INFORMATION TO USERS

While the most advanced technology has been used to photograph and reproduce this manuscript, the quality of the reproduction is heavily dependent upon the quality of the material submitted. For example:

- Manuscript pages may have indistinct print. In such cases, the best available copy has been filmed.

- Manuscripts may not always be complete. In such cases, a note will indicate that it is not possible to obtain missing pages.

- Copyrighted material may have been removed from the manuscript. In such cases, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, and charts) are photographed by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each oversize page is also filmed as one exposure and is available, for an additional charge, as a standard 35mm slide or as a 17”x 23” black and white photographic print.

Most photographs reproduce acceptably on positive microfilm or microfiche but lack the clarity on xerographic copies made from the microfilm. For an additional charge, 35mm slides of 6”x 9” black and white photographic prints are available for any photographs or illustrations that cannot be reproduced satisfactorily by xerography.
PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark ✓.

1. Glossy photographs or pages
2. Colored illustrations, paper or print
3. Photographs with dark background
4. Illustrations are poor copy
5. Pages with black marks, not original copy
6. Print shows through as there is text on both sides of page
7. Indistinct, broken or small print on several pages ✓
8. Print exceeds margin requirements
9. Tightly bound copy with print lost in spine
10. Computer printout pages with indistinct print
11. Page(s) lacking when material received, and not available from school or author.
12. Page(s) seem to be missing in numbering only as text follows.
13. Two pages numbered. Text follows.
14. Curling and wrinkled pages
15. Dissertation contains pages with print at a slant, filmed as received
16. Other

University Microfilms International
A MODEL OF ANAPHORIC REFERENCE

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Michael John Prasse, B.A., M.A.

****

The Ohio State University
1987

Reading Committee:
Neal F. Johnson
Robert A. Fox
Lester Kreuger

Approved by:
Neal F. Johnson
Adviser
Department of Psychology
To My Father and My Mother
ACKNOWLEDGMENTS

I would like to thank my dissertation committee for their willingness to carefully and constructively criticize this dissertation. I would like to especially thank my adviser, Neal Johnson, for his continual support and patience throughout my graduate career. His high standards were sometimes difficult to attain, but were always worth achieving. I also would like to thank Rob Fox and Lester Kreuger for their insights and comments on this document. I would like to thank Dave Van-Voorhis and Jeff Gerckens for the many late nights they spent in developing the methods needed to print this dissertation. Finally, a very special "thank you" to three special friends: Dale, Judi, and John.
VITA

August 11, 1954......Born - Los Angeles, California

1976....................B.A., University of Southern California

1976-197/............Graduate Research Assistant,
Department of Psychology,
University of Southern California

1978....................M.A., University of Southern California

1978-1980............Graduate Administrative Assistant,
The Ohio State Graduate School

1980-1984............Graduate Teaching Assistant,
Department of Psychology, The Ohio State University

1984-1987............Graduate Research Assistant, Online
Computer Library Center, Dublin, OH

PUBLICATIONS


FIELDS OF STUDY

Major Field: Experimental Psychology

Studies in: Language and Cognition. Professor Neal F. Johnson

Aging and Perception. Professor David A. Walsh
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>VITA</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
</tbody>
</table>

## Chapter I. INTRODUCTION

- Literature Review | 1

  - Causal-Based Theories | 5
  - Structural Theories | 21
  - The Effect of Syntax | 34

- A Model of Anaphoric Reference | 53

## Chapter II. EXPERIMENT 1

- Introduction | 80

  - Method | 81
  - Results | 89
  - Discussion | 93

## Chapter III. EXPERIMENT 2

- Introduction | 101

  - Method | 103
  - Results | 112
  - Discussion | 128
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Examples of the stimuli used in Experiment 1</td>
<td>85</td>
</tr>
<tr>
<td>2.</td>
<td>Examples of the stimuli used in Experiment 2</td>
<td>107</td>
</tr>
<tr>
<td>3.</td>
<td>Data obtained by Dell et al. (1983) and Experiment 2</td>
<td>125</td>
</tr>
<tr>
<td>4.</td>
<td>Examples of the stimuli used in Experiment 3</td>
<td>147</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Reading time of sentence 2 as a function of the number of potential referents</td>
<td>92</td>
</tr>
<tr>
<td>2.</td>
<td>Advantage times in the close condition of Experiment 2</td>
<td>118</td>
</tr>
<tr>
<td>3.</td>
<td>Advantage times in the far condition of Experiment 2</td>
<td>119</td>
</tr>
<tr>
<td>4.</td>
<td>Reaction times in the close condition of Experiment 2</td>
<td>122</td>
</tr>
<tr>
<td>5.</td>
<td>Reaction times in the far condition of Experiment 2</td>
<td>123</td>
</tr>
<tr>
<td>6.</td>
<td>Advantage times in Experiment 3</td>
<td>156</td>
</tr>
<tr>
<td>7.</td>
<td>Advantage times in Experiment 4</td>
<td>174</td>
</tr>
</tbody>
</table>
CHAPTER I

Introduction

A number of processes occur when one reads any textual material. Words must be identified, unifying gist structures formed, and so on. A key process is that of relating incoming discourse material with material already processed, and one very prominent way in which this relating can occur is by the referencing of words and/or concepts which have already been encountered. This type of backward referencing is known as anaphoric reference.

Anaphoric reference can be accomplished in a variety of ways. The name of a concept may be presented again (e.g., Jack went to town. Jack bought a ball in town.), or its instantiation may need to be inferred (e.g., Jack went to town. A ball was bought.).

However, between these two extremes lies a relatively common form of anaphoric reference: The use of category members with category labels, and synonyms. For example, in the sentence pair The chevy was brand 1
new. The car was very clean., the category member chevy is referred to by the category label car. Similarly, in the sentence pair The rock was hard to move. The stone would not budge, the word rock is referred to by the synonym stone.

Considering these two types of anaphoric reference further, one sees that they involve using a noun to refer to a noun mentioned previously. This obvious point is mentioned only to note that in this case, the noun doing the referring is generically known as the anaphor, while the noun to which it refers is the referent.

Despite its clear importance to text understanding, the process by which anaphoric reference is accomplished is often relegated to the area of "it just happens" in many theories of discourse processing. For example, Kintsch & van Dijk (1978) suggest three ways in which it occurs: conceptual overlap with concepts in Short-Term Memory (STM), conceptual overlap with concepts in Long-Term Memory (LTM) (requiring an instantiation of the concept in STM), or through inference (the mental construction of linking concepts, based on prior knowledge). But "conceptual overlap" is simply an easier way of saying, for example, that pronouns refer to nouns: It is a description of the outcome of a
process, and not the process itself. Similarly, "inference" says what happens, but not how anaphoric reference is accomplished.

Worse still are the story grammar theories (cf. Mandler & Johnson, 1978). In these theories, texts are assumed to have macrostructure chunks (e.g. a Beginning, a Setting, etc.) which fit into an already existing cognitive superstructure or schema complete with interchunk connections already in place. Little if anything is said about how these interchunk connections were originally formed. Moreover, nothing is mentioned about the equally important intrachunk relations of which anaphoric references would form a major part!

However, in fairness to these theories, they mostly were concerned with developing an accurate model of the cognitive representation of discourse material, and not with the details of each process involved in forming this representation. Thus, one cannot look to current global theories of discourse processing and expect to find an explanation of anaphoric reference. Instead, a body of literature concerned exclusively with anaphoric reference in a theoretically non-global sense must be considered.

The next section of this Introduction will present studies representative of this body of literature. This
section will review studies concerned with the effects of causality, structure, and syntax on anaphoric reference. The subsequent section will discuss additional studies and develop a model of anaphoric reference.
Causal-Based Theories

Causal-based theories of anaphoric reference are based upon the notion that the causes of the events delineated in a text influence the selection of referents for anaphors. For example, in the sentence Jack hit Bill and so he was crying, the pronoun he may be assigned to Bill because (a) the referent of he is in the act of crying, (b) there must be a cause for this act, (c) a search for possible causes leads to the verb hit in the first clause, (d) world knowledge about the verbs hit and crying indicates that whoever was hit might be crying, and (e) since it was Bill who was hit, the pronoun he refers to Bill.

It is important to note that the direction of events in the above causal sequence (i.e., from pronoun to referent) is not essential to causal theories. For example, according to some causal theory supporters, it is just as viable to suggest that the verb hit somehow sets up an expectation that the pronoun which is encountered next will refer to the experiencer (Fillmore, 1968) of the verb, namely Bill (cf. Garvey, Caramazza, & Yates, 1976). The direction here, of course, is from referent to pronoun.
Other causal-based theories suggest that the textual causality which impacts on the anaphoric process is not derived from a single verb, but rather may result from the integration of a prior clause (Keenan, Baillet, & Brown, 1984), or several prior clauses (cf. Duffy, 1986). For example, consider the following passage:

(1) Jerry's leg was broken.
(2) Bill ran for a doctor.
(3) Suddenly, the floor shook again.
(4) The boy screamed in agony.

The view of Keenan et al. (1984) would imply that the association of boy with Jerry is due to the cause for screaming provided by the clause Jerry's leg was broken. Duffy (1986) would take this a step further and suggest that the entire passage (but most critically, sentences (1) and (3)) contributes to the expectation that sentence (4) will refer to an event resulting from Jerry's broken leg being shook (which sentence (4) does viz. screamed in agony).

The thread which binds these viewpoints together is the belief that the causal relationships within a text, whether explicit or implicit, have a major impact on the determination of referents for the anaphors embedded within the text.
One of the primary proponents of a causal-based theory of anaphoric reference has been Caramazza and his associates (Garvey, Caramazza, & Yates, 1976; Caramazza, Grober, Garvey, & Yates, 1977). Their particular interpretation of the impact of discourse causality on anaphoric reference is based upon the notion of implicit causality. Implicit causality is defined as:

"...a feature (of the verb) that selects one or the other of the available candidate nouns as primarily responsible for instigating the action or state denoted by the antecedent clause" (pp.240-241, Garvey, Caramazza, & Yates, 1976).

For example, in the sentence Jack hit Bill and he cried, the implicit causality of the verb hit might select the object Bill as responsible for instigating the action (i.e., Bill deserved to be hit).

In terms of anaphoric reference, the focal point of implicit causality is on the subject or object selected as being primarily responsible for causing a stated action. The subject or object is suggested to have primary consideration as the referent of the first anaphor which follows the stated action. Whether it is the agent or the object is a function of the inherent implicit causality feature of the particular verb used.
For example, in the sentence Rosemary trusted the secretary because she was a good administrator, the verb trusted is viewed as inherently setting up the expectancy that the subject of the second clause (lexically represented as the pronoun she) will be the same as the subject of the first clause (i.e., Rosemary). Hence, the referent initially assigned to the anaphor she will be Rosemary (Garvey, Caramazza, & Yates, 1976).

However, this initial assignment may be altered by information processed after the anaphor is encountered, as in the sentence Rosemary trusted the secretary because she was efficient. In this case, the initial linking of she and Rosemary is changed by the presence of the modifier efficient in the second clause. The resulting interpretation is that she refers to the secretary. (Garvey et al., 1976).

In a series of experiments investigating the notion of implied causality, Garvey, Caramazza, & Yates (1976) presented subjects with incomplete sentences such as George criticized Walter because he... The subject's task was to complete each sentence, without any restrictions on the nature of the sentence completion. Each sentence completion was then evaluated by a set of judges as to the referent these completions indicated
was assigned to the anaphor pronoun. For example, if the completion to the above example was ...wanted sympathy, resulting in the completed sentence George criticized Walter because he wanted sympathy, the completion ...wanted sympathy was judged to indicate that the anaphor pronoun he was assigned the referent Walter.

The results indicated that for a number of the verbs used in the study, subjects had a reliable bias in assigning the referent of the pronoun anaphor to either the first or second noun of the initial clause. For example, 23 of the 28 subjects were judged to have assigned the pronoun anaphor to the first noun when the verb was joined. However, when the verb was blamed, 24 subjects gave completions which were judged to indicate the pronoun anaphor was referring to the second noun. Some verbs resulted in no clear bias, such as tied (up) (10 subjects linked the pronoun anaphor with the first noun, eight linked it with the second, and 10 gave completions which were judged ambiguous).

In a second experiment, Garvey et al. (1976) varied the surface structure of the initial clause in order to investigate the effect of surface structure on referent assignment. For example, a subject might be presented with an initial clause in the active voice
(e.g., John recognized Michael because he...) or in the passive voice (e.g., Michael was recognized by John because he...).

The results of this second experiment suggested that subject's referent assignment biases were not only influenced by the verb in the initial clause, but by the topic/comment relations (Grimes, 1975) of that clause as well: If the bias was toward the first noun of the initial clause in the active voice (i.e., the topic of the sentence), it also was toward that noun (now in the second noun position) in the passive voice. Similarly, a bias toward the second noun of the first clause in the active voice (i.e., the comment part of the sentence) was also reflected in a bias toward that noun in the passive voice. Thus, the verb in the first clause influenced referent selection for the pronoun anaphor in the second, subordinate clause in terms of a bias toward the topic/comment relations within the first clause, and not in terms of a first/second noun position bias.

Several criticisms can be made of the Garvey, Caramazza, & Yates (1976) study. The judges who determined the noun being referred to in the sentence completions were not from the same population as the subjects. The subjects were from an introductory psychology class, whereas the two judges likely were
from a post-graduate level. Hence, the judges may not have made judgments which in fact reflected the referent selected by the subject.

More importantly, it is rather specious logic to suggest that how a person completes a sentence fragment is indicative of how a subject reads an entire sentence. For example, in the sentence George criticized Walter because he wanted some sympathy, the reader may indeed have selected Walter as the referent for he before he was encountered (as suggested by Garvey et al., 1976). Conversely, both George and Walter may be available at the time he is encountered, as suggested by Swinney (1979), and the actual referent not determined until as late as the end of the sentence (Just & Carpenter, 1980). The experiments of Garvey et al., (1976) cannot, in fact, determine how many referents were available when the pronoun was read, but only what referent was suggested by the verb when the task was to write a sentence completion.

Caramazza, Grober, Garvey, & Yates (1977) attempted to answer this criticism. In this study, subjects were presented with entire sentences in the form NP1 VERB'ed NP2 because <pronoun> <bias consistent text/bias inconsistent text>. Bias consistent text is text which is in agreement with the NP selected by the implicit
causality of the verb in the initial clause; bias inconsistent text is text which is not in agreement with this selection. For example, a subject might see the entire sentence Tom scolded Bill because he was annoying (bias consistent), or the sentence Tom scolded Bill because he was annoyed (bias inconsistent). Subjects were presented visually with the entire sentence and their task was to say the referent for the pronoun as quickly as possible. The time from the presentation of the sentence to the onset of the subject’s verbal response was measured.

The results indicated that subjects were much quicker at identifying the referent in the bias consistent condition. This finding supports the claim that the implicit causality of a verb can influence the assignment of a referent to a subsequent anaphor.

However, one should be careful in extending the results of Caramazza et al. (1977) to reading in general. Subjects in this study were not asked to read for comprehension, which is the goal of most discourse processing. Instead, they were directed to determine the referent for the pronoun as quickly as possible. It is well known that changing the goals of a reader can dramatically alter the reading processes engaged in by the reader (cf. Kintsch & Keenan, 1973).
Secondly, contrary to the claims of the authors, the results of Caramazza et al. (1977) do not show that a specific referent expectation is formed by the end of the initial, referent-containing clause. It could be that the implicit causality of the verb in the major clause results in a processing prioritization of the nouns in the initial clause such that the noun favored by the bias is considered first in resolving the pronoun anaphor. If this initial consideration is in agreement with the meaning of the subordinate clause, then the referent for the pronoun in the subordinate clause is quickly determined as a side effect of the overall comprehension process. Alternatively, if the meaning of the subordinate clause is inconsistent with the referent prioritization established by the implicit causality of the initial verb, it will take longer to comprehend the sentence and hence longer to determine the referent for the pronoun in the subordinate clause.

Such an explanation would account for the results obtained in Caramazza et al. (1977). Moreover, it would implicate the end of the subordinate clause as the location for anaphoric resolution.

In summary, the results of Garvey et al. (1976) and Caramazza et al. (1977) certainly suggest that implicit causality can influence the determination of a referent
for an anaphor. However, these studies do not answer the question of whether this influence occurs most of the time in resolving an anaphor, or whether it is task specific and limited only to a small set of specific verbs.

A different viewpoint on the effect of causality on anaphoric resolution is offered by Keenan, Baillet, & Brown (1984). Rather than focusing on a single lexical item (such as a verb), this study looked at the influence of the causal cohesion of a sentence pair on the reading time of the second, pronoun-containing sentence.

For example, a subject might see one of the following sentence pairs:

(5) Joey's big brother punched him again and again.
    The next day, his body was covered with bruises.

(6) Joey went to a neighbor's house to play.
    The next day, his body was covered with bruises.

At one extreme, the events described in the first sentence of pair (5) clearly delineate a cause for the state of Joey's body described in the second sentence of pair (5). At the other extreme, the first sentence of pair (6) provides directly no cause for the bruises described in the second sentence. Between these two
extremes, Keenan et al. (1984) developed two other sentence pairs which reflected intermediate levels of causal cohesion (as evaluated by a sample of forty subjects not used in subsequent experiments).

Subjects were presented with 17 sentence pairs, with two pairs from each level of causal cohesion. The remaining nine pairs were filler and practice pairs. The reading time for the second sentence in each pair was measured. In addition, approximately 35 minutes after the completion of the reading task, each subject was given a recall test followed by a recognition test. Subjects participated in two text comprehension tasks during the 35 minute retention interval.

The results of Keenan et al. (1984) indicated that the reading time of the second sentence was faster when the causal cohesion was high or moderately high than when it was low or moderately low. However, no other differences in reading time as a function of the causal cohesion of the sentence pair was found. In addition, both recognition and recall was better at the two moderate levels of causal cohesion than at either extreme level.

The results of Keenan et al. (1984) show that the causal relationship between a referent-containing sentence and its corresponding anaphor-containing
sentence can affect the reading time of the anaphor-containing sentence. However, the effect of this relationship would appear to be a discrete, "present/absent" type of process. If causal cohesion was present, the reading time of the anaphor-containing sentence was reliably less than if causal cohesion was virtually absent. This suggests that causal cohesion is necessary for a reader to engage in anaphoric reference, but is not part of the process of anaphoric reference itself. It may be that causal cohesion determines when a series of sentences is sensed to be a single textual unit, at which point the processes involved in anaphoric reference are activated. Thus, causal cohesion may act much like the presence of a title acted in Bransford & Johnson (1972): it provides the necessary cue that the sentences under consideration should be treated as being related in some sense, and may provide some information as to the nature of that relatedness, but is not the actual process of relating those sentences.

Although the causal implications of a single preceding word or sentence may influence the reading time of a subsequent anaphor-containing sentence, most sentences which contain anaphors are preceded by several sentences. Within these several preceding sentences a multitude of causally related events may
occur. It therefore seems likely that the best way to understand the true impact of causality on anaphoric reference would be to use stimuli in which the anaphor-containing sentence follows several sentences of varying causal relatedness. Such stimuli were used in Duffy (1986).

In that study, subjects were presented with narratives which either did or did not provide a cause for a subsequent event. Duffy (1986) labeled those narratives which provided a cause as high-expectation narratives; the causal event was suggested to develop an expectation in the reader that the following sentence would refer to it. Conversely, low-expectation narratives were those which did not provide a cause for an event in the subsequent sentence. An example of each type of narrative is provided below:

**High-Expectation Narrative**

John was eating his *first meal* ever in the dining car of a train.

The waiter brought him a large bowl of bean soup.

John tasted the hot soup carefully.

Suddenly the train screeched to a stop.

**Low-Expectation Narrative**

John was eating his *first meal* ever in the dining car of a train.
The waiter brought him a large bowl of bean soup. John tasted the hot soup carefully. The train began to slow down entering a station.

Each type of narrative would be followed by either a causally related or unrelated sentence, such as the following:

**Related:** The hot soup spilled into John's lap.

**Unrelated:** That night the whole forest burned down.

The subject's task was to decide if the sentence which followed the narrative was a "reasonable next sentence". The time it took the subject to make this decision was measured.

It was found that subjects were quicker to make their decision when the high-expectation narrative was used, regardless of whether the sentence to be judged was causally related to the narrative. However, related sentences preceded by high-expectation narratives were judged faster than unrelated sentences preceded by the same type of context. Related and unrelated sentences did not differ in judgment time when preceded by low-expectation narratives.

Thus, the results of Duffy (1986) are in general agreement with the results of Keenan et al. (1984). In
both studies, causal relatedness facilitated a subject's ability to integrate a sentence under consideration with sentence(s) already read.

However, one result of Duffy (1986) would appear to disagree with the above conclusion. Sentences which were causally unrelated to the preceding narrative were nevertheless judged quicker if the preceding narrative was of high-expectancy. An inspection of the exemplars provided above of the material used in Duffy (1986) suggests one possible explanation of this finding. High-expectancy narratives changed their topic during the last sentence. In the example above, the high-expectancy narrative was about a train ride until the final sentence, when the topic suddenly changed to one of the sudden stopping of the train. Furthermore, this is not an isolated case. Indeed, last sentences in the high-expectancy narrative were selected so as to do just this: "The key causal sentences departed from the script (cf the story)..." (p. 211).

The problem with this manipulation is that the resulting high-expectancy narratives really required the subject to only consider the last sentence of the narrative in order to determine if the related/unrelated target sentences were "reasonable next sentences". In the low-expectancy narratives however, it is likely that
the entire narrative would have to be considered before a judgment could be made. Consequently, the difference in causal relatedness found for the target sentences presented with a high-expectancy narrative may have involved only a consideration of the sentence which immediately preceded the target sentence (i.e., the last sentence in the narrative). Therefore, the experimental manipulations employed in Duffy (1986) are, in fact, equivalent to those used in Keenan et al. (1984). Thus, Duffy (1986) does not really answer the question of the effect of causal cohesion in the case where the causality is a function of more than one sentence.

In summary, causal-based theories of anaphoric reference do seem to have a degree of viability in explaining certain anaphoric relationships. In particular, the studies presented above indicate that causality plays a role in integrating a text when a high degree of referent ambiguity is present (as in Garvey, Caramazza, & Yates, 1976), or when no explicit pronominal reference is available (as in Duffy, 1986). This latter finding is particularly important, for it indicates that argument overlap, such as that proposed by Kintsch & Van Dijk (1978) to account for anaphoric reference, is not necessary for a text to be perceived
as having cohesion.

Finally, the results of Keenan, Baillet, & Brown (1984) suggest that a certain level of causal cohesion is necessary even when explicit pronominal coreference is available. This implies that some amount of causal cohesion is necessary before a text is perceived as not just a sequence of unrelated sentences, but rather as a potential discourse unit. In turn, such a perception would result in the activation of the anaphoric reference processes involved in pronominal coreference.

Structural Theories

These theories of anaphoric reference center on the idea that certain structural properties of a discourse influence the development of a referent-anaphor link. Thus, unlike the causal theories, these theories focus on the multiple relationships a word or a series of words may bring to a textual representation. For example, one of the concepts embodied in the word driving is that a person (the driver) caused the driving to occur. However, another concept that one would expect to be present is that the driving occurred in a car or, more generally, a vehicle (Sanford & Garrod, 1980). Structural theories suggest that the presence of these implicit concepts and relationships may influence the construction of anaphoric inferences.
The concepts may elicit expectations on the part of the reader as to what will be presented in subsequent text (Sanford & Garrod, 1980), or may provide unstated but necessary referents (Garrod & Sanford, 1981). Similarly, implicit relationships may result in the reader keeping the relationship in an easily accessible state until it is explicitly stated in the text (Malt, 1985). The key is that in structural theories, one or many sources of implicit information are viewed as influencing anaphoric reference.

Sanford and Garrod (1980) suggest readers develop a **scenario** which guides subsequent anaphor-referent linkings. A scenario is viewed as being very similar to a schema (cf. Bartlett, 1932). A particular word or combination of words elicit a memory structure which contains uninstantiated expectations as to the concepts which might be expected to follow. For example, the presence of the concept tank in the sentence *The tank came trundling down the hill* could lead to the scenario (and thus, to the expectation) that a subsequent sentence or sentences will be concerned with the behavior of tanks, or how a tank might come to be trundling down a hill. If the subsequent sentence fulfills this scenario, it will be read quickly. However, if it disagrees with the scenario, then the
reader must find another way to link the sentence with the information contained in the previous sentence(s). This search for another method of linking will take time, and hence the sentence will be read slower.

The scenario viewpoint is very similar to the **Given-New Contract** theory of Haviland and Clark (1974). Both theories espouse the viewpoint that the lack of a direct connection between an anaphor and its referent (such as that found between the pronoun he and a male name) result in the development of an inferred link. Furthermore, both theories suggest that the nature of this link is a function of the cognitive representation of the pre-anaphor text. However, a clear distinction does exist between the two viewpoints. In the Given-New Contract, the effect of the pre-anaphor text occurs *during* or *after* the anaphor is encountered. However, the scenario theory states that the pre-anaphor text sets up one or many expectations which are in effect *before* the anaphor is read.

An interesting implication of the scenario viewpoint is that the more general the scenario is at the time the anaphor is encountered, the more expectations will be available with which the anaphor may link. As a consequence, the reader will have to consider more potential links when the anaphor is encountered and a
general scenario is available, and this will take time. For example, the sentence *The vehicle was overloaded* will take longer to read if preceded by *The vehicle would not get up the hill* than if it is preceded by *The bus would not get up the hill* (Sanford & Garrod, 1980; p. 465).

To test this prediction, Sanford and Garrod (1980) presented subjects with 64 sentence pairs, with 16 pairs from each combination of first/second sentence and general/specific sentence scenario. The reading time of the second, anaphor-containing sentence was measured.

The results of this study indicated that the presence of a general scenario in the initial sentence did lead to longer reading times for the second, anaphor-containing sentence. This finding supports the notion of a scenario.

More interestingly, a subsequent analysis revealed that this effect was largely specific to those initial sentences where the referent was in the subject position. Sanford and Garrod (1980) suggest that this lends further support to the scenario notion, in that the subject term of a sentence is more likely to be judged as the topic of a sentence than is the object term (Hornby, 1974; cited by Sanford & Garrod, 1980). As a consequence, the subject term also is more likely to
be the term which primarily determines the scenario. It should thus also be the term which shows the largest effects of scenario specificity or generality. This, of course, is just what Sanford and Garrod (1980) found.

Although the results of Sanford and Garrod (1980) suggest that the development of a scenario is involved in the resolution of an anaphor, an alternative explanation is possible. In the stimuli used in Sanford & Garrod (1980), the relationship between the referent and anaphor was not just one of general scenario to specific scenario: it also was one of category member to category type. Thus, it may be that upon encountering the category member referent in the initial sentence, the category type is activated as a byproduct of understanding the referent. For example, upon encountering tank, the category vehicle is activated as a byproduct of understanding that a tank is a type of vehicle. Thus, when the anaphor vehicle is encountered in the immediately subsequent sentence, its semantic representation is in a heightened state of activation and may therefore be easier to identify (cf. Morton, 1970). Indeed, a temporary link may already have been formed between the referent and the anaphor in the form of an isa relationship (Collins & Quilllin, 1969). Of course, it is much less likely that the
semantic representation of the anaphor would be activated if the referent were a category member and the anaphor a category type. For example, when the referent vehicle is encountered, the connection that a type of vehicle is a tank would occur only in the rare instance that a person's prototypical representation of a vehicle is a tank.

The alternative explanation presented above differs from the scenario theory of Sanford and Garrod (1980) in that it operates at the semantic level of a single lexical entry. The scenario theory suggests that a much richer conceptual representation of the referent is available at the time the anaphor is encountered.

Although this may indeed be the case, the stimuli used in Sanford and Garrod (1980) do not demand that such an complex representation be available in order to account for the results obtained in that study. However, the findings of Garrod and Sanford (1981) do suggest that a richer representation of the referent, similar to that suggested by the scenario concept, may indeed be available when an anaphor is encountered.

Garrod and Sanford (1981) presented subjects with sentence triplets, where the second sentence contained the referent for an anaphor in the third sentence. However, in half of these sentence triplets, the second
sentence referent was implied rather than stated. For example, consider the following three sentences:

(7) Keith was giving a lecture in London.
(8) He was driving there overnight.
(9) The car had been recently overhauled.

In sentence (9), the noun phrase The car implies that a car has been mentioned in one of the previous two sentences. However, no car has been directly mentioned in either sentence (8) or sentence (7). Instead, the presence of a car in the scenario has been implied by the verb driving, present in sentence (8). There are numerous studies which indicate that an implied state or object may be as "real" to a reader as a state or object which is directly stated (Bransford, Barclay, & Franks, 1972; Johnson, Bransford, & Solomon, 1973; Spiro, 1972).

Thus, if the scenario notion is correct, an implied referent should be just as salient to a reader as a referent which is directly stated. Hence, the reading time of sentence (9) in the example above (i.e., the anaphor-containing sentence) should be the same regardless of whether the presence of the car is implied (as in the example) or directly stated (by replacing sentence (8) in the example with He was taking his car there overnight).
The results of Garrod and Sanford (1980) supported the above implication of the scenario theory: The average reading time for the third sentence in the implied referent condition was only 15 msecs. longer than in the directly stated referent condition. This difference was not reliable.

In a second experiment, Garrod and Sanford (1980) investigated the possibility that a scenario might not only contain the implications of concepts which are directly stated, but might also engender the implications of implications. That is, while driving implies car, does driving also imply engine, an object whose existence is implicated by the presence of a car?

To investigate this possibility, Garrod and Sanford (1980) used the same materials as had been used in the first experiment, but replaced the third sentence in the sentence triplets with sentences that contained a direct or indirect implication of the second sentence. For example, the reader might see the second sentence He was taking his car there overnight, or the second sentence He was driving there overnight. The third sentence for both second sentences was The engine had been overhauled. When the second sentence contains car, the anaphor engine is a direct implication.
However, when the second sentence contains driving, the anaphor engine is indirectly implied viz. the direct implication of the presence of a car.

The results of this experiment indicated that subjects read the third, anaphor-containing sentence 65 msecs. quicker when the second sentence contained a directly implied referent. This effect was reliable.

Thus, the results of Garrod and Sanford (1981) support the idea that a schema-like scenario may be developed in the course of reading a pair of sentences, and this scenario can affect the reading time of a subsequent, anaphor-containing third sentence. It is interesting to note that unlike the scenario theory of Sanford and Garrod (1980), the version offered in Garrod and Sanford (1981) makes no mention of the notion of an expectation being present at the time an anaphor is encountered. The theory thus becomes very similar to the Given-New Contract theory of Haviland and Clark (1974).

Nonetheless, Garrod and Sanford (1981) do show that the time required to link an anaphor with its referent can be affected by more than just the number of schema- or scenario-implied referents (as suggested by Haviland & Clark, 1974, and Sanford & Garrod, 1980). The degree of implication also is critical. A high degree of implication, such as that between the implication of
a car's presence derived from the concept driving, results in a potential referent with the same amount of saliency as that available from the actual statement of the potential referent.

A different view on the development of anaphora-influencing textual expectations is offered by Malt (1985). This study provides evidence that for certain types of anaphoric relations, an interrogative clause or sentence may provide expectations which influence the development of anaphoric links.

The anaphoric relation which is central to the experiments of Malt (1985) is the Verb Phrase Ellipsis. Such a relation exists when a sentence contains a dangling infinitive marker (e.g., to in to run) or auxiliary (e.g., did), and lacks the subsequent verb phrase that would usually follow. For example, Yes, I did is a verb phrase ellipsis: In order to understand the phrase, a referent must be found for the implied object of the auxiliary verb did (i.e., did what?).

To manipulate expectations, Malt (1985) varied the supraordinate structure of passages that were each four sentences in length. In one condition, a subject would read an interrogatively structured sequence, such as the following:
(10) Everyone was returning from vacation.

(11) "Did Greg see Maureen and Marjorie last night?" Helen asked.

(12) "I think they just got back in town."

(13) "Yes, he did," Sophia replied. (Italics added)

In a second condition, a subject would view the same sequence as above, but sentence (11) would be changed to a declarative form:

(11') "Greg saw Maureen and Marjorie last night," Helen remarked.

According to Malt (1985), the interrogative structure sets up an expectation that at least one of the subsequent sentences will form the basis for an answer to the interrogation. Consequently, the interrogative clause or sentence is held in Short Term Memory until the answer to the interrogation is found. As a result, the verb phrase ellipsis of sentence (13) should be resolved quicker in the interrogative sequence, since did in the ellipsis is referring to the material immediately available in STM, viz., Greg seeing Maureen and Marjorie. Thus, sentence (13) should be read quicker overall when it is presented in the interrogative structure condition (e.g., when sentence (11), and not sentence (11'), is present).
The results of Malt (1985) supported the viewpoint that an expectation is created when an interrogative text structure is used. Verb phrase ellipsis sentences were read 335 milliseconds quicker in that structure condition than in the declarative condition.

In a second experiment, Malt (1985) presented passages where the structure was always interrogative. However, for half of the key passages, a potential answer to the interrogative clause was provided before the verb phrase ellipsis was encountered. For example, a subject might view the following sequence:

(14) Andrea was anxious to leave the house.
(15) "Aren't we going to the game?" she asked.
(16) "It's getting kind of late," Brian observed.
(17) "Yes, we are," Ray assured her. (Italics added)

Sentence (16) provides a potential answer to the question posed in sentence (15), namely, no: It is too late to go to the game. Conversely, sentence (16) might not provide an answer, as in:

(16') "It's getting kind of late", she observed.

If the theory proposed by Malt (1985) for interrogatives is correct, an intuitive implication is that the interrogative clause or sentence only remains
in STM until its answer is found. After that, it should not be available in STM as a referent for a verb phrase ellipsis. Thus, it should take longer to read a verb phrase ellipsis whose referent is contained in an interrogative clause when that interrogative has been answered before the verb phrase ellipsis is encountered, i.e., when sentences such as (16) are present.

The results of this second experiment confirmed the above implication: verb phrase ellipsis were read 402 msecs. quicker when the interrogative referent clause was unanswered at the time the ellipsis was read. Thus, this second experiment provides further support for the idea that interrogative clauses are held in STM until their answer is located. Once the answer is found, the clause is removed from STM.

Thus, Malt (1985) indicates that the presence of an interrogative clause or sentence in a passage may influence the resolution of an anaphoric relation. Specifically, if a referent is contained in the interrogative clause, then the referent is maintained in STM until the interrogative is answered. If the anaphor for the referent is part of the answer to the interrogative, then the anaphor is quickly resolved. However, if a potential answer to the interrogative has
been located before the anaphor is encountered, then no advantage is obtained in the time required to resolve the anaphor.

In summary, the studies presented provide strong support for structural theories of anaphoric reference. In particular, the work of Garrod and Sanford (1981) provide clear evidence that the concepts entailed by an explicitly stated term may be as "real" a part of the text representation as the items which were stated literally. Such a finding provides crucial support for the structural theories. In addition, the finding by Malt (1985) that under the proper conditions, a reader may develop an expectation as to the discourse material to follow, suggests that readers bring to the process of understanding discourse certain assumptions of communication (cf. Chafe, 1974). In particular, the reader trusts the writer to eventually answer a question that was presented in the text. The presence of one such rule suggests the possibility of others: Such rules may be a crucial part of anaphoric resolution.

The Effect of Syntax

The previous two subsections have presented theories of anaphoric reference which focus on the semantics of the referent and the anaphor. In this subsection, studies will be presented which have as their focus the
Hirst and Brill (1980) investigated the effect of syntactic constraint (Langacker, 1969) on the formation of anaphoric reference. They presented subjects with two sentence passages which contained an anaphor in the second sentence for a referent in the first sentence.

In the syntactically constrained condition, the syntax of the sentence passages was sufficient to determine the referent. As an example, consider the following passage:

(18) John drove to the beach.

(19) He brought along a surfboard after Henry spoke at a meeting.

Because the only syntactically plausible referent for the pronoun He in (19) is John in (18), a reader could link He with John based solely on the syntax of the passage. In addition, a reader could link He with John based only (by the end of the passage) on semantic constraints, inasmuch as one might be expected to take a surfboard to the beach, but not to a meeting.

In the distractor condition, subjects were presented with passages that were not syntactically constrained, such as:
(20) John went to the beach.
(21) After Henry spoke at a meeting, he brought along a surfboard.

In this case, both John and Henry are syntactically plausible referents for he. However, the semantic constraints available by the end of the passage again indicate a single referent, namely John.

Subjects were presented with both types of passages. After presentation, the subject pressed a button indicating which term was the referent for the pronoun (e.g., John or Henry). Response latency was measured.

If syntactic constraints affect the process of pronoun anaphoric reference, then response latencies should be shorter in the syntactically constrained condition. Conversely, if only semantic constraints are involved, then no difference in response time should be obtained.

The results indicated that subjects took almost three seconds less to respond in the syntactically constrained case. This supports the notion that syntactic constraint can influence anaphoric reference.

Thus, the results of Hirst and Brill (1980) certainly indicate that syntax plays a role in anaphoric reference. However, a second result of that study
suggests that that role is secondary to the role of semantics.

In the syntactically constrained condition, each passage was semantically constructed so as to either strongly or moderately favor the noun in the first sentence as the referent. The degree of noun favorability had been determined by a separate group of subjects in a preliminary experiment. Sentences (18) and (19) above represent a passage from the strong condition. The following is a passage from the moderate condition:

(22) John drove to the beach.
(23) He stopped at a store after Henry spoke at a meeting.

If the unambiguous syntactic constraint was all a subject used in determining the referent, then response latencies should not differ significantly as a function of the degree of semantically-based referent favorability. However, this was not the case: Response latencies were 446 msec. shorter in the strong favorability condition. This finding was reliable ($p<.05$).

Considered together, the findings of Hirst and Brill (1980) indicate that syntax can influence the formation of an anaphoric link between a pronoun and its referent. However, the impact of this influence would appear to be subordinate to the impact of the semantics of the text.
It may be that syntax suggests potential referents, but that semantics join the referent and anaphor together. The stronger this semantic "glue", the quicker the link between an anaphor and its referent "solidifies", and the quicker the referent is identified. This suggestion will be further explicated in the final section of this Introduction.

An interesting viewpoint on the effect of syntax on anaphoric reference is offered by Sheldon (1974). In this study, the parallel function hypothesis is presented. This hypothesis is primarily concerned with the anaphoric resolution of relative pronouns. Relative pronouns are pronouns which join subordinate clauses to nouns (APA Publication Manual, 1983). For example, in the sentence The man saw the boy who the girl hit, the word who is a relative pronoun, and its referent is the boy.

According to the parallel function hypothesis, sentences which contain a relative pronoun are processed easier if the relative pronoun and its referent share the same grammatical position. As an example, consider the following two sentences:

(24) The man saw the boy who the girl hit.
(25) The man saw the boy who hit the girl.
In sentence (24) the relative pronoun who is in the object position of the subordinate clause who the girl hit. The referent of who is the boy, which is in the object position of the main clause The man saw the boy. Because both the relative pronoun who and its referent the boy are in the same grammatical position (i.e., the object position), sentence (24) will be easily processed. Conversely, sentence (25) will be more difficult to process, since the relative pronoun who is now in the subject position of the subordinate clause who hit the girl, whereas its referent the boy is in the object position of the clause The man saw the boy.

In order to test the parallel function hypothesis, Sheldon (1974) presented subjects with four types of sentences. Subjects would hear sentences where the relative pronoun and its referent were both the objects (e.g., sentence (24) above) or subjects (e.g., The dog that jumps over the pig bumps into the lion) of their respective clauses. In addition, they would hear sentences where the referent was the subject of its clause, but the relative pronoun was not the subject of the subordinate clause (e.g., The lion that the horse bumps into jumps over the giraffe), or vice versa (i.e., referent object and pronoun subject, such as The pig bumps into the horse that jumps over the giraffe).
After hearing these test sentences, subjects would hear coordinated sentences, such as The lion jumps over the giraffe and the horse bumps into the lion. The coordinated sentences served as control stimuli, since each test sentence had a matched coordinate sentence which only differed in that the relative pronoun in the test sentence was replaced in the coordinate sentence by the conjunction and, together with any minor changes necessary for grammatical correctness.

Sheldon (1974) was primarily interested in the applicability of the parallel function hypothesis to sentence comprehension by children. Thus, subjects were from 3.8 to 5.5 years of age. Consequently, the subjects task upon hearing the sentence stimuli was quite different from tasks previously discussed in this Introduction. The subject’s task was to act out each sentence stimuli, using stuffed animals. Acts which correctly reflected the meaning of the entire sentence were marked as correct. Acts which did not meet this criterion were scored as incorrect.

The results indicated that for the test sentences, subjects were more accurate at acting out sentences where the relative pronoun and its referent were both objects or subjects of their containing clauses. However, no such difference as a function of grammatical
agreement between referent and pronoun was found for the control sentences (where the "pronoun" was actually a restatement of the referent).

These results support the parallel function hypothesis of Sheldon (1974), at least for children between the ages of 3.8 and 5.5 years. In addition, Sheldon (1974) argues that these results may be applied to adult sentence processing as well. Although presenting no empirical evidence for this viewpoint, Sheldon (1974) does suggest some anecdotal support for this contention.

According to Sheldon (1974), the natural tendency for adults is to associate the pronoun of a subordinate clause with the word in the same grammatical position in the main clause. For example, in the sentence John hit Bill and then Sarah kicked him, the tendency is to associate the pronoun him with Bill, since both are the objects of their respective clauses. This natural inclination can be overcome through contrastive stress, as in "John hit Bill and then Sarah kicked him". By stressing the pronoun him, the speaker signals the listener that the pronoun him does not refer to the parallel function referent Bill. As a consequence, the word linked to the pronoun in this case is the subject of the first clause, namely John.
Although this evidence has intuitive appeal, the study by Garvey, Caramazza, and Yates (1976) mentioned earlier in this Introduction provided clear evidence that it was the particular verb used in the main clause which influenced the choice of a referent for a pronoun in a subsequent subordinate clause. It may still be the case that stress on the pronoun can alter the choice of a referent for the pronoun, but the evidence would suggest that such an alteration would be away from the referent as determined by implicit causality (Garvey, Caramazza, & Yates, 1976) and not toward the referent as determined by the parallel function hypothesis (Sheldon, 1974).

In summary, the results of Sheldon (1974) indicate that the parallel function hypothesis may explain how young children determine the referent for a relative pronoun. However, whether the hypothesis can be applied to more general situations and populations cannot be determined from the data supplied in Sheldon (1974).

Fortunately, further research has been devoted to the parallel function hypothesis. In particular, Cowen (1980) looked at the influence of parallel function in cases where other factors could influence the anaphora process.
Cowen (1980) presented subjects with sentences where the referent for a pronoun agreed with the referent predicted by the parallel function hypothesis. For example, subjects might read the following:

(26) Maria positioned the *measuring stick* directly opposite the stake and then she lined *it* up with the reflector.

Note that both the anaphor *it* and the referent *measuring stick* occupy the object position of their respective clauses. Subjects also were presented with sentences where pragmatic information (and thereby to a degree, semantic information) indicated a referent different from that implied by parallel function, such as the following:

(27) Maria placed the *three sacks of flour* beside the *carrots*, and then she washed *them*.

According to the parallel function hypothesis, the pronoun *them* should refer to *three sacks of flour*, inasmuch as both terms occupy the object position of their respective clauses. However, pragmatic information would indicate that the referent of *them* 's *carrots*, since one does wash carrots but does not wash three sacks of flour.
Crossed with the above variables was the order of the referent-containing clauses (e.g., for sentence (26), the first two clauses could be presented as *Directly opposite the stake* Maria placed the measuring stick...). The subjects' task was to read each sentence and circle the word referred to by the pronoun.

For those sentences where pragmatic information did not contraindicate the referent favored by the parallel function hypothesis, subjects reliably selected the referent favored by parallel function. This effect did not interact with the position of the referent-containing clause, suggesting that subjects were indeed using parallel function and not surface structure cues to determine the referent.

A different result emerged when pragmatic information suggested a referent different from that indicated by the parallel function hypothesis. In these cases, subjects selected the referent indicated by the pragmatics of the sentence. This effect also did not interact with the position of the pragmatically-favored referent.

Thus, the results of Cowen (1980) show that the parallel function hypothesis does seem to be used by readers. However, the pragmatic (and thus, semantic) information available in a text would appear to be more
important in determining a referent for a pronoun. Therefore, as with Hirst and Brill (1980), the results of Cowen (1980) suggest that the role of syntax in anaphoric resolution is as a preliminary filter which suggests potential referents but does not select the actual referent.

Although syntax may only suggest potential referents, the method by which syntax accomplishes this task may be quite complex. Several theorists have suggested that the method is strongly rule-based, relying heavily on the constraints of surface structure in order to limit the set of potential referents (cf. Langacker, 1969; Reinhart, 1976). In reviewing these theories, Berent (1980) has gone so far as to suggest that a single rule of coreference might be sufficient.

Berent (1980) takes as a starting point the theory of Reinhart (1976). In that theory, a necessary foundational concept is that of the *constituent-command*, or c-command. The definition of the command is made with reference to a tree structure, such as the one below:

```
S
  /\  
 A B C
  /\  
 D E
  /\  
 F G
```

(28)
The c-command is the following:

Node A c-commands node B if neither A nor B dominates the other and the first branching node which dominates A dominates B.

Thus, in the figure above, node A c-commands node B because the path which joins A and B does not go uniformly upward or downward (so neither A nor B dominates the other) and both A and B are dominated by node S (i.e., the path connecting A to S is uniformly upward, as is the path connecting B with S). Of course, node B c-commands node A as well. In addition, node A also c-commands everything dominated by node B, since no node below B can be connected to A through a unidirectional path (hence, no node below B dominates A and vice versa), and the first branching node which dominates A (namely, S) also dominates everything dominated by B.

A second foundational concept which is necessary before the delineation of the specific anaphoric reference theory presented in Reinhart (1976) is that of syntactic domain. The definition of this concept is:

(C2) The syntactic domain of a node A consists of A together with all and only the nodes c-commanded by A.
Syntactic domain differs from the c-command concept in that the syntactic domain of a node includes (a) all the nodes which are c-commanded by that node, and (b) the node itself. Thus, the syntactic domain of A is everything but S, the syntactic domain of D is D, E, F, and G, etc.

With these two concepts, Reinhart (1976) developed a number of rules of coreference. As an example, the rule of coreference restriction states the following:

(R1) Two NPs cannot be coreferential if one is in the syntactic domain of the other and is not a pronoun.

This rule explains why the sentence He was asked to leave the class because John kept talking is not grammatical. The following figure diagrams this sentence:

```
S / \ COMP S / \ / NP1 VP \ P S  \\
| / \ | | because NP2 VP / \ \\
He was asked to leave the class \ John kept talking
```
By the concepts of c-command and syntactic domain, it can be seen that NP2 lies in the syntactic domain of NP1. However, NP2 is not terminated by a pronoun, but rather by the noun John. Hence, by rule (R1), the sentence should be perceived as ungrammatical. On the other hand, if NP1 is exchanged with NP2, resulting in the sentence John was asked to leave the class because he kept talking, then rule (R1) is not violated. Consequently, this latter sentence should be perceived as grammatical.

To see if these predictions of the coreference restriction rule (and other rules) of Reinhart (1976) were correct, Berent (1980) presented subjects with sentences which exemplified and violated each of the rules. Subjects were required to judge the grammatical correctness of each sentence.

However, as mentioned previously, Berent (1980) was primarily interested in determining a single, ubiquitous rule of coreference. In order to do this, the subjects used in the study were nonnative speakers of English who were just starting to learn English. By looking at the sentences which were grammatically correct under the rules of Reinhart (1976) but which were judged ungrammatical by these subjects, Berent (1980) hoped to
derive a single linguistic universal applicable to anaphoric reference. This would be accomplished by modifying the rules of Reinhart (1976) so that they would predict the judgments of the nonnative speakers.

The result of Berent (1980) was the development of a maximally restrictive rule of coreference (MR). This rule is:

Two NPs cannot be coreferential if one is in the syntactic domain of the other and is not a pronoun.

(MR) Furthermore, if NP1 precedes NP2 and is a pronoun, the two cannot be coreferential unless NP1 is in the domain of NP2.

Corollary: Two NPs can be coreferential only if they are in the same syntactic domain.

The validity of the first sentence of the MR rule was demonstrated above with the sentence He was asked to leave the class because John kept talking. The noun John is in the syntactic domain of the pronoun he, but is not a pronoun. Hence, the sentence should be, and is, ungrammatical.

The second sentence of the MR rule was added to account for sentences such as He picked up the newspaper and Bob walked out of the room. Because of the use of the conjunction and, the pronoun He and
the noun Bob are in different syntactic domains. Reinhart (1976) suggests that there are no restrictions on the coreferencing of a noun and a pronoun from different syntactic domains, and thus a noun and a pronoun from different domains can refer to the same entity. Thus, the sentence He picked up the newspaper and Bob walked out of the room could be construed as grammatical (i.e., He and Bob could refer to the same entity). However, the sentence was judged as ungrammatical by a large number of the nonnative speakers.

To handle this anomaly, Berent (1980) added the second sentence of the MR rule. With this addition, the rule allows such sentences as In his office, Ben spends a lot of time, but rejects sentences such as He picked up the newspaper and Bob walked out of the room.

Finally, the corollary was added to the MR rule because a large number of the nonnative speakers rejected as ungrammatical sentences such as Beside that pretty girl, you will see her umbrella. The main body of the MR rule would allow this sentence as grammatical, since that pretty girl and her are (a) not in the same syntactic domain, and (b) the first NP that pretty girl is not a pronoun. Hence, the corollary, which designates as ungrammatical sentences such as Beside
that pretty girl, you will see her umbrella, was added.

In summary, Berent (1980) is a good example of how the structures of syntax may be applied to anaphoric resolution. The study demonstrates how syntax may be used to develop rules which restrict the type of words considered as potential referents. However, no set of rules based solely on syntax can account for the entire anaphoric process (and certainly, one suspects that Berent (1980) would agree with this). In addition, by developing a single rule which attempts to account for anaphoric resolution across differing languages, Berent (1980) has shown that such a rule is only possible by rejecting as ungrammatical many sentences which would be considered grammatical (and coreferential) by most American speakers of English. Thus, Berent (1980) has sacrificed an understanding of anaphoric resolution in English for generalization on a global scale. This is, of course, a not surprising outcome of the study, but it does limit the usefulness of the MR rule as a means of understanding anaphoric resolution among native speakers of English.

In conclusion, the studies reviewed here suggest that syntax has a major impact on the process of anaphoric resolution. In particular, the effect of syntax would appear to be to limit the set of items
considered as potential referents by the anaphoric process. After this limiting function has occurred, the role of syntax would seem to become secondary to the role of semantics (cf. Hirst & Brill, 1980). This point will be pursued in the next section.
A Model of Anaphoric Reference

The previous section has presented studies which examined various aspects of anaphoric reference. This section will present additional studies concerned with anaphora. The findings of these studies, together with those of the previous section, will be used to develop a model of the processes which underlie anaphoric reference. A summary presentation of the model is available in Appendix A.

The first issue to be considered is the cognitive representation of a referent. McKoon & Ratcliff (1980) presented subjects with four-sentence paragraphs, one sentence at a time. The fourth sentence of each paragraph either did or did not contain an anaphor for a referent presented in the first sentence. After presentation of the fourth sentence, a single target word was presented and the subject was to decide if this word had been in the preceding paragraph. It was found that if the fourth sentence of the paragraph contained an anaphor whose referent was the target word, RT to the target word was faster than if it was not a referent of the anaphor (but was present in the paragraph).

More interestingly, a similar but slightly smaller effect also occurs when the target word is a member of the same clause as the referent. This was found by Dell,
McKoon, and Ratcliff (1983). This study used a procedure identical to that of McKoon and Ratcliff (1980) with the following two changes: (1) Sentences were presented one word at a time, and (2) The target word was presented at various locations within the anaphor-containing sentence. As in McKoon and Ratcliff (1980), the referent occurred in the initial sentence and the anaphor in the fourth sentence. When the target word was presented immediately after anaphor presentation, latencies were smaller for referent targets and for other targets from within the referent's clause, as compared to a control condition of targets unrelated to the referent. However, if the target was presented at the end of the anaphor-containing sentence, only the latency advantage for referent targets remained.

In both of these studies, all sentences contained a single clause. In order to determine if it was clausal or sentential boundaries which were critical in determining a referent's representation, Clark & Sengul (1979) varied the placement of the referent across both types of boundaries. For example, subjects might see one of the four contexts listed below:

(1) While curious spectators lined the river bank to watch the execution, two sentinels stood at
attention. Workman built a temporary gallows on the bridge.

(2) Curious spectators lined the river bank to watch the execution while two sentinels stood at attention. Workman built a temporary gallows on the bridge.

(3) Curious spectators lined the river bank to watch the execution. While two sentinels stood at attention, workman built a temporary gallows on the bridge.

(4) Curious spectators lined the river bank to watch the execution. Workman built a temporary gallows while two sentinels stood at attention.

In all four cases, the sentence containing the anaphor (i.e., the target sentence) was The sentinels were carrying loaded rifles. The corresponding context referent is two sentinels. The time to comprehend the target sentence when it followed each of these four contexts was measured. If the critical boundary was sentential, the RT of the target sentence presented after context (3) should be less than if the target sentence was presented after context (2), since the referent occurs in the second sentence of context (3)
but in the first sentence of context (2) (but in clause two in both context (2) and (3)). Conversely, if the clausal boundary is the critical delimiter, the target sentence should be read quicker in context (4) than in context (3), since the referent occurs in the last clause in the former case but in the next-to-last clause in the latter case (but in sentence two in both contexts).

The results supported the notion of a clausal boundary, with target sentence reading time 119 msecs. less when presented with context (4) than with context (3) \((\text{min } F'(1,46)=10.92, p<.005)\). Furthermore, reading time for the target sentence was only 12 msec. less when presented with context (3) than with context (2) (no F-test conducted).

In each of the preceding studies, the referent was separated from its anaphor by at least one intervening clause (with the exception of context four in Clark & Sengul, 1979). Furthermore, the results of these studies indicate that a referent is retrieved as part of a larger unit defined by clausal boundaries. Thus, the following assumption concerning anaphoric reference can be made:
ASSUMPTION 1

Referents are stored and initially retrieved as part of a clause when at least one clause intervenes between the referent and the anaphor. In addition, this retrieved clause makes available not only the specific referent, but also other items which were present in the referent-containing clause.

There is some evidence that Assumption One may not apply when the referent-containing clause immediately precedes the anaphor-containing clause. A case in point is Garrod and Sanford (1977).

Garrod and Sanford (1977) compared referents from the same taxonomic category which varied in their within-category frequency (i.e., words which varied in conjoint frequency). In all cases the referent-containing clause immediately preceded the anaphor-containing clause. For example, subjects might be presented with one of the following pairs of sentences:

(5) A robin would sometimes wander into the house.
Walking was liked by the bird.

(6) A goose would sometimes wander into the house.
Walking was liked by the bird.

As can be seen, the two sentence pairs differ only
in the conjoint frequency of the referent of the anaphor bird, with robin being of higher conjoint frequency.

Garrod & Sanford (1977) measured the reading time of the second sentence at both levels of referent conjoint frequency. They found that the anaphor-containing second sentence was read quicker if its referent was of high conjoint frequency than of low. Such a conjoint frequency effect is often found for words presented in isolation, i.e., without a multiclausal context (Collins & Quillian, 1969; Rosch, 1973).

Thus, Garrod & Sanford (1977) suggest that referents are retrieved as isolated lexical entries when the clause in which they are embedded immediately precedes the anaphor-containing clause. This is opposed to the general notion of Assumption One that the entire referent-containing clause is retrieved when the referent's anaphor is encountered.

Further evidence that Assumption One does not apply to cases where the referent-containing clause and the anaphor-containing clause are adjacent is provided by Murphy (1985). In Experiment 1 of that study, subjects were presented with referent-containing/anaphor-containing sentence pairs and the time to read the anaphor-containing sentence was measured. However, the number of words in the referent-containing sentence was
varied. Two examples are presented below:

(7) Jimmy swept the tile floor.          (Short referent-containing sentence)

Later, his uncle did it too.           (Anaphor-containing sentence)

(7') Jimmy swept the tile floor behind the chairs free of hair and cigarettes. (Long referent-containing sentence)

Later, his uncle did it too.           (Anaphor-containing sentence)

If Assumption One applied when the referent-containing clause and the anaphor-containing clause were adjacent, than the word length of the referent-containing clause should have no effect on the reading time of the anaphor-containing sentence. What would matter would be the number of clauses in the referent-containing sentence. Since only one clause is present in the referent-containing clause for both (7) and (7'), Assumption One implies that the reading time for the anaphor-containing clause should be the same in both examples.

The results of experiment one of Murphy (1985) showed a significant difference in the reading time for the anaphor-containing sentence as a function of the word length of the referent-containing sentence.
Anaphor-containing sentences with short referent-containing sentences were read quicker (mean difference = 244 msecs., $F(1,19) = 7.91$, $p < .02$). Thus, the number of words in the referent-containing sentence (which here is also the referent-containing clause) is a factor in resolving an anaphor when the referent-containing clause and the anaphor-containing clause are adjacent.

Furthermore, if one clause intervened between the referent-containing clause and the anaphor-containing clause (Murphy, 1985, Experiment 2), this difference is eradicated (mean difference = 25 msecs., $F<1.0$). This latter result is in keeping with Assumption One.

The results of Garrod and Sanford (1977) and Murphy (1985) lead to a second assumption concerning anaphoric reference:

**ASSUMPTION TWO**

When the referent-containing clause immediately precedes the anaphor-containing clause, referents are retrieved as single lexical entries. In addition, all potential referents (e.g., all subject, verb, and/or object terms) in the referent-containing clause are considered before the correct referent is selected.
The second part of Assumption Two follows from the referent-containing clause length effects found in Experiment One of Murphy (1985). In that experiment, only one correct referent was present regardless of the total number of words in the referent-containing clause. Thus, it can be said that anaphor-containing clause reading time was increased when the number of potential referents increased. Intuitively, this suggests that all words in the referent-containing clause which could be referents given the right context (e.g., subject, verb, and object terms) are considered to some degree before the one correct referent is selected.

Additional support for the suggestion that all potential referents are accessed can be found in Frederiksen (1981). In that study, subjects were shown two sentences on each trial. For each trial, the number of words in the first sentence which could be possible referents of an anaphor presented in the second sentence was either one or two. Where two potential referents were presented in the first sentence, the post-anaphor text of the second sentence would indicate which potential referent was the correct referent.

For example, a subject would see one of the following first sentences:
(8a) The nineteenth century was a period in which numerous immigrants came to America.

(8b) The nineteenth century was an era of immigrations.

The second sentence in both cases would be *It closed* with a second wave, stemming from Italy, Poland, Russia, and the other Slavic countries.

In the context of sentence (8a), the anaphor *it* in the second sentence could refer to either *nineteenth century* or *America*. However, in the context of (8b), *it* can only refer to *nineteenth century*. Notice that the correct referent is uniquely determined before the end of the second sentence. That is, the correct referent is determined by the time *closed* is read in the second sentence (i.e., *centuries* can be referred to as "closed", but *America* cannot). This pre-end determination was true of all the stimuli used in the experiment. Thus, any effect of the number of potential referents in the first sentence on the reading time of the second sentence can be attributed to processes occurring before the end of the second sentence.

The results of Frederiksen (1981) indicated that subjects took about 20 msecs./syllable longer to read the second sentence in the context of a first sentence
containing two potential referents ($t[80]=4.24$, $p<.001$). This outcome is in agreement with the postulates of Assumption Two.

At this point, it might seem that a simple recency explanation could account for the findings of the studies presented so far. That is, that the more recent a referent is (i.e., the closer in time a referent is to the occurrence of its anaphor), the quicker it is selected. However, this is not always the case. A referent which is temporally "farther away" from its anaphor may be selected quicker than a referent which is temporally closer, depending on its syntactic form (Corbett & Chang, 1983). More will be said of this finding later.

Having considered the form of a retrieved referent, the issue of the system into which the referent is retrieved arises. A study by Clark and Sengul (1979) would seem to implicate some type of immediate memory. Clark & Sengul (1979) varied the distance between anaphor and referent, with either zero, one or two clauses intervening between a noun referent and its pronoun anaphor. When the clause containing the referent immediately preceded the clause containing the anaphor (i.e., the case of zero intervening clauses), the clause containing the anaphor was comprehended an average of
364 msec. faster than when one or two clauses intervened between referent and anaphor ($F'(1,67)=18.99$, $p<.001$). However, reading times did not differ between the case of a referent one clause back and two clauses back. That is, RT did not increase monotonically as a function of the number of intervening clauses, but rather showed a marked discontinuity.

This discontinuity occurred between referents less than one clause back and referents more than one clause back. The presence of such a discontinuity would be expected if referents immediately unavailable in memory (e.g., those occurring more than one clause prior to the anaphor) had to be made immediately available in memory in order for the referent-anaphor connection to occur.

The results of Clark and Sengul (1979) lead to a third assumption concerning anaphoric reference:

**ASSUMPTION THREE**

The linking of an anaphor with its referent occurs in immediate memory. This linking begins after the referent's lexical entry is made available in immediate memory, either directly (when the referent-containing clause immediately precedes the anaphor-containing clause) or indirectly through the retrieval into immediate memory and subsequent
decomposition of the referent-containing clause into separate lexical entries (when the referent-containing clause is separated from the anaphor-containing clause by at least one intervening clause).

The idea above is similar in style to that of James' (1890) notions about memory and forms of thought. According to James (1890), all thoughts enter memory in a nebulous and potentially short-lived transitive state. If further processing is directed toward it, the thought may become well-defined and enduring, entering a substantive state. Thus, it may be that the transitive form of the anaphor is linked with the more substantive form of the referent. This linking occurs in primary memory, which is "...the rearward portion of the present space of time" (James, 1890, p. 647). But, if the referent is more than one clause prior to the anaphor, then the entire referent-containing clause first must be retrieved from secondary memory, where is stored "...the knowledge of an event, or fact, of which meantime we have not been thinking" (James, 1890, p.648; see also Wickens, Moody, & Dow, 1981).

Assumption Three indicates that a referent's lexical entry must be available in immediate memory before an anaphor is linked to its referent. However, stating that
a referent's lexical entry (a referent's name in the lexicon) must be currently available in memory for the referent-anaphor connection to occur is not the same as stating that a referent's concept (a referent's context-dependent meaning) also must be available for it to occur. It is logically possible that the referent concept to which an anaphor refers is not immediately available, although the referent lexical entry is so available.

For example, in the sentence pair Jack bought a birf. It was very fast., we know it refers to birf even though no actual referent concept for birf exists. This would imply that whatever the linking processes are, they probably handle lexical and conceptual information separately.

With this in mind, consider the following sentence pair from Haviland & Clark (1974):

(9) We checked the picnic supplies.
(10) The beer was warm.

The anaphor beer has as its referent lexical entry supplies. However, its referent concept is the beer which is among the picnic supplies. Given this distinction, the anaphor-referent linking process might proceed as follows.
Upon reading the beer, the reader might initially access the lexical entry for beer. This entry would contain the semantic memory address for the generic concept beer. Generic concept refers to a particular reader's context-free conceptualization of an item (cf. the notion of a prototype from Rosch, 1973). Next, because the syntactic cue the or possibly the constraints of the experiment indicates that beer is an anaphor, the reader would begin searching for a previously stated item which might serve as a referent.

This search for the referent would begin with items immediately available in memory (cf. Clark & Sengul, 1979) and could be at a non-conceptual level. For example, the search might involve checking syntax tags (e.g., a marker indicating whether a word is a determiner, subject, verb, object, etc. of a clause), with the syntax tag attached to the lexical entry supplies (i.e., object) indicating it is a plausible syntax value for a referent. This checking process will be called the referent plausibility check, and the syntax tags will be referred to as referent plausibility tags. Those terms which have a referent plausibility tag form the set of plausible referents.

It should be noted that the set of plausible referents is not stored separately from the
representation of the clause in memory, which would make the referent plausibility tags superfluous. Rather, these tags indicate those entries within the representation of the entire clause which are plausible referents.

That the syntactic value of a referent can be used as a referent plausibility tag is speculative, but that a referent's syntactic role may influence the anaphoric resolution process is documented (Corbett & Chang, 1983; Hirst & Brill, 1980; Sanford & Garrod, 1980). For example, Corbett and Chang (1983) presented subjects with two clause sentences. The first clause contained a referent in either the subject or object position, and the second clause contained a pronoun anaphor for this referent. A probe word was presented for a recognition test after the sentence had been displayed. For example, a subject might be presented with one of the following sentence-probe combinations:

Subject as Referent

(11) Karen poured a drink for Emily and then she put the bottle down.

Referent probe: Karen  Non-referent probe: Emily
Object as Referent

(11') Bonnie passed the basketball to Claire and she sank a jumpshot.

Referent probe: Claire     Non-referent probe: Bonnie

It was found that a referent probe presented at the end of the sentence was recognized much quicker than a non-referent first clause probe (mean difference = 128 msec., no F reported). More importantly, referent probes were recognized 249 msec. faster when the referent was the subject of the first clause than when it was the object. This occurred despite the fact that the subject referents were temporally "more distant" from the anaphor than were the object referents.

Thus, referent syntax may influence anaphoric resolution time. However, as noted in the earlier discussion of Hirst and Brill (1980), syntax alone is not sufficient for a referent-anaphor link to be formed. Therefore, it seems logical to assume that this effect occurs prior to any conceptual analysis in the anaphoric resolution process, but usually does not preclude such an analysis.

Returning to the previous discussion of sentences (9) and (10), the most likely referent might be found to be the lexical entry supplies. The result would be the joining of the generic concept beer to the referent's
lexical entry supplies. The reader thus might make the connection The beer (generic concept) refers to the supplies (referent's lexical entry) and leave it at that.

Although a single connection has indeed been made between the two sentences, only the generic concept beer has been associated with the referent's lexical entry supplies in response to The beer. Notice that this association is semantically asymmetrical: The meaning of supplies (i.e., picnic supplies) was not involved. Thus, the same connecting process would occur if sentence (9) were changed to We checked the glef, resulting in the connection The beer (generic concept) refers to the glef (referent lexical entry). It was the word the or the constraints of the experiment that induced the connecting process, and it was the non-semantic properties of the referent lexical entry (i.e., the presence of a referent plausibility tag) that allowed a rather superficial connection to be formed.

Alternatively, the reader could make two connections in immediate memory: The beer (generic concept) refers to the supplies (referent lexical entry) and Beer (anaphor's generic concept) can be a picnic supply (referent's generic concept). This second connection involves the semantic decision that The beer and the
picnic supplies share a generic referent: The beer which is a type of picnic supply. This semantic decision, which will be referred to as the meaning plausibility check, results in a set of candidate referents. In this example, the two connections allow the determination of a single candidate referent (picnic supplies) and a single referent concept: The beer which is among the picnic supplies.

Thus, this second connection would be needed if connecting an anaphor to its referent usually requires conceptual information. That is, this second linking is needed if anaphoric reference involves not only knowing that the anaphor and referent can be linked (as indicated by the referent plausibility tag), but also that they refer to the same, context-specific, referent concept.

If this second connection in memory is necessary for the overall referent-anaphor connection to be made, then empirically, sentence (10) should take longer to comprehend if it is preceded by (9) above than if it is preceded by a sentence which eliminates the need to decide if both anaphor and referent can have a common generic referent. Such a sentence would contain a referent whose generic concept was the same as the generic concept of the anaphor, as in:
(9') We checked the beer.

If this extra connection is not necessary, then preceding (10) with (9) or (9') should make no difference. This is because both (9) and (9') contain a referent lexical entry (i.e., supplies in (9) and the beer in (9')) which could be the referent.

In fact, Haviland & Clark (1974) did find that (10) took longer to comprehend if it was preceded by (9) than (9') (mean difference = 181 msec., \( \text{min} F'(1,36)=6.47 \), \( p<.025 \)).

The above analysis leads to three additional assumptions about anaphoric reference:

**ASSUMPTION FOUR**

Lexical entries in immediate memory consist of at least two parts relevant to anaphoric resolution. The referent plausibility tag indicates at a syntactic level a lexical entry's potential to be a referent. The generic concept address is a pointer to the lexical entry's prototypical representation in semantic memory.

**ASSUMPTION FIVE**

The search for a referent begins by locating in immediate memory those lexical entries which
contain a referent plausibility tag.

ASSUMPTION SIX

Lexical entries which have a referent plausibility tag are subsequently analyzed at a semantic level. The generic concept of the anaphor is compared with the generic concept of the plausible referent lexical entry. If this comparison determines that both generic concepts could refer to a single generic referent, the referent and the anaphor are associated. If the outcome of this comparison is negative, processing of this lexical entry ceases, and another plausible lexical entry in immediate memory is analyzed.

Implicit in Assumption Six is the notion of an exhaustive analysis of all plausible referents residing in immediate memory before any final anaphor-referent link is formed (i.e., before the single referent concept is determined). This notion is necessitated by the frequent influence of post-anaphor discourse information on the meaning of the anaphor. For example, the anaphor it acquires a pseudo "generic concept" only through the context in which it is embedded. Thus, if the sentence The deer went into the forest is followed by It was fast, then it acquires the concept deer. On the other
hand, if The deer went into the forest is followed by It was green, then it acquires the concept forest. As can be seen, no referent can be linked to it until after the entire it containing clause has been read. Thus, it is logical to assume that all plausible referents in immediate memory must be analyzed to some extent when it is first encountered.

Another example is the case of referents with potentially similar generic concepts. Thus, in the sentence Jack called Bill because he was upset with him, the anaphor he cannot be linked with its referent Jack until after the predicate with him has been read.

Assumptions Two through Six are primarily concerned with how a referent is identified once it is located in immediate memory. Furthermore, these assumptions (particularly Assumptions Two and Three) clearly imply that when an referent-containing clause immediately precedes the anaphor-containing clause the separate lexical entries of the referent-containing clause are already available in immediate memory when the anaphor in the anaphor-containing clause is encountered. However, it is often the case that the referent-containing clause is not in the clause which immediately precedes the anaphor-containing clause. In such an instance, the question arises as to how the correct
referent-containing clause is located.

From the data which support Assumption One it can be inferred that the entire referent-containing clause is placed into immediate memory once it has been located. In addition, it is reasonable to suggest that once in immediate memory, such a distal referent-containing clause is analyzed in the same manner as an referent-containing clause which immediately precedes its anaphor-containing clause. Nonetheless, the question remains of how an referent-containing clause which is not adjacent to the anaphor-containing clause is located in the first place.

A logical answer to the above question is that clauses are analyzed sequentially, starting with the clause which immediately precedes the anaphor-containing clause and moving backwards clause-by-clause from that point until the referent is found. However, Clark and Sengul (1979) argues unequivocally against this answer. If clauses were analyzed in a serial backward manner, then it should take longer to read an anaphor-containing clause when its referent is three clauses back than two clauses back. In fact, Clark and Sengul (1979) found no reliable difference in the anaphor-containing clause reading time as a function of the referent-containing clause being two or three clauses back (mean difference
A second way in which distal referent-containing clause's might be located is as a function of their importance to the current discourse topic (cf. Malt, 1985; Chafe, 1974). Thus, the more important (in some sense) a clause is to the current topic, the more likely it is to be analyzed before any other non-anaphor-containing clause adjacent clause. Of course, the clause which immediately precedes the anaphor-containing clause is assumed to be analyzed first regardless of its textual importance. This is because it is resident in immediate memory when the anaphor-containing clause is encountered, and all referent searches are assumed to begin with the items currently available in immediate memory (Assumptions Three and Five).

The view that distal referent-containing clause's are selected in a sequence dependent upon their current textual importance is supported in a study by Lesgold, Roth, and Curtis (1979). In Experiment 1 of that study, subjects read paragraphs which were seven sentences in length. The seventh sentence mentioned a referent for an anaphor-containing target sentence. Either two or four sentences intervened between the seventh sentence and the target sentence.
In the foregrounded condition, these intervening sentences were about the same topic as the seventh sentence. In the backgrounded condition, the intervening sentences were not about the same topic as the seventh sentence. The dependent measure was the time to read the target sentence under each type of "grounding" condition. Examples of these conditions are presented below:

**Foregrounded & Two Intervening Sentences**

(12) A thick cloud of smoke hung over the forest.
The smoke was thick and black, and began to fill the clear sky. Up ahead Carol could see a ranger directing traffic to slow down.

Target: The forest was on fire.

**Backgrounded & Two Intervening Sentences**

(12) A thick cloud of smoke hung over the forest.
Glancing to the side, Carol could see a bee flying around the back seat. Both of the kids were jumping around, but made no attempt to free the insect.

Target: The forest was on fire.

If the clausal distance between the referent-
containing clause (i.e., sentence (12)) and the anaphor-containing clause (i.e., the target sentence) were the critical factor in determining the speed with which the target sentence was comprehended, target sentence reading times should not differ as a function of the grounding condition. Conversely, if finding the referent for the anaphor (the) forest in the target sentence is guided by the importance of the referent to the current topic, the target sentence should be read quicker in the foregrounded condition.

The results of Lesgold et al. (1979) supported the latter hypothesis: target sentences were read an average of 360 msecs. faster in the foregrounded condition ($F'(5,25)=2.74, p<.05$). Furthermore, no effect of clausal distance between sentence (12) and the target sentence, within each grounding condition, was obtained. This latter finding supports the findings of Clark and Sengul (1979) that once the referent-containing clause is more than one clause from the anaphor-containing clause, clausal distance has no impact on anaphor resolution time.

The results of Lesgold et al. (1979) clearly indicate that the importance of a referent to the current discourse topic influences the time needed to link the referent with its anaphor. Consequently, the
following assumption is made:

ASSUMPTION SEVEN

When an anaphor and its referent are separated by at least one intervening clause, the time to locate the referent-containing clause is directly proportional to the importance of the referent-containing clause to the current discourse topic.

In conclusion, seven assumptions about the processes involved in anaphoric reference have been proposed. These assumptions are based on representative studies from the literature domain concerning anaphora. They were implicated by this literature, but not uniquely determined. Hence, these assumptions form a starting point of investigation rather than the only set of inferences to be derived from the literature. A list of the assumptions is presented in Appendix B.

The first section of this Introduction discussed the major findings of the available literature concerning anaphora. From these studies, a model of anaphoric resolution was developed in the second section of this Introduction. The following chapters will present a series of experiments designed to test the validity of this model.
CHAPTER II

Experiment 1

Introduction

The model of anaphoric resolution presented in the Introduction suggested that an initial step in anaphoric resolution is an analysis of the sentence which immediately preceded the anaphor-containing sentence. This analysis was hypothesized to begin with a word by word, syntactically-based categorization of each word in the pre-anaphor sentence as either a potential or non-potential referent item.

This syntactic classification would then be followed by a semantically-based analysis of those items classified as potential referents, in order to determine the word(s) to which the anaphor actually referred (i.e., the actual referent). Like the syntactic analysis, this semantic analysis also was hypothesized to function in a word by word, serial manner.

An implication of the two analyses outlined above is that as the number of potential referents in the
sentence which precedes the anaphor-containing sentence increases, the time required to read the anaphor-containing sentence also should increase. Such an increase should occur even if the number of actual referents in the preceding sentence remains constant. This outcome is implicated by the model because the time required to complete the syntactic and semantic analyses is predicted to increase as the number of terms which must be analyzed increases, and this number is a function of the number of potential, not actual, referents. In turn, this increase in total analysis time should result in an increase in the overall reading time of the anaphor-containing sentence. Experiment 1 is designed to test this implication.

Method

Subjects

Sixty subjects received credit in partial fulfillment of a course requirement for an Introductory Psychology course. All the subjects were native speakers of English, and had normal or corrected to normal vision.

Stimuli

A set of 48 sentence pairs was formed such that the subject term of the first sentence was a referent for
the subject term in the second sentence. For each first sentence in this base set, two additional first sentences were formed which only differed from the original first sentence in that they contained one or two additional words in the subject position. These additional items were never direct referents for a term in the corresponding second sentence. Thus, the subject position of the first sentence could contain one, two, or three words, but only one of these words was an actual referent for the subject term of the second sentence.

There were two orderings for the sequence of subject terms. In one ordering, the actual referent's position was first in the sequence of terms. In the second ordering, the actual referent's position was last in this sequence.

For each of these 48 base sentence pairs, an alternate second sentence was formed. This alternate second sentence was related to the topic of the first sentence, but did not contain an anaphor for any word in the first sentence. That is, this alternate filler second sentence required a bridging inference (Haviland & Clark, 1974) in order to be conceptually linked with the first sentence. Each of the filler second sentences and its corresponding anaphor second sentence differed
in length by no more than one syllable.

In summary, two sets of 48 sentence pairs were formed, the sets differing in the type of second sentence (anaphor or filler) used. In addition, the first sentence of each sentence pair contained one, two, or three subject terms. Within the sentence pairs which contained an anaphor in the second sentence, the corresponding referent in the first sentence was either the first or last subject term.

For each member of each set, two comprehension questions were formed. One of these questions required a "yes" response in order to be answered correctly, and the other a "no" response. All of the questions used when the second sentence contained an anaphor and most of the questions used when the second sentence was a filler required the integration of information contained in each sentence of the sentence pair in order to be answered correctly without guessing. For the majority of these question pairs, the "no" question was formed by replacing one or two words in the "yes" question. The appropriateness and answer to each question was not altered by the number of subject terms in the first sentence or the position of the referent in the first sentence.
Examples of the stimuli used in Experiment 1 are presented in Table 1. A complete list of the stimuli used in Experiment 1 is available in Appendix D.

Procedure

The following instructions were read to each subject:

In this experiment, you will be reading a series of sentence pairs. Each pair will be followed by a comprehension question. The two sentences are always related in some way. You will first get the prompt "Hit Key When Ready". When we start the experiment, you will hit a key. When you do that, the prompt will disappear and the first sentence will appear.

I would like you to read that sentence silently to yourself, read it through only once, and as soon as you are done reading it, press a key. The first sentence will then be replaced by the second sentence.

Do the same thing with the second sentence that you did with the first. As soon as you are done reading the second sentence, hit a key. The second sentence will then be replaced by the comprehension question.
TABLE 1
Examples of the Stimuli Used in Experiment 1

1. First Sentence Types

One Referent: Beef makes a good dinner.

Two Subject Terms, Referent First: Beef and potatoes make a good dinner.

Two Subject Terms, Referent Last: Potatoes and beef make a good dinner.

Three Subject Terms, Referent First: Beef, corn, and potatoes make a good dinner.

Three Subject Terms, Referent Last: Corn, potatoes, and beef make a good dinner.

2. Second Sentence Types

Anaphor-containing: The meat can be very tender.
Filler-containing: Going out is more fun.

3. Comprehension Questions

Yes Question for Referent-containing Second Sentence: Can beef be tender?

No Question for Referent-containing Second Sentence: Can beef be tough?

Yes Question for Filler-containing Second Sentence: Is going out more fun than making dinner?

No Question for Filler-containing Second Sentence: Is going out less fun than making dinner?
If the answer to the question, based on the sentence pair, is "Yes", you should hit the "Y" key (points to key labeled "Y"). If the answer is "No", you should hit the "N" key (points to key labeled "N"). Answer the question as accurately and as quickly as possible.

After you have answered the question the computer will tell you if you are correct or not, a slight delay may ensue, and then the prompt "Hit Key When Ready" will reappear, and you will be all set for the next trial. Do you have any questions?

The first of six practice trials would then be presented. Each trial began with the appearance of the prompt "Hit Key When Ready". The subject would then press a key, and the first sentence of a sentence pair would appear. The sentence was centered vertically and indented approximately one inch from the left side of the CRT screen.

After reading this sentence, the subject would press a key. This would stop a timer which had been started when the first sentence was presented. The second sentence would then replace the first sentence, and a second timer would start.

After reading the second sentence, the subject would press a key and the second timer would be stopped. The
second sentence was then replaced by the comprehension question, and a third timer was started.

The question required either a "yes" or "no" response. To respond, the subject would press either the "z" or "/" key (labeled "N" or "Y", respectively, during the experiment) on the display terminal's keyboard.

After the subject had responded to the question, the third timer was stopped and a message was displayed to the subject indicating whether the response was correct. The response, together with the reading times for the two sentences and the comprehension question, were then recorded. The screen was cleared, and the prompt "Hit Key When Ready" would then be displayed. The next trial was now ready to begin.

The above process was repeated for each trial. The entire experiment took approximately one hour.

**Design**

Three experimental factors were manipulated during the course of the experiment. These factors were the number of subject terms in the first sentence (one, two, or three), the position of the actual referent in the sequence of subject terms in the first sentence (first or last), and the type of second sentence displayed (anaphor-containing or filler-containing).
Each subject received a total of 54 trials in an experimental session. The first six trials of each session were practice, and were not included in any data analysis.

Of the remaining 48 trials, 16 presented sentence pairs where the first sentence contained one subject term and 16 presented pairs where the first sentence contained two subject terms. The remaining 16 trials displayed first sentences which contained three subject terms.

Within the group of 16 trials where the first sentence contained one subject term, eight trials presented a second sentence which contained an anaphor subject term whose referent was the subject term of the first sentence. The remaining eight trials within this group presented a second sentence which contained a filler subject term.

For each of the two remaining groups of sixteen trials (i.e., those trials where the first sentence contained more than one subject term), a set of eight trials within each group contained the critical referent term in the first subject term position. The remaining set of eight trials contained the referent in the last subject term position.
Within each of these sets of eight trials, four trials displayed a second sentence whose subject term was an anaphor for the critical referent term in the first sentence. The remaining four trials within a set presented a second sentence containing a filler word in the subject term position.

Finally, two trials within each of these four trial segments presented comprehension questions requiring a "yes" response. The other two trials in a segment displayed questions requiring a "no" response.

The presentation order for the 48 experimental trials was random, with a different random order used for each subject. The practice trials were presented to each subject in the same random order.

**Results**

The following analyses are based on the median of the reading times for the first and second sentences. This median was calculated for each subject for each of the three conditions used in Experiment 1. The calculation of the medians does not include data from those trials where the subject answered the comprehension question incorrectly.

In the following analyses, as well as those for Experiments 2, 3, and 4, a standard analysis of variance is used. The minF' statistic (Clark, 1973) was not used
because the stimuli used in the experiments were not a random sampling of all possible stimuli.

First Sentence Reading Times

The analysis of the reading times for the first sentence revealed a main effect of the number of subject terms (i.e., potential referents), $F(2, 118) = 232.77, p < .00001$. Subjects took an average of 2189 msec to read a first sentence which contained one subject term, 2927 msec when the first sentence contained two subject terms, and 3556 msec when the first sentence contained three subject terms. All other effects were not significant ($p > .05$).

Second Sentence Reading Times

Two separate analyses were carried out on the reading times for the second sentence. These were (a) an analysis of only the filler type second sentences, and (b) an analysis of only the anaphor type second sentences. Because the filler type sentences were only matched with the anaphor type sentences in the number of syllables in each sentence type, no direct analysis comparing the two sentence types will be reported.

The analysis of the filler type second sentences revealed no reliable effects. In particular, no effect of the number of subject terms in the first sentence on the reading time of the filler-containing second
sentences was found, $F < 1$. Thus, when a sentence makes no direct reference to a previous sentence, the reading time of that sentence is not affected by the number of subject terms in the previous sentence.

However, an analysis of the anaphor type second sentences did reveal a significant effect of the number of subject terms in the first sentence, $F(2, 118) = 7.42$, $p < .0009$. A subsequent Newman-Keuls procedure indicated that subjects were faster in reading the second sentence when the first sentence contained one subject term than when it contained two subject terms, $q(2, 118) = 3.29$, $p < .05$, or three subject terms, $q(3, 118) = 3.39$, $p < .05$. However, subjects did not read the second sentence faster when the first sentence contained two rather than three subject terms, $q < 1$. The means for these conditions are shown in Figure 1.

This result for one and two subject terms is consistent with the model. That is, an increase in the number of potential referents available in the immediately preceding sentence resulted in an increase in the reading time of the anaphor type second sentences.

No other effects were reliable in the analysis of the anaphor type sentences. In particular, no effect of the position of the actual referent within the set of
Figure 1. Reading Time of Sentence 2 as a Function of the Number of Potential Referents
subject terms (i.e., first or last) was found, \( F < 1 \). This suggests that all potential referents are considered before the correct one is selected.

**Comprehension Questions**

Across all conditions, 92% of the comprehension questions were answered correctly. A main effect of second sentence type was obtained, \( F = 19.69, p < .00001 \). Subjects answered 91% of the comprehension questions correctly when the second sentence contained an anaphor. However, this percentage increased to 95% when the second sentence contained a filler item. No other effects were reliable \((p > .20)\).

**Discussion**

The model presented in the Introduction suggested that upon encountering an anaphor, a reader begins his/her search for the corresponding referent by analyzing the words in the sentence which immediately preceded the anaphor-containing sentence. It was proposed that one step in this analysis was a semantically-based, **serial-exhaustive** analysis of a subset of words contained in the preceding sentence. The members of this subset were those words which had been classified as potential referents based on their syntactic function within the preceding sentence.
The results of Experiment 1 largely support this proposal. Subjects did take longer to read the second sentence when the number of potential referents in the first sentence was increased from one to two, as would be expected under the assumption of a serial analysis.

In addition, the position of the actual referent within the subset of subject terms, namely, first or last, had no effect on the reading time of the second sentence. This supports the hypothesis proposed in the model that all potential referents are considered before the correct one is selected.

However, the model also predicted an increase in the reading time of the anaphor type second sentence when the number of subject terms in the first sentence increased from two to three. Such was not the case: increasing the number of subject terms in the first sentence from two to three resulted in an increase of only five msec in the reading time of the anaphor type second sentence.

At least two possible explanations of this finding are available. First, it is possible that subjects ignored the additional potential referent in the three potential referent condition. That is, subject's read the additional term (as indicated by the increase in the
reading time of the first sentence when the number of subject terms was increased from two to three), but did not include it in the set of potential referents. This would have made the two potential referent and three potential referent conditions equal in terms of the number of words requiring a semantic analysis. This explanation gains indirect support from the fact that the middle subject term in the three potential referent condition was never the actual referent. Hence, the subject could ignore this middle term when determining the set of potential referents, and still be assured of processing the actual referent for a second sentence anaphor.

The second possible explanation for the results of Experiment 1 is that readers engage in a parallel search of the set of potential referents when this set contains more than one member. This explanation is very similar to the view of anaphoric resolution advocated by Marslen-Wilson and his colleagues (Marslen-Wilson & Tyler, 1980; Marslen-Wilson, Levy, & Tyler, 1982). In this view, the locating of a referent for an anaphor is not essentially different from determining the meaning for any word in a text: "...what we are really dealing with is a general process of utterance resolution, rather than a series of separate processes" (Marslen-
Wilson, Levy, & Tyler, 1982, p. 361). Both processes are hypothesized to involve the generation of "multiple partial lexical and structural readings of the input, and simultaneously assessing these in terms of their compatibility with, and implications for, a discourse-level interpretation." (Marslen-Wilson, Levy, & Tyler, 1982, p. 340).

In terms of Experiment 1, the Marslen-Wilson explanation would imply that the number of potential referents available in the first sentence would have little effect on the reading time of the second sentence. This is because multiple interpretations of the first sentence would be simultaneously considered in determining the referent for the second sentence anaphor, and thus whether these multiple interpretations involved differing numbers of potential referents would be irrelevant.

The Marslen-Wilson explanation could account for the lack of a difference in reading times for the second sentence when two or three potential referents were available in the subject position of the first sentence. However, two other results of Experiment 1 would argue against this explanation.

First, this explanation suggests that the pattern of reading times for the anaphor type and filler type
second sentences should be similar regardless of the number of subject terms in the first sentence, since the same processes would be involved in analyzing either type of second sentence. Clearly, this was not the case, as indicated by Figure 1. Subjects took about 100 msec longer to read the anaphor type second sentence than the filler type sentence when multiple subject terms were present in the first sentence. Thus, an additional process seems to be involved when a reader must resolve an anaphor. This result is consistent with the model outlined in the Introduction.

A second, similar reason why the Marslen-Wilson explanation is insufficient for explaining the results of Experiment 1 is the difference in reading times for the anaphor type second sentence when the number of subject terms in the first sentence is increased from one to two. The Marslen-Wilson explanation would imply that increasing the number of subject terms from one to two should not effect the reading time of the second sentence. However, this increase in subject terms had a large and reliable effect on the reading time of the anaphor type second sentence (although not on the reading time of the filler type second sentence).

Thus, the findings for the anaphor type second sentence do not agree with those implicated by the
Marslen-Wilson explanation when the number of subject terms in the first sentence is increased from one to two. However, these same findings are consistent with the implications of the model proposed in the 
Introduction.

Finally, the analysis of the comprehension questions yielded a somewhat surprising result: Subjects were more accurate in answering the questions when the second sentence was a filler type than when it was an anaphor type. A consideration of how the filler type second sentences were formed suggests a possible explanation.

The second sentences used in Experiment 1 were constructed so as to relate to the first sentence through the formation of a bridging inference (Haviland & Clark, 1974). Such an inference is formed when a reader uses their knowledge about the world to relate two sentences which do not directly relate through the use of an anaphor-referent relation. For example, in the sentence pair (used in Experiment 1) *Smells are processed by the brain. Some muscles are known as extendors.*, the two sentences can be related through the formation of the bridging inference that both sentences are about a third, supraordinate concept, namely *anatomy*. Approximately one half of the filler second sentences were related to the preceding first sentence
through the use of such a supraordinate bridge.

However, only about one half of the comprehension questions used in these cases of a supraordinate bridge tested for the presence of that bridge. This was because it was felt that subjects might develop a strategy of looking for such indirect inferences for all the sentence pairs if too many of the comprehension questions required the formation of such an inference in order to be answered. This would result in an artificial increase in the reading times for the second sentences beyond the amount of time required for normal processing.

To discourage the formation of such a strategy, the comprehension questions for about half of those filler condition sentence pairs which involved a supraordinate bridge only used information present in the second sentence. For example, the "yes" comprehension question for the sentence pair presented above was Are some muscles known as extendors?

It may be that these questions were easier to answer than those questions which required the integration of information from both sentences in a sentence pair, e.g., all the comprehension questions used for the anaphor second sentence condition. This would explain why subjects were correct 95% of the time when the
second sentence contained a filler item, and were correct 91% of the time when the second sentence contained an anaphor.

In summary, the results of Experiment 1 are in general agreement with the model proposed in the Introduction. The only deviation from the model occurred when the reading time for the anaphor type second sentences did not increase when the number of potential referents in the first sentence was increased from two to three. However, this result may be due to the subject excluding the middle subject term from the set of potential referents when the first sentence contained three subject terms, since the middle term was never the actual referent.
CHAPTER III
Experiment 2

Introduction

When an anaphor and its referent are separated by more than one intervening clause, the model hypothesizes that the entire referent-containing clause will be retrieved into immediate memory after it is located. An implication of this hypothesis is that words contained in the referent-containing clause which are not the referent also will be transferred to immediate memory.

As a consequence, these referent companions should be quickly recognized as having previously occurred if the recognition test occurs after the referent-containing clause has been transferred to immediate memory. Of course, this transfer can only occur after the anaphor has been read.

For example, Dell, McKoon, and Ratcliff (1983) presented probe words to be recognized immediately before or immediately after an anaphor (embedded in a sentence) had been read. The anaphor was separated from its referent by four intervening sentences. For probes
presented before the anaphor had been read, whether the probe was a word unrelated to the anaphor or a referent companion made no difference in mean recognition time (720 vs. 721 msec, respectively). However, when presented after the anaphor had been read, referent companion probes were recognized on the average 45 msec faster than referent-unrelated probes (700 msec vs. 745 msec), which was reliable.

An implication of the above results (and the proposed model) is that companion words should take longer to recognize if the recognition task occurs before the anaphor is read than after the anaphor is read (note that Dell, McKoon, & Ratcliff (1983) did not perform this companion word only comparison). Experiment 2 was designed to investigate this theoretical implication.

In addition, Experiment 2 investigated the effect of changing the distance between the anaphor and the referent on the recognition time for the companion. The model suggests that if the referent-containing clause immediately precedes the anaphor-containing clause, the companion will be available in immediate memory even before the anaphor-containing clause is encountered. As a result, the location of the recognition test (i.e., pre- or post-anaphor) should have little impact on
companion recognition time. Experiment 2 tested this suggestion.

Method

Subjects

Forty-eight subjects participated in the experiment in partial fulfillment for an Introductory Psychology course requirement. All subjects had normal or corrected to normal vision and were native speakers of English.

Stimuli

A set of 96 stories was constructed. Each story was four sentences in length. The first sentence of each story contained in the subject position a referent for an anaphor, with the anaphor always being the subject term of the fourth sentence. This will be referred to as the far condition, because the anaphor and its corresponding referent are as far apart in terms of the number of intervening clauses as possible. The second and third sentence of each far condition story were filler sentences. These two sentences were related to the same topic as the first and fourth sentences, but did not directly refer to any specific term in the first or fourth sentences.

Each far condition story was constructed in such a manner as to permit the movement of the referent-
containing first sentence into the third sentence position without destroying the theme or cohesiveness of the story. This movement resulted in the two filler sentences becoming the first two sentences of each story. The set of 96 stories which resulted from this movement will be denoted as close condition stories, inasmuch as the sentences which contained the anaphor and referent were now as close as possible to each other.

The fourth sentence (i.e., the anaphor-containing sentence) for each story in the far condition was identical to the fourth sentence in the corresponding close condition story. For each of these anaphor-containing fourth sentences a matching anaphor-control fourth sentence was constructed. These anaphor-control fourth sentences were formed by replacing the anaphor in the anaphor-containing fourth sentence's with a word that maintained the cohesiveness of the story but did not directly refer to any word in the first three sentences of the story. In all other respects, the anaphor-control fourth sentence’s and the anaphor-containing fourth sentence’s were identical for each story.

Thus, a subject could read one of four story types during a particular trial. Each story type reflected a
combination of the close/far story condition with the anaphor-containing or anaphor-control fourth sentence type. It should be noted that the close/far story condition did not exist per se when the fourth sentence was an anaphor-control fourth sentence, since no anaphor was present in the fourth sentence in that condition.

In addition to the stories, a set of probe stimuli was constructed for each story. These probes were displayed to the subject sometime during the presentation of the fourth sentence of each story (see the Procedure section for details). These probes were different for each story but were identical for each of the four story type versions of a given story. Four probes were constructed for each story, and every probe was a highly familiar, concrete noun.

The referent probe was identical to the referent term in the stories of the close/far condition which had an anaphor-containing fourth sentence. The companion probe was identical to the object term of the sentence which contained the referent probe (i.e., it was a "companion" to the referent). The in-paragraph control probe was identical to the subject term of the first sentence of the filler sentence pair. Finally, the out-of-paragraph control probe was a word which did not appear in the story and was semantically unrelated to
any word in the story. This probe also was unrelated to
the theme of the story.

Examples of the four story types and their
corresponding probes are presented in Table 2. A list
of all the stimuli used in Experiment 2 is available in
Appendix E.

Procedure

Subjects were read the following instructions:

In this experiment, you will read a series of
stories. Each story is four sentences in length.
When you press the space bar, the screen will go
blank and then the story will be presented one word
at a time. At the end of each sentence, the screen
will go blank, and then the next sentence will be
presented, again one word at a time.

Sometime during the presentation of the story,
the screen will go blank and a single word, all in
capital letters, will appear. Your task is to
decide if this word had previously appeared in the
story. If it had, press the "Y" key (points to key
marked "Y"). If it had not, you should press the
"N" key (points to key marked "N").

The computer will then tell you if you are
correct or not, a slight delay will ensue, and then
the prompt "Press Spacebar When Ready" will
### TABLE 2
Examples of the Stimuli Used in Experiment 2

1. **Story Types**

   **Anaphor-containing, Far Condition**
   
   A *yacht* was returning home.  
   A storm was fast approaching.  
   The seagulls were very quiet.  
   The *ship* quickly moved on.

   **Anaphor-containing, Close Condition**
   
   A storm was fast approaching.  
   The seagulls were very quiet.  
   A *yacht* was returning home.  
   The *ship* quickly moved on.

   **Anaphor-control, Far Condition**
   
   A *yacht* was returning home.  
   A storm was fast approaching.  
   The seagulls were very quiet.  
   The *crabs* quickly moved on.

   **Anaphor-control, Close Condition**
   
   A storm was fast approaching.  
   The seagulls were very quiet.  
   A *yacht* was returning home.  
   The *crabs* quickly moved on.

2. **Probes**

   **Referent Probe:** YACHT
   **Companion Probe:** HOME
   **In-paragraph Control Probe:** STORM
   **Out-of-Paragraph Control Probe:** BOOT

3. **Probe Positions**

   The *ship/crabs* quickly moved on.

   Immed. Before    Immed. After    Two Words After
reappear, and you'll be all set for the next story.

You should make your response as quickly and as accurately as possible. Do you have any questions?

The first of ten practice trials would then be presented. Each trial began with the appearance of the prompt "Press Spacebar When Ready" centered on the CRT screen. The subject would then press the spacebar, and the screen would go blank.

Three-hundred msec later, the first word of the first sentence of the story would appear. The word was centered vertically and indented approximately one inch from the left side of the CRT screen.

After a delay of 300 msec, the second word of the first sentence was presented. This word was positioned on the same line as the first word, with one character space separating the final character of the first word from the initial character of this second word.

This procedure continued with one additional word in the first sentence of the story being displayed every 300 msec. The word-by-word presentation ended when the entire first sentence was displayed.

Three-hundred msec after the presentation of the final word in the first sentence, the screen would go blank. The screen remained blank for 300 msec, and
then the first word of the second sentence was displayed. This word was located in the same position as the first word of the first sentence. Presentation of the remainder of the second sentence was identical to the presentation of the first sentence.

This process of presenting a word every 300 msec continued for the third and fourth sentence of the story. However, sometime during the presentation of the fourth sentence, the screen would be cleared and 300 msec later, the probe word was displayed.

The probe was always presented in capital letters, and was displayed in the second, third, or fifth word position of the fourth sentence. Since the anaphor or its control replacement was always in the second word position of the fourth sentence, probe presentation was either immediately before, immediately after, or two words after presentation of the critical anaphor or control term. The two-words-after probe position was selected in order to determine if the effect of presenting the probe after the anaphor decreased with increasing anaphor-probe distance.

The subject's task was to indicate whether the probe word had occurred previously in the story. To do this, the subject would press either the "z" or "/" key (labeled "N" or "Y", respectively, during the
experiment) on the display terminal's keyboard. This would stop a timer which had been started when the probe word was presented.

After pressing one of the two keys, a message was displayed indicating whether the response selected was correct. The screen was then cleared, a slight delay ensued as the response time was recorded, and then the prompt "Press Spacebar When Ready" would reappear. The next trial was then ready to begin.

The above process was repeated for each story trial. The entire experiment took approximately one hour.

**Design**

Four experimental factors were manipulated during the course of the experiment. These factors were the distance between the anaphor and the referent (close or far), the fourth sentence type (anaphor-containing or anaphor-control), the type of probe displayed (referent, companion, in-paragraph control or out-of-paragraph control), and the position of the probe relative to the anaphor/control term (immediately-before, immediately-after, or two-words-after).

The four factors were completely crossed, resulting in 48 data cells. Each subject received two trials per cell, resulting in 96 trials per subject being used for data analysis.
In addition, each subject received an extra 24 trials in the out-of-paragraph probe control condition. These extra trials were necessary in order to better balance within an experimental session the percentage of trials where a "No" response was correct. Trials where an out-of-paragraph probe was presented were the only trials where a "No" response was correct; without the additional 24 trials in this condition, only 25% of the trials presented during an experimental session would have required a "No" response. With the inclusion of the extra trials, the percentage of "No" trials presented during an experimental session increased to 40% (48 of 120 total experimental trials). It was felt that this percentage was sufficient to avoid the development of a "Yes" response bias, without making the duration of the experiment so great as to result in significant subject fatigue. The extra trials were not included in the final data analysis.

In summary, a subject received a total of 130 trials during the course of the experiment. The first ten of these trials were practice. Twenty-four of the remaining 120 trials were filler trials which helped to balance the number of correct "Yes" and "No" probe responses. Neither the practice trials or the filler trials were included in the final data analysis. The
remaining 96 trials formed the basis for the data analysis, with two trials per each of the forty-eight combinations of experimental conditions. Of these 96 trials, only data from those trials where the subject responded correctly to the probe recognition task were included in the final data analysis. If a subject responded incorrectly to both trials within the same condition, the subject was replaced. With the exception of the practice trials, order of presentation was random for each subject. The same random order was used for displaying the practice trials for each subject.

Results

Four separate analyses were conducted on the results of Experiment 2. The data for these analyses were the median RTs for each condition for each subject. The first analysis was an overall analysis on the raw data.

The second analysis was on the difference scores obtained by subtracting the reaction times for the referent and companion probes from the RT for the in-paragraph probes, for each level of the close/far factor and only for paragraphs where the last sentence contained an anaphor. These difference scores represent the amount of advantage in RT for probes which are (1) located in the anaphor-containing paragraph and (2) are
located in the referent-containing sentence, as compared to probes which are (1) located in the anaphor-containing paragraph, but (2) are not located in the referent-containing sentence. Thus, in this comparison, different probes are compared (i.e., the in-paragraph controls with the referent or companion probes) under the same context (i.e., in the anaphor-containing context).

The third analysis separately considered data in the close and far conditions, with the data for the in-paragraph control and out-of-paragraph "no" probes excluded. The analysis for the far condition is the same analysis as conducted by Dell, McKoon, and Ratcliff (1983), and thus will allow a very direct comparison with the results of that study.

The fourth analysis looked at the error rates across the various experimental conditions.

Overall Analysis

There was a significant effect of the close/far factor, $F(1,47) = 22.79$, $p < .00001$. Probes were responded to 37 msec faster in the close condition.

There was a significant effect of the type of probe displayed, $F(3,141) = 15.50$, $p < .00001$. A Newman-Keuls procedure revealed that subjects were faster overall when the referent probe was used than when any of the
other three probes was displayed, minimum \( q(2, 141) = 6.87, p < .01 \), but did not differ among the three remaining probes, \( p > .05 \). Subjects had an average RT of 968 msec to the referent probe, and an average RT of 1045 msec across the remaining three probes.

There was a reliable effect of probe location, \( F(2, 94) = 7.35, p < .001 \). A Newman-Keuls procedure showed that subjects responded slowest when the probe was located two words past the anaphor or control item than when it was immediately before or immediately after this item, minimum \( q(2, 141) = 3.97, p < .01 \). Overall RT did not differ between the immediately-before and immediately-after levels, \( q > .05 \). Overall, the mean RTs for the immediately-before, immediately-after, and two-words-after levels were 1016 msec, 1006 msec, and 1047 msec, respectively.

Finally, an interaction was obtained between probe type and the close/far condition, \( F = 6.44, p < .0004 \). This interaction was largely due to a significant difference for the companion probe between the close and far conditions, \( F(1, 47) = 25.6, p < .00001 \), with a mean RT in the close condition of 984 msec and a mean RT in the far condition of 1085 msec. In addition, a similar (but smaller) effect was obtained for the in-paragraph control probe, \( F(1, 47) = 4.47, p < .04 \), with a
mean RT of 1039 msec in the close condition and a mean 
RT of 1071 msec in the far condition.

The lack of a triple interaction between probe type, 
final sentence type (anaphor-containing or control-
containing), and probe location (also found by Dell, 
McKoon, & Ratcliff, 1983) suggests that there is no 
difference in identifying a referent or companion probe 
as a function of the probe being presented before or after the referent's anaphor. However, it may be that 
such a difference does exist, but is masked by global 
effects which would be present for any word in the 
story which is used as a probe item.

To investigate this, a separate analysis was 
performed using the in-paragraph control condition 
probes. These control probes should be subject to the 
same global effects (if present) as the anaphor and 
companion probes (e.g., lexical access time, 
intrasentence integration, etc.). However, the control 
probes should not be effected by those effects which are 
unique to recognizing the anaphor or companion probes. 

In-Paragraph Control Analysis

In this analysis, only data in the anaphor-
containing final sentence condition was used, and 
separate analyses were conducted for the close and far 
conditions. Because the close and far conditions
represent different contexts (i.e., the referent-containing sentence is in different locations in the two conditions), separate analyses within each condition will allow a comparison of RTs to the probes within the same context. Thus, all analyses of data obtained in the close condition are analyses of data obtained in the same context. Likewise, all analyses of data obtained solely in the far condition are analyses of data obtained in the same context (but in a context different from that in the close condition).

In addition, the data for the referent and companion conditions were subtracted from the corresponding in-paragraph control values for each probe position. This was done in order to test the possibility that there was a differential availability due to probe type of the referent and companion probes over the availability of other probed words in the paragraph.

Thus, each data point represented the net advantage for a referent or companion probe as compared to a non-referent, non-companion, but in-paragraph probe. It is this data which is the basis of the following analyses.

For the data in the close condition, a reliable effect of the mean was found, $F(1,47) = 16.17, p < .0002$. This finding is not trivial; it indicates that an overall effect for the referent and companion probes
when compared with the in-paragraph control probes was found. However, no other reliable effects were obtained (p > .05). The data are illustrated in Figure 2.

Subsequent t-tests indicated that the effect of the mean (i.e., an overall advantage) was localized at the probe location immediately following the anaphor, $t(47) = 2.57, p < .01$, and at the position two words past the anaphor, $t(47) = 2.06, p < .025$. No advantage was obtained at the position immediately preceding the anaphor, $t < 1$. In addition, no reliable differences between the referent and the companion were found at any of the probe locations. Thus, these data suggest that a referent and a word in the referent-containing sentence are recognized equally well when the referent-containing sentence immediately precedes the anaphor-containing sentence.

For the data in the far condition, a main effect of the mean was again found, $F(1,47) = 5.35, p < .02$. In addition, a main effect of probe type was obtained, $F(1,47) = 17.30, p < .0001$, and a main effect of probe location, $F(1,47) = 5.04, p < .008$. The probe type by probe location interaction was not significant ($F < 1$). The data are shown in Figure 3.

As can be seen, referent probes have a greater recognition advantage than companions across all three
Figure 2. Advantage Times in the Close Condition of Experiment 2
Figure 3. Advantage Times in the Far Condition of Experiment 2
However, subsequent $t$-tests indicated that this advantage difference was only present when the referent probe was presented immediately after the anaphor, $t(47) = 3.21, p < .005$, and when the referent probe was presented two words past the anaphor, $t(47) = 2.77, p < .005$. No advantage difference was found when the probes were presented immediately before the anaphor, $t(47) = 1.33, p > .05$. In fact, no overall advantage was obtained for either the referent or the companion when they were presented immediately before the anaphor, $t(47) = 1.24, p > .05$.

This latter result suggests that no advantage might be obtained for the companion probe in the far condition at any probe location. To investigate this, an analysis was conducted only on the advantage data for the companion probes in the far condition.

The results of this analysis indicated that there was no overall advantage for the companion probe $F(1,47) = .02$, and no effect of probe location, $F(1,47) = 1.50, p > .05$. This suggests that in the far condition, words in the referent-containing sentence are not recognized any better than words not in the referent-containing sentence (but in the paragraph). This is contrary to the prediction of the model proposed in the Introduction.
Separate Close and Far Data Analyses

These analyses separately considered data in the close and far conditions, with the data for the in-paragraph control and out-of-paragraph "no" probes excluded. The analysis for the far data is the same analysis as conducted by Dell, McKoon, and Ratcliff (1983).

The results of the close data analysis showed a main effect of probe location, $F(2, 94) = 5.24, p < .007$. A Newman-Keuls procedure revealed that probes were recognized reliably faster when presented immediately after the anaphor or control than two words past this item, $q(3, 94) = 4.57, p < .01$. No other comparisons were reliable ($p > .05$). In addition, no other effects were significant ($p > .15$). In particular, referent and companion probes were recognized equally fast within each probed location and regardless of the type of last sentence displayed (anaphor or anaphor-control). The means are displayed in Figure 4.

The results of the far data analysis showed a main effect for probe type, $F(1, 47) = 8.05, p < .006$, with referent probes being recognized an average of 112 msec quicker than companion probes. No other effects were significant ($p > .05$). The means are presented in Figure 5.
Figure 4. Reaction Times in the Close Condition of Experiment 2
Figure 5. Reaction Times in the Far Condition of Experiment 2
Because the far condition of the current experiment was comparable to Experiment 2 of Dell, McKoon, and Ratcliff (1983), it is important to note any discrepancies between the results of that experiment and the current experiment. In Experiment 2 of Dell et. al. (1983), a significant effect of last sentence type (i.e., anaphor-containing or anaphor-control) was found. In the present analysis, this effect was not significant ($F(1,47) = 1.14, p < .29$), but was in the same direction, with an advantage for the anaphor-containing last sentence. Similarly, Dell et al. (1983) obtained an interaction between the anaphor/control last sentence type condition and probe location which was close to significance in the current study, $F(2,94) = 2.29, p < .10$.

Nonetheless, an important difference does exist in the pattern of results in the two studies. This pattern for each study is presented in Table 3.

The most important difference in the two patterns is in the data for the companion probe when presented in an anaphor-containing last sentence. In Dell et al. (1983), the absolute difference for the companion probe between probe location one (immediately before the anaphor) and two (immediately after the anaphor) is 16 msec. In the current study, this absolute difference
### TABLE 3

Data obtained by Dell et al. (1983) and Experiment 2

<table>
<thead>
<tr>
<th>Position of Probe Relative to the Position of the Anaphor or Control</th>
<th>Immediately Before</th>
<th>Immediately After</th>
<th>Two Words After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referent in Text Containing an Anaphor</td>
<td>653</td>
<td>643</td>
<td>591</td>
</tr>
<tr>
<td>Referent in Text Containing a Control Item</td>
<td>650</td>
<td>684</td>
<td>626</td>
</tr>
<tr>
<td>Companion in Text Containing an Anaphor</td>
<td>721</td>
<td>705</td>
<td>----</td>
</tr>
<tr>
<td>Companion in Text Containing a Control Item</td>
<td>720</td>
<td>737</td>
<td>----</td>
</tr>
</tbody>
</table>

Dell, McKoon, and Ratcliff, 1983

| Referent in Text Containing an Anaphor                              | 1010               | 924              | 970             |
| Referent in Text Containing a Control Item                           | 972                | 1002             | 967             |
| Companion in Text Containing an Anaphor                              | 1072               | 1068             | 1081            |
| Companion in Text Containing a Control Item                          | 1087               | 1124             | 1080            |

Experiment 2
was 4 msec. In more comparable terms, the corresponding percentage change in Dell et al. (1983) is 2%, whereas in the current study it is .3%. More will be said of this difference in the Discussion.

Error Rate Analysis

The overall error rate in Experiment 2 was 3.5%. Despite this low rate, an Analysis of Variance revealed several reliable effects.

A significant effect of the close/far factor was obtained, $F(1,47) = 5.15$, $p < .00001$. Subjects made fewer errors in the close condition (2%) than in the far condition (6%).

A reliable effect of the type of probe was found, $F(3,141) = 12.84$, $p < .00001$. A Newman-Keuls procedure revealed that the referent and out-of-paragraph probes did not differ ($p > .05$), and the companion and in-paragraph probes did not differ ($p > .05$), but these two probe groups did differ, minimum $q(2,141) = 7.29$, $p < .01$. The average error rate of the referent and out-of-paragraph probe group was 2%, and the average error rate of the companion and in-paragraph probe group was 5%.

The effect of probe location was significant, $F(2,94) = 5.90$, $p < .003$. A Newman-Keuls procedure indicated that subject's error rates did not differ when
the probe was presented immediately before or immediately after the anaphor or control item, $p > .10$, but did differ between these two locations and the two-words-after location, minimum $q(2,94) = 3.125$, $p < .05$. Subjects had an error rate of 2.6% for probes presented before the anaphor or control item, 3.25% when presented after this item, and 5% when presented two words past the anaphor or control item.

Of particular interest is the finding of a triple interaction between close/far, type of probe, and the anaphor/control last sentence type variable, $F(3,141) = 3.16$, $p < .02$. In the close condition, the error rate was uniform across the anaphor/control variable for each of the probe types with the exception of the out-of-paragraph control probes, which were recognized more accurately when the last sentence contained a control item (0.5% error rate) than when the last sentence contained an anaphor (4% error rate). Overall in the close condition, referent probes were recognized best (1% error rate), with the companions next (3% error rate), and the in-paragraph control probes worst at 7%.

In the far condition, a different pattern emerged. Referent probes were again recognized best overall at a 2% error rate, but this rate was lower when the final, probed sentence contained an anaphor (1% error rate)
than when it contained a control item (3% error rate).

However, for the companion probes, the pattern was just the opposite: When the final sentence contained an anaphor, the error rate for the companion probe was 8%, but when the final sentence contained a control item, the error rate was 5%. For the in-paragraph probe, the error rate was 5% in the anaphor-containing context and 6% in the anaphor-control last sentence context.

Thus, in the close condition, error rates did not differ as a function of the type of last sentence presented (anaphor-containing or anaphor-control). However, in the far condition, error rates were smaller for the referent probe when the anaphor was present, but were actually larger for the companion probe when the anaphor was present.

Discussion

The results of Experiment 2 were quite surprising. The model's predictions for the close condition were, for the most part, supported. However, the results of the far condition suggest a major revision in the model.

In the close condition, the model suggested that the words in the referent-containing sentence are available to the reader in immediate memory as separate units. Hence, the model predicted no main effect of probe type
in the close condition for the referent and companion probes, since each of these probes should be equally available as separate word units. For the same reasons, the model also predicted no interaction between probe type (referent or companion) and probe location or last sentence type (anaphor-containing or anaphor-control).

As can be seen in Figure 2, there was no difference in the advantages obtained by the referent probe and the companion probe when compared with the RT for the in-paragraph control probe. In addition, as indicated by Figure 4 and the analysis of the means presented in that figure, referent and companion probe RTs did not reliably differ across probe location or last sentence type.

This result indicates that subjects are indeed accessing a single word level, unintegrated representation of the referent-containing sentence. Thus, this assumption of the model is supported.

A second prediction of the model when applied to the close condition of Experiment 2 is that subjects should be quicker at recognizing the referent or the companion probe when the probe is presented after an anaphor than when it is presented after a control item. This effect would be because the presence of the anaphor would initially direct the reader's cognitive processes to the
immediately preceding sentence, whereas the presence of a control item would have no effect on the direction of these processes.

However, as seen in Figure 4 at the immediately-after probe location, both anaphor and companion probes were recognized equally well regardless of whether the preceding word was an anaphor or a control item. A possible explanation of this finding is that in a probe recognition task, a subject always first considers those items which are immediately available in memory. In the close case, the model would predict that those items would be the referent-containing sentence in a word-by-word representation.

The data presented in Figure 2 also would appear to support this explanation. In the immediately-after probe location, subjects recognized a referent or companion probe quicker than the in-paragraph control probe. This in-paragraph control probe was in the first sentence in the close condition, and hence would not be located until after the initial check of immediate memory, i.e., after the initial check of the referent-containing sentence.

It may be argued that this explanation fails to account for the equivalency of the RTs for the referent, companion, and in-paragraph control probes
when they are presented immediately before the anaphor (See Figure 2). One possible reply to this argument is that the effect of searching immediate memory first does not show up at this presentation position because of the initial "start-up" effects of reading a sentence, which may tend to inhibit the initial search of immediate memory.

However, the reliable increase in RT to the referent and companion probes in the two-words-after probe location (See Figure 4) would also seem to argue against the suggestion that subjects always do an initial search of the material available in immediate memory when a probe is presented. This is because a clear implication of this suggestion is that RTs to probes present in immediate memory should not differ across probe location.

One possible explanation of this finding is that by the time the two-words-after probe location is encountered, the cognitive resources available for the probe recognition task are decreased due to the use of these resources by text integration processes (cf. Daneman & Green, 1986). This decrease in the amount of available cognitive resources slows down the immediate memory search process.
In the far condition, the model hypothesized that a referent probe would be recognized quicker if it was presented after an anaphor or two words past the anaphor than if it was displayed immediately before the presentation of the anaphor. This is because the referent would be not be associated with the anaphor prior to the presentation of the anaphor, but would be associated once the anaphor had been read.

This hypothesis was supported in Experiment 2. As Figure 3 shows, a referent probe was recognized quicker than the in-paragraph probe when it was presented immediately after, or two words after, the anaphor. This is despite the fact that the in-paragraph probe in the far condition was always temporally closer to the anaphor than was the referent (i.e., in the far condition, the in-paragraph probe item was always in the second sentence of the paragraph, and the referent was always in the first sentence).

In addition, the referent and in-paragraph probe did not differ in RT in the far condition when presented before the anaphor. Furthermore, the referent probe was recognized quicker overall when presented after the anaphor, or two words past the anaphor, then when it was presented before the anaphor or immediately after a control item (see Figure 5).
These results clearly support the model. Where the model predicted an advantage should be found for recognizing the referent probe (immediately after and two words past the anaphor), an advantage was found. Conversely, where no advantage was predicted (before the anaphor or after a control item), no advantage was obtained.

However, in the two-words-after probe location, the referent was recognized equally fast in both the anaphor-containing and anaphor-control last sentence contexts. This was not predicted by the model.

An examination of the error data suggests that this finding in the far condition may have been due to a speed/accuracy tradeoff: In the anaphor-containing last sentence context, a referent probe presented two words past the anaphor was not recognized only 2% of the time. However, when the referent was presented two words past a control item, the error rate increased to 6.5%. Thus, the referent probe may have been recognized just as quickly two words past the control item as it was two words past the anaphor, but it was recognized much less often as well.

Unlike the data for the referent probe, the data for the companion probe in the far condition do not support the model's predictions for this condition. In
particular, the prediction that the availability of a companion word is increased when the companion word is probed immediately after the presentation of the anaphor was not supported.

For example, Figure 3 and the analysis of the data presented in that figure indicate that the companion was not recognized any better than the in-paragraph control probe at any of the three probed locations. In addition, inspection of Figure 5 shows that in the anaphor-containing context, the companion was recognized only 3 msec faster when presented after the anaphor than when it was presented before the anaphor, and was actually recognized 10 msec slower when presented two words after the anaphor than immediately before it.

Moreover, the error data also do not agree with the models' predictions for the companion probe presented in the far condition. The error rate for the companion probe in the anaphor context was 6.5% when the companion was presented before the anaphor, and increased to 8.5% when the companion was presented immediately after the anaphor. It increased further to 9.5% when the companion was presented two words past the anaphor. In contrast, the same data for the referent probe was 1%, 0%, and 2%, respectively.
Thus, the companion probe was no more available when presented after the anaphor had been displayed than when presented before the anaphor had been displayed. This is contrary to the predictions of the model presented in the Introduction.

The above results for the companion also are contradictory to those obtained by Dell, McKoon, and Ratcliff (1983). In that study, the authors concluded that the companion did have greater availability when it was presented immediately after, and several words past, the anaphor. Table 3 shows the Dell et al. (1983) data and the comparable data obtained in the current experiment.

The most important difference in the data obtained in the two experiments is in the data obtained for the companion probe in the anaphor context. These values are presented in Table 3. As is apparent, Dell et al. (1983) found a decrease of 16 msec in RT to the companion probe when it was presented immediately after the anaphor as opposed to when it was presented immediately before the anaphor. This is a change of 2%. In the present study, the similar decrease was 4 msec, which was only .3% (i.e., three tenths of a percent). The key percentage difference is quite large, almost a factor of 10. An inspection of the stimuli used in both
studies suggest a possible explanation of this difference.

With the obvious exception of the exact words used in each story, the stimuli were identical except for the anaphor-control sentences. In Dell, McKoon, and Ratcliff (1983), the anaphor-control sentences differed from the anaphor-containing sentences not only in the presence of a control item instead of an anaphor, but also in the article which began the sentence. For example, one anaphor-containing sentence was The criminal slipped away from the street lamp. The corresponding anaphor-control sentence was A cat slipped away from the street lamp. Thus, not only was the anaphor (for the referent burglar) changed from criminal to the control item cat, but the definite article the was changed to the indefinite article a. In the current study, the definite article the was always used, as in the anaphor-containing sentence The insect did not like afternoons (referent is grasshopper), and in the corresponding anaphor-control sentence The police did not like afternoons.

Dell et al. (1983) point out that RTs to probes presented immediately before the anaphor or immediately before the control item did not differ in their study, suggesting that changing the initial word from the to a
did not have any effect on the anaphoric process. However, it may be that the effect of the change in initial articles was not related to the anaphoric process per se, but rather to the development of a strategy by the subject.

In particular, a subject in Dell et al. (1983) would know that an anaphor was going to be presented as soon as the initial article The was displayed, since The was the initial word in the final sentence of the story only when the sentence contained an anaphor. Furthermore, since the referent in Dell et al. (1983) was always in the first sentence of the story (i.e., they only used the "far" manipulation), the subject would know that a word in the first sentence would be used as a referent before the "referencing" anaphor was encountered.

As a result, the subject may have started (but not necessarily completed) the recall of the entire first sentence before the anaphor was presented, thereby decreasing the RT to not only the referent but also to the companion when it was presented after the anaphor (when recall likely would have been completed). Thus, the results of Dell et al. (1983) for the companion probe may be due to the development of a stimulus-induced subject strategy which could not have occurred in Experiment 2 of this study.
Since the companion does not seem to have been more available to a subject after the anaphor had been presented, the assumption that the entire proposition is retrieved in the far condition must be questioned. However, this assumption may not need to be abandoned, but rather modified.

It is possible that the referent-containing proposition is associated with the anaphor-containing proposition after the anaphor is read, but that the proposition's contents are not immediately available. That is, some type of association may have occurred at the time the anaphor was read, but this association (in the far condition) did not immediately render the contents of the referent-containing sentence available at an individual word level.

For example, after encountering an anaphor, the reader may search for the corresponding referent, and after finding it, only associate the address of the generic concept of the referent or the referent-containing proposition. This address is directly linked to the referent (at least, in the stories used in Experiment 2, where the referent was also the subject of the referent-containing clause), and thereby the referent is more easily accessible.
However, the other members of the referent-containing sentence are not available. This lack of availability may be because clausal decomposition naturally occurs only at sentence wrap-up (Just & Carpenter, 1980), i.e., at the end of a sentence. This lack of availability may also be due to the nature of text integration processes, wherein the gist of a sentence which was read sometime back may be retained but not the exact wording (cf. Johnson, Bransford, & Solomon, 1973; Harris, 1974).

Thus, in the far condition, the referent would be more available immediately after the anaphor is read, but other members of the same sentence would not be more available. These are, of course, the results obtained in Experiment 2.

In summary, the results of Experiment 2 indicate that Assumption Two of the model proposed in the Introduction is correct. Both referent and companion probes were recognized equally fast when no clauses intervened between the referent-containing clause and the anaphor-containing clause. This would be expected if they were directly available as single lexical entries, as hypothesized by Assumption Two.

However, the results of Experiment 2 for the case where the referent-containing and anaphor-containing
clauses are separated by at least one intervening clause (i.e., in the far condition) argue against Assumption One of the model. Nonreferent items in the referent-containing clause (i.e., companion probes) were not recognized faster than nonreferent items which were not in the referent-containing clause (i.e., in-paragraph control probes). In addition, companion probes were not recognized any faster when they were presented after the anaphor had been displayed than when they were presented before the anaphor had been displayed. Although this is not conclusive evidence that the entire referent-containing clause is not retrieved in the far case (the basic tenet of Assumption One), it does show that only the referent is more available immediately after its anaphor has been read.
CHAPTER IV
Experiment 3

Introduction

Experiment 3 investigated the effect on referent location time of the relatedness of the referent-containing clause to the theme of the story in which it is embedded. The theme of a story is defined as the concept which is most often referred to (directly or indirectly) by the clauses contained in the story. This definition is essentially identical to that of Kintsch & Van Dijk (1979), who argue that the theme of a story is the concept shared most often by the arguments of the propositions which make up the story.

Given this definition of theme, a clause can be defined as related to the theme of a story if the clause requires the instantiation of the thematic concept in order to be understood. For example, in the sentence pair Jack's hand was big. The fingers were quite long., the theme of the story is Jack's hand, because it is referred to directly in the first sentence and is
indirectly referred to in the second sentence by the noun phrase the fingers. Conversely, the second sentence is related to the theme of the story because the theme Jack's hand must be instantiated in some form in order to correctly understand the noun phrase the fingers.

In terms of the theory presented in the Introduction, theme and relatedness become important when the initial search of the clause which immediately precedes the anaphor-containing clause fails to identify a referent. When this occurs, the theory hypothesizes that the subsequent referent search is guided by the thematic relatedness of the remaining clauses.

The most thematically related clause (i.e., the topic clause) is searched first. If this clause does not contain the referent (i.e., the referent search fails), then the next most thematically related clause is searched, and so on. Hence, the more related the referent-containing clause is to the discourse theme, the faster it will be located and the referent identified.

As mentioned, this effect of thematicity is suggested to occur when the referent is not located in the clause which immediately precedes the anaphor-containing clause. Conversely, when the referent is located in the clause which immediately precedes the
anaphor-containing clause, the thematic relatedness of previous clauses is hypothesized to have no effect on referent locating time. Experiment 3 was designed to investigate these hypotheses.

However, it would be inappropriate to test these hypotheses by only considering the data obtained when an anaphor was present in the story. It is possible that processes common to reading any sentence presented within a text (e.g., lexical access, intrasentence integration, etc.) could effectively obscure those processes which are exclusively associated with anaphoric reference (e.g., locating a referent, integrating the referent and the anaphor, etc.).

For example, it is possible that certain global effects, such as lexical access and intraclausal integration, affect the dependent measures used in Experiment 3 (i.e., reading time) in a manner opposite to the effects of anaphoric resolution. The net result would be the appearance of no effect of anaphoric reference on reading time, when such an effect was, in fact, present.

These global effects, although of potential interest, are not the primary concern of Experiment 3. Consequently, for each anaphor-containing sentence an anaphor-control sentence was developed. These anaphor-
These global effects, although of potential interest, are not the primary concern of Experiment 3. Consequently, for each anaphor-containing sentence an anaphor-control sentence was developed. These anaphor-control sentences were similar to those used in Experiment 2: They only differed from the anaphor-containing sentence in that a control item replaced the anaphor. By analyzing the differences in reading times between the anaphor-containing and anaphor-control conditions, the unique effects of anaphoric reference should become evident.

Method

Subjects

Forty-eight subjects received credit in partial fulfillment of a course requirement for an Introductory Psychology course. All the subjects in this experiment were native speakers of English, and had normal or corrected to normal vision.

Stimuli

The set of ninety-six stories used for the final data analysis in Experiment 2 formed the basis of the
filler sentences but was unrelated to the meaning of the critical anaphor or referent. This third filler sentence was added in order to accentuate the unrelatedness of the theme of the story to the meaning of the anaphor or referent.

The resulting set of 48 stories were each five sentences in length and had a theme which was unrelated to the meaning of the critical anaphor or referent. These stories were denoted as members of the nontheme condition.

For each member of this set of nontheme stories, a new set of three filler sentences was constructed. These new filler sentences were constructed such that they were thematically related to the critical referent (and thereby to the critical anaphor). The 48 stories which incorporated these filler sentences with the corresponding anaphor and referent-containing sentences were denoted as members of the theme condition.

Thus, a total of 96 stories with 96 different themes were constructed. In addition, the nontheme and theme conditions were crossed with the factor of anaphor-referent distance. The anaphor-containing sentence was always the last sentence of the story. However, the referent-containing sentence could be the first sentence of the story (far anaphor-referent distance) or the
fourth sentence of the story (close anaphor-referent distance).

As in Experiment 2, the last sentence of each story could be one of two types. The last sentence could either be the anaphor-containing sentence as described previously, or a anaphor-control sentence. The anaphor-control sentences were the same as those used in Experiment 2; they were formed by replacing the anaphor in the anaphor-containing sentences with a word that maintained the cohesiveness of the story but did not refer directly to any word in the story.

Thus, a subject could be presented with one of eight story types. The eight types were formed by the crossing of the theme/nontheme, close/far anaphor-referent distance, and anaphor-containing/anaphor-control last sentence factors.

Examples of the eight types of stories are presented in Table 4. A listing of all the stimuli used in Experiment 3 can be found in appendix F.

In addition to the stories, a set of yes/no comprehension questions were constructed. In the theme condition, half of these questions required information from one or two of the filler sentences in order to be answered correctly. The other half of the questions required the integration of information from the
TABLE 4

Examples of the Stimuli Used in Experiment 3

1. Story Conditions

A. Theme, Far Condition

A saloon was somehow left intact.
Old bottles lined the wall.
Only one door still worked.
The tables were covered with dust.

B. Theme, Close Condition

Old bottles lined the wall.
Only one door still worked.
The tables were covered with dust.
A saloon was somehow left intact.

C. Nontheme, Far Condition

A saloon was somehow left intact.
The ghost town had been flooded.
The center of the city was all mud.
A bulldozer would be needed to clear the mess.

D. Nontheme, Close Condition

The ghost town had been flooded.
The center of the city was all mud.
A bulldozer would be needed to clear the mess.
A saloon was somehow left intact.

In all four cases, the referent is **saloon**.

2. Fifth Sentences

Anaphor-containing Sentence: The **bar** had been well protected.

Anaphor-control Sentence: The **area** had been well protected.
referent-containing sentence and one other sentence (but not the anaphor-containing sentence) from the story in order to be answered correctly.

The anaphor-containing sentence was never the other sentence for two reasons: (a) In order to equate question difficulty, the same questions were used within the theme condition for both the anaphor-containing and anaphor-control last sentence story conditions, and hence, an anaphor-containing last sentence was not always present, and (b) the presence of questions only requiring integration of information from the referent and anaphor-containing sentences could result in an unusual processing of the relationship between those sentences in later stories.

Unfortunately, it was virtually impossible to construct questions for the nontheme condition using the method described above. This is because the only sentence in the nontheme stories related to the referent-containing sentence was the anaphor-containing sentence (when present). Hence, comprehension questions for stories presented in the nontheme condition involved the integration of material contained in one or two of the filler sentences in each story.
Procedure

Subjects were read the following instructions:

In this experiment, you will read a series of stories. Each story is five sentences in length.

First, you will see the prompt 'Press Spacebar When Ready' (experimenter points to prompt on screen). When you press the spacebar, the screen will go blank. When you press the spacebar again, the first word of the first sentence will be displayed.

I would like you to read that word silently to yourself. When you are done, you should press the spacebar again, and the second word of the story will be displayed next to the first word. Read that word, and when you are done, press the spacebar. The third word of the story will then be displayed next to the second word.

This process will continue until the entire first sentence is displayed on the screen. At that point, when you press the spacebar, the screen will clear.

When the spacebar is pressed again, the first word of the second sentence will appear, and it will be displayed where the first word of the first sentence had been presented. The next press will
display the second word of the second sentence, and so on.

This process will continue until the last word of the last sentence of the story is presented. As usual, the next press of the spacebar will clear the screen.

The next time the spacebar is pressed, a row of asterisks will be displayed, and this is to warn you that the comprehension question is coming up. When you press the spacebar again, the row of asterisks will be replaced by the entire comprehension question.

If the answer to this question, based on the story, is 'Yes', you should press the 'Y' key (experimenter points to key labeled 'Y'). If the answer is 'No', you should press the 'N' key (experimenter points to key labeled 'N').

When you do that, the computer will tell you if you are correct or not, a slight delay may ensue, and then the prompt 'Press Spacebar When Ready' will reappear, and you'll be all set for the next story.

Do you have any questions?

The first of ten practice trials were then presented. Each trial began with the appearance of the
prompt "Press Spacebar When Ready" centered on the CRT screen. The subject would then press the spacebar, and the screen would go blank.

The next press of the spacebar displayed the first word of the first sentence of the story. Each subsequent press displayed one additional word in the sentence (separated from the previous word by one character space) until the entire first sentence was displayed.

The next press cleared the screen. The following press of the spacebar presented the first word of the second sentence in the same location as the first word of the first sentence.

Presentation of the remaining words in this sentence and the words in the third and fourth sentences in the story preceded in the same manner as described for the first sentence.

From the subject's viewpoint, the presentation of the last sentence of the story was identical to the presentation of the preceding four sentences. However, a timer was started when the subject pressed the spacebar to display the second word (i.e., the anaphor or the control word) in the last sentence. This timer stopped when the spacebar was pressed again. The time measured by this timer was denoted as the reading time.
for the anaphor/control word.

In a similar manner, the reading time was measured for the third word (i.e., the word following the anaphor/control word) in the last sentence of the story. The reading time of this word was measured because processes related to anaphoric reference may occur during the reading of the word which follows the anaphor (cf. Ehrlich & Rayner, 1983).

The first press of the spacebar after the presentation of the final word in the final sentence of the story blanked the screen. The "reading" time of this blank period was measured, together with the reading time of the last word in the story.

The reading time of the last word in the story was measured due to the possibility of anaphora-related effects occurring during the "end-of-sentence" wrap-up period (Just & Carpenter, 1980). The blank period was measured because it was felt that the end-of-sentence wrap-up process might extend into this time period.

The next press of the spacebar displayed a row of asterisks which signaled that the next press would display the comprehension question. The subsequent press displayed the comprehension question, to which the subject responded by pressing the "z" or "/" key (labeled 'Y' and 'N', respectively, during the
experiment).

After responding to the question, a message indicating whether the response was correct appeared on the screen. A slight delay then ensued as the reading time for the anaphor/control word, the word following the anaphor/control word, the last word in the last sentence, and the blank interval following the last sentence, were recorded.

The screen was then cleared, and the prompt "Press Spacebar When Ready" was presented. The next trial was now ready to begin. The above process was repeated for each trial. The entire experiment took approximately 50 minutes.

Design

Three experimental factors were varied during the course of the experiment. These factors were story type (theme or nontheme), anaphor-referent distance (close or far), and last sentence type (anaphor-containing or anaphor-control). The crossing of these factors resulted in a total of eight presentation conditions.

Each subject received a total of 58 trials in an experimental session. The first ten trials were practice trials and were not included in any data analysis.
Of the remaining 48 trials, six trials were devoted to each of the eight presentation conditions. Half of these six trials used comprehension questions which required a "yes" response, while the remaining half used questions which required a "no" response. The four reading times for a trial were not included in the final data analysis unless the comprehension question for that trial was answered correctly.

The presentation order for the 48 experimental trials was random, with a different random order used for each subject. The practice trials were presented to each subject in the same random order. Across subjects, each story appeared equally often in each of the eight presentation conditions.

Results

Two analyses were conducted on the results of Experiment 3. One of these analyses was on the error data.

The other analysis was performed on a set of transformed data. These data consisted of the difference scores between a data point obtained in the context of an anaphor-containing sentence and the data point obtained in the context of a corresponding anaphor-control sentence.
Consequently, these data represent the amount of the advantage (or disadvantage) in reading time for (a) the anaphor, (b) the word right after the anaphor, (c) the last word in an anaphor-containing sentence, and (d) the blank period between the presentation of the last word in the story and the comprehension question warning cue, when these four timed events occurred in an anaphor-containing context as opposed to an anaphor-control context. As discussed in the Introduction to Experiment 3, this analysis effectively isolates the direct effects of the anaphor on reading time from other variables which might influence reading time, such as lexical access, intra-sentence structure formation, etc.

**Transformed Data Analysis**

As noted above, the data used in these analyses were the difference scores obtained by subtracting reading times obtained in the anaphor-containing context from the corresponding reading times found in the anaphor-control context. In such a transformation, the effect of the mean indicates whether some advantage in some condition was found for the reading times of words presented in the anaphor-containing context. Such an effect was found, $F(1,47) = 6.63$, $p < .01$. The means are presented in Figure 6.
Figure 6. Advantage Times in Experiment 3
An effect of story type was obtained, $F(1,47) = 9.09, p < .004$. There was a 34 msecs. advantage when the story's theme was related to the referent. However, there also was an interaction between this effect and the position of the event being timed, $F(3,141) = 5.23, p < .002$. The theme condition had a reliable advantage of 18 msecs. when the position timed was the word following the anaphor/control item, $F(1,47) = 6.21, p < .01$, and an advantage of 94 msecs. when the position timed was the last word in the story, $F(1,47) = 8.81, p < .004$. This finding suggests that the presence of an anaphor which is related to the theme of the story decreases the amount of time involved in processing the word following the anaphor, and the time required to conduct an "end of sentence" wrap-up (cf. Just & Carpenter, 1980).

Most importantly, there was a triple interaction between the theme/nontheme, position timed, and close/far conditions, $F(3,141) = 3.65, p < .01$. This effect was due to an interaction between the theme/nontheme and close/far factors when the position timed was the last word in the story, $F(1,47) = 3.86, p = .055$. This interaction did not approach reliability for the other three timed positions (largest $F < .07$).
A Newman-Keuls procedure on this interaction for the last word in the story revealed an advantage for this word in the theme-far condition when compared to (a) the theme-close condition ($q(2,47) = 8.21, p < .01$), (b) the nontheme-far condition ($q(3,47) = 8.78, p < .01$), and (c) the nontheme-close condition ($q(4,47) = 9.14, p < .01$). No other comparisons were reliable ($q < 1$). Thus, effects appeared only for the last word in the story, and subjects performed better in the theme-far condition than in the theme-close condition (contrary to the predictions of the model).

A final effect obtained in the overall analysis of the transformed data was an interaction between the position timed and the close/far manipulation, $F(3,141) = 9.75, p < .00001$. For the end-of-story timed position, subjects had an advantage time in the far condition which was 83 msecs. greater than the comparable advantage time in the close condition, $F(1,47) = 5.23, p < .02$.

However, when the timed position was the blank period which followed the last word in the story, the close condition had an advantage time which was 78 msec. greater than the corresponding time in the far condition, $F(1,47) = 10.98, p < .001$. No effect of the close/far manipulation was obtained for the remaining
two timed positions (See Figure 6).

The results of the overall analysis of the transformed data indicate that the majority of effects occurred during the processing of the last word in the story and the blank period which followed. Very few effects were reliable for the anaphor and one-word-past the anaphor reading times. Because of these apparent groupings, a separate analysis was conducted for the transformed data obtained from the reading times of the anaphor and the word which followed, and for the last word in the story and the blank period which followed.

Due to the post hoc nature of these analyses, their results can only be considered suggestive (Winer, 1971). Nevertheless, these results should be informative.

In the analysis of the reading times of the anaphor and the word which followed the anaphor, only an interaction between story type and timed position was obtained, $F(1,47) = 3.36$. Inspection of Figure 6 clearly shows that this result was due to a larger advantage time of 13.5 msecs. in the theme condition for the reading time of the word which followed the anaphor. No other effects were reliable ($p > .14$). In particular, no effects for the reading time of the anaphor were found.
In the analysis of the last word in the story and the blank period which followed, several effects were obtained. The theme condition had a larger advantage time than the nontheme condition, $F(1,47) = 8.58$, $p < .005$. In addition, a larger overall advantage time was obtained for the last word in the story than for the blank period which followed, $F(1,47) = 12.11$, $p < .001$.

There was an interaction between story type and timed position, $F(1,47) = 4.44$, $p < .04$: The effect of the theme/nontheme story type conditions were larger for the last word in the story than the blank period which followed (See Figure 6). However, the effect of the close/far manipulation was greater for the blank period than for the last word in the story, as indicated by an interaction between the close/far condition and timed position factor, $F(1,47) = 15.87$, $p < .0002$.

The most important finding suggested by the above two analyses is that effects did not occur for the anaphor or, in general, for the word which followed the anaphor, but clearly did occur for the last word in the story and the blank period which followed. In addition, the size of the theme/nontheme effect for these latter two timed positions, and the size of the interactions between these two timed positions and the theme/nontheme and close/far conditions, indicate that the magnitude of
the effects for the last word in the story and the blank period which followed is not small.

Error Analysis

Overall, subject error rates were very low, with an average error rate of six percent. No reliable effects were obtained in the analysis of the error rates.

Discussion

One of the most consistent results of Experiment 3 was the finding that the majority of effects occurred during the reading of the last word in the story, or during the blank period which followed. Indeed, no reliable effects were found during the reading of the anaphor, contrary to the predictions of the model proposed in the Introduction.

A possible explanation of this finding may lie in the type of anaphor used in Experiment 3. The anaphors were always words to which a meaning could be attached without reference to the preceding four sentences.

For example, if the referent-containing sentence was A banquet was set for the heroes now, the corresponding anaphor-containing sentence was The feast could go on for days. The anaphor feast is a word which has a meaning independent of the story context or the presence of the referent banquet.
However, studies where an increase has been found in the amount of time devoted to processing the anaphor may use anaphors which do not have an independent meaning, such as pronouns (Carpenter & Just, 1977; Erlich & Rayner, 1983). In such cases, an increase in the amount of time devoted to the anaphor is not surprising, since the anaphor cannot be understood independent of its referent.

Task demands also may effect the amount of time devoted to an anaphor, as in Just and Carpenter (1978). In that study, a reliable increase in the amount of time devoted to the anaphor as a function of the degree of inference required to find a referent was found when the task was to determine the thematic consistency of each successive sentence in a story; this effect was not reliable when the task was to simply read each sentence.

For example, subjects would be presented with the following text, one sentence at a time:

(1) The millionaire (was murdered/died) on a dark and stormy night.

(2) The killer left no clues for the police to trace.

(3) The millionaire was found in his bed by the housekeeper.

(4) There was no electricity in the house because of the storm.

(5) It was the butler who discovered the body.
The target anaphor is killer, in sentence (2).

When subjects were required to judge whether sentence (2) contradicted sentence (1), subjects spent more time gazing at killer when was murdered was present in the first sentence than when died occurred in the first sentence (presumably because fewer inferences are necessary to relate killer to was murdered). This effect was not reliable when the subject's task was to simply read the sentences.

Thus, it may be that when the resolution of an anaphor is required to understand a word (e.g., a pronoun) or to complete a specific task, an attempt is made to resolve the anaphor at the time it is encountered. However, when the anaphor is a word which has a meaning independent of the presence of a referent, the resolution of the anaphor does not occur until the end of the text in which it is embedded, or during a sentence wrap-up procedure (Just & Carpenter, 1980).

It may be that in such an instance, the anaphor or the control item is only tagged as a potential anaphor when it is encountered (possibly because the item was preceded by the word The), as suggested by the lack of any differential effects between the reading times of the anaphor and the control item across conditions (See Figure 6). When the end of the anaphor-containing or
anaphor-control sentence is encountered, these tags are used to indicate those items to which the anaphoric resolution process should be applied.

The second major result of Experiment 3 was that the close/far manipulation generally gave results opposite to those predicted by the model. In particular, subjects processed the last word in the story quickest when the last sentence contained an anaphor and the story was thematically related to the referent, but the referent was far from the anaphor. Subjects were slowest in processing the last word when it was presented in the same anaphor-theme context but the referent was close (i.e., in the immediately preceding sentence).

An inspection of the stimuli used in Experiment 3 suggests a likely cause for this finding. For example, consider the following stimulus which was presented in the theme/anaphor-containing/close condition:

(6) The wheels squealed.
(7) Smoke began to pour from the engine.
(8) The accelerator stuck to the floor.
(9) A chevy turned off at an exit.
(10) The car went roaring past seventy.
The anaphor in this passage is car, and its corresponding referent is chevy.

The theme of this passage is supposed to be the referent, namely chevy. However, the use of the indefinite article a in sentence (9) is a syntactic cue that a change of topic is occurring (O'Brien, Duffy, & Myers, 1986). Hence, the chevy referred to in sentence (9) is syntactically cued as not being the car implicated by sentences (6), (7), and (8).

As a consequence, when the subject attempts to resolve the anaphor the car in sentence (10), he/she is faced with two equally likely referents: The car implicated by the first three sentences of the story, and the chevy mentioned in sentence (9). The result is that the subject is very slow in processing the last word in the story.

In order to correct this problem, a fourth experiment was conducted where the indefinite article a was replaced by the definite article the. This should effectively indicate to the reader that the referent explicitly stated in the fourth sentence is the same referent implicitly referred to by the preceding three sentences.

Finally, a third finding of Experiment 3 deserves mentioning. This is the unexpected finding of an effect
of the close/far manipulation for the blank period which followed the last word of the story (See Figure 6).

Although the model makes no predictions related to this timed position, it is interesting to note that the advantage time for this timed position was 36 msecs. in the close condition. In the far condition, the corresponding advantage time was -42 msecs., a difference of 78 msecs.

This is somewhat more consistent with the model than the analogous findings for the last word in the story. However, the lack of an interaction with the theme/nontheme manipulation still contradicts the model.

A possible explanation of this effect is that subjects resolved the anaphor in the close condition at the end-of-sentence position, and resolved the anaphor in the far condition during the blank period which followed the end-of-sentence position. As a result, subjects would be slow in the close condition at the end-of-sentence position but fast during the blank period (having already resolved the anaphor), and would be fast in the far condition at the end-of-sentence position (since they would not be resolving the anaphor), but would be slow during the blank period which followed (since they would be resolving the anaphor).
However, because this effect may be related to the presence of the indefinite article a in the referent-containing sentence, further discussion of it will be delayed until the discussion of Experiment 4.

In summary, The most surprising finding of Experiment 3 was that virtually all effects occurred during the reading of the last word in the story. No effects were apparent during the reading of the anaphor or control item. This finding was contradictory to the implicit assumption of the model presented in the Introduction that a number of processes related to anaphoric reference occur at the time the anaphor is read.

Nonetheless, the effects which were present during the reading of the last word in the story supported Assumptions Five and Seven of the model proposed in the Introduction. There was no difference in the advantage reading times between the theme-close and nontheme-close conditions, supporting the implication of Assumption Five that thematicity would have little effect in the close condition. However, subjects had a greater reading time advantage in the theme-far condition than in the nontheme-far condition, indicating that thematicity had an impact on the time involved in locating a referent separated by two intervening clauses.
from its anaphor. This supports Assumption Seven.

Experiment 3 did contradict the hypothesis of Assumption Three that a greater reading time advantage would be obtained in both close conditions (theme and nontheme) than in the theme-far condition. In fact, the greatest advantage of any condition was found in the theme-far case. However, this may have been due to always preceding the referent with the indefinite article a, resulting in a thematic distinction and thereby partial processing of the referent-containing sentence.
CHAPTER V

Experiment 4

Introduction

Experiment 4 was designed to test the suggestion that preceding the referent with the indefinite article a in the theme-close condition of Experiment 3 resulted in the slow reading times for the last word of the stories presented in the theme-close condition of Experiment 3. It is possible that the use of a resulted in the subject classifying the theme of the referent-containing sentence as different from the theme of the story in the theme-close condition. Such a classification would certainly attenuate any effects due to a theme-close interaction in the theme-close condition of Experiment 3.

In order to test this suggestion, the definite article the was substituted for a wherever a preceded the referent. This substitution was done for all the stories which had been used in Experiment 3. For example, instead of seeing story A below (used in
In both stories, the referent is *chevy* and the corresponding anaphor is *car*.

The use of the definite article *the* was expected to result in the subject processing the theme of the story and the referent of the anaphor as the same concepts. This, of course, was the original intent of the theme condition in the case where the last sentence of the story contained an anaphor. In all other respects, Experiment 4 was identical to Experiment 3.
Method

Subjects

Forty-eight subjects received credit in partial fulfillment of a course requirement for an Introductory Psychology course. All the subjects in Experiment 4 were native speakers of English, and had normal or corrected to normal vision.

Stimuli

The stimuli used in Experiment 4 were identical to those used in Experiment 3 with the exception of the selective replacement of the word a with the word the, as discussed above.

Procedure and Design

The procedure and design of Experiment 4 were identical to the procedure and design of Experiment 3, with the exception of an addition to the instructions which were read to the subject. The following lines were added to the instructions:

You should read each word as it is presented. Under no circumstances should you display the entire sentence and then read it. You also should try to avoid re-reading those parts of the sentence which have been previously displayed. If this interferes with your natural reading process, then do what you normally do when you read. However, do not go out
of your way to re-read the sentence currently displayed.

These instructions were added based on the suggestion made in Just, Carpenter, and Woolly (1982) that subjects might initially display the entire sentence and then read it, when the sentence can be presented in this fashion (as in Experiments 2, 3 and 4 of the current study). However, it should be noted that there was absolutely no evidence in any of the experiments conducted in the current study that subjects were engaging in such an activity.

Results

The same two analyses conducted in Experiment 3 were performed on the data of Experiment 4. These were an overall analysis on the transformed data, and an analysis of the error data.

In addition, two other analyses were conducted on the transformed data. One analysis used only the reading times obtained from the anaphor/control and one-word-after the anaphor/control timed positions. The second analysis looked at the data from the last word and blank period timed positions.

Both of these analyses were indicated a priori by the results of Experiment 3. Because of their a priori
nature, these analyses, unlike the similar analyses conducted in Experiment 3, are statistically feasible (Winer, 1971).

Overall Transformed Data Analysis

This analysis used the difference scores constructed by subtracting the reading time for each timed position in the anaphor-containing last sentence from the reading times for the corresponding timed positions in the anaphor-control last sentences. These advantage times were used in Experiment 3 for the same reasons that they were used in Experiment 4. That is, these advantage times indicate the exclusive effects of anaphoric reference on the reading times measured in the last sentence, isolated from those global effects common to reading any last sentence in the stories used in Experiment 4.

The means of the data used in this analysis are shown in Figure 7.

A main effect of the mean was obtained, $F(1,47) = 19.35, p < .0001$. Thus, an overall advantage was found for words presented in an anaphor-containing sentence.

A reliable effect of the theme/nontheme factor was found, $F(1,47) = 6.25, p < .01$. Subjects had a greater overall advantage in the theme condition, with a mean
Figure 7. Advantage Times in Experiment 4
advantage of 40 msec. In the nontheme condition, this same advantage was 15 msec.

An overall advantage of the position timed was obtained, \( F(3,141) = 12.33, p < .00001 \). A Newman-Keuls procedure indicated that the reading time advantages for the anaphor, the word following the anaphor, and the blank period following the last word in the story did not differ, but each of these three timed positions were reliably different from the advantage obtained for the last word in the anaphor-containing sentence (\( p < .01 \)). The smallest difference in these advantage scores was between the last word in the story and the blank period which followed, \( t(2,141) = 6.23, p < .01 \). The mean advantage for the anaphor timed position was 6 msec, the mean for the word following the anaphor was 5 msec, the mean advantage for the last word in the story was 81 msec, and the advantage for the blank period was 17 msec. These results again indicate that the effects of the anaphors used in Experiment 4 occurred almost exclusively during the end of sentence wrap-up (Just & Carpenter, 1980).

A main effect of the close/far factor was found, \( F(1,47) = 5.59, p < .02 \). The advantage in the close condition was 39 msec, and in the far condition the advantage was 16 msec.
An interaction between the theme/nontheme and position timed factors was obtained, $F(3,141) = 7.06$, $p < .0002$. Not surprisingly, this effect was due to a main effect of the theme/nontheme factor when the position timed was the last word in the story, $F(1,47) = 8.55$, $p < .005$. The advantage for the theme condition at this timed position was 125 msec, while this same measure was 37 msec for the nontheme condition. No effect of the theme/nontheme factor was found at any of the remaining three timed positions ($F < 1$).

Finally, a triple interaction for the position timed, close/far, and theme/nontheme factors was very close to reliability, $F(3,141) = 2.64$, $p = .052$. This result was due to a reliable position-timed by close/far interaction in the theme condition, $F(3,141) = 3.25$, $p < .02$. In turn, this two-way interaction in the theme condition was due to a close to reliable effect of the close/far factor when the timed position was the last word in the sentence, $F(1,47) = 3.84$, $p = .056$. At this timed position, the advantage for the close condition was 175 msec. For the far condition, the corresponding advantage was 76 msec.

The above findings, although only close to reliability, nevertheless show that the far condition
did not approach the same level of advantage as the close condition even in the theme condition. Thus, the prediction made by the model proposed in the Introduction that thematicity would offset the distance disadvantage in the theme-far condition is clearly not supported.

Analysis of Transformed Data From the First Two Timed Positions

The analysis of the advantage data from the first two timed positions (i.e., from the anaphor/control and one-word-after the anaphor/control timed positions) the revealed a triple interaction between the theme/nontheme, close/far, and position timed factors, $F(1,47) = 4.57, p < .03$. This effect was due to an interaction between the theme/nontheme and close/far factors at the one-word-after timed position, $F(1,47) = 4.67, p < .03$. Inspection of Figure 7 suggests that this interaction was due to an unusual negative advantage in the nontheme-far condition of 10 msec.

No other effects were reliable in the analysis of the anaphor/control and one-word-after timed positions ($p > .14$). Thus, as in Experiment 3, there appears to be virtually no effect of the experimental manipulations on the advantage reading times of the anaphor or the word immediately after the anaphor.
Analysis of Transformed Data
From the Last Two Timed Positions

The analysis of the advantage times obtained when the timed positions were the last word in the story and the blank period following this last word reveal a different story. The analysis of this data revealed a main effect of theme, $F(1, 47) = 8.52, p < .0054$. The advantage in the theme condition was 73 msec, and the advantage in the nontheme condition was 25 msec.

A main effect of position also was found, $F(1, 47) = 8.52, p < .005$. The advantage at the last word timed position was 81 msec, and it was only 17 msec when the timed position was the blank period. Thus, the largest effects again were occurring during the end of sentence wrap-up period (Just & Carpenter, 1980).

A main effect of the close/far manipulation was found, $F(1, 47) = 5.16, p < .02$. The advantage in the close condition was 69 msec, and the advantage was 29 msec for the far condition. This can be contrasted with the same data for Experiment 3, where the advantage for the far condition was 35 msec, but the advantage for the close condition was only 32 msec. Thus, it would seem that changing the initial word in the referent-containing sentence from a to the did enhance the overall advantage for the close condition.
Finally, an interaction was obtained between the theme/nontheme and position timed factors, $F(1,47) = 6.22, p < .01$. This was due to a main effect of the theme/nontheme manipulation when the position timed was the last word in the story, $F(1,47) = 8.55, p < .005$. The advantage for the theme condition at this timed position was 126 msec, and the advantage for the nontheme condition was 37 msec. In Experiment 3, these same measures were 118 msec for the last word-theme condition, and 22 msec for the last word-nontheme condition.

These data indicate that the overall theme/nontheme effect for the last word of the story was about the same in both Experiment 3 and Experiment 4. Nevertheless, the pattern for the close/far manipulation at this timed position did differ between the two experiments, most noticeably in the theme condition. In Experiment 3, the advantage for the far-theme condition for the last word in the story was much greater than the advantage for the remaining three combinations of the theme/nontheme and close/far factors. However, in Experiment 4, the advantage for the close-theme condition for the last word in the story was the largest, while the advantage for the far-theme case decreased but was still superior to the close- and far-nontheme conditions.
Error Data Analysis

The overall error rate was 7%. No effects were reliable ($p > .05$). However, the theme effect was close to reliable, $F(1,47) = 3.38$, $p < .07$. Subjects had an error rate of 6% in the theme condition, and 8% in the nontheme condition.

Discussion

One of the main purposes of Experiment 4 was to investigate the suggestion that preceding the referent with the indefinite article a in Experiment 3 resulted in an attenuation of the theme-close effect in that experiment for the reading times of the last word in the story. The results of Experiment 4 support this suggestion. In Experiment 3, the advantage (i.e., the difference in reading times for the same words when presented in the anaphor-containing and anaphor-control conditions) for the last word of the story in the theme-close condition was 38 msec (See Figure 6). However, in Experiment 4, the same advantage reading time was 175 msec (See Figure 7).

A second important result of Experiment 4 was the finding that again the experimental manipulations exerted their strongest effects during the reading of the last word in the story and during the blank period.
which followed the last word in the story. This result also was obtained in Experiment 3.

Conversely, as before for Experiment 3, no effects were obtained during the reading of the anaphor in Experiment 4. For the word which followed the anaphor, a main effect of theme was found in Experiment 3 for the advantage reading time, and an interaction between theme/nontheme and close/far was found for the advantage reading time for the same word in Experiment 4.

However, the magnitude of these effects was by no means large. In particular, the size of these effects was quite small when compared with the size of the effects occurring for the advantage reading time of the last word in the story and the blank period.

These common results for Experiment 4 and Experiment 3 clearly indicate that the model proposed in the Introduction was incorrect in hypothesizing that the resolution of the anaphors used in Experiments 3 and 4 occurs during the reading of the anaphor. Instead, this resolving process appears to largely occur during the end of sentence wrap-up process (Just & Carpenter, 1980), and to a lesser degree, during the blank period which followed the last word in Experiments 4 and 3. Thus, the most parsimonious modification of the model would move the location of the resolving process from
the anaphor to the last word in the sentence which contains the anaphor.

However, the most important results obtained in Experiment 4 argue against such a simple modification of the model. These results are: (1) The finding of a large advantage in the theme condition for the reading time of the last word in the story; (2) An advantage in the close condition for the reading time of the last word in the story and the blank period which followed; and (3) No interaction between the theme/nontheme and close/far factors. Taken together, these findings strongly argue against several contentions proposed in the model presented in the Introduction, and against a simple "relocation" of the model at the end-of-sentence position.

One of these contentions was that people always initially attempt to locate the referent in the sentence which immediately precedes the anaphor-containing sentence, regardless of the thematicity of the story. Had this been the case, subjects should have had an equal advantage at reading the last word of the story in both the close-theme and close-nontheme conditions.

Inspection of Figure 7 clearly shows that this was not the case: In the close-theme condition, the advantage time was 175 msecs, while in the close-
nontheme condition, this advantage time was only 41 msec. Thus, thematicity did have an impact on the time associated with resolving a nonpronoun anaphor, even when the anaphor’s referent was located in the sentence which immediately preceded the anaphor-containing sentence.

A second contention of the model which the results of Experiment 4 dispel is the contention that the reading times in the theme-far condition would be similar to the reading times in the theme-close condition. It was hypothesized that the effects of thematicity in the far condition would offset the effects of distance (i.e., offset the fact that the referent was not in the immediately preceding sentence in the theme-far condition), thereby making the reading times in the theme-far and theme-close conditions similar.

However, the advantage for the last word in the story in the theme-far condition was 76 msec, while the advantage in the theme-close condition was 175 msec (See Figure 7). This difference approached reliability ($p = .056$), and suggests that the two conditions were not similar in their effects on the resolution time of the anaphor. In addition, while the theme-far condition was 35 msec better in advantage time than the nontheme-far
condition, this difference was relatively small and did not approach reliability ($t(47) = 1.34, p < .18$). Thus, the presence of a story theme which was related to the referent had little impact on the resolution time of an anaphor presented in the theme-far condition.

These results are somewhat at odds with the findings of Lesgold, Roth, and Curtis (1979). As discussed in the Introduction, that study found a main effect of theme similar to that obtained in Experiment 4, but no effect within the theme (or nontheme) condition of the location of the referent (i.e., close or far from the anaphor). In Experiment 4, such an effect was found in the theme condition for the advantage reading times obtained for the last word in the story.

However, it may be that in Lesgold et al. (1979) the effect of distance in the theme condition was obscured by reading processes not associated with anaphoric resolution. This is suggested by the fact that subjects in their study did read the anaphor-containing sentence quicker in their theme-close condition than in their theme-far condition (mean reading times of 2930 msec and 3040 msec, respectively), but this difference was not reliable ($p > .05$). However, there was no anaphor-control condition with
which to compare this difference and thereby determine the amount of this difference exclusively due to the resolution of the anaphors used in their study.

Two other results of Experiment 4 are worth discussion. One of these results is the finding in the overall analysis that subjects took 45 msec longer on the last word of the story in the theme condition than in the nontheme condition. The second finding is that subjects made more errors in the nontheme condition (8%) than in the theme condition (6%).

These two results suggest that subjects are less likely to form the bridging inferences necessary to integrate the anaphor-containing sentence in the nontheme condition. Indeed, it may be that subjects do very little processing of sentences which clearly are unrelated to the theme of the story, as is the case with the anaphor-containing sentence presented in a nontheme context. Because they do very little processing in the nontheme context, the reading time of the anaphor-containing and anaphor-control sentences are less in the nontheme condition than in the theme condition (where the anaphor-containing sentence takes longer to process). However, this lack of processing has its price, as reflected in the higher error rates in the nontheme condition.
If the above explanation is correct, then it also should be substantiated in the results of Experiment 3. In particular, if preceding the referent with the indefinite article a in the close-theme condition resulted in the subject classifying the referent as different from the theme of the story, then the above explanation would suggest that the referent-containing sentence was not fully processed in the close-theme condition of Experiment 3. Consequently, the referent would be less available (and possibly, not available at all) in the close-theme condition of Experiment 3. Thus, the search for a referent would take longer (and possibly never succeed) in the close-theme condition, and overall error rates would be higher in this condition than in the far-theme case (since the comprehension questions usually required integration of information in both the anaphor- and referent-containing sentences).

Both of these effects were found in Experiment 3. Subjects took 803 msec to read the last word of the story in the close-theme condition, but required 700 msec to read the same word in the far-theme condition. In addition, subjects had a 6% error rate in the close-theme condition, while the error rate in the far-theme condition was 4%.
Thus, it may not be that subjects had two potential and equally likely referents available in the theme-close condition of Experiment 3, as suggested in the Discussion of that experiment. Instead, subjects may virtually have had no actual referents available in the theme-close condition of Experiment 3. That is, when faced with a sentence which is difficult to relate to preceding sentences, subjects may have decided to essentially ignore the sentence rather than attempt to form the bridging inferences required to integrate the sentence.

Finally, it should again be noted that none of the experimental manipulations used in Experiment 4 had any measurable effects on the reading time of the anaphor or anaphor-control word. The same finding was obtained in Experiment 3. These results would be expected if the anaphor tagging process proposed in Experiment 3 were true. That is, it may be that a word which (a) follows the definite article the (e.g., the anaphor and anaphor control words used in Experiments 3 and 4) and (b) has a well defined meaning independent of the context in which it is presented (e.g., is not a pronoun such as he or they) is tagged as a potential anaphor at the time it is encountered. When the end of the sentence is encountered, this tag is then used as an indicator that
the anaphoric resolution process should be applied to this word.

In summary, the results of Experiment 4 clearly show that the definite article the and the indefinite article a have differential effects on the resolution of an anaphor when either article precedes the anaphor's referent. Use of the article a may result in the referent-containing sentence being processed as a sentence thematically unrelated to the preceding text. As a consequence, the referent-containing sentence is less available to the anaphoric resolution process.

Conversely, preceding the referent with the definite article the allows the referent-containing sentence to be processed as part of the preceding text, at least in the case where the referent-containing sentence immediately precedes the anaphor-containing sentence. This may enable the referent-containing sentence to be readily available to the anaphoric resolution process.

In terms of the model presented in the Introduction, the results of Experiment 4 were not supportive. The greatest effects again were apparent at the end-of-sentence position, and only those effects will be presented here.

The advantage times for the theme-far and nontheme-far conditions were equal, indicating that theme did not
have an effect in the far condition. This is contrary to Assumption Seven of the model.

In addition, the advantage times in the theme-close condition were much greater than the advantage times in the nontheme-close condition. This indicates a substantial effect of theme in the close condition, contrary to the implications of Assumption Five.

However, one effect of Experiment 4 was supportive of the model. The largest advantage times were in the theme-close condition. This finding of the largest advantage time in a close condition is supportive of Assumption Three of the model proposed in the Introduction, and suggests that readers may indeed first consider the immediately preceding sentence in resolving an anaphor.
CHAPTER VI

General Discussion

The results of the four experiments conducted in this study have demonstrated that despite the apparent ease with which a reader links concepts in the ongoing process of comprehending a story, the actual processes which underlie this linking are rather complex. In particular, the model of this linking proposed in the Introduction of this study has been shown to have been correct in some aspects, and clearly incorrect in other aspects.

In the following pages, the results of each experiment will be reviewed. Where indicated by the results of each experiment, suggested revisions in the model will be proposed. It is hoped that the new model which will emerge from these revisions will be one step closer to representing the actual processes involved in anaphoric reference.

Before proceeding, a restriction must be placed on the generality of the results obtained in this study and
the new model of anaphoric reference which will emerge. This restriction is that the results and the new model only apply to the case of anaphoric reference where the anaphor is a synonym of the referent (e.g., the relationship between inferno and fire), or has a supracategorical relationship to the referent (e.g., where the anaphor is flower and the referent is carnation). In particular, these results and the new model should not be generalized to the case where the anaphor is a pronoun (e.g., he or they). Such pronoun anaphors were used in less than 1% of the stimuli employed in the four experiments. In addition, pronoun anaphors appear to result in anaphoric reference processes which are qualitatively different from the anaphoric processes involved in the current study (cf. Ehrlich & Rayner, 1983). With this restriction in mind, the results of the experiments conducted in this study can be presented.

The purpose of Experiment 1 was to test Assumption Two of the model. This assumption stated that:

When the referent-containing clause immediately precedes the anaphor-containing clause...all potential referents in the referent-containing clause are considered before the correct referent is selected.
A corollary of this assumption was that each potential referent was considered by a process operating in a serial, exhaustive fashion. Thus, the specific prediction made for Experiment 1 was that the reading time of the anaphor-containing sentence would increase as the number of potential referents in the referent-containing sentence increased.

The results of Experiment 1 largely supported this assumption. As the number of subject terms (i.e., potential referents) in the referent-containing sentence increased from one to two, the reading time of the anaphor-containing sentence also increased. In addition, although an increase of only 5 msec occurred when the number of subject terms in the referent-containing sentence was increased from two to three, this nonincrease can be attributed to a procedural constraint. This constraint was that the middle subject term in the three subject term condition was never the actual referent. Consequently, the subject could quickly learn to ignore the middle subject term and still be assured of having processed the actual referent. This would have made the two subject term and the three subject term conditions essentially equivalent, thereby resulting in the similar findings in both conditions.
A secondary finding of Experiment 1 also supports Assumption Two. This was the finding that the placement of the actual referent within the set of subject terms in the referent-containing sentence (i.e., first subject term or last subject term) did not affect the reading time of the anaphor-containing sentence. This result would be expected if the search for the actual referent was exhaustive.

Thus, the results of Experiment 1 support Assumption Two of the model proposed in the Introduction. Consequently, this assumption will not be altered. It will be incorporated in the new model in its current form.

Experiment 2 was designed to primarily test Assumption One of the model. This assumption stated:

Referents are stored and initially retrieved as part of a clause when at least one clause intervenes between the referent and the anaphor...this retrieved clause makes available not only the actual referent, but also other items which were present in the referent-containing clause.

For example, if the referent-containing sentence was A single street went into town, and the anaphor-containing sentence was The road needed to be renovated, both street
and town (referred to as the companion term) in the referent-containing sentence should have been available after the anaphor road was linked with its referent street. This should occur when at least one clause intervenes between the referent-containing and anaphor-containing sentences.

The specific prediction made for Experiment 2 was that in a probe recognition task, both a referent probe and a companion probe should be recognized quicker than a probe which was present in the story but not in the referent-containing sentence (i.e., an in-paragraph control probe). This effect should occur even if two clauses intervene between the referent-containing sentence and the anaphor-containing sentence, but only if the probe was presented after the anaphor has been read.

The results of Experiment 2 indicated that the referent probe was recognized quicker than an in-paragraph control probe when presented immediately after, or two words past the position of the anaphor. However, the in-paragraph control probe and the referent probe were recognized equally fast when presented before the anaphor had been read. Thus, the predictions of Assumption One for the referent probe were substantiated.
However, the companion probe was not recognized better than the in-paragraph control probe, regardless of the location in which the probe was presented (i.e., immediately before, immediately after, or two words past the location of the anaphor). In addition, the companion probe was not recognized any better when presented after the anaphor than when it was presented after a control word. Both of these results indicate that the assumptions embodied in Assumption One for nonreferent, companion words in the referent-containing clause referents must be altered.

It is suggested that Assumption One be changed to the following statement:

NEW ASSUMPTION ONE

Referents are stored and initially retrieved as part of a clause when at least one clause intervenes between the referent and the anaphor. However, only the referent in this clause is immediately available after the referent-containing clause is retrieved.

It may be argued that the referent was not retrieved as part of a clause when the anaphor was encountered. However, the results of Experiment 2 do not allow a determination of the validity of this argument, nor do
those results require such a change. For example, it may have been that the referent-containing clause was retrieved as a unit when at least one clause separated it from the anaphor-containing clause, but that this unit could not be readily decomposed into its constituent parts. The referent itself might have been particularly available in Experiment 2 because it always was the subject term of the referent-containing sentence.

Indirect support for this unit viewpoint is the finding that the number of propositions in a passage is a better predictor of reading time than the number of words in the passage (Kintsch & Keenan, 1973). Of course, this viewpoint is only one of several possible reasons for the results for the companion probe in Experiment 2. Much more research is necessary before a definitive conclusion can be drawn concerning the state of companion words in a referent-containing clause.

A secondary purpose of Experiment 2 was to investigate another component of Assumption Two which was not tested in Experiment 1. This component was:

When the referent-containing clause immediately precedes the anaphor-containing clause, referents are retrieved as single lexical entries.
A corollary derived from this assumption was that the entire referent-containing clause was represented in immediate memory at the individual word level, as well as at a unitized, propositional level, immediately after the referent-containing clause was read. The individual word level representation however, would be no longer directly available once at least one clause following the referent-containing clause had been read (cf. Clark & Sengul, 1979).

Based on Assumption One and the corollary to that assumption presented above (also see Appendix A, points 2 and 6), the specific prediction for Experiment 2 was that when the referent-containing sentence immediately preceded the anaphor-containing sentence, both the referent and companion probes would be recognized equally fast (and equally better than the in-paragraph control probe), regardless of probe position. In particular, presentation of either probe after the anaphor had been read would result in equal facilitation for both probes, since the anaphor would only serve to direct cognitive processing to immediate memory, where both the referent and companion probe would be equally available at the individual word level (i.e., as individual lexical entries: See Appendix A, point 6 for a more complete explanation).
This prediction was supported (See Figures 2 and 4). Recognition times for the referent and the companion did not differ from each other as a function of probe position. Thus, Assumption One and the corollary presented above will be incorporated into the model as they are currently stated.

It should be noted that another prediction resulting from Assumption One and the above corollary is that both referent and companion probes should have been recognized faster when presented after an anaphor than when presented after a control item. This would be anticipated because the control item would not direct cognitive processing to the immediately preceding clause before the probe was presented, as would the anaphor. Thus, subjects were expected to take longer to recognize the referent and control probes when they were presented after a control item, but this increase in recognition time also was expected to be equal for both of these probe types. This extra time should reflect the amount of time required to redirect cognitive processing after the probe had been presented to the immediately preceding sentence.

The results of Experiment 2 did not support this prediction. Recognition times for the referent and companion probes were not reliably longer when either
probe was presented after the control word as compared to when they were presented after the anaphor.

However, a reasonable explanation of this finding would be that in probe recognition tasks such as that used in Experiment 2, subjects always look to immediate memory first in determining if a probe item has previously occurred. In Experiment 2, immediate memory would have contain the word level representation of the referent-containing sentence. Hence, subjects would always first access this word-level representation, regardless of whether the probe was presented after a control item or after an anaphor.

This explanation was indirectly supported by the finding that the in-paragraph control probe (which was never in the immediately preceding sentence) took longer to recognize than the referent or control probes, when presented after the anaphor or control item. However, the referent, companion, and in-paragraph probes were recognized equally well when presented before the anaphor or control item. This may have been due to sentence processing start-up effects which overshadowed the actual probe recognition process.

Thus, one major modification of the model presented in the Introduction was required in order to explain the results of Experiment 2. This modification was that
when an entire referent-containing clause is retrieved, words in the clause other than the referent are not more readily available than words which are in the text but are not in the referent-containing clause.

Experiment 3 was primarily intended to test Assumption Seven of the model presented in the Introduction. This assumption stated:

When an anaphor and its referent are separated by at least one intervening clause, the time to locate the referent-containing clause is directly proportional to the importance of the referent-containing clause to the current discourse topic.

Experiment 3 tested this assumption by presenting subjects with stories which were five sentences in length. The theme of a story was either directly related to the referent (e.g., by being about physical features of the referent), or was about a topic which was unrelated to the referent. The last sentence of a story contained either an anaphor or a control word, and the reading time of this word and several other words in the story was measured. Because of these stimuli and the unobtrusive nature of the measurement procedures used in Experiment 3, this experiment (and Experiment 4) represented investigations of reading processes which
occurred in a fairly natural situation.

Based on Assumption Seven, the major prediction for Experiment 3 involved the experimental condition where the referent was in the first sentence of the story, and the anaphor was in the fifth sentence of the story (i.e., the far condition). In this condition, it was predicted that the anaphor would be read more quickly (as compared to an anaphor control item) when the second, third, and fourth sentences of the story were thematically related to the referent than when these intervening sentences were not thematically related to the referent.

A second assumption which was investigated in Experiment 3 was Assumption Five:

The search for a referent begins by locating in immediate memory those lexical entries which contain a referent plausibility tag.

The critical point of Assumption Five was that the search for a referent was assumed to always begin with those items available in immediate memory, namely, the representation at an individual word level (i.e., the lexical entry level) of the clause which immediately preceded the anaphor-containing clause. Two clear implications of this assumption were that (a) the
anaphor should always have been read the most quickly when the referent-containing sentence immediately precedes the anaphor-containing sentence, and (b) the thematicity of the story should have had no effect on the reading time of the anaphor when the referent-containing sentence immediately preceded the anaphor-containing sentence (i.e., when the story was presented in the close condition of Experiment 3).

The results of Experiment 3 revealed a surprising lack of effect of any of the experimental manipulations on the reading time of the anaphor. In particular, when compared to an anaphor control condition, the reading time of the anaphor was a maximum of 11 msec faster than the reading time of the control item (See Figure 6). However, large effects of the experimental manipulations did occur for the reading time of the last word in the story, and for the blank period which followed this last word.

These two surprising results suggested that an anaphor which bore a synonymous or supracategorical relationship to its referent was resolved during the end of sentence wrap-up process (Just & Carpenter, 1980). It was proposed that for such anaphor-referent relationships, the anaphor is tagged as a potential anaphor when it is read, but is not resolved until the
end of sentence wrap-up. This tagging occurs due to syntactic cues available in the portion of the anaphor-containing sentence read before the anaphor was encountered. Since the most common of these syntactic cues, the word the, preceded both the anaphor and the anaphor control items in Experiment 3, no difference in the reading times of the anaphor and the control item were found.

Under the assumption that the anaphoric resolution process was occurring during the end of sentence wrap-up, the focus of Experiment 3 became the effects which did occur during the end of sentence wrap-up process. In particular, did these effects concur with those effects predicted by the model proposed in the Introduction?

In relation to the predictions of Assumption Seven, the results of Experiment 3 for the reading time of the last word in the story were supportive. The advantage (i.e., the difference between the same word presented in the anaphor-containing and anaphor control conditions) in the far-theme condition was 197 msec. In the far-nontheme condition, the advantage was 26 msec. Thus, the presence of a theme which was related to the referent did decrease the amount of time needed to locate the referent (See Figure 6). This difference
also was present in the raw reading times, where the average reading time for the last word in the story in the far-theme condition was 700 msec, and the corresponding reading time in the far-nontheme condition was 770 msec. Thus, Assumption Seven was supported by the results of Experiment 3.

A second finding obtained in Experiment 3 was an effect of the distance between the anaphor and the referent on the advantage time for the blank period (i.e., the period which followed the presentation of the last word in the story). This advantage time was much greater when the referent-containing sentence immediately preceded the anaphor-containing sentence (i.e., in the close condition) than when three sentences intervened between the referent- and anaphor-containing sentences (i.e., in the far condition). Interestingly, this effect was quite clear cut and did not interact with the thematicity of the story (See Figure 6).

This effect was unanticipated by the model: It may have been due to a tradeoff between anaphor resolution location and the close far/condition. That is, subjects may have deferred resolving the anaphor in the far condition until the blank period, thereby decreasing their advantage time at this period for the far condition. In the close condition however, the anaphor
may have been resolved at the end of sentence position, and thus subjects had no resolving to do in this condition during the blank period. This would explain the large advantage time in the close condition at the blank period.

However, an unusual finding in the close condition for the advantage reading times of the last word in the story suggested that it might be premature to presume that Assumption Seven and the close/far effect found for the blank period were valid. This finding was that subjects had a reliably smaller advantage time in the theme-close condition (38 msec) than in the theme-far condition (197 msec).

It was hypothesized that this unusual result was due to the word which preceded the referent in the stories used in Experiment 3. This word was the word *a*. By using *a* to introduce the referent, it was suggested that the referent was classified as being distinct from the theme of the story (cf. O'Brien, Duffy, & Myers, 1986). This would have been opposite to the intent of the theme stories.

As a consequence, the results of Experiment 3 were considered tentative at best. Their acceptance depended on the results of a subsequent experiment which replaced the indefinite article *a* with the definite article *the*. 
This experiment was Experiment 4.

Experiment 4 was designed to test the same notions as Experiment 3. Thus, the investigation of Assumption Seven and Assumption Five again was the main purpose of Experiment 4.

However, Experiment 4 differed from Experiment 3 in that the stories used in Experiment 4 were slightly different from the stories used in Experiment 3. Specifically, wherever the referent term had been preceded by the word a in the stories used in Experiment 3 it was replaced by the word the in Experiment 4. Thus, the referent term was always preceded by the word the in Experiment 4.

This change was intended to make the referent and the theme of the stories in the theme-close condition more likely to be classified by the subject as the same concepts. Such a congruent classification was the original intent of both the theme-close and the theme-far conditions.

Another purpose of Experiment 4 was to investigate the surprising findings in Experiment 3 of (a) reliable effects for the advantage reading time of the last word of the story and the blank period which followed this last word, but (b) no reliable effects in the advantage reading times of the anaphor itself. If these findings
were replicated in Experiment 4, it would indicate that the model proposed in the Introduction was incorrect in assuming that the anaphor resolution process occurred during the processing associated with the reading of the anaphor.

The results of Experiment 4 contradict the implications of Assumption Seven. The far-theme condition was only slightly better than the far-nontheme condition in advantage reading times (See Figure 7). The 43 msec difference between the two conditions was not reliable ($p < .18$). Thus, Assumption Seven seems to be incorrect: The time to locate the referent-containing clause, when at least one clause intervenes between it and the anaphor-containing clause, does not seem to be proportional to the importance of the referent-containing clause to the current discourse topic.

However, the results of Experiment 3 which did support this assumption were indeed due to preceding the referent with the indefinite article a. It is possible that the theme-far condition of Experiment 3 was the only true theme condition in Experiment 3. A more complete explanation of this possibility will be provided later in this Discussion. For the time being, it will be presumed that Assumption Seven is incorrect.
In addition, Experiment 4 provided strong evidence against the presumption stated in Assumption Five that the clause which immediately precedes the anaphor-containing clause is always searched first for the referent. This presumption resulted in the prediction that thematicity would have no effect on the advantage times obtained in the theme-close and nontheme-close conditions, and that these times would thus be equivalent.

In fact, for the last word in the story, the advantage time in the theme-close condition was much greater than the advantage time in the nontheme-close condition (175 msec and 41 msec, respectively: See Figure 7). Thus, thematicity did have an effect in the close condition. In fact, the close condition did not differ from the far condition when the theme of the story was unrelated to the referent (i.e., in the nontheme condition). This finding also was obtained in Experiment 3.

It should be noted that another implication of the model which was unsubstantiated by the results of Experiment 4 was the implication that thematicity would offset distance in the theme-far condition, making this condition similar to the theme-close condition. Clearly, this was not the case: The advantage time in
the theme-far condition was 99 msec. less than the advantage time in the theme-close condition (p = .056).

The results of Experiment 4 did replicate the results of Experiment 3 in that the largest and most pronounced effects occurred for the advantage time of the last word in the story and the blank period which followed (See Figure 7). As a result, it is safe to assume that the resolution of the anaphors used in this study occurred during the end of sentence wrap-up period.

Considered together, Experiment 4 and Experiment 3 lead to several conclusions concerning the resolution of the anaphors presented in this study. One of these conclusions is that the resolution of the anaphor occurred at the end of the anaphor-containing sentence, and not during the reading of the anaphor.

It is hypothesized that no resolution occurred at the time the anaphor was read because the anaphors used in Experiments 3 and 4 were words which had meanings independent of the presence of a referent. For example, the word feline does not require an external referent in order to be understood (e.g., as in the sentence The feline was hungry). However, anaphors used in studies which have found duration effects at the anaphor position (cf. Ehrlich & Rayner, 1983) are usually
pronouns, such as he or they. Such anaphors have context dependent meanings (i.e., they always have an external referent) and thus must be resolved at the time they are encountered in order to be understood.

It might be hypothesized that these results also indicate that in Experiments 3 and 4 nothing related to anaphoric resolution was occurring at the time the anaphor was read. Such a hypothesis would suggest that the subject waited until the end of the sentence and then re-read the anaphor or control word to determine if it was an anaphor and thus needed to be resolved.

However, the results of Experiment 2 would argue against this hypothesis: The screen was cleared of all material before the probe was presented. Nonetheless, a reliable advantage was obtained for a referent probe presented after the anaphor had been read. It should be noted that this effect, like those effects obtained in Experiments 3 and 4, occurred at the end of the last sentence of the story, since probe presentation in Experiment 2 terminated the presentation of the story.

The alternative hypothesis to be suggested here is that a process related to anaphoric resolution was occurring at the time the anaphor or control item was read, but that this process equally affected the reading time of the anaphor and control in all the manipulations
used in Experiments 3 and 4. This process will be referred to as anaphor tagging.

The anaphor tagging process involves tagging a word as a potential anaphor, based on syntactic or semantic cues available prior to the reading of the anaphor. In Experiments 2, 3, and 4 the cue was the word the, which always preceded the anaphor or control word. During end of sentence wrap-up, the anaphoric resolution process is applied to those items which have anaphor tags. Consequently, no effects of the experimental conditions would show up at the time the anaphor was read, but would instead appear during the reading of the last word in the last sentence of the story.

The preceding hypotheses lead to a new assumption concerning anaphoric resolution:

ASSUMPTION EIGHT

If prior syntactic and/or semantic cues indicate that a word may be an anaphor, but the word has a meaning independent of its textual context, the word is not anaphorically resolved at the time it is read. Instead, the word is tagged as a potential anaphor to which the anaphoric resolution process is applied at the end of the current sentence.
It may be that the anaphoric resolution process is applied at the end of the current clause and not at the end of the sentence (cf. Haviland & Clark, 1974). Unfortunately, the current set of experiments cannot determine the validity of this possibility since the vast majority of sentences used in the experiments were one clause in length.

It should be noted that Assumption Eight is similar to a proposal made in Just and Carpenter (1980) that unresolved anaphors are resolved during the end of sentence wrap-up period. What Assumption Eight does add are the constraints that determine what anaphors remain unresolved by the end of the sentence.

The results of Experiments 3 and 4 also indicate that the theme of a story is a critical factor in determining the speed at which an anaphor is resolved. This fact is most strongly suggested by the results for the theme-close conditions in Experiments 3 and 4.

In Experiment 3, subjects probably did not perceive the referent-containing sentence presented in the theme-close condition as actually part of the theme of the story, due to the use of the indefinite article a to introduce the referent. Consequently, advantage times in the theme-close condition where no different from the advantage times for either the nontheme-close or nontheme
In Experiment 4 however, the referents in the referent-containing sentences were always preceded by the word the. By Assumption Eight, an attempt would have been made to incorporate these referents as anaphors into the preceding context. This attempt would succeed in the theme-close condition, and fail in the nontheme-close condition.

It is hypothesized that when a sentence can be readily incorporated into the preceding context (i.e., requires few bridging inferences: See Haviland & Clark, 1974), it is more readily available for processing by subsequent textual processes (cf. Kintsch & van Dijk, 1979). In particular, it is more readily available for use by a subsequent anaphoric resolution process.

Conversely, sentences which cannot be readily incorporated into the preceding text, such as the referent-containing sentence in the nontheme-close condition, are very difficult to access (Johnson, Doll, Bransford, and Lapinski, 1974). In fact, such sentences may not be retained correctly at all (Fillenbaum, 1974).

The above hypothesis would imply that subjects should have done much better in the theme-close condition than the nontheme-close condition of Experiment 4. This was indeed the case: The advantage
time in the theme-close condition for the last word in the story was 175 msec, and the advantage time for the nontheme-close condition was 41 msec.

The above results indicate that the following assumption should be added to the model:

ASSUMPTION NINE

Sentences which are easily integrated into the preceding text are more readily available to the anaphoric resolution process than sentences which are difficult to integrate into the preceding text.

It should also be noted that Assumption Nine allows the retention of Assumption Five of the model. That is, subjects do look first to the immediately preceding sentence for the referent. However, in the nontheme-close condition, the immediately preceding, referent-containing sentence has been classified as not related to the theme of the story, and thus is difficult, if not impossible, to access in immediate memory. Consequently, such a sentence is difficult to access by the anaphoric resolution process.

However, this hypothesis would also appear to imply that the advantage time in the theme-far condition should have been greater than the advantage time for the nontheme-far condition. Such a result also was
indicated by Assumption Seven of the model.

As discussed previously, this was not the case. The advantage time for the last word of the story in the theme-far condition of Experiment 4 was 76 msec. In the non-theme-far condition this advantage time was 33 msec, and the 43 msec difference between the two conditions was not reliable. In addition, in Experiment 3, where it was suggested that the theme condition was less "theme like" than the theme condition of Experiment 4, the advantage time for the last word of the story in the theme-far condition was a huge 197 msec (See Figure 6).

First, these results indicate that Assumption Seven is incorrect. The presence of a theme which is ostensibly related to the referent does not decrease the anaphoric resolution time in the far condition. Thus, Assumption Seven is removed from the model.

Secondly, the above results imply that some modification of Assumption Nine is needed. However, it may be that a careful application of Assumptions Eight can explain the above results.

Assumption Eight implies that a subject would attempt to apply the anaphoric resolution process to any nonpronoun which is preceded by the definite article the. A strict application of this implication to
Experiment 4 would suggest that the subject viewed the referent in the theme-far case as a type of potential anaphor, inasmuch as the referent was preceded by the word the. Consequently, the anaphoric resolution process would be applied to the referent (as if it were an anaphor) at the end of the first sentence of the story. Of course, this process would fail to find an external referent, since it is occurring during the end of the first sentence of the story. As a consequence, the subject is faced with the dilemma of what to do with the referent-containing sentence.

It is suggested that in general, subjects resolve this dilemma by attaching a particular internal representation of the referent to the referent-containing sentence. For example, the referent-containing sentence The grasshopper was on the lawn, when presented in the theme-far case, results in the subject attaching their particular prototypical grasshopper to the referent word grasshopper.

However, the subject next reads the following second sentence: The long legs were tired. If the subject's prototypical grasshopper does not have the feature of tired long legs, then the first, referent-containing sentence may be classified as thematically unrelated to the second sentence. Similarly, all the subsequent
sentences may be classified as thematically unrelated to the referent-containing sentence. The result is that the theme-far condition becomes equivalent to the nontheme-far condition. This would explain the similar results obtained for each of these conditions in Experiment 4.

In the theme-far condition of Experiment 3, the dilemma described above was never encountered. The word a always preceded the referent in this experiment, and thus no search for an external referent occurred for the referent-containing sentence in the theme-far condition. Moreover, by preceding the referent with the article a, a cue was provided for the subject that a new topic was beginning (cf. O'Brien, Duffy, & Myers, 1986).

Consequently, the subject had an expectation that the subsequent sentences would be about the same topic. The effect of theme would thus be very strong in this condition, resulting in the very large advantage times obtained in the theme-far condition of Experiment 3.

Of course, the above explanation must be considered tentative until tested in an experimental context. It does however, explain the conflicting findings in Experiments 3 and 4.

In summary, the major results of the four experiments conducted in this study were:
(1) All potential referents are considered when a nonpronoun anaphor is resolved (Experiment 1);

(2) Only the referent is easily available after a anaphor which is more than one clause away from its referent is resolved (Experiment 2);

(3) The resolution of an anaphor which has a context-independent meaning occurs during the end of sentence wrap-up period, although this may not be the case for other types of anaphors (Experiments 3 and 4);

(4) A priori syntactic and/or semantic cues may indicate that a word should be tagged as a potential anaphor at the time that word is read (Experiments 3 and 4);

(5) A referent which is related to the theme of a story is more available than a referent which is not related to the theme of a story (Experiment 4).

The experiments conducted in this study are only a subset of the experiments which might have been performed in investigating the model proposed in the Introduction. Additional experiments which test the validity of such
model concepts as the **referent plausibility tag** (Assumption Four) and **generic concept** (Assumption Six) are certainly required before the model can be considered anything but preliminary and quite tentative.

In addition, it would be worthwhile to investigate some of the concepts tested in the current study with a different procedure. For example, it would be very informative to test the memorial state of a word which is in the same sentence as the referent (i.e., a companion to the referent: See Dell, McKoon, & Ratcliff, 1983) by means of the conditional probability of that word being recalled, given that the referent was recalled. This would aid in determining if such a companion word is simply difficult to access in a probe recognition paradigm (as was conducted in Experiment 2), or if such a companion is actually unavailable in memory.

It also would be informative to repeat the same set of experiments conducted in this study but with the referent in the object position of the referent-containing clause. The results of these experiments would indicate the generalizability of the current results.

For example, in Experiment 2, it may be that the lack of an advantage for the companion probe in the far
condition was due to its syntactic role as object of the referent-containing sentence. Thus, if the referent was in the object position, and the companion item were the subject of the referent-containing sentence, an advantage for the companion probe might be obtained (in addition to an advantage for the referent). Such a result would suggest that the subject of a referent-containing sentence has a special place in the propositional representation of that sentence, e.g., the name or access point of the proposition.

Only through the continued investigation of unresolved issues, and the use of different procedures focusing on the same questions, can the major issues of anaphoric reference be resolved. In particular, only these methods will lead to a valid model of anaphoric reference.
FOOTNOTES

1. The model presented in this document was developed independently of, and prior to knowledge of a somewhat similar model proposed by Guindon (1985).

2. Although large, the 62 msec. difference in the close condition for the immediately before timed position, between the companion probe presented in an anaphor-containing context and the same probe presented in an anaphor-control context, was not reliable, $F(1,47) = 2.55, p < .12$. See Figure 4.
LIST OF REFERENCES


APPENDIX A

A Summary of the Model

The following 13 points summarize the sequence of events which the model presented in Section Two of the Introduction suggested occur in linking an anaphor with its referent.

1. The referent-containing clause (RCC) is read.

2. The RCC is integrated into a propositional unit in immediate memory. This unit is in addition to an immediate memory representation of the RCC at the individual word level.

3. The anaphor-containing clause (ACC) is read.

4. When the anaphor (in the ACC) is encountered, syntactic or experiment-caused cues indicate that the anaphor has a referent in a previously processed clause.

5. A search for the RCC begins, starting with the clause most recently processed. This clause is stored in immediate memory.

6. This most recently processed clause is decomposed into its separate lexical entries. A lexical entry minimally consists of a referent plausibility tag and the address of a generic concept stored in...
The referent plausibility tag indicates the lexical entry's potential as an anaphoric referent. It may be based on the lexical entry's syntactic role within the clause. For example, the lexical entry for the subject of a sentence will always have a referent plausibility tag; the lexical entry of a determiner (e.g., the) will never have such a tag.

The address of a generic concept indicates the generic concept's location in semantic memory. The generic concept of a lexical entry is the entry's prototypical meaning (cf. Rosch, 1976) for a given individual. Thus, the generic concept of cat for person A may be entirely different from the generic concept of cat for person B. In addition, the generic concept may be temporarily modified by textual content (cf. Anderson & Ortony, 1977).

7. Potential lexical entries for the anaphor's referent are determined. This is accomplished by a check of the referent plausibility tags of the individual lexical entries. The result of this referent plausibility check is the set of plausible referents. It is a set of lexical entries, any one of which could be the correct referent.

8. Next, a member of the set of plausible referents is selected for further processing. This selection is based on the syntactic role of the member in the corresponding clause. For example, it may be that clause subjects are selected first, clause objects second, and clause verbs third. The generic concept of this member is compared with the generic concept of the anaphor. This comparison, known as the meaning plausibility check, will determine if the two generic concepts could refer to the same thing. For example, the meaning plausibility check would determine if the anaphor beer and the implied referent picnic supplies could refer to the same physical item in the following sentence pair:
(1) John checked the picnic supplies.
(2) The beer was warm.

For most people, the generic concept of picnic supplies would allow for the generic concept of beer as a probable constituent. Thus, the meaning plausibility check would find that picnic supplies and beer could refer to the same generic referent, the beer which is a type of picnic supply.

However, notice how the outcome of this check is altered if beer is replaced with car in sentence (1) (although a referent is still found).

It should be noted that a true meaning plausibility check may not always be possible. For example, anaphors such as it are probably nonconceptual, having no true generic concept associated with their lexical entry. In such instances, the outcome of the meaning plausibility check is a function of the number of plausible referents. If there is only one plausible referent, its generic concept becomes the temporary generic concept of the nonconceptual anaphor. If there is more than one plausible referent, no generic concept is assigned until the complete anaphor-containing clause has been read (see Point 11 below).

9. If the meaning plausibility check finds that the generic concepts of the plausible referent and the anaphor could refer to the same thing, then the plausible referent becomes a candidate referent.

A candidate referent is initially only a plausible referent. However, if the plausible referent's generic concept is compatible with that of the anaphor, the plausible referent becomes a candidate referent and a member of the set of candidate referents. This set is usually smaller in number than the set of plausible referents.

If the meaning plausibility check finds that the generic concepts of the plausible referent and the anaphor could not refer to the same thing, then the plausible referent does not become a member of the set of candidate referents. Usually, no further analysis is devoted to such plausible but incompatible referents.
10. Regardless of the outcome of the meaning plausibility check, the next procedure is to repeat steps eight and nine above. These steps will be repeated until every member of the set of plausible referents has been analyzed.

11. If more than one candidate referent exists after all plausible referents have been analyzed, determination of the one correct referent is suspended until after the entire ACC has been read. After the entire ACC has been read, a second meaning plausibility check occurs. The outcome of this check may differ from that of the first meaning plausibility check. This change in outcome would result from a temporary change in the generic concept of the anaphor induced by the meaning of the entire ACC (cf. Anderson & Ortony, 1977). Thus, the outcome of this second check may be the determination of the single correct referent and referent concept. In this case, the anaphor and this referent would be linked, completing the referent search process.

A different situation occurs if only one candidate referent exists after all plausible referents have been considered by the meaning plausibility check. In this case, the referent and the anaphor would be linked before any post-anaphor processing of the ACC is initiated. After this link is formed, the processing of the remainder of the ACC proceeds.

12. If the outcome of the meaning plausibility check of step ten is that no candidate referents are found, the search for another potential RCC (step five) is reinitiated. However, this second search is not based on the temporal ordering of clausal units relative to the ACC. Instead, this second search is a function of the entire textual representation. It begins with the clause that is most important to the current local discourse topic and ends with the clause of least topical importance.

The topical importance of a clause is hypothesized to be a function of the degree of local argument overlap, as suggested by Kintsch and van Dijk (1978).
Each clause is analyzed according to steps six through 11 above. If this analysis results in a link being formed between the anaphor and a referent, this second referent search is terminated. Post-anaphor processing of the ACC then continues.

13. The most common final outcome of steps one through 12 above is the formation of a link between an anaphor and its one correct referent. This in turn results in the integration of the ACC into the current discourse structure. If no such link is formed after all clauses in the textual representation have been analyzed, this final outcome is indeterminant.
APPENDIX B

Assumptions of the Original Model

These are the seven assumptions which underlie the model of anaphoric reference presented in Section Two of the Introduction.

ASSUMPTION ONE

Referents are stored and initially retrieved as part of a clause when at least one clause intervenes between the referent and the anaphor. In addition, this retrieved clause makes available not only the specific referent, but also other items which were present in the referent-containing clause.

ASSUMPTION TWO

When the referent-containing clause immediately precedes the anaphor-containing clause, referents are retrieved as single lexical entries. In addition, all potential referents (e.g., all subject, verb, and/or object terms) in the referent-containing clause are considered before the correct referent is selected.
ASSUMPTION THREE

The linking of an anaphor with its referent occurs in immediate memory. This linking begins after the referent's lexical entry is made available in immediate memory, either directly (when the referent-containing clause immediately precedes the anaphor-containing clause) or indirectly through the retrieval into immediate memory and subsequent decomposition of the referent-containing clause into separate lexical entries (when the referent-containing clause is separated from the anaphor-containing clause by at least one intervening clause).

ASSUMPTION FOUR

Lexical entries in immediate memory consist of at least two parts relevant to anaphoric resolution. The referent plausibility tag indicates at a syntactic level a lexical entry's potential to be a referent. The generic concept address is a pointer to the lexical entry's prototypical representation in semantic memory.

ASSUMPTION FIVE

The search for a referent begins by locating in immediate memory those lexical entries which contain a referent plausibility tag.
ASSUMPTION SIX

Lexical entries which have a referent plausibility tag are subsequently analyzed at a semantic level. The generic concept of the anaphor is compared with the generic concept of the plausible referent lexical entry. If this comparison determines that both generic concepts could refer to a single generic referent, the referent and the anaphor are associated. If the outcome of this comparison is negative, processing of this lexical entry ceases, and another plausible lexical entry in immediate memory is analyzed.

ASSUMPTION SEVEN

When an anaphor and its referent are separated by at least one intervening clause, the time to locate the referent-containing clause is directly proportional to the importance of the referent-containing clause to the current discourse topic.
APPENDIX C

Assumptions of the New Model

These are the assumptions which underlie the new model of anaphoric reference presented in the General Discussion. For the most part, these are the same assumptions as discussed in the model presented in the Introduction. However, Assumptions One and Seven of that model have been modified, and two new assumptions (Assumptions Eight and Nine) have been added.

NEW ASSUMPTION ONE

Referents are stored and initially retrieved as part of a clause when at least one clause intervenes between the referent and the anaphor. However, only the referent in this clause is immediately available after the referent-containing clause is retrieved.

ASSUMPTION TWO

When the referent-containing clause immediately precedes the anaphor-containing clause, referents are retrieved as single lexical entries. In addition, all potential referents (e.g., all
subject, verb, all potential referents in the referent-containing clause are considered before the correct referent is selected.

ASSUMPTION THREE

The linking of an anaphor with its referent occurs in immediate memory. This linking begins after the referent's lexical entry is made available in immediate memory, either directly (when the referent-containing clause immediately precedes the anaphor-containing clause) or indirectly through the retrieval into immediate memory and subsequent decomposition of the referent-containing clause into separate lexical entries (when the referent-containing clause is separated from the anaphor-containing clause by at least one intervening clause).

ASSUMPTION FOUR

Lexical entries in immediate memory consist of at least two parts relevant to anaphoric resolution. The referent plausibility tag indicates at a syntactic level a lexical entry's potential to be a referent. The generic concept address is a pointer to the lexical entry's prototypical representation in semantic memory.
ASSUMPTION FIVE

The search for a referent begins by locating in immediate memory those lexical entries which contain a referent plausibility tag.

ASSUMPTION SIX

Lexical entries which have a referent plausibility tag are subsequently analyzed at a semantic level. The generic concept of the anaphor is compared with the generic concept of the plausible referent lexical entry. If this comparison determines that both generic concepts could refer to a single generic referent, the referent and the anaphor are associated. If the outcome of this comparison is negative, processing of this lexical entry ceases, and another plausible lexical entry in immediate memory is analyzed.

ASSUMPTION SEVEN

(This assumption has been deleted from the new model)

ASSUMPTION EIGHT (Added)

If prior syntactic and/or semantic cues indicate that a word may be an anaphor, but the word has a meaning independent of its textual context, the word is not anaphorically resolved at the time it is
read. Instead, the word is tagged as a potential anaphor to which the anaphoric resolution process is applied at the end of the current sentence.

ASSUMPTION NINE (Added)

Sentences which are easily integrated into the preceding text are more readily available to the anaphoric resolution process than sentences which are difficult to integrate into the preceding text.
APPENDIX D

Stimuli Used in Experiment 1

The first sentences presented below represent the referent first condition of Experiment 1. To obtain the referent last condition, the first subject term of the first sentence (i.e., the referent) was moved to the position immediately preceding the first verb. For example, if the first sentence was Jane, Bill, and Myron were quite happy. (Jane is the referent), the corresponding referent last condition was Bill, Myron, and Jane were quite happy.

Also, in the stimuli below, the presence of ellipses indicate that the rest of the sentence is identical to the rest of the previous sentence. For example, if the initial sentence is Jane was quite happy, the form Jane and Bill were... indicates that the subjects were given the sentence Jane and Bill were quite happy.

The 48 stimuli presented below are those stimuli used for the data analyses. The six practice trials are not shown.
Stimulus 1

First Sentence
1 Subject term : John went to the store.
2 Subject terms: John and Kathy went...
3 Subject terms: John, Kathy, and Ruth went...

Second Sentence
Anaphor type : He bought some milk.
Filler type: The day was rainy.

Comprehension Questions:
Ana. type, Yes answer: Did John buy some milk?
Ana. type, No answer : Did John buy some cheese?
Fil. type, Yes answer: Was it rainy when John went
to the store?
Fil. type, No answer: Was it sunny when John went
to the store?

Stimulus 2

First Sentence
1 Subject term : Checkers are sold in stores.
2 Subject terms: Checkers and records are...
3 Subject terms: Checkers, records, and soap are...

Second Sentence
Anaphor type : The game is quite fun.
Filler type: Shopping can be fun.

Comprehension Questions:
Ana. type, Yes answer: Is playing checkers fun?
Ana. type, No answer : Is playing checkers boring?
Fil. type, Yes answer: Can shopping in stores be
fun?
Fil. type, No answer: Is shopping in stores
always dull?

Stimulus 3

First Sentence
1 Subject term : Mary had a cold.
2 Subject terms: Mary and Bill had...
3 Subject terms: Mary, Bill, and Frank had...
Second Sentence
Anaphor type: She was taking cold medicine.
Filler type: Cold medicine would have helped.

Comprehension Questions:
Ana. type, Yes answer: Was Mary taking a cold medicine?
Ana. type, No answer: Was Mary taking an arthritis medicine?
Fil. type, Yes answer: Would cold medicine help get rid of colds?
Fil. type, No answer: Would cold medicine cause harm?

Stimulus 4

First Sentence
1 Subject term: Beef makes a good dinner.
2 Subject terms: Beef and potatoes make...
3 Subject terms: Beef, corn, and potatoes make...

Second Sentence
Anaphor type: The meat can be very tender.
Filler type: Going out is more fun.

Comprehension Questions:
Ana. type, Yes answer: Can beef be tender?
Ana. type, No answer: Can beef be tough?
Fil. type, Yes answer: Is going out more fun than making dinner?
Fil. type, No answer: Is going out less fun than making dinner?

Stimulus 5

First Sentence
1 Subject term: Glue can hold wood together.
2 Subject terms: Glue and nails can...
3 Subject terms: Glue, nails and screws can...

Second Sentence
Anaphor type: The adhesive alone is often sufficient.
Filler type: Using tape alone is rarely sufficient.
Comprehension Questions:
Ana. type, Yes answer: Can glue alone often hold wood together?
Ana. type, No answer : Is glue alone often unable to hold wood together?
Fil. type, Yes answer: Is tape alone rarely enough to hold wood together?
Fil. type, No answer: Can tape alone always hold wood together?

Stimulus 6

First Sentence
1 Subject term : Snakes can be found in the desert.
2 Subject terms: Snakes and sand can...
3 Subject terms: Snakes, sand, and cacti can...

Second Sentence
Anaphor type : The reptiles sleep during the day.
Filler type: The sun burns down during the day.

Comprehension Questions:
Ana. type, Yes answer: Do snakes sleep during the day?
Ana. type, No answer : Do snakes sleep at night?
Fil. type, Yes answer: Does the sun burn down on the desert?
Fil. type, No answer: Does the sun cool off the desert snake?

Stimulus 7

First Sentence
1 Subject term : Motorcycles are found along the highway.
2 Subject terms: Motorcycles and hitchhikers are...
3 Subject terms: Motorcycles, hitchhikers and billboards are...

Second Sentence
Anaphor type : The two-wheeler can be difficult to ride, however.
Filler type: Airplanes can be seen at night flying overhead.
Comprehension Questions:

Ana. type, Yes answer: Can motorcycles be difficult to ride?
Ana. type, No answer: Are motorcycles always easy to ride?
Fil. type, Yes answer: Do airplanes fly over the highway at night?
Fil. type, No answer: Do helicopters fly over the highway at night?

Stimulus 8

First Sentence
1 Subject term: Television can convey information.
2 Subject terms: Television and newspapers can...
3 Subject terms: Television, newspapers, an...

Second Sentence
Anaphor type: Watching the tube is the most popular way.
Filler type: Watching the neighbors is also not unusual.

Comprehension Questions:

Ana. type, Yes answer: Is television a popular way to convey information?
Ana. type, No answer: Is radio a popular way to convey information?
Fil. type, Yes answer: Is getting information by watching the neighbors common?
Fil. type, No answer: Is getting information by watching the neighbors unusual?

Stimulus 9

First Sentence
1 Subject term: Pants are made of cloth.
2 Subject terms: Pants and sheets are...
3 Subject terms: Pants, sheets, and awnings are...

Second Sentence
Anaphor type: The trousers often need a belt.
Filler type: Buildings are made of strong concrete.
Comprehension Questions:

Ana. type, Yes answer: Do pants frequently need a belt?
Ana. type, No answer: Do pants rarely require a belt?
Fil. type, Yes answer: Are buildings made of strong concrete?
Fil. type, No answer: Are buildings made of strong cloth?

Stimulus 10

First Sentence
1 Subject term: Ronald Reagan is a famous person.
2 Subject terms: Ronald Reagan and Johnny Cash are famous people.
3 Subject terms: Ronald Reagan, Johnny Cash, and Bill Cosby are...

Second Sentence
Anaphor type: The president was once an actor.
Filler type: This has been a decade of real change.

Comprehension Questions:

Ana. type, Yes answer: Did Ronald Reagan ever act?
Ana. type, No answer: Was Ronald Reagan an announcer?
Fil. type, Yes answer: Have the eighties been a decade of real change?
Fil. type, No answer: Were the seventies a decade of real change?

Stimulus 11

First Sentence
1 Subject term: Hawaii is west of Ohio.
2 Subject terms: Hawaii and the Grand Canyon are...
3 Subject terms: Hawaii, the Grand Canyon, and Las Vegas are...

Second Sentence
Anaphor type: The islands are very beautiful in the winter.
Filler type: Tahiti is very beautiful in the winter.
Comprehension Questions:
Ana. type, Yes answer: Is Hawaii pretty in the winter?
Ana. type, No answer: Is Hawaii beautiful in the summer?
Fil. type, Yes answer: Is Tahiti very pretty in the winter?
Fil. type, No answer: Is it in the spring that Tahiti is very pretty?

Stimulus 12

First Sentence
1 Subject term: Spaghetti is found in Italy.
2 Subject terms: Spaghetti and fountains are...
3 Subject terms: Spaghetti, fountains, and relics are...

Second Sentence
Anaphor type: The pasta is very good.
Filler type: The roads are very bad.

Comprehension Questions:
Ana. type, Yes answer: Is Italian spaghetti good?
Ana. type, No answer: Is Italian spaghetti bad?
Fil. type, Yes answer: Are the roads in Italy bad?
Fil. type, No answer: Are the roads in Italy good?

Stimulus 13

First Sentence
1 Subject term: Dogs are sold in petshops.
2 Subject terms: Dogs and birdseed are...
3 Subject terms: Dogs, birdseed, and cages are...

Second Sentence
Anaphor type: The canine is considered a man's best friend.
Filler type: The profit margins are not very high.

Comprehension Questions:
Ana. type, Yes answer: Is a man's best friend considered to be a dog?
Ana. type, No answer: Is a child's best friend considered to be a dog?
Fil. type, Yes answer: Are most petshop profit margins low?
Fil. type, No answer: Are most petshop profit margins high?

Stimulus 14

First Sentence
1 Subject term: Snacks can help a person study.
2 Subject terms: Snacks and books can...
3 Subject terms: Snacks, books, and silence can...

Second Sentence
Anaphor type: The food should not be overlooked.
Filler type: Leisure should not be overlooked.

Comprehension Questions:
Ana. type, Yes answer: Is studying with food good?
Ana. type, No answer: Is studying with food bad?
Fil. type, Yes answer: Should leisure be considered?
Fil. type, No answer: Should leisure be overlooked?

Stimulus 15

First Sentence
1 Subject term: Apples can be red.
2 Subject terms: Apples and stoplights can...
3 Subject terms: Apples, stoplights, and hair can...

Second Sentence
Anaphor type: The fruit is very tasty.
Filler type: Color perception is complex.

Comprehension Questions:
Ana. type, Yes answer: Do apples taste good?
Ana. type, No answer: Are all red fruits tasty?
Fil. type, Yes answer: Is color perception complicated?
Fil. type, No answer: Is color perception simple?
Stimulus 16

First Sentence
1 Subject term: A cube is a geometric figure.
2 Subject terms: Cubes and spheres are geometric figures.
3 Subject terms: Cubes, spheres, and cones are...

Second Sentence
Anaphor type: The box has eight corners.
Filler type: Pentagons have five sides.

Comprehension Questions:
Ana. type, Yes answer: Does a cube have eight corners?
Ana. type, No answer: Does a cube have eight sides?
Fil. type, Yes answer: Does a pentagon have five sides?
Fil. type, No answer: Does a cube have five sides?

Stimulus 17

First Sentence
1 Subject term: Screwdrivers can be used to open locks.
2 Subject terms: Screwdrivers and keys can...
3 Subject terms: Screwdrivers, keys, and hairpins can...

Second Sentence
Anaphor type: The tool also can be used to remove hinges.
Filler type: Tightening security is a problem.

Comprehension Questions:
Ana. type, Yes answer: Can a screwdriver take off hinges?
Ana. type, No answer: Can a screwdriver remove nuts?
Fil. type, Yes answer: Is tightening security a problem?
Fil. type, No answer: Is opening locks a problem?
Stimulus 18

First Sentence
1 Subject term: Boards can be bought at a hardware store.
2 Subject terms: Boards and windows can...
3 Subject terms: Boards, windows, and curtains...

Second Sentence
Anaphor type: The planks are often made of wood.
Filler type: Some salesmen are not helpful.

Comprehension Questions:
Ana. type, Yes answer: Are boards usually made of wood?
Ana. type, No answer: Can planks be bought at Penneys?
Fil. type, Yes answer: Can salesman be unhelpful?
Fil. type, No answer: Are salesman always helpful?

Stimulus 19

First Sentence
1 Subject term: Smells are processed by the brain.
2 Subject terms: Smells and sights are...
3 Subject terms: Smells, sights, and sensations...

Second Sentence
Anaphor type: The odors are of four basic types.
Filler type: Some muscles are known as extendors.

Comprehension Questions:
Ana. type, Yes answer: Do smells come in four basic types?
Ana. type, No answer: Do smells come in six basic types?
Fil. type, Yes answer: Are some muscles known as extendors?
Fil. type, No answer: Are muscles controlled by the brain known as intendors?

Stimulus 20

First Sentence
1 Subject term: Referees make a football game exciting.
2 Subject terms: Referees and players make...
3 Subject terms: Referees, players, and cheerleaders make...

Second Sentence
Anaphor type: The officials have the toughest job.
Filler type: Using lights at night can be costly.

Comprehension Questions:
Ana. type, Yes answer: Do football referees have a tough job?
Ana. type, No answer: Do football referees have an easy job?
Fil. type, Yes answer: Can using lights at a night football game be costly?
Fil. type, No answer: Is using lights at a baseball game always costly?

Stimulus 21

First Sentence
1 Subject term: Organs can be found in a church.
2 Subject terms: Organs and candles can...
3 Subject terms: Organs, candles, and pews can...

Second Sentence
Anaphor type: The instrument accompanies the choir.
Filler type: Silence can be good for meditation.

Comprehension Questions:
Ana. type, Yes answer: Does an organ accompany the church choir?
Ana. type, No answer: Is it people who accompany the organ?
Fil. type, Yes answer: Is meditation helped by silence?
Fil. type, No answer: Is meditation helped by noise?

Stimulus 22

First Sentence
1 Subject term: Penguins are found in the Antarctic.
2 Subject terms: Penguins and ice are...
3 Subject terms: Penguins, ice, and bitter cold...

Second Sentence
Anaphor type: The bird cannot fly.
Filler type: The tropics are lush.

Comprehension Questions:
Ana. type, Yes answer: Are penguins unable to fly?
Ana. type, No answer: Can penguins fly?
Fil. type, Yes answer: Are the tropics lush?
Fil. type, No answer: Is the Antarctic lush?

Stimulus 23

First Sentence
1 Subject term: Conversing is part of loving someone.
2 Subject terms: Conversing and sharing are...
3 Subject terms: Conversing, sharing, and respect...

Second Sentence
Anaphor type: The talking is often overlooked.
Filler type: Emotions are hard to understand.

Comprehension Questions:
Ana. type, Yes answer: Is talking part of loving someone?
Ana. type, No answer: Is sharing often overlooked?
Fil. type, Yes answer: Are emotions difficult to understand?
Fil. type, No answer: Are emotions easy to understand?

Stimulus 24

First Sentence
1 Subject term: Sweating may occur during an argument.
2 Subject terms: Sweating and yelling may...
3 Subject terms: Sweating, yelling, and hitting...

Second Sentence
Anaphor type: Perspiring also happens during tennis.
Filler type: Little incidents can grow into problems.
Comprehension Questions:
Ana. type, Yes answer: Does sweating occur during tennis?
Ana. type, No answer: Does sweating happen during racquetball?
Fil. type, Yes answer: Can little incidents grow into problems?
Fil. type, No answer: Do big arguments grow into little problems?

Stimulus 25

First Sentence
1 Subject term: Soreness is part of working out.
2 Subject terms: Soreness and straining are...
3 Subject terms: Soreness, straining, and stretching...

Second Sentence
Anaphor type: The pain soon goes away.
Filler type: Being healthy is good.

Comprehension Questions:
Ana. type, Yes answer: Does the soreness caused by working out soon go away?
Ana. type, No answer: Does the soreness caused by working out linger?
Fil. type, Yes answer: Is being healthy good?
Fil. type, No answer: Is being healthy bad?

Stimulus 26

First Sentence
1 Subject term: Tuna makes a good lunch.
2 Subject terms: Tuna and chips make...
3 Subject terms: Tuna, chips, and a Pepsi...

Second Sentence
Anaphor type: The fish can be delicious.
Filler type: Eating can cause drowsiness.

Comprehension Questions:
Ana. type, Yes answer: Can tuna be delicious?
Ana. type, No answer: Does tuna always taste bad?
Fil. type, Yes answer: Can eating cause drowsiness?
Fil. type, No answer: Is drowsiness caused by not eating?
Stimulus 27

First Sentence
1 Subject term: Computers are sold at Sears.
2 Subject terms: Computers and clothes are...
3 Subject terms: Computers, clothes, and toys...

Second Sentence
Anaphor type: The machine used to be expensive.
Filler type: Christmas shopping can cause headaches.

Comprehension Questions:
Ana. type, Yes answer: Are computers cheaper now than they used to be?
Ana. type, No answer: Are expensive computers sold at Sears?
Fil. type, Yes answer: Can Christmas shopping cause headaches?
Fil. type, No answer: Is it birthday shopping at Sears which causes headaches?

Stimulus 28

First Sentence
1 Subject term: Monkeys have been in space.
2 Subject terms: Monkeys and people...
3 Subject terms: Monkeys, people, and rats...

Second Sentence
Anaphor type: The chimps were among the first to go.
Filler type: Sputnik was an artificial moon.

Comprehension Questions:
Ana. type, Yes answer: Were monkeys among the first to go into space?
Ana. type, No answer: Were monkeys among the last to go into space?
Fil. type, Yes answer: Was Sputnik an artificial moon?
Fil. type, No answer: Was Sputnik considered a real moon?
Stimulus 29

First Sentence
1 Subject term: Being tall is a trait of many basketball players.
2 Subject terms: Being tall and swift are traits...
3 Subject terms: Being tall, swift, and rich...

Second Sentence
Anaphor type: Height alone is not enough to be great, however.
Filler type: College sports has become a big time business.

Comprehension Questions:
Ana. type, Yes answer: Are many basketball players tall?
Ana. type, No answer: Are all tall people great basketball players?
Fil. type, Yes answer: Has college sports become a big time business?
Fil. type, No answer: Has professional sports become a small time business?

Stimulus 30

First Sentence
1 Subject term: A wall can be found in Berlin.
2 Subject terms: A wall and beer...
3 Subject terms: A wall, beer, and soldiers...

Second Sentence
Anaphor type: The barrier is not enough to stop everyone.
Filler type: Germany is today economically strong.

Comprehension Questions:
Ana. type, Yes answer: Is the Berlin wall unable to stop everybody?
Ana. type, No answer: Can the Berlin wall stop everyone?
Fil. type, Yes answer: Is Germany strong economically today?
Fil. type, No answer: Is Germany politically weak today?
Stimulus 31

First Sentence
1 Subject term: Rats often accumulate in the sewer.
2 Subject terms: Rats and water...
3 Subject terms: Rats, water, and trash...

Second Sentence
Anaphor type: The rodents can carry disease.
Filler type: City services can be slow.

Comprehension Questions:
Ana. type, Yes answer: Can rats carry disease?
Ana. type, No answer: Do sewer rats carry food?
Fil. type, Yes answer: Can city services be slow?
Fil. type, No answer: Are city services always fast?

Stimulus 32

First Sentence
1 Subject term: Meters are commonplace in cockpits.
2 Subject terms: Meters and parachutes...
3 Subject terms: Meters, parachutes, and radios...

Second Sentence
Anaphor type: The gauges are always in front of the pilot.
Filler type: Fighter pilots have a dangerous job to do.

Comprehension Questions:
Ana. type, Yes answer: Are meters in front of a pilot?
Ana. type, No answer: Are gauges unusual in cockpits?
Fil. type, Yes answer: Do fighter pilots face danger in their job?
Fil. type, No answer: Is it commercial pilots that have a dangerous job?
Stimulus 33

**First Sentence**
1 Subject term: Rocks are plentiful in the ocean.
2 Subject terms: Rocks and fish are...
3 Subject terms: Rocks, fish, and salt...

**Second Sentence**
Anaphor type: The stones are usually quite smooth.
Filler type: Water covers much of the earth.

**Comprehension Questions:**
Ana. type, Yes answer: Are smooth stones found in the ocean?
Ana. type, No answer: Are jagged rocks found in the ocean?
Fil. type, Yes answer: Does water cover most of the earth?
Fil. type, No answer: Does water cover only a little of the earth?

Stimulus 34

**First Sentence**
1 Subject term: Scientists can be seen in laboratories.
2 Subject terms: Scientists and chemicals...
3 Subject terms: Scientists, chemicals, and equipment...

**Second Sentence**
Anaphor type: The researchers don't always wear white coats.
Filler type: Most inventions start out as small ideas.

**Comprehension Questions:**
Ana. type, Yes answer: Can researchers be seen in laboratories?
Ana. type, No answer: Do scientists always wear white coats?
Fil. type, Yes answer: Do many inventions begin as small ideas?
Fil. type, No answer: Is it rare for an invention to start as a small idea?
Stimulus 35

First Sentence
1 Subject term: Politicians can cause laughter.
2 Subject terms: Politicians and comedians...
3 Subject terms: Politicians, comedians, and actors...

Second Sentence
Anaphor type: The bureaucrats try to be serious.
Filler type: Being serious can depress people.

Comprehension Questions:
Ana. type, Yes answer: Do politicians try to be serious?
Ana. type, No answer: Do politicians try to be funny?
Fil. type, Yes answer: Can being serious depress people?
Fil. type, No answer: Can laughter depress people?

Stimulus 36

First Sentence
1 Subject term: Dirt frequently fills the summer air.
2 Subject terms: Dirt and heat...
3 Subject terms: Dirt, heat, and insects...

Second Sentence
Anaphor type: The soil is carried by warm updrafts.
Filler type: Stars can be seen at night.

Comprehension Questions:
Ana. type, Yes answer: Is dirt carried by warm updrafts?
Ana. type, No answer: Is dirt carried by cold updrafts?
Fil. type, Yes answer: At night, can stars easily be seen?
Fil. type, No answer: Is it the moon that can be easily seen at night?
Stimulus 37

First Sentence
1 Subject term: Ghosts are seen at Halloween.
2 Subject terms: Ghosts and monsters...
3 Subject terms: Ghosts, monsters, and witches...

Second Sentence
Anaphor type: The spirits may not be sheets covering people.
Filler type: October is the month when the leaves change colors.

Comprehension Questions:
Ana. type, Yes answer: Might a Halloween ghost not be a person wearing a sheet?
Ana. type, No answer: Are ghosts seen at cemeteries?
Fil. type, Yes answer: Is Halloween in the month when the leaves change color?
Fil. type, No answer: Do the leaves change color in late November?

Stimulus 38

First Sentence
1 Subject term: Horses were in the parade.
2 Subject terms: Horses and clowns...
3 Subject terms: Horses, clowns, and dancers...

Second Sentence
Anaphor type: The animals were well behaved.
Filler type: The circus had arrived in town.

Comprehension Questions:
Ana. type, Yes answer: Were the horses well behaved?
Ana. type, No answer: Were the horses being stubborn?
Fil. type, Yes answer: Had the circus come to town?
Fil. type, No answer: Did the elephants arrive in town?
Stimulus 39

First Sentence
1 Subject term : Centipedes live underground.
2 Subject terms: Centipedes and worms...
3 Subject terms: Centipedes, worms, and gophers...

Second Sentence
Anaphor type : The bug does not really have one hundred legs.
Filler type: Dirt is a good insulator.

Comprehension Questions:
Ana. type, Yes answer: Might a centipede not have one hundred legs?
Ana. type, No answer : Does a centipede have one hundred legs?
Fil. type, Yes answer: Is dirt a good insulator?
Fil. type, No answer: Is dirt a poor insulator?

Stimulus 40

First Sentence
1 Subject term : Cats are warm blooded.
2 Subject terms: Cats and dolphins...
3 Subject terms: Cats, dolphins, and bats...

Second Sentence
Anaphor type : The felines can be very quiet.
Filler type: Lizards adjust to the surroundings.

Comprehension Questions:
Ana. type, Yes answer: Can cats be quiet?
Ana. type, No answer : Are felines cold blooded?
Fil. type, Yes answer: Do lizards adjust to their environment?
Fil. type, No answer:Are lizards warm blooded?

Stimulus 41

First Sentence
1 Subject term : Boxers can be found in rings.
2 Subject terms: Boxers and cakes...
3 Subject terms: Boxers, cakes, and fingers...

Second Sentence
Anaphor type : The fighters are often muscular.
Filler type: Donuts have a hole in the center.
Comprehension Questions:
Ana. type, Yes answer: Are boxers muscular?
Ana. type, No answer: Are boxers weak?
Fil. type, Yes answer: Do donuts have a hole in the center?
Fil. type, No answer: Do donuts have a hole in the side?

Stimulus 42

First Sentence
1 Subject term: Water can travel in waves.
2 Subject terms: Water and electricity...
3 Subject terms: Water, electricity, and sound...

Second Sentence
Anaphor type: The liquid lies flat when indoors.
Filler type: Particle theory is different.

Comprehension Questions:
Ana. type, Yes answer: Is water which is stored indoors flat?
Ana. type, No answer: Are there waves in indoor water?
Fil. type, Yes answer: Is particle theory different?
Fil. type, No answer: Are particle theory and wave motion the same?

Stimulus 43

First Sentence
1 Subject term: Wealth is a goal of many people.
2 Subject terms: Wealth and popularity are ...
3 Subject terms: Wealth, popularity, and fame...

Second Sentence
Anaphor type: Being rich cannot guarantee happiness.
Filler type: Being happy is difficult to obtain.

Comprehension Questions:
Ana. type, Yes answer: Is being rich a goal of many people?
Ana. type, No answer: Does wealth guarantee happiness?
Fil. type, Yes answer: Is being happy hard to
Fil. type, No answer: Is being happy easy to obtain?

Stimulus 44

First Sentence
1 Subject term: Streets are always present in a city.
2 Subject terms: Streets and buildings...
3 Subject terms: Streets, buildings, and police...

Second Sentence
Anaphor type: The roads are lined with lights.
Filler type: Crime rates can be high.

Comprehension Questions:
Ana. type, Yes answer: Are there roads in a city?
Ana. type, No answer: Are city streets lined with buildings?
Fil. type, Yes answer: Can crime rates in a city be high?
Fil. type, No answer: Are crime rates in the country high?

Stimulus 45

First Sentence
1 Subject term: Boots are worn by soldiers.
2 Subject terms: Boots and knives...
3 Subject terms: Boots, knives, and backpacks...

Second Sentence
Anaphor type: The shoes are very heavy.
Filler type: Saluting is required.

Comprehension Questions:
Ana. type, Yes answer: Are a soldier's boots heavy?
Ana. type, No answer: Are light shoes worn by soldiers?
Fil. type, Yes answer: Is saluting by soldiers required?
Fil. type, No answer: Is saluting by soldiers optional?
Stimulus 46

First Sentence
1 Subject term: Bacteria can cause bad breath.
2 Subject terms: Bacteria and food...
3 Subject terms: Bacteria, food, and cigarettes...

Second Sentence
Anaphor type: The germs also can cause decay.
Filler type: Eating mints may not help at all.

Comprehension Questions:
Ana. type, Yes answer: Can bacteria cause decay?
Ana. type, No answer: Is bacteria a result of tooth decay?
Fil. type, Yes answer: Might eating mints not get rid of bad breath?
Fil. type, No answer: Does eating mints always get rid of bad breath?

Stimulus 47

First Sentence
1 Subject term: Cooks work with steam.
2 Subject terms: Cooks and saunas...
3 Subject terms: Cooks, saunas, and cleaners...

Second Sentence
Anaphor type: The chefs use freezers as well.
Filler type: Lung congestion can be cleared.

Comprehension Questions:
Ana. type, Yes answer: Do cooks use freezers?
Ana. type, No answer: Do cooks use utensils?
Fil. type, Yes answer: Can lung congestion be cleared?
Fil. type, No answer: Is it nasal congestion which can be cleared?

Stimulus 48

First Sentence
1 Subject term: Tin can be found in Chile.
2 Subject terms: Tin and mountains...
3 Subject terms: Tin, mountains, and revolutionaries...
Second Sentence
Anaphor type: The metal is widely used in America.
Filler type: South America has natural resources.

Comprehension Questions:
Ana. type, Yes answer: Is tin widely used in America?
Ana. type, No answer: Is steel widely used in America?
Fil. type, Yes answer: Does South America have natural resources?
Fil. type, No answer: Does South America have no natural resources?
APPENDIX E

Stimuli Used in Experiment 2

In the following stimuli, the far condition of Experiment 2 was formed by presenting the referent sentence before the filler sentences. The close condition was formed by presenting the referent sentence after the filler sentences.

In the probed sentences, the word before the slash is the anaphor; the term after the slash is the anaphor-control item. When the probed sentence included the anaphor word, the probed sentence was in the anaphor-containing condition. When the anaphor-control item was displayed instead of the anaphor, the probed sentence was in the anaphor-control condition.

The stimuli below are the 96 stimuli used in the data analyses. The 10 practice stimuli and the 24 "no" filler stimuli are not shown.
Stimulus 1

Filler  Children were getting home from school.
Sentences: Kids were walking every which way.

Referent Sentence: A grasshopper was on the lawn.

Probed Sentence: The insect/police did not like afternoons.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRASSHOPPER</td>
<td>LAWN</td>
<td>HOME</td>
<td>BALL</td>
</tr>
</tbody>
</table>

Stimulus 2

Filler  The drought had lasted two years.
Sentences: Little remained alive in the dust.

Referent Sentence: A rose had fallen to the ground.

Probed Sentence: The flower/buzzard was almost dead.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSE</td>
<td>GROUND</td>
<td>DROUGHT</td>
<td>KNEE</td>
</tr>
</tbody>
</table>

Stimulus 3

Filler  Wedding bells chimed loudly.
Sentences: The best man had yet to arrive.

Referent Sentence: A diamond was on the ring.

Probed Sentence: The jewel/minister made a strong impression.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIAMOND</td>
<td>RING</td>
<td>BELLS</td>
<td>BIRD</td>
</tr>
</tbody>
</table>
Stimulus 4

Filler The bus would soon be here.
Sentences: The fare was fifty cents.

Referent Sentence: All Mary had was a quarter.

Probed Sentence: So she/officials decided to walk.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARY</td>
<td>QUARTER</td>
<td>BUS</td>
<td>DOG</td>
</tr>
</tbody>
</table>

Stimulus 6

Filler The plains are very level.
Sentences: One can see for miles in any direction.

Referent Sentence: Kansas has few hills.

Probed Sentence: The state/pollution has grown rapidly.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>KANSAS</td>
<td>HILLS</td>
<td>PLAINS</td>
<td>ROCKET</td>
</tr>
</tbody>
</table>

Stimulus 7

Filler The Bering Strait can be quite frigid.
Sentences: Icebergs as big as a house are common.

Referent Sentence: Alaska has cold weather most of the year.

Probed Sentence: The state/money is way up north.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALASKA</td>
<td>COLD</td>
<td>BERING</td>
<td>PHYSICS</td>
</tr>
</tbody>
</table>
Stimulus 8

Filler: The jungle became very dense.
Sentences: Weird sounds could be heard.

Referent: A python was in a tree.
Probed: The snake/situation looked quite dangerous.

PROBES

Referent | Companion | In-paragraph | Out-of-paragraph
---|---|---|---
PYTHON | TREE | JUNGLE | BOOK

Stimulus 9

Filler: A storm was fast approaching.
Sentences: The sea gulls were very quiet.

Referent: A yacht was returning home.
Probed: The ship/crabs quickly move on.

PROBES

Referent | Companion | In-paragraph | Out-of-paragraph
---|---|---|---
YACHT | HOME | STORM | BOOT

Stimulus 10

Filler: The mountains had jagged outcroppings.
Sentences: Steep ledges surrounded the canyon.

Referent: A goat was perched on a cliff.
Probed: The animal/lizards did not mind.

PROBES

Referent | Companion | In-paragraph | Out-of-paragraph
---|---|---|---
GOAT | CLIFF | MOUNTAINS | FORK
Stimulus 11

Filler The crime rate had started to decrease. Sentences: Still, felonies continued to occur.

Referent Sentence: A robber had just escaped from prison.

Probed Sentence: The thief/mayor was quite proficient.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBBER</td>
<td>PRISON</td>
<td>RATE</td>
<td>BALLOON</td>
</tr>
</tbody>
</table>

Stimulus 12

Filler Garbage was strewn everywhere. Sentences: A foul smell filled the air.

Referent Sentence: A cat prowled the alley.

Probed Sentence: The feline/poor looked for food.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>ALLEY</td>
<td>GARBAGE</td>
<td>FOREST</td>
</tr>
</tbody>
</table>

Stimulus 13

Filler The city was nearly empty. Sentences: It was early in the morning.

Referent Sentence: A Chevy turned off at an exit.

Probed Sentence: The car/heat went roaring past seventy.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEVY</td>
<td>EXIT</td>
<td>CITY</td>
<td>SPOON</td>
</tr>
</tbody>
</table>
Stimulus 14

Filler  The screen door had a hole.
Sentences:  Food was on the table.

Referent  Sentence:  A fly was on the butter.

Probed  Sentence:  The insect/sink was soon to be full.

PROBES

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLY</td>
<td>BUTTER</td>
<td>DOOR</td>
<td>FOOTBALL</td>
</tr>
</tbody>
</table>

Stimulus 15

Filler  Many people have moved to Texas.
Sentences:  The climate is usually pleasant.

Referent  Sentence:  Houston is an attraction.

Probed  Sentence:  The city/food has much to offer.

PROBES

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOUSTON</td>
<td>ATTRACTION</td>
<td>PEOPLE</td>
<td>DISTRACTION</td>
</tr>
</tbody>
</table>

Stimulus 16

Filler  The new tar was slippery.
Sentences:  A light mist filled the air.

Referent  Sentence:  A taxi slowly rounded the corner.

Probed  Sentence:  The vehicle/rain had begun to stop.

PROBES

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAXI</td>
<td>CORNER</td>
<td>TAR</td>
<td>RUG</td>
</tr>
</tbody>
</table>
Stimulus 17

Filler Good health requires good nutrition.
Sentences: Trace elements also are important.

Referent Sentence: Carrots contain useful vitamins.

Probed Sentence: The vegetable/idea is popular out west.

PROBES
Referent Companion In-paragraph Out-of-paragraph
CARROTS VITAMINS HEALTH DUST

Stimulus 18

Filler Medical research has improved life considerably.
Sentences: Still, some serious problems persist.

Referent Sentence: Polio may attack children.

Probed Sentence: The disease/weather has a big effect.

PROBES
Referent Companion In-paragraph Out-of-paragraph
POLIO CHILDREN RESEARCH TURKEY

Stimulus 19

Filler The store manager was upset.
Sentences: He hated violence intensely.

Referent Sentence: A gun was in the display window.

Probed Sentence: The weapon/ad was quickly removed.

PROBES
Referent Companion In-paragraph Out-of-paragraph
GUN WINDOW MANAGER CORN
Stimulus 20

Filler  The Orient is overpopulated.
Sentences:  Too little land, too many births.

Referent
Sentence:  Japan has many citizens.

Probed
Sentence:  The country/apartments will soon be filled.

PROBES

Referent  Companion  In-paragraph  Out-of-paragraph
JAPAN    CITIZENS    ORIENT    HAIR

Stimulus 21

Filler  Many colleges offer tutoring.
Sentences:  The homework can be overwhelming.

Referent
Sentence:  Freshman biology can be a frustration.

Probed
Sentence:  The class/library is available at night.

PROBES

Referent  Companion  In-paragraph  Out-of-paragraph
BIOLOGY  FRUSTRATION  COLLEGES  MEASLES

Stimulus 22

Filler  Little kids like simple things.
Sentences:  Even different generations may share the same fun.

Referent
Sentence:  Slinkys have regained popularity.

Probed
Sentence:  The toy/emotion will last a long time.

PROBES

Referent  Companion  In-paragraph  Out-of-paragraph
SLINKYS  POPULARITY  KIDS  LAKE
Stimulus 23

Filler  The beach was considered unsafe.
Sentences: The waves pounded the shoreline.

Referent
Sentence: A shark was seen in the surf.

Probed
Sentence: The fish/food was close to land.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SHARK SURF BEACH PARROT

Stimulus 24

Filler  Fads are part of Americana.
Sentences: Such things come and go.

Referent
Sentence: The Twist was once a craze.

Probed
Sentence: The dance/decade began with a typical Sixties look.

PROBES
Referent Companion In-paragraph Out-of-paragraph
TWIST CRAZE FADS CANNON

Stimulus 25

Filler  Spring was in the air.
Sentences: April showers gave way to May flowers.

Referent
Sentence: A robin chirped with happiness.

Probed
Sentence: The bird/bears had taken a bath.

PROBES
Referent Companion In-paragraph Out-of-paragraph
ROBIN HAPPINESS SPRING PAPER
Stimulus 26

Filler  The valley was covered with water.
Sentences:  The dam had broken last night.

Referent
Sentence:  A church was all Bill could see.

Probed
Sentence:  The building/rise was just tall enough.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
CHURCH  ALL  VALLEY  POLO

Stimulus 27

Filler  Malls usually have many different stores.
Sentences:  Some places only sell one thing.

Referent
Sentence:  Checkers are sold in toyshops.

Probed
Sentence:  The game/money can go quickly.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
CHECKERS  TOYSHOPS  MALLS  RED

Stimulus 28

Filler  Juice is good for breakfast.
Sentences:  Snacks during the day are common.

Referent
Sentence:  Beef makes for a filling dinner.

Probed
Sentence:  The meat/stove can be any type.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
BEEF  DINNER  JUICE  FIRST
Stimulus 29

Filler: Clothes are fastened with buttons.
Sentences: Rivets are used with metal.

Referent
Sentence: Sticky **paste** may hold paper.

Probed
Sentence: The adhesive/clamp is rarely used.

**PROBES**

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASTE</td>
<td>PAPER</td>
<td>CLOTHES</td>
<td>BONE</td>
</tr>
</tbody>
</table>

Stimulus 30

Filler: Our thirst for news is intense.
Sentences: Newspapers are no longer sufficient.

Referent
Sentence: Television conveys information very fast.

Probed
Sentence: The tube/radio is the most frequent way.

**PROBES**

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>TELEVISION</td>
<td>INFORMATION</td>
<td>THIRST</td>
<td>DISK</td>
</tr>
</tbody>
</table>

Stimulus 31

Filler: Local elections were not far away.
Sentences: The conservatives were in power.

Referent
Sentence: Reagan had just argued with Tip.

Probed
Sentence: The President/British hoped for a landslide.

**PROBES**

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>REAGAN</td>
<td>TIP</td>
<td>LOCAL</td>
<td>NAPKIN</td>
</tr>
</tbody>
</table>
**Stimulus 32**

**Filler**  
Goldfish were growing large teeth.  
**Sentences:** Pets were suddenly turning vicious.

**Referent**  
**Sentence:** Dogs in Australia had become wild.

**Probed**  
**Sentence:** The canines/birds had eaten their masters.

**PROBES**

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOGS</td>
<td>AUSTRALIA</td>
<td>GOLDFISH</td>
<td>BOLT</td>
</tr>
</tbody>
</table>

**Stimulus 33**

**Filler**  
The crew feared no one.  
**Sentences:** The ship could be taken.

**Referent**  
**Sentence:** Tahiti was on the horizon.

**Probed**  
**Sentence:** The islands/injustices were many in number.

**PROBES**

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAHITI</td>
<td>HORIZON</td>
<td>CREW</td>
<td>CLUB</td>
</tr>
</tbody>
</table>

**Stimulus 34**

**Filler**  
The match had been peaceful.  
**Sentences:** The crowd was now angry.

**Referent**  
**Sentence:** A referee had made a bad call.

**Probed**  
**Sentence:** The official/timer began to run.

**PROBES**

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFEREE</td>
<td>CALL</td>
<td>MATCH</td>
<td>DOT</td>
</tr>
</tbody>
</table>
Stimulus 35

Filler The fire had raged all night. Sentences: The hall was completely gutted.

Referent Sentence: A piano was spared any damage.

Probed Sentence: The instrument/conductor had been in the right place.

PROBES

Referent | Companion | In-paragraph | Out-of-paragraph
-------- | --------- | ------------ | -----------------
PIANO    | DAMAGE   | FIRE         | GLASS

Stimulus 36

Filler The painters were getting worried. Sentences: Nothing was working right today.

Referent Sentence: One compressor had broken a valve.

Probed Sentence: The machine/crane suddenly started up.

PROBES

Referent | Companion | In-paragraph | Out-of-paragraph
-------- | --------- | ------------ | -----------------
COMPRESSOR | VALVE   | PAINTERS    | DAISY

Stimulus 37

Filler The park had just opened. Sentences: Everyone was in a good mood.

Referent Sentence: A monkey was entertaining the crowd.

Probed Sentence: The chimp/owner was quite amusing.

PROBES

Referent | Companion | In-paragraph | Out-of-paragraph
-------- | --------- | ------------ | -----------------
MONKEY   | CROWD    | PARK        | PLUG
Stimulus 38

Filler: Many families had fled to the West.
Sentences: The rulers decided to stop the flow.

Referent
Sentence: A wall was built in Berlin.

Probed
Sentence: The barrier/situation still exists today.

PROBES
Referent Companion In-paragraph Out-of-paragraph
WALL BERLIN FAMILIES ERmine

Stimulus 39

Filler: The war had ended quickly.
Sentences: The remains of life littered the street.

Referent
Sentence: A rat rummaged through the debris.

Probed
Sentence: The rodent/alien found little to eat.

PROBES
Referent Companion In-paragraph Out-of-paragraph
RAT DEBRIS WAR FOAM

Stimulus 40

Filler: The pool could not be filled.
Sentences: Nothing came out of the faucets.

Referent
Sentence: A meter indicated the water was off.

Probed
Sentence: The gauge/digging had been okay this time.

PROBES
Referent Companion In-paragraph Out-of-paragraph
METER WATER POOL PENCIL
Stimulus 41
Filler A mudslide had occurred recently.
Sentences: No one could get to work.

Referent Sentence: A **boulder** was blocking the street.

Probed Sentence: The rock/camper could not be moved.

PROBES
Referent Companion In-paragraph Out-of-paragraph
BOULDER STREET MUDSLIDE BANK

Stimulus 42
Filler The program had just been restarted.
Sentences: The first results were unusual.

Referent Sentence: One **scientist** still had questions.

Probed Sentence: The researcher/president did not like it.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SCIENTIST QUESTIONS PROGRAM DRAPES

Stimulus 43
Filler The problem was what to cut.
Sentences: The budget was due next week.

Referent Sentence: A **politician** had the answer.

Probed Sentence: The bureaucrat/floor belonged to the Democrats.

PROBES
Referent Companion In-paragraph Out-of-paragraph
POLITICIAN ANSWER PROBLEM SCROLL
Stimulus 44
Filler The moon cast an eerie glow.
Sentences: The time of the season was right.

Referent Sentence: A ghost stalked the deserted house.

Probed Sentence: The spirit/voice had risen from within.

PROBES
Referent Companion In-paragraph Out-of-paragraph
GHOST HOUSE MOON TACK

Stimulus 45
Filler The route seemed to be clear.
Sentences: No large shadows were seen.

Referent Sentence: A cockroach surveyed the scene.

Probed Sentence: The bug/owl decided to chance it.

PROBES
Referent Companion In-paragraph Out-of-paragraph
COCKROACH LANDSCAPE ROUTE NAIL

Stimulus 46
Filler The day was finally here.
Sentences: The long awaited bout was going to start.

Referent Sentence: A boxer entered the arena.

Probed Sentence: The fighter/bookie looked too confident.

PROBES
Referent Companion In-paragraph Out-of-paragraph
BOXER ARENA DAY FIVE
Stimulus 47
Filler The market was robbed completely.
Sentences: The employees couldn't believe their eyes.

Referent Sentence: One Pepsi sat on the shelf.

Probed Sentence: The drink/damage was very noticeable.

PROBES
Referent Companion In-paragraph Out-of-paragraph
PEPSI SHELF MARKET RAIL

Stimulus 48
Filler The pace was exceedingly slow.
Sentences: Most residents were old timers.

Referent Sentence: A single street went into town.

Probed Sentence: The road/stable had been renovated.

PROBES
Referent Companion In-paragraph Out-of-paragraph
STREET TOWN PACE VOLUME

Stimulus 49
Filler The band clearly had a good time.
Sentences: This was their first gig.

Referent Sentence: A sneaker was found near the stage.

Probed Sentence: The shoe/bar smelled of booze.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SNEAKER STAGE BAND PURPLE
Stimulus 50

Filler  No growth was visible on the hillside.
Sentences: The bare rock was scarred forever.

Referent Sentence: Iron in the area had been mined.
Probed Sentence: The metal/beauty had been completely removed.

PROBES
Referent Companion In-paragraph Out-of-paragraph
IRON AREA GROWTH COLUMN

Stimulus 51

Filler  A draft had been called.
Sentences: Threatening troop movements had been spotted.

Referent Sentence: Jeff was joining the Marines.
Probed Sentence: Everyone he/that knew was getting ready.

PROBES
Referent Companion In-paragraph Out-of-paragraph
JEFF MARINES DRAFT GIN

Stimulus 52

Filler  The date had been fun.
Sentences: The romance of the evening lingered.

Referent A carnation was laying on the dresser.
Sentence:

Probed Sentence: The flower/memory was still fresh.

PROBES
Referent Companion In-paragraph Out-of-paragraph
CARNATION DRESSER DATE TIRE
Stimulus 53
Filler Auditions would be that night. Sentences: The ballet needed some extras.

Referent Sentence: Judy had hoped for a chance.

Probed Sentence: All she/Frank had wanted was a tryout.

PROBES
Referent Companion In-paragraph Out-of-paragraph
JUDY CHANCE AUDITIONS TIGER

Stimulus 54
Filler The banquet was but a week away. Sentences: The caterer hadn’t been sure of what to serve.

Referent Sentence: Chicken could result in leftovers.

Probed Sentence: The poultry/speeches would be good.

PROBES
Referent Companion In-paragraph Out-of-paragraph
CHICKEN LEFTOVERS BANQUET MIAMI

Stimulus 55
Filler The students had smiles on their faces. Sentences: The quarter would soon be over.

Referent Sentence: Christmas was a week away.

Probed Sentence: The holiday/feeling was happily anticipated.

PROBES
Referent Companion In-paragraph Out-of-paragraph
CHRISTMAS WEEK STUDENTS CORE

Stimulus 56
Filler  The desert was hot that day.
Sentences:  Not too much was happening.

Referent
Sentence:  A lizard was sunning on the sand.

Probed
Sentence:  The reptile/scientist stayed till evening.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIZARD</td>
<td>SAND</td>
<td>DESERT</td>
<td>CONTROL</td>
</tr>
</tbody>
</table>

Stimulus 57

Filler  The circus had many daredevils.
Sentences:  Some worked on pretty horses.

Referent
Sentence:  A motorcycle went up the ramp.

Probed
Sentence:  The two-wheeler/clowns amazed the crowd.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTORCYCLE</td>
<td>RAMP</td>
<td>CIRCUS</td>
<td>SOCKS</td>
</tr>
</tbody>
</table>

Stimulus 58

Filler  The girl had never seen anything so pretty.
Sentences:  She had been poor all of her life.

Referent
Sentence:  Silk was in the dress.

Probed
Sentence:  The cloth/wish shimmered in the light.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILK</td>
<td>DRESS</td>
<td>GIRL</td>
<td>SUB</td>
</tr>
</tbody>
</table>
Stimulus 59

Filler Thursday nights have changed for many.
Sentences: No more boring television sitcoms.

Referent Sentence: Cosby is a delight to watch.

Probed Sentence: The comedian/business is doing very well.

PROBES
Referent Companion In-paragraph Out-of-paragraph
COSBY DELIGHT NIGHTS CIRCLE

Stimulus 60

Filler We take many things for granted.
Sentences: Such complacency may be mistaken.

Referent Sentence: Wheat is a staple in our society.

Probed Sentence: The grain/ riches could someday be gone.

PROBES
Referent Companion In-paragraph Out-of-paragraph
WHEAT STAPLE WE SPORT

Stimulus 61

Filler The gun was heard for miles.
Sentences: The morning chill had still dampened the sound.

Referent Sentence: A duck had been shot by a hunter.

Probed Sentence: The fowl/ season had just started up.

PROBES
Referent Companion In-paragraph Out-of-paragraph
DUCK HUNTER GUN HANDLE
Stimulus 62

Filler Security had been lax this weekend. Sentences: The cops showed up too late.

Referent Sentence: A screwdriver was found at the scene.

Probed Sentence: The tool/window was used to break in.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SCREWDRIVER SCENE SECURITY SLEEVE

Stimulus 63

Filler His birthplace was to be removed. Sentences: This was a last look.

Referent Sentence: A smell permeated the house.

Probed Sentence: The odor/area was of days long gone.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SMELL HOUSE BIRTHPLACE PETAL

Stimulus 64

Filler The weights had been increased ten pounds. Sentences: Jack needed at least thirty repetitions.

Referent Sentence: A sweat was shining on the skin.

Probed Sentence: The perspiration/powder fell on the floor.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SWEAT SKIN WEIGHTS TUBA
Stimulus 65
Filler The summer had been dry.
Sentences: The brush was like a tinderbox.

Referent
Sentence: A fire had swept the hillside.

Probed
Sentence: The inferno/state had moved quickly.

PROBES
Referent Companion In-paragraph Out-of-paragraph
FIRE HILLSIDE SUMMER TOOTH

Stimulus 66
Filler The leader was about to speak.
Sentences: The people were worried about inflation.

Referent
Sentence: A hush fell over the crowd.

Probed
Sentence: The silence/banner was a sign of respect.

PROBES
Referent Companion In-paragraph Out-of-paragraph
HUSH CROWD LEADER STEM

Stimulus 67
Filler The fog was heavy this evening.
Sentences: A full moon could not be seen.

Referent
Sentence: A howl filled the night.

Probed
Sentence: The cry/cold sent shivers down the spine.

PROBES
Referent Companion In-paragraph Out-of-paragraph
HOWL NIGHT FOG TRASH
Stimulus 68

Filler  The customers had already left.
Sentences: The shop was ready to close:

Referent
Sentence: A wallet was left on the chair.

Probed
Sentence: The billfold/boss would be needed.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
WALLET  CHAIR  CUSTOMERS  PORT

Stimulus 69

Filler  The game was about to start.
Sentences: Soon, it would be too late.

Referent
Sentence: A bet with a player was to be made.

Probed
Sentence: The wager/clock was of little value.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
BET  PLAYER  GAME  MIX

Stimulus 70

Filler  The virus had escaped from the lab.
Sentences: Soon, the hospital would be informed.

Referent
Sentence: One blotch would first appear on the hand.

Probed
Sentence: The blemish/disaster could quickly spread.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
BLOTCH  HAND  VIRUS  SOLID
Stimulus 71

Filler One side felt too much money had been requested.

Sentences: An argument concerning ethics had begun.

Probed Sentence: The quarrel/scene would last till nightfall.

PROBES
Referent Companion In-paragraph Out-of-paragraph
ARGUMENT ETHICS SIDE PHYSICS

Stimulus 72

Filler Tempers were about ready to snap.

Sentences: The humidity had continued to increase.

Referent Sentence: A light wind would calm nerves.

Probed Sentence: The breeze/change was thus quite welcome.

PROBES
Referent Companion In-paragraph Out-of-paragraph
WIND NERVES TEMPERATURES SQUARE

Stimulus 73

Filler John’s wife did not understand.

Sentences: To be together was the main thing.

Referent Sentence: A cabin at the beach would be fine.

Probed Sentence: The cottage/repairs needed to be cheap.

PROBES
Referent Companion In-paragraph Out-of-paragraph
CABIN BEACH WIFE TUTOR
Stimulus 74

Filler  
Tom had to get away.

Sentences:  This might be the only chance.

Referent  
Sentence:  A *canoe* was adrift in the river.

Probed  
Sentence:  The boat/moment seemed to be just right.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANOE</td>
<td>RIVER</td>
<td>TOM</td>
<td>GREEN</td>
</tr>
</tbody>
</table>

Stimulus 75

Filler  
The play was supposed to be serious.

Sentences:  However, an actor had forgotten his lines.

Referent  
Sentence:  A *chuckle* rippled through the audience.

Probed  
Sentence:  The laughter/feeling was one of embarrassment.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHUCKLE</td>
<td>AUDIENCE</td>
<td>PLAY</td>
<td>MUG</td>
</tr>
</tbody>
</table>

Stimulus 76

Filler  
The matter had persisted for years.

Sentences:  Gum chewing simply could not be tolerated.

Referent  
Sentence:  A *law* about the issue was considered.

Probed  
Sentence:  The rule/session passed without comment.

<table>
<thead>
<tr>
<th>Referent</th>
<th>Companion</th>
<th>In-paragraph</th>
<th>Out-of-paragraph</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAW</td>
<td>ISSUE</td>
<td>MATTER</td>
<td>INCH</td>
</tr>
</tbody>
</table>
Stimulus 77

Filler The dictator said what any despot would.
Sentences: The statement was one long monologue.

Referent Sentence: A copy was shown to the reporters.
Probed Sentence: The duplicate/idea was very fuzzy.

PROBES
Referent Companion In-paragraph Out-of-paragraph
COPY REPORTERS DICTATOR STRIPE

Stimulus 78

Filler More lights were needed at the intersection.
Sentences: Too many accidents had occurred.

Referent Sentence: A body near the curb was being covered.
Probed Sentence: The corpse/driver looked to be young.

PROBES
Referent Companion In-paragraph Out-of-paragraph
BODY CURB LIGHTS WING

Stimulus 79

Filler The earth was still moving.
Sentences: Luckily, the people had been warned.

Referent Sentence: A nearby fault had caused the noise.
Probed Sentence: The fissure/evacuation had been mapped out.

PROBES
Referent Companion In-paragraph Out-of-paragraph
FAULT NOISE EARTH TOMATO
Stimulus 80

Filler  The team could use a new quarterback.
Sentences:  The old one couldn’t throw.

Referent  Sentence:  A trade was the solution.

Probed  Sentence:  The deal/season hinged on one player.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
TRADE  SOLUTION  TEAM  DROWN

Stimulus 81

Filler  The ghost town had been flooded.
Sentences:  Most of the buildings were gone.

Referent  Sentence:  A saloon was somehow left intact.

Probed  Sentence:  The bar/area had been well protected.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
SALOON  INTACT  GHOST  NARROW

Stimulus 82

Filler  The feel of autumn was all around.
Sentences:  Soon, winter would exert its icy grip.

Referent  Sentence:  A doe scampered in the dry leaves.

Probed  Sentence:  The deer/squirrels knew little of the seasons.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
DOE  LEAVES  FEEL  TRAIN
Stimulus 83

Filler  The critic had found something to criticize.
Sentences: A devilish grin could be seen.

Referent  Sentence: One dot marred the painting.

Probed  Sentence: The spot/look was almost invisible.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
DOT  PAINTING  CRITIC  SCARF

Stimulus 84

Filler  The break had occurred by accident.
Sentences: The refrigerator slipped from the straps.

Referent  Sentence: One knee felt the crushing weight.

Probed  Sentence: The joint/object could be removed.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
KNEE  WEIGHT  BREAK  MEMO

Stimulus 85

Filler  The big day was only a week away.
Sentences: Yet, not all the toys had been made.

Referent  Sentence: An elf angrily pounded the wall.

Probed  Sentence: The dwarf/shop would have to work overtime.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
ELF  WALL  DAY  COOKIE
Stimulus 86
Filler  The general tried to return to his wife.
Sentences: The trip took twenty years.

Referent
Sentence: An epic about the journey is well known.

Probed
Sentence: The saga/love endured the test of time.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
EPIC  JOURNEY  GENERAL  TAPE

Stimulus 87
Filler  The attitude was completely different.
Sentences: Most of the members were puzzled by the change.

Referent
Sentence: An impostor had joined the council.

Probed
Sentence: The fake/president appeared to notice.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
IMPOSTOR  COUNCIL  ATTITUDE  BEAN

Stimulus 88
Filler  Anger gripped the kidnapped passengers.
Sentences: Most were holding American passports.

Referent
Sentence: One terrorist had threatened the captain already.

Probed
Sentence: The fanatic/cruise was out of control.

PROBES
Referent  Companion  In-paragraph  Out-of-paragraph
TERRORIST  CAPTAIN  ANGER  AWARD
Stimulus 89

Filler  "Not many warriors had that much courage."
Sentences: Fortunately, a brave few is all it took.

Referent Sentence: A banquet was set for the heroes now.

Probed Sentence: The feast/joy could go on for days.

PROBES

Referent Companion In-paragraph Out-of-paragraph
BANQUET HEROES WARRIORS FLAP

Stimulus 90

Filler The recession had lasted six years.
Sentences: Business had to improve to avoid a conflict.

Referent Sentence: A forecast of the economy indicated little hope.

Probed Sentence: The prediction/mail only brought more gloom.

PROBES

Referent Companion In-paragraph Out-of-paragraph
FORECAST ECONOMY RECESSION BULLET

Stimulus 91

Filler The Russian chess player had defected.
Sentences: Freedom was too great a temptation.

Referent Sentence: A delay in the match had been requested.

Probed Sentence: The postponement/stay might become permanent.

PROBES

Referent Companion In-paragraph Out-of-paragraph
DELAY MATCH RUSSIAN LIVER
Stimulus 92

Filler: The prince had become a frog.
Sentences: How he wished for a magic kiss.

Referent Sentence: A witch had caused the change.

Probed Sentence: The sorceress/answer lurked near the reeds.

PROBES
Referent Companion In-paragraph Out-of-paragraph
WITCH CHANGE PRINCE PLATE

Stimulus 93

Filler: The company was going to make a profit.
Sentences: The collapsible toilet had caught on.

Referent Sentence: A leap in sales was definite.

Probed Sentence: The jump/product had taken Wall Street by surprise.

PROBES
Referent Companion In-paragraph Out-of-paragraph
LEAP SALES COMPANY GRAY

Stimulus 94

Filler: Secret information was leaked to the press.
Sentences: The damage might be irreparable.

Referent Sentence: A spy in the navy was suspected.

Probed Sentence: The traitor/reason would be found.

PROBES
Referent Companion In-paragraph Out-of-paragraph
SPY NAVY SECRET SPINACH
Stimulus 95

Filler: The boys had been playing medieval knights.
Sentences: Who stabbed first was unknown.

Referent:
Sentence: A lotion was placed on the wounds.

Probed:
Sentence: The ointment/spanking stung for a long time.

PROBES
Referent   Companion   In-paragraph   Out-of-paragraph
LOTION     WOUNDS      BOYS           SPIDER

Stimulus 96

Filler: Food was scarce in the barren Arctic.
Sentences: The thaw had been late this year.

Referent:
Sentence: A wolf felt the pangs of hunger.

Probed:
Sentence: The animal/hope would soon parish.

PROBES
Referent   Companion   In-paragraph   Out-of-paragraph
WOLF       PANGS       FOOD           MODE
APPENDIX F

Stimuli Used in Experiment 3

In the following stimuli, the **far** condition of Experiment 3 was formed by presenting the **referent** sentence before the **theme filler** and **nontheme filler** sentences. The **close** condition was formed by presenting the referent sentence after the theme or nontheme filler sentences.

In the last (i.e., fifth) sentences of the story (labeled **Last Sent.**), the word before the slash is the **anaphor**; the term after the slash is the anaphor-control item. When the last sentence included the anaphor word, the last sentence was in the **anaphor-containing** condition. When the anaphor-control item was displayed instead of the anaphor, the last sentence was in the **anaphor-control** condition.

In the theme and nontheme comprehension questions (labeled **Theme Q.** and **Nontheme Q.**, respectively), the use of the word(s) before the slash made the question a "yes" question. Use of the word(s) after the slash made the question a "no" question.
The stimuli below are the 48 stimuli used in the data analyses. The 10 practice stimuli are not shown.

Stimulus 1

Theme
Filler
Sentences: The long legs were tired.
One antenna was drooping.
Hoping had been replaced by walking.

Nontheme
Filler
Sentences: Children were getting home from school.
Kids were walking every which way.

Referent
Sentence: It was about three o'clock.

Last Sent.: The insect/police did not like afternoons.

Theme Q.: Were the grasshopper’s legs tired/rested?

Nontheme Q.: Were children getting home from school/church?

Stimulus 2

Theme
Filler
Sentences: The skin was like leather.
Light reflected from the eyes.
A hissing noise could be heard.

Nontheme
Filler
Sentences: The jungle became very dense.
Weird sounds could be heard.

Referent
Sentence: A python was in a tree.

Last Sent.: The snake/situation looked quite dangerous.

Theme Q.: Did light reflect from the python’s eyes/skin?

Nontheme Q.: Was the python in a very dense/sparse jungle?
Stimulus 3

**Theme**
The hooves were well worn.

**Filler**
Gray hairs dotted the fur.

**Sentences:**
The lungs wheezed with age.

**Nontheme**
The mountains had jagged outcroppings.

**Filler**
Steep ledges surrounded the canyon.

**Sentences:**
The hillside was dotted with caves.

**Referent**
Sentence: A **goat** was perched on a cliff.

**Last Sent.:**
The animal/lizards did not mind.

**Theme Q.:** Were the hooves (well worn)/(like new)?

**Nontheme Q.:** Did the mountains have very jagged/smooth outcroppings?

Stimulus 4

**Theme**
The paws were silent on the pavement.

**Filler**
The motion was smooth.

**Sentences:**
The whiskers began to twitch.

**Nontheme**
Garbage was strewn everywhere.

**Filler**
A foul smell filled the air.

**Sentences:**
Trash overflowed the cans.

**Referent**
Sentence: A **cat** prowled the alley.

**Last Sent.:**
The feline/poor looked for food.

**Theme Q.:** Was the cat's motion smooth/jerky?

**Nontheme Q.:** Did a foul/sweet smell fill the air in the alley?

Stimulus 5

**Theme**
The wheels squealed.

**Filler**
Smoke began to pour from the engine.

**Sentences:**
The accelerator stuck to the floor.

**Nontheme**
The city was nearly empty.

**Filler**
It was early in the morning.
Sentences: The town was just awakening.

Referent Sentence: A **chevy** turned off at an exit.

Last Sent.: The car/heat went roaring past seventy.

Theme Q.: Was smoke beginning to pour from the chevys engine/accelerator?

Nontheme Q.: Was the city nearly empty/full?

Stimulus 6

Theme The size is not critical.
Filler A bright orange color is desirable.
Sentences: The roots should be thick.

Nontheme Good health requires good nutrition.
Filler Whole wheat is one example.
Sentences: Trace elements also are important.

Referent Sentence: **Carrots** contain useful vitamins.

Last Sent.: The vegetable/idea is popular out West.

Theme Q.: Is a bright orange/blue color desirable?

Nontheme Q.: Is whole wheat an example of good/bad nutrition?

Stimulus 7

Theme The stock was made of wood.
Filler The safety was on.
Sentences: The barrel had been considerably shortened.

Nontheme The store manager was upset.
Filler Business had not been going well.
Sentences: Sales had dipped recently.

Referent Sentence: A **gun** was in the display window.

Last Sent.: The weapon/ad was quickly removed.

Theme Q.: Was the gun's stock made of wood/metal?
Nontheme Q.: Had business sales dipped/increased recently?

Stimulus 8

<table>
<thead>
<tr>
<th>Theme</th>
<th>A little aging doesn’t hurt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler</td>
<td>Overcooking can cause toughness.</td>
</tr>
<tr>
<td>Sentences:</td>
<td>The juices can be used for gravy.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nontheme</th>
<th>Juice is good for breakfast.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler</td>
<td>Some like pineapple, others prefer grapefruit.</td>
</tr>
<tr>
<td>Sentences:</td>
<td>Another favorite is tomato.</td>
</tr>
</tbody>
</table>

Referent

Sentence: Beef makes for a filling dinner.

Last Sent.: The meat/stove can be any type.

Theme Q.: Is a little aging of beef harmless/harmful?

Nontheme Q.: Do some people like tomato juice for breakfast? / Does everybody like grape juice for breakfast?

Stimulus 9

<table>
<thead>
<tr>
<th>Theme</th>
<th>All the keys worked fine.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler</td>
<td>The pedals needed some repair.</td>
</tr>
<tr>
<td>Sentences:</td>
<td>A tuning also was in order.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nontheme</th>
<th>The fire had raged all night.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler</td>
<td>The hall was completely gutted.</td>
</tr>
<tr>
<td>Sentences:</td>
<td>Smoke damage was everywhere.</td>
</tr>
</tbody>
</table>

Referent

Sentence: A piano stood alone.

Last Sent.: The instrument/conductor had been in the right place.

Theme Q.: Did all/none of the keys work fine?

Nontheme Q.: Was there /no smoke damage from the fire?
Stimulus 10

Theme The nose sensed a meal.
Filler Only pangs of hunger had filled the stomach.
Sentences: Sadly, the eyes saw no food.

Nontheme The war had ended quickly.
Filler The remains of civilization littered the street.
Sentences: At least the guns were finally silent.

Referent Sentence: A rat rummaged through the debris.

Last Sent.: The rodent/alien found little to eat.

Theme Q. : Did the rat's nose sense (a meal)/danger?
Nontheme Q.: Were the guns of war silent/(still firing)?

Stimulus 11

Theme The beady little eyes saw no threat.
Filler The thin legs began to move.
Sentences: Suddenly, danger was perceived.

Nontheme The house was quite clean.
Filler The floors were waxed and polished.
Sentences: There was no dust on the mantel.

Referent Sentence: A cockroach surveyed the scene.

Last Sent.: The bug/maid decided to chance it.

Theme Q. : Did the thin legs (begin to move)/(stand still)?

Nontheme Q.: Were the floors of the house polished/unwaxed?

Stimulus 12

Theme The bottle glistened with moisture.
Filler Little bubbles floated to the top.
Sentences: The taste was eagerly awaited.

Nontheme The market was robbed completely.
Filler The employees could not believe their eyes.
Sentences: All the cash registers were empty.

Referent
Sentence: One Pepsi sat on the shelf.

Last Sent.: The drink/damage was very noticeable.

Theme Q.: Did the Pepsi bottle glisten with moisture/dryness?

Nontheme Q.: Were the market's cash registers empty/full?

Stimulus 13

Theme: The tar was well worn.
Filler: Cracks were appearing in the curbs.
Sentences: Only one lane remained open.

Nontheme: The pace was exceedingly slow.
Filler: Most residents were old timers.
Sentences: The mayor was eighty years old.

Referent
Sentence: A single street went into town.

Last Sent.: The road/stable needed to be renovated.

Theme Q.: Was the tar (well worn)/new?

Nontheme Q.: Was the pace of the town exceedingly slow/fast?

Stimulus 14

Theme: The laces were dirty.
Filler: A hole was worn in the sole.
Sentences: Rubber was peeling off of the sides.

Nontheme: The band clearly had a good time.
Filler: This was their first gig.
Sentences: The guitarist was only eighteen.

Referent
Sentence: A sneaker was found near the stage.

Last Sent.: The shoe/drums smelled of booze.
Theme Q. : Were the laces of the sneaker clean/dirty?
Nontheme Q.: Was this the band's first/third gig?

Stimulus 15

Theme
The petals were still intact.

Filler
The stem was very long.

Sentences:
Only a few leaves had fallen off.

Nontheme
The date had been fun.

Filler
The romance of the evening lingered.

Sentences:
A relationship had started.

Referent
Sentence:
A carnation was laying on the dresser.

Last Sent.:
The flower/memory was still fresh.

Theme Q. : Was the carnation's stem very long/short?

Nontheme Q.: Did the romance of the evening linger/(quickly disappear)?

Stimulus 16

Theme
Santa Claus would soon appear.

Filler
On the radio was 'Jingle Bells'.

Sentences:
Eggnog was easy to find.

Nontheme
The students had smiles on their faces.

Filler
The quarter would soon be over.

Sentences:
No classes until next year.

Referent
Sentence:
Christmas was a week away.

Last Sent.:
The holiday/freedom was happily anticipated.

Theme Q. : Was eggnog easy/hard to find?

Nontheme Q.: Did the students have smiles/frowns on their faces?
Stimulus 17

Theme
Filler
Sentences:
Nontheme
Filler
Sentences:
Referent
Sentence:
Last Sent.: The inferno/state had moved quickly.
Theme Q.: Had the fire burned the brush rapidly/slowly?
Nontheme Q.: Did the fire occur in summer/spring?

Stimulus 18

Theme
Filler
Sentences:
Nontheme
Filler
Sentences:
Referent
Sentence:
Last Sent.: The billfold/boss would be needed.
Theme Q.: Was a dollar/twenty hanging out of the side?
Nontheme Q.: Had (Were) the customers left/(still in) the shop?

Stimulus 19

Theme
Filler
Sentences:
Nontheme
Filler
Sentences:
answer.

Referent
Sentence: An argument concerning ethics had begun.

Last Sent.: The quarrel/situation would last till nightfall.

Theme Q.: Were people beginning to yell/(quiet down)?
Nontheme Q.: Was the issue busing/(gun control)?

Stimulus 20

Theme
Filler
Sentences: Some words were smudged.
Others did not come out at all.
The letter quality was terrible.

Nontheme
Filler
Sentences: The text was one long monologue.
The dictator said what any despot would.
Ridiculous laws were issued.

Referent
Sentence: A copy was shown to reporters.

Last Sent.: The duplicate/idea was very fuzzy.

Theme Q.: Was the letter quality of the copy terrible/good?
Nontheme Q.: Did the dictator issue ridiculous/sensible laws?

Stimulus 21

Theme
Filler
Sentences: Old bottles lined the wall.
Only one door still worked.
The tables were covered with dust.

Nontheme
Filler
Sentences: The ghost town had been flooded.
The center of the city was all mud.
A bulldozer would be needed to clear the mess.

Referent
Sentence: A saloon was somehow left intact.

Last Sent.: The bar/area had been well protected.
Theme Q. : Did one/no door still work?
Nontheme Q.: Was the saloon (left intact)/destroyed?

Stimulus 22

Theme
Filler
Sentences:
The makeup was well done.
Even the ears were correct.
The resemblance was incredible.

Nontheme
Filler
Sentences:
The members were about to decide.
One vote either way would be crucial.
Many jobs hung in the balance.

Referent
Sentence: An impostor had joined the council.

Last Sent.: The fake/meeting appeared to be unnoticed.

Theme Q. : Was the impostor’s makeup well/poorly done?

Nontheme Q.: Were the council members about to decide/adjourn?

Stimulus 23

Theme
Filler
Sentences:
A roast pig was being prepared.
Food of all types would be served.
Best of all would be the desserts.

Nontheme
Filler
Sentences:
Not many warriors had that much courage.
Fortunately, a brave few is all it took.
The deed would become legend.

Referent
Sentence: A banquet was set for the heroes now.

Last Sent.: The feast/joy could go on for days.

Theme Q. : Would the best/worst food be the desserts?

Nontheme Q.: Would the deed of the heroes (become legend)/(be soon forgotten)?
Stimulus 24

Theme          Coconut oil was one ingredient.
Filler         Cortisone also was included.
Sentences:     The texture was rich and creamy.
Nontheme       The boys had been playing medieval knights.
Filler         Their parents had forbidden this game.
Sentences:     Now, they were both in pain.

Referent Sentence: A **lotion** was placed on the wounds.

Last Sent.:    The ointment/spanking stung for a long time.

Theme Q.:      Was cortisone included/(not included)?
Nontheme Q.:   Was a lotion placed on the boy's/dog's wounds?

Stimulus 25

Theme          Light reflected off in every direction.
Filler         The edges were sharp.
Sentences:     The size was above average.
Nontheme       Wedding bells chimed loudly.
Filler         The best man had yet to arrive.
Sentences:     The groom was getting nervous.

Referent Sentence: A **diamond** was on the ring.

Last Sent.:    The jewel/bride made a strong impression.

Theme Q.:      Was the size of the diamond above/below average?
Nontheme Q.:   Did wedding bells chime loudly/quietly?

Stimulus 26

Theme          Wind filled the sails.
Filler         The rudder moved smoothly.
Sentences:     Water flowed past the keel.
Nontheme       A storm was fast approaching.
Filler         The sea gulls were very quiet.
Sentences: Threatening clouds covered the sun.

Referent Sentence: A *yacht* was returning home.

Last Sent.: The ship/crabs quickly moved on.

Theme Q.: Did the yacht's rudder move smoothly/(with difficulty)?

Nontheme Q.: Were the sea gulls very quiet/noisy?

**Stimulus 27**

Theme Sentences: The tires were new.

Filler Sentences: The engine was very quiet.

A single dent marred the body.

Nontheme Sentences: The old asphalt was slippery.

Filler Sentences: A light mist filled the air.

The fog had begun to lift.

Referent Sentence: A *taxi* slowly rounded the corner.

Last Sent.: The vehicle/rain had begun to stop.

Theme Q.: Were the taxi's tires new/old?

Nontheme Q.: Was the old asphalt slippery/rough?

**Stimulus 28**

Theme Sentences: The fin cutting through the water was unmistakable.

Filler Sentences: The body could be seen just below the waves.

The skin was a metallic blue.

Nontheme Sentences: The picnic was winding down.

Filler Sentences: The beachcombers had yet to return.

Everyone had to wait.

Referent Sentence: A *shark* was seen in the surf.

Last Sent.: The fish/relic was close to land.
Theme Q. : Was the shark's skin a metallic blue/gray?

Nontheme Q.: Had the beachcombers (still not returned) returned to the picnic?

Stimulus 29

Theme
Filler
Sentences:
Nontheme
Filler
Sentences:
Referent
Sentence:
Last Sent.:
Theme Q. : Is remote control common/unusual now?
Nontheme Q.: Do most tabloids tell lies/(the truth)?

Stimulus 30

Theme
Filler
Sentences:
Nontheme
Filler
Sentences:
Referent
Sentence:
Last Sent.:
Theme Q. : Did waves fall gently/violently on the shore?
Nontheme Q.: Were the ship's officers asleep/awake?
Stimulus 31

Theme  
A piston was in bad shape.

Filler  
Not much pressure was being generated.

Sentences:  
The power cord looked okay.

Nontheme  
The painters were getting worried.

Filler  
Nothing was working right today.

Sentences:  
Most of the paint had dried out.

Referent  
Sentence:  
One *compressor* had broken a valve.

Last Sent.:  
The machine/crane suddenly started up.

Theme Q.:  
Was a piston in bad shape? / Were all the pistons in good shape?

Nontheme Q.:  
Was nothing/anything working right for the painters today?

Stimulus 32

Theme  
The fur was well groomed.

Filler  
The face was very human.

Sentences:  
The hands grappled with a banana.

Nontheme  
The park had just opened.

Filler  
Everyone was in a good mood.

Sentences:  
Little kids got free popcorn.

Referent  
Sentence:  
A *monkey* was entertaining the crowd.

Last Sent.:  
The chimp/owner was quite amusing.

Theme Q.:  
Was the monkey's fur well/poorly groomed?

Nontheme Q.:  
Was everyone in a good/bad mood?

Stimulus 33

Theme  
The furrowed brow was a sign of trouble.

Filler  
Still, determination filled the eyes.

Sentences:  
Sleepless nights had wrinkled the lab coat.

Nontheme  
The program had just restarted.

Filler  
The first results were unusual.
Sentences: The company could lose millions.

Referent Sentence: One scientist still had questions.

Last Sent.: The researcher/chairman did not like the doubt.

Theme Q.: Were the eyes of the scientist filled with determination/despair?

Nontheme Q.: Were the first results of the restarted program unusual/expected?

Stimulus 34

Theme The trunks were bright red.
Filler Moisture shined on the muscles.
Sentences: The mouth was tightly clenched.

Nontheme The day was finally here.
Filler The long awaited event was about to start.
Sentences: Anticipation had been growing for weeks.

Referent Sentence: A boxer entered the ring.

Last Sent.: The fighter/bookie looked too confident.

Theme Q.: Was bright red/green the color of the boxer's trunks?

Nontheme Q.: Was the event about to start/end?

Stimulus 35

Theme The tip was embedded in the ground.
Filler A little rust was on the shaft.
Sentences: The handle had been smashed.

Nontheme Security had been lax this weekend.
Filler The cops showed up too late.
Sentences: The thieves had already left.

Referent Sentence: A screwdriver was found at the scene.

Last Sent.: The tool/window was used to break in.
Theme Q.: Was the handle of the screwdriver smashed/(still in one piece)?

Nontheme Q.: Was a screwdriver/hammer used to break in?

Stimulus 36

Theme
The front wheel seemed to rattle.

Filler
Blue flame came from the exhaust.

Sentences: The gears made a loud grinding sound.

Nontheme
The circus had many daredevils.

Filler
Some worked on pretty horses.

Sentences: Others would appear to eat fire.

Referent
Sentence: A motorcycle went up the ramp.

Last Sent.: The two-wheeler/sight amazed the crowd.

Theme Q.: Did/Was the front wheel rattle/silent?

Nontheme Q.: Did some daredevils eat fire/glass?

Stimulus 37

Theme
The main color was a dark red.

Filler
The edges were usually ragged.

Sentences: In the middle, bumps would develop.

Nontheme
People might need to be evacuated.

Filler
Soon, the hospital would be informed.

Sentences: The National Guard might be called out.

Referent
Sentence: One blotch would appear on the hand.

Last Sent.: The blemish/disaster could quickly spread.

Theme Q.: Were the edges of the blotch usually ragged/smooth?

Nontheme Q.: Would the hospital be informed soon/(much later)?
Stimulus 38

Theme  
Wood could be used in the construction.
Filler  
A porch would be nice.
Sentences:  
An essential would be screen doors.

Nontheme  
John's wife did not understand.
Filler  
To be together was the main thing.
Sentences:  
Being apart can destroy a marriage.

Referent  
Sentence:  
A cabin at the beach would be fine.

Last Sent.:  
The cottage/situation had to be just right.

Theme Q.  
Were screen doors (a necessity)/unnecessary?

Nontheme Q.:  
Was being together/apart the main thing?

Stimulus 39

Theme  
A crack was heard.
Filler  
Ligaments had been broken.
Sentences:  
A tendon also may have snapped.

Nontheme  
The freezer slipped from the straps.
Filler  
A forklift would have been better.
Sentences:  
Using a bigger truck also would have helped.

Referent  
Sentence:  
One knee felt the crushing weight.

Last Sent.:  
The joint/company could be replaced.

Theme Q.  
Was a crack/buzz heard?

Nontheme Q.:  
Would a bigger truck/car have helped with the freezer?

Stimulus 40

Theme  
Everyone waited and waited.
Filler  
A restart might never occur.
Sentences:  
The time passed very slowly.

Nontheme  
The Russian chess player had defected.
Filler  
Freedom was too great a temptation.
Sentences:  
The Soviet coach did not understand.
A delay in the match had been requested.

The postponement/penalty might become permanent.

Was the time passing very slowly/quickly?

Did the Soviet coach (not understand)/understand?

Many warehouses were already ash.
Some docks were beginning to burn.
Soon, ships would be threatened.

Arson was suspected.
An empty gasoline can had been found.
In addition, a burnt pack of matches had been discovered.

A harbor was in flames.
The port/investigation had just opened.

Were docks at the harbor (beginning to burn)/(finished burning)?

Was (an empty)/(a full) gasoline can found?

The petals were starting to wilt.
Only a few thorns remained.
The leaves were all shriveled.

The drought had lasted two years.
Once fertile land was now dust.
The topsoil had eroded completely.

A rose had fallen to the ground.
The flower/hope was almost dead.
Theme Q.: Were there some/no thorns on the rose?
Nontheme Q.: Had a rose/tulip fallen to the ground?

Stimulus 43

Theme: A shoulder had been hurt in the breakout.
Filler: In addition, one leg was broken.
Sentences: The other leg was fine.
Nontheme: The crime rate had started to decrease.
Filler: Federal authorities were quite happy.
Sentences: Still, felonies continued to occur.

Referent: A robber had just escaped from prison.

Last Sent.: The thief/FBI continued to press on.

Theme Q.: Was/Were one/both legs broken?
Nontheme Q.: Were federal authorities quite happy/sad?

Stimulus 44

Theme: Many shops line the main street.
Filler: The Astrodome is one trademark.
Sentences: The Space Center is also nearby.
Nontheme: The climate is nice in that region.
Filler: Temperatures usually don’t get that low.
Sentences: However, many things are brown, not green.

Referent: Houston is an attraction in the Southwest.

Last Sent.: The city/food has much to offer.

Theme Q.: Do many/few shops line the main street in Houston?
Nontheme Q.: Is the climate nice/bad in that region?
Stimulus 45

Theme  
The legs were clearly stuck.
Filler  
The wings buzzed with fear.
Sentences:  
Anxiety filled the bulging green eyes.

Nontheme  
Most of the food was covered.
Filler  
The apple pie was still baking.
Sentences:  
The drinks were ready.

Referent  
Sentence:  
A fly was on the butter.

Last Sent.:  
The insect/cooking was almost finished.

Theme Q.:  
Were the fly's legs stuck/free?
Nontheme Q.:  
Was the apple pie still/done baking?

Stimulus 46

Theme  
The blue feathers laid flat.
Filler  
A worm was in the beak.
Sentences:  
The wings started to flap.

Nontheme  
Spring was in the air.
Filler  
April showers gave way to May flowers.
Sentences:  
The sun peeked through the clouds.

Referent  
Sentence:  
A robin chirped with happiness.

Last Sent.:  
The bird/world was glad winter was over.

Theme Q.:  
Did the robin's wings (start to flap)/(lay flat)?
Nontheme Q.:  
Was spring/autumn in the air?

Stimulus 47

Theme  
The scales were warming up.
Filler  
The forked tongue waited for food.
Sentences:  
However, the eyes were closed.

Nontheme  
The desert was hot that day.
Filler  
The cacti could have used some water.
Sentences:  
Alas, no rain was in sight.
Referent
Sentence: A lizard was sunning on the sand.

Last Sent.: The reptile/scientist stayed till evening.

Theme Q.: Were the lizard's scales starting to (warm up)/(cool down)?

Nontheme Q.: Could the cacti in the desert have used some water/air?

Stimulus 48

Theme
Filler
Sentences: The steeple was very distinct.
Some shingles had disappeared.
A large section of masonry was missing as well.

Nontheme
Filler
Sentences: The valley was covered with water.
The dam had broken last night.
The old levee had finally given way.

Referent
Sentence: A church was all Bill could see.

Last Sent.: The building/rise was just tall enough.

Theme Q.: Was the church missing (some shingles)/(its steeple)?

Nontheme Q.: Had the dam broken last night/week?