) = 4.05$, $p < .05$ by subjects, $F(1, 19) = 3.98$ $p < .05$ by materials) and an interaction of time x character ($F(1, 39) = 4.92$, $p < 0.03$ by subjects, $F(1, 19) = 4.42$, $p < 0.05$ by materials Min $F'(1,49)$ 2.33 n.s.). Questions concerning main characters are answered more quickly than questions about scenario dependent characters. Scenario dependent questions are answered more slowly particularly following beyond range

gure 7.2 Reading Times for pronoun reference sentences in Experiment I : a comparison of the effect of time change and antecedent character type.



time changes.

The analysis of reading times for sentences containing pronoun references shows a main effect of character type ($F(1,39) = 15.50$ $p < 01$ by subjects, $F(1, 19) = 23.39$, $p < .01$ by materials, Min $F'(1, 75)$ 10.7 $p < 0.01$). The main effect of time and the time x character interaction were not significant.

From the analysis of the experimental data, three main results emerge. First subjects take longer to read the lines of text which contain the beyond range condition of time changes statement. This is inexplicable in terms of any propositional analyses such as Kintsch used to describe reading times for text. In this experiment the two conditions of the time change sentences often only differ by one word, for example

(1) Seven minutes)
(2) Seven hours) later the film was forgotten.

Yet the reading times are reliably different for condition (2) of the text.

Another possible explanation of this difference might be that in the beyond range condition the sentence is so bizarre that the reader slows down processing as any expectations concerning a type of short narrative have been violated. For example in the second sentence below readers might well be expected to have longer reading times.

(1) Seven minutes)
(2) Seven centuries) later the film was forgotten.

In the experimental data however for the subsequent sentence containing the pronoun reference, no difference in reading times is found if the character to whom reference is made is the main character of the text. If the longer reading times for beyond range time changes resulted from the addness of the sentence it seems likely that this would last for more than one line of text.

The other aspect of the time change manipulation which counters this sort of explanation is the actual size of the time changes involved. The difference in within predicted range changes and beyond predicted range changes derives from estimates produced by reading descriptions of particular stereotyped situations. For example

"Seven hours later the film was forgotten"

contains a beyond predicted range time change. Seven hours was considered by subjects to be longer than they would expect the events involved in going to the cinema to see a film, to occupy in a text. The sentence

"Seven hours later the operation was a vivid memory"

contains a time change within the predicted range of having an operation in hospital.

As the experiment was designed to test time changes linked to particular scenarios, rather than as units in a conceptual temporal continuum such as the various time lines described in Chapter 3, the size (in real time units such as hours) difference in the two conditions of time change stated in the text was correlated with the

difference in reading time between the two conditions of time change. The Spearmans Rank Correlation for this is 0.07, which is not significant.

The difference in reading times for the time change conditions is not due to different propositional content, is not due to the strangeness of the beyond range sentences, and is not due to the absolute size of the differences in time between the two conditions.

It seems that the beyond range time changes do slow reading and that this is due to a particular time change in a particular scenario. The original hypothesis that such changes act as cues as to the past or present relevance of the current scenario, seems to have received experimental support.

The next finding of interest to the original hypothesis is the question answering data. The first comparison of interest is between time taken to access information about the scenario independent character as opposed to the time taken to access information about the scenario dependent character. Subjects were reliably quicker in accessing information about the scenario independent character as opposed to the time taken to access information about the scenario dependent character. Subjects were reliably quicker in accessing information about the independent character across both time change conditions. The preferential status of the independent character observed in Chapter 6 is confirmed.

The other pertinent aspect of the question answering times is the effect of the time change in the preceding

text. The beyond range time change leads to reliably longer question answering times where information about the scenario dependent character has to be accessed. This type of time change has no effect on question answering times for the independent character questions. The time change which is categorized as beyond or within range in terms of the expectations concerning the scenario, only influences the accessibility of information bound to that scenario. Where a time change cues a scenario as no longer relevant, the reader takes longer to access information in that scenario. The data supports the hypothesis that time changes are used as relevance cues and that this leads to scenarios being dropped from active processing. The scenario and its associated information can still be retrieved but this takes longer to process than when the scenario is currently active.

A third hypothesis made at the start of this experiment concerned the time taken to make pronoun references. Two factors were involved in the texts, the status of the character to whom reference was made, and the nature of the time change in the text. From the experimental data it can be seen that the privileged status of the independent character found in the question answering data is confirmed. Subjects process sentences containing pronoun references to the main character reliably more quickly than sentences containing references to the scenario dependent characters.

The results concerning the influence of time changes followed the same pattern as the question data. The

time taken to make references to the independent character remained unchanged across time change conditions. Numerically the time taken to make references to the scenario dependent character increased following a beyond range time change. This difference however did not prove to be statistically reliable.

The data from the pronoun reference sentences was then examined in some detail, to see if any explanation could be found for this one contradictory finding.

When the results were examined text by text, it seemed that although the majority of texts showed an increase in reading time in scenario dependent references following a beyond range time change, there was a group of passages where the scenario dependent references were noticeably slow even in the within range time condition and increased little further in the beyond range condition. An explanation was sought for this apparent ceiling effect.

When the scenario dependent characters in these passages were compared with the predictability ratings obtained in the course of the continuation studies, they were discovered to have mainly very high predictability scores. These were compared with the predictability scores of the dependent characters which showed an increased reading time in the beyond time range condition. These were found to have generally lower predictability scores. This difference was tested using a Mann Whitney U test ($U = 4$, $p < .002$) and found to be reliable.

The predictability scores for each scenario dependent character were then correlated with the reading times for

that passage in the within range time change condition. The more predictable scenario dependent characters took longer to reference in the within range condition. (Spearman's rho = - .71 $p < .01$). When the difference in reading times between the two time change conditions was correlated with predictabilly, highly predictable scenario dependent characters showed smaller increases in reading times in the beyond range condition, (Spearman's rho = - .43 $p < .05$).

It seems that it is sufficiently difficult to refer to a predicted entity by a pronoun in any condition and that a ceiling effect operates which reduces the effect of the beyond range condition. It may be that as the questions use noun phrase references, they do not have this problem. This would parallel the continuation studies where pronoun references were so few that there was no decrease in their frequency over time change conditions yet total numbers of references did decrease.

Discussion

The reading time study confirms the main hypotheses derived from earlier experiments. Time change information can be shown during the actual process of reading to act in a manner compatible with the concept of cueing scenario shifts. If a time change is beyond the predicted range for a given event, it seems reasonable to suggest that the increased time to read such a sentence reflects the time to remove the current scenario from focus. When the scenario is no longer in focus subsequently accessing and

retrieving information from that scenario is more difficult and hence longer question answering times result. Simply referencing scenario dependent characters when the scenario is no longer in focus seems a more problematic issue and may depend on the predictability of the information involved. Experiment II will pursue this problem.

The foregrounded status of the scenario independent character is confirmed. Although pronoun references to this character require an antecedent search of greater distance in the text than do dependent character references, this process is reliably and substantially faster. No detriment of greater distance is found in these results. The relationship of the character to the text, i.e. if the character is the nonstereotyped or main character is far more important than the distance between the antecedent and referrent.

The question answering data again show that this character has a privileged status. Information about independent characters can be more readily retrieved in all conditions. A further test of the robustness of this foregrounding effect, was made by comparing question answering times to the scenario independent character where the pronoun in the last sentence of the text referred either to the scenario dependent or the independent character. There was no difference in qustion answering times even where the character references in sentence five was the dependent one. (Mean RTs 1687 sentence five independent, 1647 sentence five

dependent).

Although the scenario dependent character always has a less privileged status, this experiment provided further evidence to support the notion of a scenario being even less accessible when time changes cue the reader to move it out of active processing or focus. The question answering times show a marked increase in the beyond range time condition and although no statistically significant differences in pronoun reference times were found, the pattern of results was numerically similar. Experiment II will investigate predictability and reference times more fully.

Experiment II

In this experiment the predictability of the scenario dependent character was systematically manipulated. It was hoped that the apparent ceiling effect found when highly predictable characters are referenced by pronoun could be demonstrated or disproved, and the effect of time changes on less predictable entities could be shown to follow the pattern of question answering and continuation data, namely that following a beyond range time change scenario dependent characters will be less accessible.

Aim

To test the hypothesis that predictability affects the accessibility of scenario dependent characters. The measures of interest are the reading times for sentences containing pronoun references to scenario dependent

characters in the two time change conditions and the corresponding question answering times. The accessibility of the scenario independent character was to be measured and compared in the same conditions.

Materials

From the list of scenario titles and the characters predicted from them, described in Chapter 6, thirty two titles were selected. The titles chosen were those for which subjects had produced at least one highly predicted character and at least one character of low predictability. Predictability was determined by the number of mentions by the subjects who participated in the task, predictable characters were those most frequently mentioned, for example the character "judge" following the title "The Trial" was mentioned by 45 out of 48 subjects whilst the character "Clerk of Court" was mentioned by two subjects.

Unfortunately only eleven of the twenty passages from experiment one produced this kind of dichotomy between highly predictable and unpredictable characters and for the other passages which were selected for this predictability difference, time range norms were not available and the time range differences were selected by the experimenter.

The passages were constructed similarly to those in Experiment I and an example is shown below.

The Tennis Match

Sue was playing well in her first match at Wimbeldon.

The spectators (Pred) / ballboys (Unpred) were feeling the heat.

Perhaps it would be cooler soon.

Ten minutes) / Seven Hours) later a wind blew up.

She was) / They were) glad that play was going so well.

Questions

Was this Sue's second match?

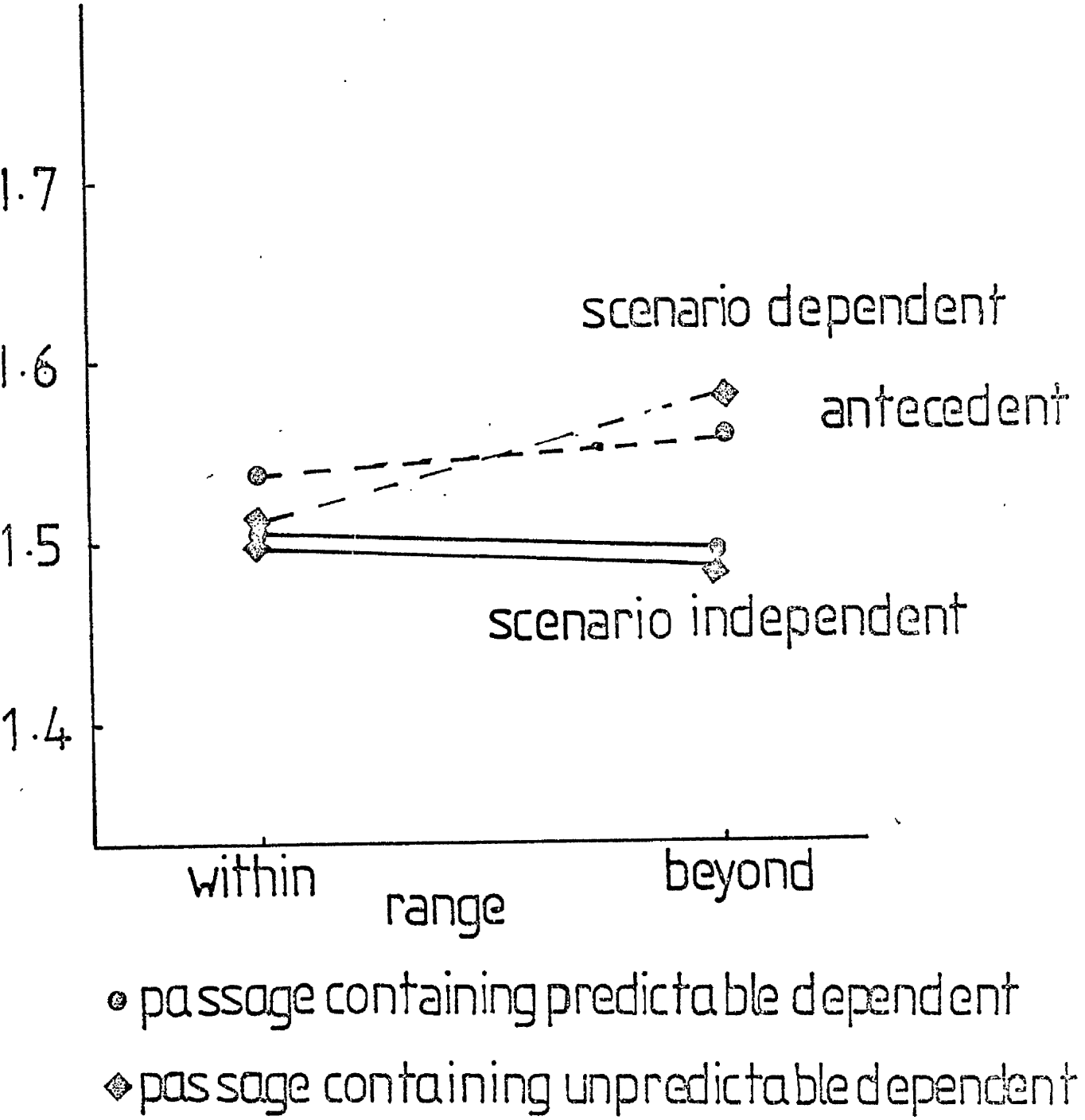
Were the spectators) / ballboys) cold?

Subjects were presented with two blocks of thirty two texts. In each block each subject was presented with four passages in each of the eight possible treatment conditions in randomized presentation order. Across the two blocks each text was presented in both time change conditions. Across the four groups of 10 subjects each passage appeared in all treatment conditions. The full experimental design is shown in Appendix D. The experimental procedure was as described in Experiment I.

Results

The results are summarized in Figures 7.3 and 7.4. As in Experiment I, mean reading times for sentences

gure 7.3 Reading Times for pronoun reference sentences in Experiment II : a comparison of the effect of time change and antecedent character type.



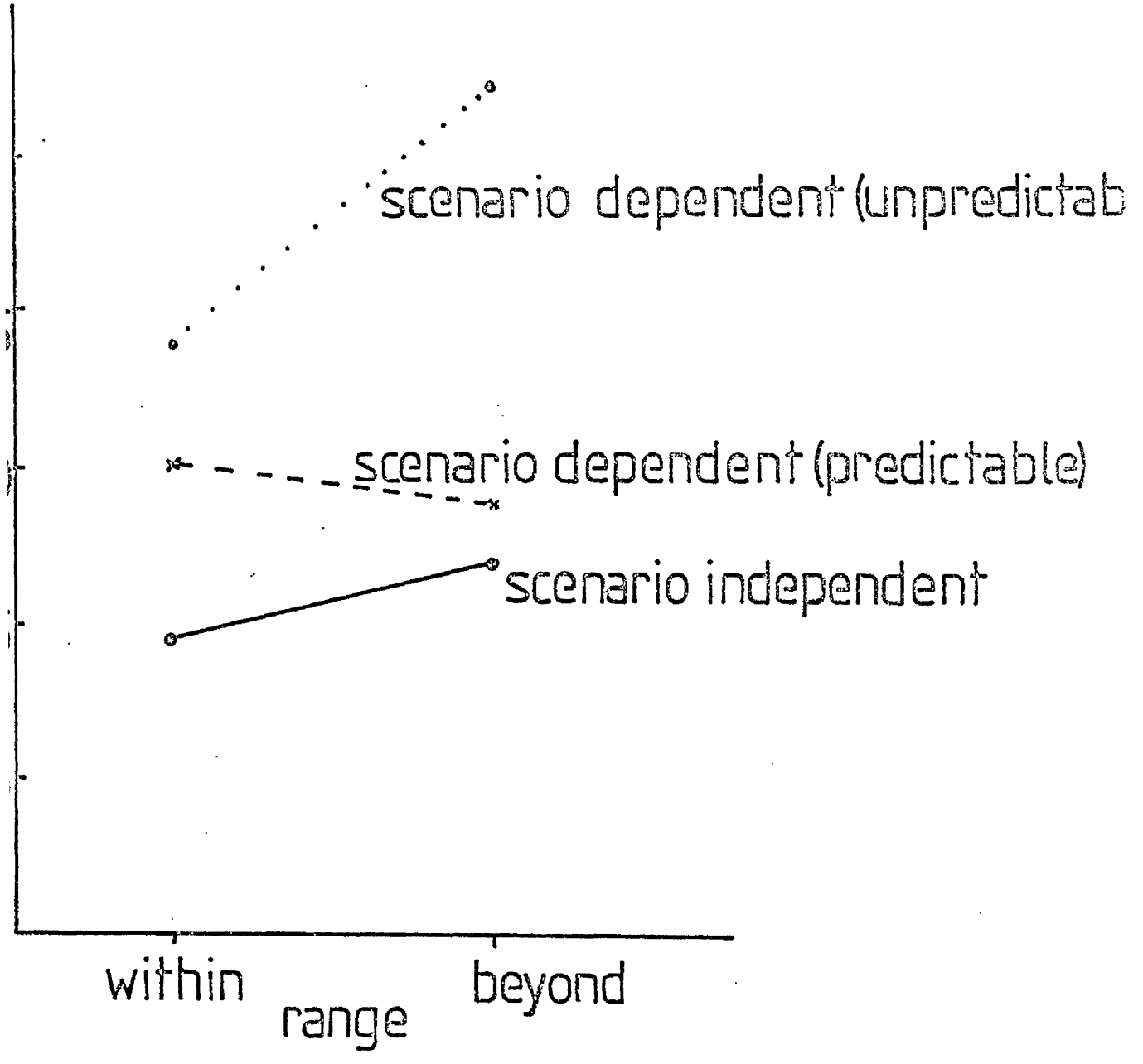
containing pronoun references were calculated for references to each character type in each time change condition. Analyses of variance were performed on this data first treating subjects as a random effect collapsing across materials and secondly treating materials as a random effect collapsing across subjects in both analyses character, predictability and time change were treated as fixed effects.

Mean question answering times were also calculated for all correctly answered qustions and analyses of variance were performed on this data both treating subjects materials as a random effect against character, predictability and time change were treated as fixed effects.

The comparisons of interest are firstly in the pronoun reference time analysis. A main effect of character type ($F(1, 39) = 5.1$ $p < .02$ by subjects, $F(1, 32) = 3.74$ $p < 05$ by materials, Min F' n.s.). The time change x character interaction within unpredicted scenario dependent condition is a trend which does not reach significance ($F(1, 39) = 2.94$ $p = .09$ by subjects, $F(1, 31) = 2.85$ $p = .09$ by materials).

The simple main effects comparisons within this interaction however, do show significant differences. References to less predictable scenario dependent characters are slower following a beyond range time change (Min F' $(2, 69) = 3.9$ $p = .05$). References to less predictable scenario dependent characters are slower than references to scenario independent characters in the

igure 7.4 Question Answering Times for Experiment II : a comparison of the effect of time change and antecedent character type.



beyond range time change condition ($F(1, 39) = 8.28$ $p < .01$ by subjects $F(1, 22) = 5.26$ $p < .05$ by materials Min $F'(1, 69) = 3.14$ ($F = 3.9$, $= p.05$). There are no significant differences with the predicted scenario dependent condition.

The question answering data was analysed first including both questions in the one analysis treating subjects then materials as a random factor with question type, and time change condition as fixed factors. The main effect of question type was significant by materials but not by subjects ($F(1, 31) = 3.81$ $p < 0.05$, $F(1, 32) = 2.67$ $p = 0.1$ respectively). The main effect of time was significant by subjects but not by materials ($F(1, 39) = 8.98$ $p < .005$ $F(1, 31) = 1.1$ $p = .3$). The interaction of question type x time was not significant. To test the effect of predictability on question answering times the questions concerning scenario dependent characters were analysed separately. Within the scenario dependent question analysis there is a main effect of predictability ($F(1, 39) = 4.93$ $p < 0.05$ by subjects $F(1, 32) = 6.89$ $p < .01$ by materials. Min $F'(1, 70) = 2.87$ n.s.) no main effect of time ($F1$ and $F2 = 1.08$, 1.42). The interaction of time x predictability was significant by subjects ($F(1, 39) = 6.16$ $p < .01$ and marginal by materials ($F(1, 31) = 3.43$ $p = .07$). Within this interaction the simple main effect comparisons showed questions to less predicted characters to have longer answering times in the beyond range condition compared to the within range condition ($F(1, 39) = 6.16$ $p < .05$ by

subjects, F (1, 32) = 4.5 p < .05 by materials Min F' = 2.61 n.s). The other significant difference within the interaction was between the question answering times for less predicted character which were longer than for highly predicted characters in the beyond range time condition. (F (1, 39) = 11.34 p < .01 by subjects, F (1, 32) = 10.5 p < .01 by materials, Min F' 1, 65 = 5.66 p < .05).

The remaining test for the effect of predictability was made by analysing the reading times for the second sentence of the text where the scenario dependent characters are introduced. There was an effect of predictability with less highly predicted characters leading to longer reading times. (F (1, 39) = 43.4 p < .001 by subjects, F (1, 32) = 6.62 p < .01 by materials. Min F' (1, 42) = 5.67 p < .05). The reading times for sentence four, the time change sentence, show no significant difference between the time change conditions. See Appendix D for full details of analyses.

Discussion

The aim of this experiment was to test the hypothesis that the predictability of the dependent characters in the scenario in which they occur affects their accessibility. This experiment showed that the predictability of such characters affects their accessibility in several interesting ways. The first effect of predictability, when a reader is presented with a text, is that following an appropriate scenario title and opening information, the introduction of a highly predictable dependent character

is more rapidly processed than the introduction of a less predictable character.

The effect of predictability on pronoun reference resolution times was largely as hypothesized. The less highly predicted characters took longer to reference following a beyond range time change. The highly predicted characters were more rapidly accessed in this condition and did not show statistically reliable character type or time effects. The scenario independent characters were generally more accessible and showed no effect of time change.

The question answering data again show that it is the less highly predictable characters which show the effect of time change condition. The question answers also show that the highly predicted characters show less effect of character type. It seems that the reader can access highly predicted characters even after a beyond range time shift. A processing model explanation is suggested for this data in the next section.

However as the time change sentence does not show a within - beyond range effect another possibility exists. As the main aim of this experiment was to manipulate predictability, passages were designed for which clear predictability differences could be manipulated. As there were time range norms available for only eleven of the thirty two experimental passages, the experimenter decided on the within - beyond time changes for the other texts. The eleven passages previously presented in Experiment I do show an increase in reading times across

time change conditions, the complete set of passages do not. It may be that the reduced effect of time change on the accessibility of predictable scenario dependent character results partly from the two time changes failing to represent agreed time range differences.

As the predictability data are interesting in themselves and generally consistent with earlier findings, the experimental results are presented and discussed. The conclusions from this particular experiment howver must be made tentatively. The following section describes how the general pattern of results from both reading time experiments can be incorporated into an account of how the reader builds a representation of the text from the information explicitly stated and from previously stored knowledge. The data do not conclusively support every aspect of this model but the general concepts seem both intuitively plausible and consistent with the observed behaviour of readers described in these experiments.

The pattern of results suggests that when reading the experimental texts the reader is involved in several processes. First, on reading the title of a known standard event such as "In the Restaurant" the stored scenario, based on past experiences of restaurants is invoked by the reader. This automatically activates the highly associated dependent roles such as 'waiter', plus many predictions about normal event sequences and activities in restaurants, including a prediction about how long normal restaurant activities, such as eating

meals are likely to last. When a named character is introduced by the text the reader interprets this character as being the main interest of the text and although this character is described in the standard event, is not seen as being completely bound to the scenario. A representation for such a character has to be created by the reader, although this may often be linked to the scenario it does involve incorporating novel information. Thus the line of text "The Browns were eating a meal in a restaurant" means the reader has to explicitly link the information that the customer slo of the scenario is to be filled by named individuals "The Browns". This is not a prestored fact and this may cause such novel information to have a privileged status.

If the following line of text introduces an already activated item of information such as there is a waiter, the information associated with this character is readily slotted into the scenario. If the character is less predictable the reader has to activate one of the many 'lower level' slots of the scenario, that is, the scenario will have many stored slots which are not always essential but are present as options. A restaurant story is almost certain to involve waiters or waitresses but not every such story will involve dishwashers. Dishwashers are a prestored aspect of restaurants. A lower level or less readily activated slot will exist in the readers' restaurant scenario so a definite reference can be made, but it will require the slot to be specifically filled from the text. Indefinite references

would be required if a character was not bound in any way to a scenario e.g. "A gypsy violinist had been engaged to play to the customers" where 'the customers' is part of the scenario, whilst for most readers 'a gypsy violinist' is novel inforamtion not in their scenario.

Where a less predictable but scenario dependent character has been incorporated in the readers' model of the text, the explicit linking to the scenario seems to make such characters relatively easy to access whilst the scenario is in focus. The highly predicted characters tend to be less easy to access by pronouns as though explicitly mentioning such characters added little to their status, as the reader teats them as merely part of the background scenario which is helping interpret the text, rather than also part of the text foreground itself.

Following a beyond range time change, the current scenario is moved out of focus. The scenario dependent characters become less accessible in this condition. The reader has a model of the text which may include the scenario independent character plus tags of which scenarios have been previously active. If a pronoun reference has to be resolved, this character is still foregrounded and no difficulties arise. If the pronoun cannot refer by reason of gender or number to this character the scenario tag will cue the reader to reactivate this scenario and search for a possible scenario dependent antecedent. The highly predicted slots may be searched first and hence although these references tend to take longer following such a time

change the numerical difference was not statistically significant. The lower level, less predictable slots will take longer to access and hence the time to resolve such references is greater.

Question answering should follow a similar pattern. At the end of reading the text the reader has a model which has novel information such as the named scenario independent character, tagged in some way, as what the text was about. Information about the main character is easily retrieved to answer questions. To answer questions about the scenario dependent characters is generally less easy as the scenario has to be searched. If a time change in the text has cued the reader that the scenario is no longer relevant, and the reader has moved the senario out of focus, then the information retrieval will generally take longer still. From the question answering data in the highly predicted scenario dependent condition, it seems that if all the characters who have to be accessed are sufficiently highly predicted no increase across time changes occurs. Again the solution may be that the scenario tag which the reader retains from the text, plus the more specified noun phrase used in the questions enables rapid access of high level slots in the scenario. If the scenario dependent characters are of mixed predictability as in Experiment I, or less predictable as in Experiment II, then these characters take longer to access in this condition. The question answering time data support the concept of reduced accessibility of characters bound to out of focus

scenarios.

Conclusion

The aim of these reading time experiments was to test the hypotheses that emerged from the continuation studies concerning the effect of time changes on text processing. Although the data do not confirm and replicate every finding from the earlier studies, the general model of text processing as described in the previous section is supported by a fairly consistent pattern of results. These demonstrate that measures of the actual process of comprehension confirm the main hypothesis of the previous chapter.

Readers do use time change information as a cue to the relevance of the current scenario. If the expected time range is exceeded, the scenario is dropped from active focus. There is some reading time data which shows that this removal from focus takes the reader time to process. This difference is hard to explain in terms other than some kind of knowledge based manipulation such as scenario shift.

When this scenario shift has occured the information dependent on, or bound to, that scenario is generally less accessible both in terms of reference resolution and inforamtion retrieval. The actual status of the information within the scenario, as defined by the predictability of the given item determines the particular accessibility of scenario dependent information.

The named individual in a text, is not dependent on

the scenario and has a priviliged status; this foregrounded individual is therefore generally easy to access and is unaffected by scenario changes.

CHAPTER 8

Conclusions

The aim of this thesis was to investigate some aspects of text comprehension. In Chapter 1 it was suggested that text comprehension involved at least three processes; segmentation, integration and interpretation. The research described in this thesis investigated aspects of all these processes.

The initial experiments described in Chapter 2, investigated the process of segmentation by asking subjects to paragraph continuous prose. One feature of the text which appeared to be important in readers' paragraph decisions, was the presence in a sentence of explicit temporal information. Where a sentence contained such information, readers were more likely to choose this sentence as a starting point for a new paragraph.

One possible explanation of this effect was that temporal information cued the reader that a new temporal setting had begun at this point in a text. The paragraph was seen as a kind of conceptual unit whose constituent information was more interrelated than information in separate paragraphs. The shared temporal setting was one possibly helpful cue to the reader, as it could signal which information the reader had to integrate at any point in the text and which information might no longer be relevant. This could simplify the task for the reader by segmenting in a continuous flow of information

in a nonarbitrary way, into a series of smaller more manageable chunks.

In Chapter 3 the literature on the influence of temporal information in language was reviewed in an attempt to find either supporting evidence for this view of the role of temporal information or viable alternative accounts. From the literature it appeared in general that cognitive or pragmatic factors on readers' processing of temporal information which seemed particularly pertinent to the paragraphing data was the concept of time lines. In several papers, temporal information was perceived as cues to the reader for how to map events on to an ordered time line. This seemed of interest because in these accounts the role of the temporal information could be interpreted to be clarifying the meaning of the passage by ordering the described events in the appropriate sequence.

In Chapter 4 some simple reading time experiments were described. The aim of these experiments was to test the effect of temporal information during on-line text processing. The results of these experiments were inconclusive as in one experiment with fairly long texts time change information did slow processing and this effect tended to be more marked where the implied time change was large. This supported the view that at these points in a text a new temporal setting was instantiated by the readers and that this process was a time consuming one. In a subsequent experiment, which tested the ease of information retrieval and reference resolution in short

texts following small and large time changes, no clear effect of time change was observed, as information retrieval and reference resolution were differently influenced by the size of the time changes in the text. Following from these inconclusive results a more general account of text processing was sought, from which an account of the processing of temporal information could be derived.

In Chapter 5, several models of text processing were investigated and several themes emerged from these which seemed relevant to an acccount of the role of temporal information in text. Three features seemed to be important for an adequate account of text processing. The first of these was the reader's ability to use his general knowledge to expand and interpret the information stated in the text. Readers are believed to have particular structured knowledge based units, variously termed script or frame or scenario which they use in this way during text processing.

The second feature which emerged was the importance of reference resolution in text processing. The knowledge units can influence the ease or difficulty of this process, for example by themselves providing antecedents for references in the text.

The third feature which emerged as an important aspect of text processing was also related to reference resolution, namely that there is a dyamic aspect to reference resolution. During the processing of a text, there are changes in the availability and ease of

reference to various ante cedent entities in the text. These changes seem to result from changes in the reader's model of the text in which different entities appear prominent or relevant at different points in the text.

From these processing models, more sensitive experiments were planned to investigate the role of temporal information in text processing. It was hypothesized that one item of general knowledge namely the normal time ranges for events might be incorporated into an interpretive knowledge structure termed a 'scenario' in this thesis such information was available to the reader, then a time change in a text which exceeded this expected time range could cue the reader that the events described in the text were over. This would imply that the information bound to the corresponding scenario, derived both from the text and from the readers' prestored information that is the scenario itself would no longer be in focus and as a result would not be as readily accessible as when the temporal information in the text suggested that the described events were ongoing.

The experiments described in Chapters 6 and 7 tested these hypotheses in a number of ways, first by comparing the way in which readers continued unfinished narratives where a time change in the text either did or did not exceed the normal time range for a particular event. Subsequent experiments investigated the ease with which readers resolved references and retrieved information in the two time change conditions. From all these experiments a general pattern of results was observed,

which highlighted several interesting features of text processing.

The first important feature was the status of the entities in the text. Time changes in a text seem to have no effect on the topic character in a text. The topic character is always more liable to be mentioned in the continuation of a story, and is the character to whom references can be made most rapidly and about whom information can be retrieved most easily. The experiments in Chapters 6 and 7 provide ample evidence for the privileged status that topic characters enjoy and following the term devised by Chafe (1972) these topic characters can be termed foregrounded in all conditions of these experiments.

The influence of temporal information is seen when we observe the impact of time changes which are beyond the expected range for any standard events, on the other characters mentioned in a text.

When these characters are described in terms of their role in the standard events, their status depends on the interpretive scenario which the text has caused the readers to instantiate, being currently perceived as relevant. The presence of a time change beyond the expected range for the standard event, seems to cue the readers that the current scenario is no longer relevant. The experimental data show that characters other than the topic become even less liable to feature in continuations of narratives, to become more difficult to refer to and to become more difficult to retrieve information about,

following such a time change. These characters are therefore termed scenario-dependent, because their status in a text depends on the appropriate scenario being perceived by the reader as being currently relevant. Following the work of Grosz (1977) this process of the changing relevance of the scenario and its dependent entities is termed moving in and out of focus. In these experiments time changes cue the reader when a scenario as an interpretive device and a domain of reference is in focus.

The results of the experiments described in this thesis are interesting not because explicit statements about temporal information are to be found in every text not because they are the most important features of a text in which they do occur but because by investigating this particular feature in particular texts a number of insights have been gained into more general features of text comprehension.

This thesis began by considering that text comprehension involved at least three processes, segmentation, integration and interpretation. The experimental results show how these three processes interrelate. It seems very plausible from various theorists' accounts that text comprehension requires the processor to use substantial amounts of information in prestored knowledge units to interpret the information explicitly stated in the text. There is a real problem therefore in preventing the processor being swamped by this increased amount of information. The results of the

time change experiments show how the two processes, segmentation and integration compliment one another. The time range information seemed to be used by subjects in the experiments to interpret the events described in the text. The readers assumed that when a time change exceeded the predicted range for the described events in the experimental texts then these events were over. In many real texts, of course, the end of events are explicitly announced in the text. The real interest in script or scenario based models of text comprehension however is that they describe how readers can cope with real texts which are unlikely to contain an uninteresting and extensive list of stereotyped information which would be required if a text was to be fully explicit in all respects. The scenario or script allows the reader to process texts which only signal that a standard event is taking place, as the instantiated scenario or script provides the 'missing' information. The readers' interpretation of the time change information in the experimental texts is one example of this which go beyond the stated information expansion and detail filling function of the scenario in action. At the same time the readers seem to be using the time cues to segment the text and thus to move apparently no longer relevant information out of focus. This kind of segmentation seems likely to be an efficient processing procedure as it may well allow the reader to concentrate processing capacity on only the most important and relevant aspects of a text at any point in time.

The data on the production and resolution of referential expressions, again indicate how the particular phenomenon under study namely the influence of temporal information on comprehension, reflects on more general issues in text processing. The interpretation of time change statements which lead to a scenario being moved out of focus, and hence to a segmentation of the readers' model of the text is reflected in the integration process of reference resolution. The accessibility of the various entities in the text as has been mentioned previously, depends on the status of the entities. This status seems to be determined by the relationship of the entity to the scenario. Readers accord a privileged status to those characters who are not merely predictable role players in the scenario and this is demonstrated by their ready accessibility in all conditions. Even those characters who are merely role fillers in the scenario and therefore dependent on it, have their status determined by the readers' interpretation of the time change information, as their accessibility is reduced even further when the readers' interpret the time change to mean that the scenario and its dependent entities are no longer in focus. The ease or speed of reference resolution and information retrieval in the experimental texts demonstrate how the readers' interpretation both of the time change information and the relationship of the characters in the text and the currently instantiated scenario are reflected in an efficient text comprehension process. The reader concentrates processing on the novel

scenario independent entities. At the start of this thesis it was pointed out that text comprehension must be a very complex process or series of processes. To be able to "comprehend" a text in a short period of time as readers are able to do, must involve very efficient processing.

The results of the experiments described in this thesis are most interesting where they reflect on these general issues of efficient processing. The experiments described here have indicated how some aspects of the problem are overcome by readers, in their decisions about the status and relevance of entities in a text as related to the particular phenomena of attention and how processing is allocated accordingly. Although much further research is required for a fully adequate general model of text comprehension, the research described in this thesis has shown some interesting phenomena which seem relevant to any such model and which would seem fruitful areas for further research.

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APPENDICES

* - Sentences with explicit temporal information

Appendix A

Stimulus Text: Experiment 1. Chapter 2

Alain Toch possessed a deep pride in his native country. France's invincibility was central to Toch's belief. * Toch feared the idea of a French defeat in 1940. The shame of the debacle, the shame of the rout, became for him, concentrated in a single image, that of Colonel de Gaulle, the head military commander. Toch reserved his greatest contempt for "men like radishes, who are red on the outside and white on the inside". He was ready to give himself entirely to a cause, and was against all "isms" - such as, royalism, Socialism, Marxism and above all Gaullism. The intensity of his commitment would make his reaction to what he considered betrayal all the more passionate, Moreover, Toch was taught by his father that violence or the threat of violence was effective. Thousands of other frenchmen were virulently opposed to de Gaulle, but noneof them chose political assassination as their form of protest. * Toch's attempt to assassinate de Gaulle 21 years after the 1940 humiliation resulted in a very near miss. * Perhaps the most disconcerting aspect of the French defeat in 1940 for Toch was the manner in which de Gaulle acted. Toch disapproved of Colonel de Gaulle for riding a woman's bicyle away from the front. Indeed, Toch wept with rage when he saw French soldiers and their leader de Gaulle decorated for having retreated with their weapons intact. * It was then when

Toch was eighteen that de Gaulle first came to the attention of the young Toch. *The general in his celebrated June 18th appeal said, "France has lost a battle but not the war". Toch listened to the speech with great emotion. It was decided by Toch that de Gaulle was a demagogue who was consumed by ambition, and Toch did not like a man in England telling him what to do. To say those things from the safety of unoccupied England seemed to him a form of cowardice. Thus Toch's hostility to de Gaulle dates from that day. Toch was influenced by the German occupation of France. Toch was impressed by the German army. Its men were always very correct and well disciplined. Thus at that time Toch was drawn to Fascism, mainly because he hated any kind of losers. His mind knew no grey zones or ambiguities. Honour, consistency and above all strength he worshipped. *At the time the strongest dictator in Europe was the Portugeuse general, Salazar. Toch admired Salazar for his strong government. Toch hoped that France would acquire a powerful government, which would uphold France's position in the world. Toch believed that the preservation of France's colonies was central to any attempt to maintain such a position. Moreover, Toch felt that de Gaulle was a weak man who would allow France's colonies to achieve independence. Toch's fears soon became realized. *By 1961, it was clear that de Gaulle intended to put an end to the Algerian war which he felt was destroying France. A coup was staged by four generals in Algeria. Toch's

decision to support the generals was immediate. Toch went immediately to his friend General Bijou the commanding officer of the French Army in Algeria. Toch told Bijou that he was ressigning from the army. "It was then I crossed the Rubicon" he says. "It was like a medieval knight breaking his sword". *The coup failed two days later and three of the four were arrested. To Toch this meant that the struggle could not be won in Algeria. He came to the conclusion that the only solution was the physical elimination of General de Gaulle. This was not for Toch a radical decision for he was drawn to simple violent solutions. He simply felt that when a dangerous man is in his way, then that man must be killed whoever he might be. *Toch's clandestine activities were interrupted in June 1961. His hiding place was given away to the police by rivals. As a result, Toch was caught and shipped to a Paris prison. Toch was helped by his friend Pierre to escape from prison. *Pierre visited Toch on January 31st, 1962. Pierre left his I.D. card at the gate and handed his visitor's permit to the cell-block guard. Under his coat (visitors were seldom searched) a make up kit and a pair of elevator shoes were hidden. Pierre was allowed to be alone in the cell with Toch. With a few strokes of eyebrow pencil, a false moustache, the shoes and Pierre's hat and dark glasses. Toch appeared to be a completely different man. Posing as Pierre, Toch escaped peacefully. Toch was in an apartment not far from the prison, plotting de Gaulle's assassination when

he met Bastion Thiry through the "organisation". Like Toch, Thiry was also a disenchanted officer. Toch was impressed that Thiry possessed the same determination to put an end to de Gaulle as himself. Toch found Thiry to be a kindred spirit another knight willing to risk his neck for his convictions. Thiry was a brilliant engineer, a Polytechnique graduate and a man who seldom made errors in judgement. Toch was pleased by Thiry for these reasons. They began to meet regularly to discuss the method. It was felt by Toch that bombs should not be used as something always went wrong at the last moment. He was also against the kamikaze-style action of a lone assassin as he "would never send a man to be killed". Thus it was decided that an ambush along the route de Gaulle took between Colombey and the Elysee was best. The next problem for Toch was finding men, weapons, cars, and money to assist him in his planned assassination. *A dozen volunteers were recruited at the end of May. Toch would lead these men in the assassination attempt. Finding weapons was a more difficult task however. On one occasion Toch was about to receive four automatic weapons for the operation when the shipment was stolen. In addition Toch was compelled to steal cars for the operation because he could not afford to keep renting them. * In May and June there were a dozen abortive attempts. They either arrived too late or took the wrong route. The tactic which was devised by Toch, called for two vans with automatic machine guns in the back to start

moving in traffic on the route the general was expected to take and wait for the convoy to catch up with them. Once they were one car away from the general's on the Avenue du Maine, near the Invalides, but Toch chose to issue an order that precluded them from taking advantage of that golden opportunity. Toch commanded the men and they did not fire since too many bystandards would have been killed. A feeling that it would never work began to be felt. The faith of the early days was shaken. They went through their motions mechanically. On that gray drizzling August 22nd the built up despair of months of abortive attempts may have been as vital a factor as the weather in their near miss.

Appendix B

Experimental Materials and Design: Experiment I

Chapter 4

All Subjects	Block 1	Block 2
Passages 1, 3, 5	Large time change	Small time change
	Small time change	Large time change
	Large time change	Small time change
	Small time change	Large time change
	Large time change	Small time change
	Small time change	Large time change
Passages 2, 4	Small time change	Large time change
	Large time change	Small time change
	Small time change	Large time change
	Large time change	Small time change
	Small time change	Large time change
	Large time change	Small time change

Analyses of Experimental Results

Analyses of variance on mean reading rates, comparing sentences with small and large time changes and the intervening sentences with no time change information, the main effects are therefore time change, (small, large and absent)

Analyses by materials

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	2011.78	44			
Cases	981.37	14			
A (Time)	601.89	2	300.90	19.65	.001
EA	428.61	28	15.30		

Analysis by subjects

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	22757.27	77			
Subjects	19854.06	25			
A (Time)	652.20	2	326.10	7.24	0.002
EA	2251.00	50	45.02		

Experimental materials and design Experiment II.

Chapter 4

All subjects	Block 1	Block 2
Passages 1, 2, 4, 8, 9, 11, 14	Small time change	Large time change
Passages, 3, 5, 6, 7, 10, 12. 13	Large time change	Small time change

Experimental Materials Experiment II

1. The pilot banked the plane out of the clouds.
   He checked his instruments to see that all was well.
   The flight had begun {half an hour / thirty hours} ago.
   At take-off he had been worried about the weather.

   ** Questions **

   Was the pilot landing the plane?

2. Mary was typing some letters for her boss.
   She was feeling very bored and depressed.
   She had come to work here {15 months / 15 years} ago.
   At that time she had enjoyed the work.

   ** Questions **

   Was Mary typing letters?

3. The Doctor examined the patient quickly.

He had many patients still to see.

He had come to this practice { Three / Thirty } years earlier.

He had just qualified at that time.

** Questions **

Was the nurse examining the patient?

4. The filmstar stepped down on to the runway.

She waved to the fans waiting to see her.

She had first visited Britain { twenty / two } years before.

Then she had been a struggling unknown actress.

** Questions **

Was the filmstar leaving a plan?

5. Paul was repainting his boat.

It made the boat look almost new.

He had bought it nine { weeks / years } ago.

Then it had looked very shabby.

** Questions **

Was Paul varnishing his boat?

6. The teacher wrote a sum on the board.

She looked round at the class as they copied it.

She had started teaching eighteen {weeks / years} before.

She had been very nervous in the beginning.

** Questions **

Did the teacher draw on the board?

7. The painter put the last strokes on the canvas.

He was pleased with the finished painting.

{Two / Forty} years later he sold the picture.

It fetched over ten thousand pounds.

** Questions **

Was the painter finishing a painting?

8. June was going water-skiing with friends.

As she waded into the water she was scared.

It was {ten months / ten years} since her last attempt.

On that occasion she had been terrified.

** Questions **

Was June going water-skiing?

9. The astronomer looked through the telescope.

He could see the star faintly in the sky.

He had first spotted it thirteen {years / weeks} ago.

It had seemed to glow brightly that night.

** Questions **

Did the astronomer use a microscope?

10. The boxer fell heavily to the ground.

He was rapidly losing the contest.

{Three / Eleven} years before he had been a champion.

At that time in his career he was unbeatable.

** Questions **

Did the boxer jump up?

11. John started the car and drove down the street.

The roads were busy so he had to drive slowly.

{Twenty minutes / Twelve hours} later he reached his destination.

He parked the car and walked up to the house.

** Questions **

Did John start the car?

12. The dancer was practicing at the bar.

She knew she had to practise to improve.

She became a start fourteen {months / years} later.

Even then she still practiced daily.

** Questions **

Was the dancer performing?

13. The frenchman held the wine up to the light.

Next he slowly took a small sip of it

He had bought twelve cases sixteen {months / years} before.

The wine had had a sharp flavour then.

** Questions **

Did the man hold his glass up?

14. The gardener was trimming the privet hedge.

He cut the hedge into fantastic shapes.

He had planted the bushes {four / twenty} years earlier.

They had seemed likely to die at first.

** Questions **

Was the gardener trimming the hedge?

Analysis of Experimental Results

Analyses of Variance on mean reading rates. Comparing sentences 2 and 3 with order (blocks 1 and 2) and time change condition (preceeding sentence small and large) as main effects.

By subjects collapsing across materials:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	23295.05	83			
A (Order)	1436.58	1	1436.58	1.83	0.18
EA	20398.69	26	784.56		
B (Time)	134.27	2	67.13	2.65	0.07
AB	9.53	2	4.76	0.18	Not Sig.
EAB	1315.96	52	25.30		

By Materials collapsing across subjects:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	2910.74	41			
Cases	1300.23	13			
A (Time)	1.80	2	0.902	0.01	Not sig.
EA	1608.70	26	61.873		

Analyses of variance on mean reading rates, comparing sentence 4 with order and time change conditions in preceding sentence as main effects.

By Subjects collapsing across materials:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	8137.60	55			
A (Order)	139.23	1	139.23	0.48	N.S.
EA	7398.75	26	284.56		
B (Time)	141.76	1	141.76	8.60	0.006
AB	29.58	1	29.58	1.79	0.189
EAB	428.28	26	16.47		

By materials collapsing across subjects:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	2136.47	27			
Cases	1398.53	13			
A (Time)	76.39	1	76.39	1.50	0.24
EA	661.54	13	50.88		

Analyses of variance on mean question answering times with subject group and time change in preceding passage as main effects.

By subjects collapsing across materials:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	20138799.7	55			
A (Group)	244993.14	1	244992.14	0.48	N.S.
EA	13044277.57	26	501702.98		
B (Time)	1524600.60	1	1524600.00	7.52	0.001
AB	55314.28	1	55314.28	0.27	N.S.
EAB	5269614.71	26	202677.48		

By Materials collapsing across subjects:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	10103.00	27			
Cases	8343.23	13			
A (Time)	427.05	1	427.05	4.16	0.05
EA	1332.72	13	102.51		

Appendix C:

Materials, Design and results of continuation experiments

Group 1 Subjects	Block 1	Block 2
Passages		
1, 2, 3, 4, 9, 10, 12	Within range	Beyond range
13, 18, 19	Time change	Time change
Passages		
5, 6, 7, 8, 11, 14,	Beyond range	Within range
15, 16, 17, 20	Time change	Time change

Group B Subjects

Passages		
1, 2, 3, 4, 9, 10	Beyond Range	Within Range
12, 13, 18, 19	Time change	Time change
Passages		
5, 6, 7, 8, 11, 14	Within range	Beyond range
15, 16, 17, 20	Time change	Time change

Experimental Materials: Experiment 1: Chapter 6

1. In the Restaurant.

The Browns were eating a meal in a restuarant.

The waiter felt tired.

The restaurant was well known for its food.

Forty minutes} later the restaurant was empty.
Five hours }

---

2. Going shopping

Mrs. Lamb was shopping in the town centre.

The shop assistant hovered in the background.

There were two bags full to the brim.

Half an hour}
Six hours } later irritation crept in.

---

3. The Bus Journey

Miss Grey was travelling by bus from the terminal.

The conductor stood beside the driver.

The bus rattled and jolted as it went.

Ten minutes}
Ten hours } later joints still ached.

---

4. The Wedding

Anne smiled shyly as the wedding progressed.

The groom looked very serious.

The guests were all beaming at the couple.

Ten minutes}
Ten hours } later nervousness had evaporated.

---

5. The Trial

Jan gave her evidence at the trial

The judge appeared very formal.

The courtroom was hot and stuffy.

Three months}
Three hours } later unease was widespread.

---

6. The Birthday Party

Susy was enjoying her birthday party.

The conjurer was full of fun.

No expense was spared to make the party a success.

Twelve hours}
One hour } later energies flagged.

---

7. At the Cinema.

Jenny and Tom were finding the film rather boring.

The projectionist was very clumsy.

It was supposed to be a silent clasic.

Seven hours}
Ten minutes} later the film was forgotten.

---

8. Car Repairs

Katy used several spanners as she worked on the car.

The mechanic surveyed the scene.

Tools and oily rags lay all around.

Nine hours }
Fifty minutes} later frustration set it.

---

9. The Operation.

Mr. Smith was having his appendix removed.

The nurse looked around the operating theatre.

The operation was fairly straight forward.

Seven hours}
Seven days } later the operation was a vivid memory.

---

10. At the Hairdressers.

Don was having his hair cut fairly short.

The receptionist was very talkative.

The style was very neat and tidy.

Twenty minutes}
Seven hours }
later many comments were passed.

---

11. At the Hotel.

Mr. and Mrs. Fox entered the hotel foyer.

The manager came forward to assist.

Dinner was in progress.

Three months}
Three hours }
later the hotel was very busy.

---

12. Making a Film.

Glenda Jackson arrived on the set.

The stuntman discussed the first scene.

The costumes of the extras made a colourful display.

One month }
Three years}
later many awards had been won.

---

13. The Road Accident.

Liz knelt beside her in injured companion.

An ambulanceman applied a tourniquet.

A press of onlookers huddled around.

Fifteen minutes}
Six hours }
later nerves had settled.

---

14. The Football Match

John waved his scarf in the air.

The linesmen were pulling their socks up.

Three goals had now been scored.

Three hours } later there was heavy rain.
Thirty minutes}

---

15. At School.

Bobby was almost late for school.

A teacher was crossing the playground.

It had started to rain.

Eight hours } later the classroom was quiet.
Twenty five minutes}

---

16. In the Airport.

The Jones family had lost their luggage.

An air hostess began a search.

The airport was crowded because of weather delays.

Two days } later annoyance was setting in.
Twenty minutes}

---

17. On the Newspaper.

Pam took her story to the local newspaper.

A sportswriter recorded the details.

The office was full of bustling activity.

Three days} later the latex edition was out.
Two hours }

---

18. At the Bank

Meg went to the bank to cash a cheque.

A teller was busily counting money.

There were lots of other customers.

Five minutes}
Five hours } later the bank was empty.

---

19. Debate in Parliament.

Jim Callaghan left the chamber.

The whips muttered among themselves.

Eventually the debate continued.

Forty minutes}
Four days } later the issue was resolved.

---

20. The Tennis Match.

Sue was playing well in her first match at Wimbeldon.

The ballboys were very hot.

The match was being closely contested.

Eight hours}
One hour } later a wind blew up.

Analysis of experimental results

Analyses of variance were performed first treating subjects as a random factor collapsing across materials, second treating materials as a random factor collapsing across subjects on the total number of continuations in each of the fixed factor levels; time change (within vs. beyond range) and character featured in the continuation (scenario indepedent vs. scenario dependent)

Analysis by subjects

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	1829.95	343			
Subjects	343.95	42			
A (Time)	4.19	1	4.19	3.21	0.07
EA	54.54.	42	1.30		
B (Char-racter)	931.26	1	931.26	270.2	0.00001
EB	144.73	42	3.44		
AB	15.06	1	15.06	14.74	0.0006
EAB	42.93	42	1.02		

Analysis by materials:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	4215.44	159			
Cases	795.31	19			
A (Time)	0.15	1	0.15	0.04	N.S.
EA	60.71	19	3.19		
B (Character)	1581.30	1	1581.30	29.19	0.0001
EB	1029.06	19	54.16		
AB	49.50	1	49.50	9.71	0.005
EAB	96.86	19			

Experimental Materials and Design,
Experiment 2, Chapter 6

Group A Subjects	Block 1	Block 2*
Passages: 1, 2, 6, 11	Within range time change No adjective modifying Scenario dependent character	Beyond range time change No adjective modifying Scenario dependent character
Passages: 4, 5, 9, 12, 13	Beyond range time change No adjective modifying Scenario dependent character	Beyond range time change Adjective modifying Scenario dependent character
Passages: 7, 10, 18, 19, 20	Within range time change Adjective modifying Scenario dependent character	Within range time change No adjective modifying Scenario dependent character
Passages: 3, 8, 14, 15, 17	Beyond range time change Adjective modifying Scenario dependent character	Within range time change Adjectifing modifying Scenario dependent character

* Not included in analysis.

Group B Subjects		
Passages: 1, 2, 6, 11, 16	Within range time change Adjective modifying scenario dependent character	Beyond range time change Adjective modifying scenario dependent character

Passages: 4, 5, 9, 12, 13	Within range time change No adjective modifying scenario dependent character	Within range time change Adjective modifying scenaric Scenario dependent character
Passages: 7, 10, 18, 19, 20	Beyond range time change Adjective modifying scenario dependent character	Beyond range time change No adjective modifying Scenario dependent character
Passages: 3, 8, 14, 15, 17,	Beyond range time change No adjective modifying Scenario dependent character	Within range time change No adjective modifying scenario dependent character

Experimental Materials.

Experimental 2. Chapter 6

In the Restaurant.

The Browns were eating a meal in a restaurant.

The (clumsy) waiter was hovering around the table.

This restaurant was well known for its food.

Forty minutes}
Five hours } later the restaurant was empty.

The Birthday Party.

The children were all enjoying the birthday party.

There was a (well-known) entertainer to amuse them.

No expense was spared to make the party a success.

One hour}
Ten hours} later energies flagged.

On the Beach

Joan was sunbathing on the beach.

A (skinny) life guard was stationed on the pier.

The sun was shining brightly.

Eight hours}
Ten minutes} later an old friend came by.

Going Shopping

Mr. Lamb was shopping in the town centre.

The (surly) shop assistant helped to pack the groceries.

There were two bags filled to the brim.

Six hours }
Half an hour} later irritation crept in.

On Holiday

The old couple were enjoying their holiday.

The landlady was very kind and helpful.

A kindly landlady had been recommended.

Even the weather had been mild.

Three months}
Three days } later spirits were still high.

At the Cinema

Jenny found the film rather boring.

The (clumsy) projectionist had to keep changing reels.

It was supposed to be a silent classic.

Ten minutes}
Seven hours} later the film was forgotten.

The Bus Journey

Mrs. Grey was travelling by bus.

A (teenage) conductor collected the fares.

The bus jolted and rattled as it went.

After ten minutes}
ten hours } joints still ached.

The Country Walk

Jean admired the countryside as she walked.

An (ancient) tramp was resting by the roadside.

The fields were bathed in sunshine.

Two weeks}
Two hours} later the sun was still shining.

Car repairs

Joe used several spanners as he worked on the car.

Mother came out to offer advice.

Tools and oily rags lay all around.

Nine hours}
One hour } later frustration set in.

The Wedding

The bride smiled shyly as the wedding proceeded.

A (young) minister was reading from the bible.

The guests all beamed at the couple.

Ten minutes}
Ten hours } later nervousness had evaporated.

Spring Cleaning

Mary wore an apron while she spring cleaned.

A (cheeky) window cleaner was washing the windows.

The whole house would soon be sparkling.

One hour}
One week} later everything was in order.

The Operation

Mr Smith was having his appendix removed.

The (an anxious) nurse helped in the operating theatre.

The operation was fairly straight forward.

Seven hours}
Seven days } later the operation was a vivid memory.

The Trial

Jan gave her evidence at the trial.

The (a cynical) judge advised the jury as the trial proceeded.

The courtroom was hot and stuffy.

Three months}
Three hours } later unease was widespread.

At the Hairdressers

Don was having his hair cut fairly short.

A (cautious) girl was taking great care with the scissors.

The style was very neat and tidy.

Seven hours }
Twenty minutes} later many comments were passed.

The Examination

Liz was nervous at the start of the exam.

A (new) invigilator walked around the hall.

The exam was in advanced mathematics.

One week}
One hour} later tension eased.

The Race

Fred was in line at the start of the race.

A (noisy) crowd watched with great interest.

The games featured many world class runners.

Two minutes}
Two days } later there were celebrations.

At the Concert

Miss Bell was enjoying the music.

A (temperamental) orchestra played well throughout the concert.

The programme included many famous pieces.

Two hours}
later the medolies remained.
Two days }

Changing the Baby

David was changing his baby's nappy.

A (new) babysitter was due any minute.

The baby was crying noisily.

One day }
later everything was calm again.
One hour}

The Tennis Matach

Sue was playing well in her first match at Wimbeldon.

The (dosy) umpire called the first serve out.

The match was being closely contested.

Two hours }
later a wind blew up.
Seven hours}

Going Swimming

Sally was swimming in the warm blue sea.

The (a local) fisherman sat on the shore mending nets.

The waves lappped gently on the sand.

Half an hour}
later the weather grew rough.
Five hours }

Analysis of experimental results.

An analysis of variance was performed on the total number of continuations by subjects, collapsing across materials, in Block 1 only treating subjects as a random factor and time change (within vs. beyond range) adjective (presence vs absence) and character featured in the continuation (scenario independent vs. scenario dependent) as fixed main effects.

Source	Sums of Squares	Degrees of Freedom	Mean Square	F Ratio	Probability
Total	876.96	399			
Subjects	59.46	49			
A (Time)	1.69	1	1.69	3.97	0.04
EA	20.81	49	0.42		
B (Adjective)	2.89	1	2.89	6.87	0.01
EB	20.61	49	0.42		
AB	1.96	1	1.96	4.45	0.03
EAB	21.54	49	0.43		
C (Character)	538.24	1	538.24	348.24	0.00
EC	75.76	49	1.54		
AC	0.81	1	0.81	1.06	0.30
EAC	37.19	49	0.75		
BC	2.89	1	2.89	3.07	0.08
EBC	46.11	49	0.94		
ABC	4.00	1	4.00	4.55	0.03
EABC	43.00	49	0.87		

Experimental Materials and Design.

Experiment 3, Chapter 6

Group A Subjects	Block 1	Block 2
Passages: 1, 4, 9, 13, 18	Within range time change Predictable scenario-dependent character	Beyond range time change Predictable scenario-dependent character
Passages: 2, 3, 10, 12, 19	Within range time change Unpredictable scenario-dependent character	Beyond range time change Unpredictable scenario-dependent character.
Passages: 7, 11, 14, 15, 20	Beyond range time change Predictable scenario-dependent character	Within range time change Predictable scenario-dependent character
Passages: 5, 6, 8, 16, 17	Beyond range time change Unpredictable scenario-dependent character	Within range time change Unpredictable scenario-dependent character.

Group B Subjects		
Passages: 1, 4, 9, 13, 18	Within range time change Unpredictable scenario-dependent character	Beyond range time change Unpredictable scenario-dependent character
Passages: 2, 3, 10, 12, 19	Within range time change Predictable scenario-dependent character	Beyond range time change Predictable scenario-dependent character.

Passages:	Beyond range time change	Within range time change
7, 11, 14, 15, 20	Unpredictable scenario-dependent character	Unpredictable scenario-dependent characer
Passages:	Beyond range time change	Within range time change
5, 6, 8, 16, 17	Predictable scenario-dependent character	Predictable scenario-dependent character

Scenario titles and the predictable and unpredictable scenario dependent characters generated from each title. Figures in brackets are the number of subjects (out of 48) who mentioned each character. Data shown for passages used in Experiment 2, Chapter 7. Data marked * used in Experiment 3, Chapter 6.

(1) In the restaurant*	waiter (46)	dishwasher (1)
(2) The birthday party*	guests (23)	conjurer (1)
(3) At the hotel*	manager (27)	bellboy (3)
(4) In the airport*	airhostess (30)	flight controller (1)
(5) Going shopping*	shop assistant (24)	store detective (2)
(6) At the cinema*	usherette (30)	projectionist (5)
(7) The bus journey*	conductor (42)	inspector (9)
(8) Making a film	director (38)	stuntman (3)
(9) Car repairs*	mechanic (45)	apprentice (1)
(10) The wedding*	groom (45)	minister (17)
(11) On the newspaper*	journalist (36)	sportswriter(1)
(12) The operation*	nurse (38)	medical students (1)
(13) The trial*	judge (45)	clerk of court (2)
(14) At the hairdressers*	hairdresser (44)	receptionist (3)
(15) The road accident*	ambulance man (35)	witness (2)
(16) At the bank*	teller (41)	accountant (2)
(17) The football match*	the players (44)	linesman (9)
(18) Debate in parliament*	MPs (30)	whips (1)
(19) At the schol*	teacher (48)	dinner lady (2)
(20) The tennis match*	spectators (30)	ballboys (14)
(21) Aboard ship	captain (44)	purser (3)

(22) At the Universtiy	lecturer (43)	secretary (3)
(23) On strike	pickets (34)	negotiators (1)
(24) Making a record	popstar (46)	record producer (18)
(25) In the battle	soldier (33)	chaplain (1)
(26) At the races	jockeys (20)	stewards (1)
(27) Dinner at the mansion	butler (31)	footman (1)
(28) The Wild West	cowboys (39)	saloon girls (1)
(29) In the shipyards	welders (21)	riveters (1)
(30) In the royal palace	queen (44)	lady in waiting (1)
(31) At the concert	popstars (30)	roadies (3)
(32) At the dentists	dentist (48)	anaesthetist (1)

Experimental Materials.

Expriment 3, Chapter 6

In the Restaurant.

The dishwasher / waiter felt tired.

The Browns were eating a meal in the restaurant.

The restaurant was well known for its food.

Forty minutes / Five hours later the restaurant was empty.

Going Shopping.

The shop assistant / store detective hovered in the background.

Mrs. Lamb was shopping in the town centre.

There were two bags full to the brim.

Half an hour / Six hours later irritation crept in.

The Bus Journey.

A conductor / An inspector stood beside the driver.

Miss Grey was travelling by bus from the terminal.

The bus rattled and jolted as it went.

Ten minutes / Ten hours later joints still ached.

The Wedding.

Minister}
The looked very serious.
Groom }

Anne smiled shyly as the wedding progressed.

The guests were all beaming at the couple.

Ten minutes}
later nervousness had evaporated.
Ten hours }

The Trial.

judge}
The of court appeared very formal.
clerk}

Jan gave her evidence at the trial.

The courtroom was hot and stuffy.

Three months}
later unease was widespread.
Three hours }

The Birthday Party.

guests were }
The full of fun.
conjurer was}

Susy was enjoying her birthday party.

No expense was spared to make the party a success.

One hour }
later energies flagged.
Twelve hours}

At the Cinema.

The projectionist / usherette was very clumsy.

Jenny and Tom were finding the film rather boring.

Seven hours / Seven minutes later the film was forgotten.

Car Repairs.

The mechanic / apprentice surveyed the scene.

Katy used several spanners as she worked on the car.

Tools and oily rags lay all around.

Nine hours / One hour later frustration set in.

The Operation.

The medical students / nurse looked around the operating theatre.

Mr. Smith was having his appendix removed.

The operation was fairly straight forward.

Seven hours / Seven days later the operation was a vivid memory.

At the Hairdressers.

The hairdresser / receptionist was very talkative.

Don was having his hair cut fairly short.

The style was vey neat and tidy.

Twenty minutes / Seven hours later many comments were passed.

At the Hotel.

The bellboy / manager came forward to assist.

Mr. and Mrs. Fox entered the hotel foyer.

Dinner was in progress.

Three months / Three hours later the hotel was very busy.

Making a Film.

The director / stuntman discussed the first scene.

Glenda Jackson arrived on the set.

The costumes of the extras made a colourful display.

Three years / One month later many awards had been won.

The Road Accident.

A witness } applied a tourniquet.
An ambulanceman}

Liz knelt beside her injured companion.

A press of onlookers huddled around.

Fifteen minutes} later nerves had settled.
Six hours }

The Football Match.

The players }
linesmen}

John waved his scarf in the air.

Three goals had now been scored.

Three hours } later there was heavy rain.
Thirty minutes}

At School.

A dinnerlady} was crossing the playground.
teacher }

Boby was almost late for school.

It had started to rain.

Eight hours } later the classroom was quiet.
Twenty five minutes}

In the Airport.

A flight controller}
An airhostess } began to search.

The Jones family had lost their luggage.

The airport was crowded because of the weather delays.

Two hours}
Two days } later annoyance was setting in.

On the Newspaper.

A journalist }
A sportswriter} recorded the details.

Pam had taken her story to the local newspaper.

The office was full of bustling activity.

Three days }
Three hours} later the latest edition was out.

At the Bank.

An accountant}
A teller } was busily counting money.

Meg went to the bank to cash a cheque.

There were lots of other customers.

Five minutes}
Five hours } later the bank was empty.

Debate in Parliament.

The { MPs / whips } muttered among themselves.

Jim Callaghan left the chamber.

Eventually the debate continued.

{ Forty minutes / Twelve hours } later the issue was resolved.

The Tennis Match.

The { ballboys / spectators } were very hot.

Sue was playing well in her first match at Wimbeldon.

The match was being closely contested.

{ Eight hours / One hour } later a wind blew up.

Analysis of Experimental Materials.

Analysis of variance were performed first treating subjects as a random factor collapsing across materials and second treating materials as a random factor collapsing across subjects on the total number of continuations in each of the categories of fixed effects, order (block 1 vs. block 2) time change (within range vs. beyond range) predictability of scenario dependent character (predictable vs. unpredictable) and character featured in the continuation (scenario-independent vs. scenario dependent character).

Analysis by subjects:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	960.28	575			
Subjects	115.60	35			
A (Order)	0.62	1	0.62	0.54	N.S.
EA	40.43	35	1.15		
B (Time)	1.66	1	1.66	2.66	0.10
EB	21.89	35	0.62		
ABC	0.001	1	0.001	0.001	N.S.
EAB	35.31	35	1.00		
C (Predict-ability	0.08	1	0.08	0.10	N.S.
EC	27.47	35	0.78		
AC	0.50	1	0.50	0.51	N.S.
EAC	33.81	35	0.96		
BC	0.04	1	0.04	0.06	N.S.
EBC	23.26	35	0.66		
ABC	0.62	1	0.62	0.79	N.S.
EABC	27.43	35	0.78		
D (Char-acter)	304.79	1	304.79	252.37	0.00
ED	42.26	35	1.20		
AD	0.08	1	0.08	0.08	N.S.
EAD	35.22	35	1.00		
BD	1.08	1	1.08	1.36	0.24
EBD	27.72	35	0.79		

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
ABD	11.96	1	11.96	12.64	0.001
EABD	33.10	35	0.94		
CD	3.21	1	3.21	2.03	0.15
ECD	55.10	35	1.57		
ACD	0.91	1	0.91	1.12	0.29
EACD	28.64	35	0.81		
BCD	1.89	1	1.89	2.39	0.12
EBCD	27.67	35	0.79		
ABCD	1.26	1	1.26	0.78	N.S.
EABCD	56.54	35	1.61		

Analysis by materials:

Source	Sum of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	2529.78	159			
Cases	433.11	19			
A (Time)	3.90	1	3.90	0.88	N.S.
EA	83.46	19	4.39		
B (Predictability)	2.75	1	2.75	0.52	N.S.
EB	100.11	19	5.26		
AB	0.05	1	0.05	0.01	N.S.
EAB	97.81	19	5.14		
C (Character)	1015.81	1	1015.05	33.66	0.00
EC	572.81	19	30.14		
AC	13.80	1	13.80	3.97	0.05
EAC	66.06	19	3.47		
BC	9.50	1	9.50	2.82	0.10
EBC	63.86	19	3.36		
ABC	0.006	1	0.006	0.00	N.S>
EABC	67.36	19	3.54		

Appendix D

Design of Materials in Experiment 1, Chapter 7

Group 1	Block 1	Block 2
Passages: 1, 2, 6, 8, 20, (A)	Within range time change (W) Reference to scenario (1) independent character.	Beyond range time change (B) Reference to scenario independent character (1)
Passages: 5, 9, 12, 13, 19, (B)	Within range time Reference to scenario dependent character. (2)	Within range time change (W) Reference to scenario independent character. (1)
Passages: 7, 10, 11, 16, 17	Beyond range time change (B) Reference to scenario independent character (1)	Beyond range time change (B) Reference to scenario dependent character. (2)
Passages: 3, 4, 14, 15, 18,	Beyond range time change (B) Reference to scenare dependent character (2).	Within range time change (W) Reference to scenario dependent character (2)

Group 2

Subjects

A Passages	B1	W1
B Passages	W1	W2
C Passages	B2	B1
D Passages	W2	B2

Group 3

Subjects

A Passages	W2	B2
B Passages	B2	B1
C Passages	W1	W2
D Passages	B1	W1

Group 4

Subjects

A Passages	B2	W2
B Passages	B1	B2
C Passages	W2	W1
D Passages	W1	B1

Experimental Materials, Experiment 1, Chapter 7

In the Restaurant.

The Browns were eating a meal in a restaurant.

The waiter was hovering around the table.

This restaurant was well known for its food.

Five hours } later the restaurant was empty.
Forty minutes}

They} had enjoyed eating } all the good food.
He } serving}

** Questions **

Were the Browns eating in a restaurant?

Did the waiter enjoy serving?

** Next Trial **

The Birthday Party.

The children were all enjoying the birthday party.

There was an entertainer to amuse them.

No expense was spared to make the party a success.

Twelve hours} later energies flagged.
One hour }

Playing } all the games had exhausted them}
Organizing} him }

** Questions **

Were the children enjoying the party?

Was the entertiner exhausted?

** Next Trial **

On the Beach

Joan was sunbathing on the beach.

The lifeguard was stationed on the pier.

The sun was shining brightly.

Eight hours}
Ten minutes} later an old friend came by.

She}
He} was glad to see the friend again.

** Questions **

Was Joan sunbaithing?

Did the lifeguard meet a friend?

** Next Trial **

The Holiday.

The old couple were enjoying their holiday.

The landlady was very kind and helpful.

Even the weather had been mild.

Three months}
Three days } later spirits were still high.

** Questions **

Were the old couple enjoying themselves?

Did the landlady make a profit?

** Next Trial**

Going Shopping.

Mr. Lamb was shopping in the town centre.

The shop assistant helped to pack the groceries.

There were two bags filled to the brim.

Twenty minutes} later irritation crept in.
Six hours }

He } going to }
found the shops depressing.
She} working in}

** Questions **

Was Mr. Lamb shopping?

Was the shop assistant depressed?

** Next Trial **

At the Cinema.

Jenny found the film rather boring.

The projectionist had to keep changing reels.

It was supposed to be a silent classic.

Seven minutes} later the film was forgotten.
Seven hours }

She}
had fallen asleep and was dreaming.
He }

** Questions **

Was Jenny enjoying the film?

Did the projectionist fall asleep?

** Next Trial **

The Bus Journey.

Mrs. Grey was travelling by bus from the terminus.

The conductor collected the fares.

The bus rattled and jolted as it went.

After {ten minutes / ten hours} joints still ached.

{She / He} {hated} {going / working} on this old boneshaker.

** Questions **

Was Mrs. Grey going by train?

Did the conductor hate the bus?

** Next Trial **

The Country Walk.

Jean admired the countryside as she walked.

The old tramp was resting by the roadside.

The fields were bathed in sunshine.

{Two hours / Two weeks} later the weather was still fine.

{She / He} {enjoyed} {being / living} on the open road.

** Questions **

Did Jean admire the countryside?

Did the tramp enjoy the open road?

** Text Trial **

Car Repairs

Joe used several spanners as he worked on the car.

Mothers came out to offer advice.

Tools and oily rags lay all around.

One }
hour(s) later frustration set in.
Nine}

his} work }
All good had achieved very little.
her} advice}

** Questions **

Did Joe use one spanner?

Was mother's advice successful?

** Next Trial **

The Wedding.

The bride smiled shyly as the wedding proceeded.

The minister was reading from the bible.

The guests were all beaming at the couple.

Ten minutes}
later nervousness had evaporated.
Ten hours }

She } her} love }
had happily married first
He } his} couple}

** Questions **

Did the bride smile?

Did the minister relax?

** Next Trial **

Spring Cleaning.

Mary wore an apron while she spring cleaned.

The window-cleaner was washing the windows.

The whole house would soon be sparkling.

One hour}
later everything was in order.
One week}

She}
found cleaning a very satisfying job.
He }

** Questions **

Did Mary wear an overall?

Did the window clear enjoy his job?

** Next Trial **

The Operation

Mr. Smith was having his appendix removed.

The nurse helped in the operating theatre.

The operation was fairly straightforward.

Seven hours}
later moving was still sore.
Seven days }

This was the first operation he } had had } }
she} attended}

** Questions **

Were Mr. Smith's tonsils being removed?

Was this the nurse's first operation?

** Next Trial **

The Trial

Jan gave her evidence at the trial.

The judge advised the jury as the trial progressed.

The courtroom was hot and stuffy.

Three hours }
later unease was widespread.
Three months}

She} her evidence}
was unsure if was correct.
He } his advice }

** Questions **

Did Jan give evidence?

Was the judge feeling uncertain?

** Next Trial **

At the Hairdressers.

Don was having his hair cut fairly short.

The girl was taking great care with the scissors.

The style was very neat and tidy.

Twenty minutes}
Seven hours } later many comments were passed.

He } was complimented on his good taste}
She} her good work}

** Questions **

Was Don having his hair dyed?

Was the girl comlimented?

** Next Trial **

The Examination

Liz was nervous at the start of the exam.

The invigilator walked round the hall.

The exam was in advanced mathematics.

One hour}
One week} later tension eased.

She} had studied all the work } for the exam.
He } rules}

** Questions **

Was Liz nervous?

Did the invigilator relax later?

** Next Trial **

The Race

Fred was in line at the start of the race.

The spectators watched with great interest.

The games featured many world class runners.

Two minutes}
Two days } later there were celebrations.

He } had broken the world record easily.

They} had seen the world record broken.

** Quetions **

Was Fred in line?

Did the spectators celebrate?

** Next Trial **

At the Concert

Miss bell was enjoying the music.

The orchestra played well throughout the concert.

The programme included many famous pieces.

Two hours}
Two days } later the melodies remained.

She } hearing}
always enjoyed the classics.
They} playing}

** Questions **

Was Miss Bell enjoying the music?

Did the orchestra enjoy the classics?

** Next Trial **

Changing the Baby.

David was changing the baby's nappy.

The babysitter was due any minute.

The baby was crying noisily.

One hour}
          later everything was calm again.
One day }

** Questions **

Was David feeding the baby?

Was the babysitter glad of the quietness?

** Next Trial **

The Tennis Match

Sue was playing well in her first match at Wimbeldon.

The umpire called the first serve out.

The match was being closely contested.

Ten minutes}
              later a wind blew up.
Seven hours}

She}
      was glad that the play was going so well.
He }

** Questions **

Was this Sue's second match?

Was the umpire glad about the play?

** Next Trial **

Going Swimming

Sally as swimming in the warm blue sea.

The fisherman sat on the shore mending nets.

The waves lapped gently on the sand.

Half an hour}
                later the water grew rough.
Five hours }

She}
     noticed the wind flapping the nets.
He }

** Questions **

Was Sally Swimming?

Did the fisherman notice the nets flapping?

Analysis of experimental results.

Analyses of variance were performed on mean reading times for sentence four treating subjects as a random factor collapsing across materials and treating time change (within range vs. beyond range) as a fixed effect, then treating materials as a random factor collapsing across subjects.

Sentence 4, Experiment I, Chapter 7

Analysis by subjects:

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	12083533.38	79			
Subjects	11202208.88	39			
A (Time)	297314.11	1	297314.11	19.85	0.0001
EA	584010.38	39	14974.62		

Analysis by materials.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	7058320	39			
A (Time)	556992	1	556992	7.11	0.02
EA	148840	19	7883		

Analyses of variance were performed on mean reading times for sentence five, treating subjects as a random factor collapsing across materials then treating materials as a random factor collapsing across subjecs treating time change unpreceding sentence (within range vs. beyond range) and character referenced (scenario independent vs. scenario dependent) as fixed effects.

Anaysis by subjects.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	39022205.84	159			
Subjects	35012753.09	39			
A (Time)	3638.55	1	3638.55	0.18	N.S.
EA	750313.69	39	19238.81		
B (Char-acter)	714626.55	1	714626.55	15.50	0.0005
EB	1797714.69	39	46095.24		
AB	43197.75	1	43197.75	2.40	0.12
EAB	699961.49	39	17947.73		

Analysis by materials.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	2281586.38	79			
Cases	782652.63	19			
A (Time)	2964.61	1	2964.61	0.11	N.S.
EA	487575.63	19	25661.87		
B (Char-acter)	357915.01	1	357915.01	23.09	0.0002
EB	294392.23	19	15494.42		
AB	18942.01	1	18942.01	1.06	0.31
EAB	337144.23	19	17744.43		

Analyses of variance were performed on mean question answering times first treating subjects as a random factor collapsing across matrials, second treating matrials as a random factor collapsing across subjects treating time change in preceding passage (within range vs. beyond range) and question type questions concerning scenario independent vs. scenario dependent) as fixed factors.

By subjects.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	39496186.69	159			
Subjects	28583924.44	39			
A (Question Type)	5708180.25	1	5708180.25	80.87	0.0000
EA	2752743.49	39	70583.16		
B (Time)	130131.05	1	130131.05	4.05	0.04
EB	1251025.69	39			
AB	120066.80	1	120066.80	4.92	0.03
EAB	950114.94	39	24361.93		

By materials

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	7788266.88	79			
Cases	2259598.13	19			
A (Question Type)	3828562.51	1	3828562.51	106.08	0.00001
EA	685689.73	19	36088.93		
B (Time)	108118.51	1	108118.51	3.98	0.05
EB	515302.73	19	27121.19		
AB	73872.01	1	73872.01	4.42	0.04
EAB	317123.23	19	16690.69		

Design of Materials, Experiment 2, Chapter 7

Group 1	Block 1	Block 2
Subjects		
Passages: 1, 9, 18, 26 (A)	WP1	WU1
Passages: 2, 13, 19, 23 (B)	WP2	WP1
Passages: 6, 20, 25, 29 (C)	WU1	WU2
Passages: 5, 12, 22, 32 (D)	WU2	WP2
Passages: 7, 17, 21, 28 (E)	BP1	BU1
Passages: 8, 15, 16, 30 (F)	BP2	BP1
Passages: 10, 11, 27, 31 (G)	BU1	BU2
Passages: 3, 4, 14, 24 (H)	BU2	BP2

Group 2		
Subjects		
A Passages	WU2	WP2
B Passages	WU1	WU2
C Passages	WP2	WP1
D Passages	BP2	BU2
E Passages	BU2	BP2
F Passages	BU1	WU1
G Passages	WP1	BU1
H Passages	BP1	BU1

Group 3

Subjects

A Passages	BP2	BP1
B Passages	BU2	BU1
C Passages	BP1	BP2
D Passages	BU1	WU1
E Passages	WP2	WP1
F Passages	WP1	BU2
G Passages	WU2	WP2
H Passages	WU1	WU2

Group 4

Subjects

A Passages	BU1	BU2
B Passages	BP1	BP2
C Passages	BU2	BU1
D Passages	WP1	BP1
E Passages	WU1	WU2
F Passages	WU2	WP2
G Passages	BP2	WU2
H Passages	WP2	WP1

Key:

W = Within range time change B = Beyond range time change

P = predictable scenario dependent character

U = Unpredictable scenario dependent character

1 = Pronoun reference to scenario

2 = Pronoun reference to scenario dependent character.

** Next Trial **

In the restaurant.

The Browns were eating a meal in a restaurant.

The {waiter / dish-washer} was feeling rather tired.

This restaurant was well known for its food.

{Five hours / Forty minutes} later the restaurant was empty.

{They / He} had enjoyed {seeing / eating} all the good food.

** Questions **

Were the Browns eating in a restaurant?

Did the {waiter / dish-washer} enjoy the job?

** Next Trial **

The birthday party.

Suzy was enjoying her birthday party.

The {guest were / conjurer was} full of fun.

No expense was spared to make the party a success.

{Ten hours / One hour} later energies flagged.

Playing all the games had exhausted {her / him / them}

** Questions **

Was Suzy enjoying the party.

{Were / Was} the {guests / entertainer} exhausted?

** Next Trial **

At the hotel

Mr. and Mrs. Fox entered the hotel foyer.

The {bellboy / manager} came forward to help.

Dinner was in progress in the restaurant.

Three {hours / months} later the weather was hotter.

{The / He} preferred a quieter hotel than this.

** Questions **

Did Mr. and Mrs. Fox leave the foyer?

Did the {bellboy / manager} come forward?

** Next Trial **

In the airport.

The Jones family had lost their luggage.

The {flight controller / air hostess} helped them search.

The airport was crowded with holidaymakers.

Two {days / hours} later annoyance was setting in.

{They / She} was irritated by such inefficiency.

** Questions **

Did the Jones family lose something?

Did the {air hostess / flight controller} help them?

** Next Trial **

Going shopping

Mr. Lamb was shopping in the town centre.

The {lady store detective / shop assistant} helped to pack the groceries.

There were two bags filled to the brim.

{Twenty minutes / Six hours} later irritation crept in.

{He / She} {found / going to / working in} the shops depressing.

** Questions **

Was Mr. Lamb shopping?

Was the {shop assistant / lady store detective} depressed?

** Next Trial **

At the cinema

Jenny and Tom found the film rather boring.

The {projectionist / usherette} was very clumsy.

It was supposed to be a silent classic.

{Seven hours / Seven minutes} later the film was forgotten.

{They / She / He} had fallen asleep and was dreaming.

** Questions **

Was Jenny enjoying the film?

Did the {projectionist / usherette} fall asleep?

** Next Trial **

The bus journey

Mrs. Grey was travelling by bus from the terminus.

The {conductor / inspector} stood beside the driver.

The bus rattled and jolted as it went.

After {ten minutes / ten hours} joints still ached.

{She / He} hated going on this old boneshaker.

** Questions **

Was Mrs. Grey going by train?

Did the {conductor / inspector} hate the bus?

** Next Trial **

Making a film

Glenda Jackson arrived on the set.

The {director / stuntman} discussed the first scene.

The costumes of the extras made a colourful display.

Three {weeks / years} later many awards had been won.

{She / He} was proud of her contribution to the film.

** Questions **

Did Glenda Jackson leave the set?

Did the {director / stuntman} discuss the scene?

** Next Trial **

Car repairs

Katy watched as her car was repaired.

The {mechanic / apprentice} surveyed the scene.

Tools and oily rags lay all around.

{Nine hours / One hour} later frustration set in.

{She / He} was annoyed nothing had been achieved.

** Questions **

Was Katy having her van repaired?

Did the {mechanic / apprentice} fix it easily?

** Next Trial **

The wedding

Anne smiled shyly as the wedding proceeded.

The {minister / groom} was looking very serious.

The guests were all beaming at the couple.

{Ten minutes / Ten hours} later nervousness had evaporated.

{She / He} had happily married his first first love.

** Questions **

Did the bride smile?

Did the {minister / groom} relax?

** Next Trial **

On the newspaper

Pam took her story to the local newspaper.

A {sportswriter / journalist} recorded the details.

The office as full of bustle.

{Three hours / Three days} later the story was out.

{She / He} read the story with pleasure.

** Questions **

Did Jill go to the newspaper?

Did the {sportswriter / journalist} take the story?

** Next Trial **

The operation

Mr. Smith was having his appendix removed.

The {medical students / nurse} looked around the operating theatre.

The operation was fairly straight forward.

{Seven days / Seven hours} later the operation was a vivid memory.

This was the first operation {he / she / they} had attended.

** Questions **

Were Mr. Smith's tonsils being removed?

Did the {medical students / nurse} look around?

** Next Trial **

The Trial

Jan gave her evidence at the trial.

The judge} of court seemed very formal.
clerk}

The courtroom was hot and stuffy.

Three months}
Three hours } later unease was widespread.

She as unsure if her opinion was correct.

** Questions **

Did Jan give evidence?

Was the judge} feeling uncertain?
clerk}

** Next Trial **

At the hairdressers.

Don was having his hair cut fairly short.

The receptionist} was very talkative.
hairdresser }

The tyle was very neat and tidy.

Seven hours}
Seven days } later many comments were passed.

He }
She} was complimented on his good taste.

** Questions **

Was Don having his hair dyed?

Was the receptionist} complimented?
hairdresser }

** Next Trial **

The road accident.

Liz knelt beside her injured companion

An ambulance}
A witness }
applied a tourniquet.

A crowd on onlookers huddled around.

Half an hour}
Six hours }
later nerves had settled.

She}
He}
had been able to cope in a crisis.

** Questions **

Did Liz kneel with a stranger?

Did the ambulanceman}
witness }
cope?

** Next Trial **

At the bank

Meg went to the bank to cash a cheque.

The teller }
accountant}
was busycounting money.

There were many other customers.

Five minutes}
hours }
later the bank was empty.

She}
He }
was glad to be clear of the crowds.

** Questions **

Did Meg have a cheque?

Was the teller }
accountant}
counting cash?

** Next Trial **

The football match

John waved his scarf in the air.

The {players / linesmen} were pulling their socks up.

Three goals had to be scored.

{Twenty minutes / Three hours} later there was heavy rain.

{He was / They were} starting to feel frozen.

** Questions **

Did John wave a rattle?

Were the {players / linesmen} pulling their ties?

** Next Trial **

Debate in parliament.

Jim Callaghan left the chamber.

The {MPs / whips} murmmered angrily.

Eventually the debate continued.

{Twelve hours / Forty minutes} later the issue was resolved.

{He / They} were relieved that the bill went through.

** Questions **

Did Callaghan leave?

Were the {MPs / whips} angry?

** Next Trial **

At school.

Bobby was almost late for school.

The {lady school teacher / dinner-lady} was crossing the playground.

It was beginning to rain.

{Four hours / Twenty minutes} later the classroom was quiet.

{She / He} was glad the noise and bustle was over.

** Questions **

Was bobby early?

Was the {teacher / dinner-lady} in the playground?

** Next Trial **

The tennis match.

Sue was playing well in her first match at Wimbeldon.

The {ballboys / spectators} were feeling the heat.

Perhaps soon it would become cooler.

{Two days / Ten minutes} later a wind blew up.

{She / They} were glad that the play was going so well.

** Questions **

Was this Sue's second match?

Were the {ballboys / spectators} cold?

** Next Trial **

Aboard ship

Miss Smith was on a luxury cruise.

The captain} was strolling along the deck.
purser}

The ship was large and brand new.

Ten days } later spirits remained high.
Nine months}

She} had benefitted from an enjoyable cruise.
He }

** Questions **

Was Miss Smith on a cargo boat?

Was the captain} rushing?
purser }

** Next Trial **

At the university

Joe } was going to her first lecture.
Janet}

The secretary} walked along the corridor.
lecturer }

The lecture was to be in mathematics.

Five minutes} later confusion was felt.
hours }

He } still felt lost in this new place.
She}

** Questions **

Was Joe } coming from a lecture>
Janet}

secretary}
Was the new?
lecturer }

** Next Trial **

On strike

Fred was on strike from the factory.

pickets }
The were at the factory gates.
negotiators}

The dispute concerned overtime pay.

months}
Five later feelings were high.
days }

He }
wanted compensation for lost wages.
They}

** Questions **

Was Fred on strike?

pickets }
Were the at the gates?
negotiators}

** Next Trial **

Making a record.

Jean was watching a record being made.

record producer}
The looked very anxious.
popstar }

The record ws played back over loud speakers.

One hour later excitement mounted.

She felt the record would be a hit.

** Questions **

Was Jean singing?

record producer}
Was the anxious?
popstar }

** Next Trial *

In the battle

Maria watched as the battle progressed.

chaplain}
The soldiers} seemed very brave.

The battle was clearly visible.

months}
Two hours } later the cause was unimportant.

She}
He } felt sorry for the wounded and dying.

** Questions **

Did Maria watch the battle?

chaplain}
Did the soldier } seem brave?

** Next Trial **

At the races

Sandra was at her first horse race.

jockey }
The stewards} were looking at the horses.

There was a large crowd of reacegoers.

Six hours }
Ten minutes} later the thrill remained.

She }
They} found horse racing very exciting.

** Questions **

Did Sandra often go racing?

jockey }
Did the steward} look at the horses.

** Next Trial **

Dinner at the mansion.

Fiona was having dinner at the mansion.

The {footman / butler} stood at the door.

The table was gleaming with silver.

Two days later the meal was savoured.

{She / He} enjoyed seeing really gracious life.

** Questions **

Was Fiona having dinner?

Was the {footman / butler} at the door?

** Next Trial **

The wild west.

Jake was getting ready to draw his gun.

The {cowboys / saloon girls} watched avidly.

The fight was the first in town.

Five {minutes / hours} later the tension eased.

{He / They} were glad the outlaw was dead.

** Questions **

Was Jake using a knife?

Did the {cowboys / saloongirls} turn away?

** Next Trial **

In the shipyards.

Ian was helping build a ship.

The {riveters / welders} were hard at work.

The ship was a small cargo boat.

{He / They} were pleased with their skills.

** Questions **

Was Ian building a ship?

Were the {riveters / welders} slacking?

** Next Trial **

In the royal palace.

James was to have a royal audience.

The {Queen / lady in waiting} was very kind.

The palace was a magnificent building.

{Ten minutes / Two weeks} later impressions lingered.

{He / She} thought how charming a person

** Questions **

Was James to meet royalty.

Was the {queen / lady in waiting} kind?

** Next Trial **

At the pop concert.

Babs was thrilled to be at the concert.

The { roadies / popstars } were approaching the stage.

The hall was filled with screaming fans.

{ Two hours / Three days } later the songs remained.

{ She / They } thought it had been a great night.

** Questions **

Was Babs happy?

Were the { roadies / popstars } approaching the stage?

** Next Trial **

At the dentists

Mary was having all her teeth out.

The { anaesthetist / dentist } seemed very efficient.

The equipment was all round the chair.

{ Twenty minutes / Three days } later sensation returned.

{ She / He } was glad it was over successfully.

** Questions **

Was Mary having all her teeth out?

Was the { anaestheist / dentist } efficient?

Analysis of Experimental Results

Analyses of variance were performed on mean rading times for sentence five first treating subjects as a random factor collapsing across materials then treating materialls as a random factor collapsing across subjects with the predictability of the scenario dependent character time change (and character referenced as fixed effects).

Analysis by subjects.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	53598254.17	319			
Subjects	43853552.29	39			
A (Time)	32220.37	1	32220.37	0.76	N.S.
EA	1649377.74	39	42291.73		
B (Predict-ability)	3.40	1	3.40	0.00	N.S.
EB	1650019.72	39	42308.19		
AB	12612.75	1	12612.75	0.73	N.S.
EAB	668706.37	39	17146.31		
C (Character)	232470.70	1	232470.70	5.10	0.02
EC	1776635.92	39	45554.76		
AC	95807.40	1	95807.40	2.94	0.09
EAC	1411113.22	39	36182.39		
BC	10706.87	1	10706.87	0.36	N.S.
EBC	1146416.74	39	29395.30		
ABC	29548.82	1	29548.82	1.12	0.29
EABC	1029061.79	39	26386.19		

Analysis by materials.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	25206725.99	255			
Cases	8931804.62	31			
A (Time)	111180.56	1	111180.56	2.27	0.13
EA	1514229.55	31	48846.11		
B (Predict-ability)	6370.03	1	6370.03	0.08	N.S.
EB	2310152.08	31	74521.03		
AB	154.69	1	154.69	0.004	N.S.
EAB	1165991.93	31	37612.64		
C (Char-acter)	205945.93	1	205945.75	3.74	0.05
EC	1703510.83	31	54951.96		
AC	69993.31	1	69993.31	1.30	0.26
EAC	15659847.80	31	53543.49		
BC	194977.44	1	194977.44	3.99	0.05
EBC	1511557.18	31	48759.90		
ABC	34619.25	1	34619.25	0.18	N.S.
EABC	5786390.87	31	186657.77		

Analyses of variance were also performed on mean question answering times for both questions together treating subjects then materials as a random factor and treating question type and time change as fixed factors.

By subjects.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	1799928.97	159			
Subjects	7200094.97	39			
A (Question Type)	616032.40	1	616032.40	2.67	0.10
EA	8981287.60	39	230289.42		
B (Time)	96628.90	1	96628.90	8.98	0.004
EB	419341.10	39	10752.33		
AB	366.02	1	366.02	0.02	N.S.
EAB	486177.97	39	12466.10		

By materials.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	19620140.00	255			
Cases	9272300.00	31			
A (Question Type)	400530.76	1	400530.76	3.81	0.05
EA	3256269.73	31	105040.95		
B (Time)	536050.14	1	53650.14	1.10	0.30
EB	1506351.35	31	48591.97		
AB	1785.06	1	1785.06	0.06	N.S.
EAB	842066.93	31	27163.44		

Analyses of variance were performed on question two alone treating subjects then materials as random factors and treating time change and predictability as fixed factors.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	21163376.77	159			
Subjects	16640655.77	39			
A (Predict-ability)	167443.60	1	167443.60	4.93	0.03
EA	1322548.40	39	33911.49		
B (Time	41667.02	1	41667.02	1.08	0.30
EB	1501596.97	39	38502.48		
AB	203347.60	1	203347.60	6.16	0.01
EAB	1286117.40	39	32977.36		

By materials.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	11604686.46	127			
Cases	8078938.46	31			
A (predict-ability)	228488.00	1	228488.00	6.89	0.01
EA	1027187.00	31	33135.06		
B (Time)	60031.12	1	60031.12	1.42	0.23
EB	1302334.87	31	42010.80		
AB	90418.78	1	90418.78	3.43	0.07
EAB	817288.21	31	26364.13		

Analyses of variance were performed on mean reading times for sentence two, where the scenario dependent character was introduced, first treating subjects then materials as random factors with predictability as a fixed effect.

By subjects.

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	11100324.88	79			
Subjects	10632583.38	39			
A (Predict-ability)	246309.01	1	246309.01	43.38	0.000006
EA	221432.48	39	5677.75		

By materials

Source	Sums of Squares	Degree of Freedom	Mean Square	F Ratio	Probability
Total	2010241.75	63			
Cases	1586726.75	31			
A (Predict-ability)	74529.00	1	74529.00	6.62	0.01
EA	348986.00	31	11257.61		