THE EFFECTS OF READING CONTEXT ON ACCESS TO WORLD KNOWLEDGE

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ABSTRACT

Cognitive psychologists have started to explore how people use their world knowledge in order to accomplish a variety of tasks. The focus of the thesis research was to investigate how world knowledge is accessed during the reading comprehension process. It has been suggested (Barsalou, 1982) that very familiar knowledge is readily available regardless of what the reading context emphasizes, but that less frequently used knowledge is readily available only in contexts which emphasize that knowledge. Experiment 1 demonstrated that findings consistent with this point of view are obtained only when subjects know what concepts they will be tested on, otherwise, both familiar and less familiar knowledge are accessed more quickly in appropriate contexts than in other contexts.

Experiment 2 provided further support for the findings from Experiment 1 even though a different baseline and two different literary forms were used. Experiment 2 also demonstrated that the distinction between access to familiar and less familiar knowledge is a quantitative one rather than a qualitative one, as access to less familiar knowledge was speeded relatively more by an appropriate context than was access to very familiar knowledge. Experiment 3 confirmed that this distinction is robust, as it remained stable despite changes in task variables and subjects' strategies. Experiment 3 also demonstrated that access to both types of knowledge is hindered by inappropriate contexts but only when the degree of congruency between contexts and test items is increased so that it resembles the degree of congruency common to natural text.

The results of the research are important because they lead to the proposal of a principle by which fluent comprehension is achieved and by which new information is obtained from text. The studies also suggest that if experimental results are to be generalized to what normally happens during reading, it is of utmost importance that reading materials be presented in a manner which does not differ significantly from the natural reading situation.

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CHAPTER 1

Cognition is the activity of knowing:
the acquisition, organization, and use of knowledge.

(Neisser, 1976, p.1)

Much of what a reader needs in order to understand the written word is not provided by the text itself. The fluent reader, however, experiences little difficulty in deciphering the written message, and is often not aware of the cryptic nature of reading material. Readers supply the missing information from their own knowledge about objects, events and relations in the world, and do so in an apparently effortless fashion. In fact, writers assume that their audiences possess a wealth of knowledge, and consequently they do not have to include information that can be inferred by the reader. Consider the sentence, "The zebra pelts on the wall clashed with the checkered sofa". The individual words in this sentence do not provide a complete semantic description of the writer's message. The writer must assume that his audience knows what zebras look like and that they know stripes and checks are not pleasing to look at when they are next to one another. But, assume that a reader from the 22nd century is reading the same sentence and that tastes have changed so that putting stripes and checks together is the height of fashion. The reader still has to use his knowledge about zebras in order to understand what he reads, but he also gains knowledge about 20th century aesthetics.

Not only does the writer's exclusion of information usually cause the reader no problem, but the inclusion of this same information can actually seem awkward. The writer might have chosen to express his message as follows: "The striped zebra pelts clashed with the checkered sofa. Stripes and checks look terrible together." This longer description of the original sentence seems redundant, and material constructed in a highly redundant fashion is

boring to read. One would not want to argue, however, that language is never redundant. In fact, redundancy is necessary for young readers who have much to learn, for individuals learning a new subject, and for a person reading a story from a different culture. As such, the 22nd century reader may have been aided by an editor who included a footnote about the peculiar aesthetic tastes of 20th century man.

The exclusion of redundant information, however, is not merely a stylistic convention; it is also a necessity. Even though, in practice, much of the missing information could be stated in a text, it is simply not possible to supply all the information needed in order to fully comprehend what is read. Linguistic descriptions are analogous to scaffolding which is buttressed by a much richer cognitive system. Imagine having to supply the information that pelts of animals are used decoratively, that they must be hung on the wall with nails, that the room being referred to is probably a study or a living room and so on. Leaving information out of text, then, is not only a linguistic convention, it is also a necessary part of the translation between cognition and linguistic description. Consequently, linguistic descriptions must be supplemented by the reader's world knowledge. Understanding how knowledge is accessed, therefore, is crucial to understanding reading.

In the past two decades, however, many of the questions asked by cognitive psychologists have focussed on the nature of mental representation (Block, 1980) rather than on exploring how those representations are used to accomplish the myriad tasks that human beings engage in. In other words, much work has concentrated on elucidating the structure of knowledge rather than on the process by which that knowledge is utilized. The thesis research, however, explores the process by which world knowledge is accessed during the task of reading. The three hypotheses which have been advanced in the literature in an attempt to characterize this process are a) that knowledge is accessed in an invariant fashion regardless of the reading context; in other words, access to knowledge is context-independent; b) that

what knowledge is accessed is determined by the reading context; in other words, access to knowledge is context-dependent; and c) that access to very familiar knowledge is not sensitive to variations in context but access to less frequently used knowledge is dependent on the reading context.

A. THE CONTEXT-INDEPENDENT HYPOTHESIS

The hypothesis that access to knowledge is insensitive to contextual constraint has its origins in attempts to characterize how knowledge is structured in the human mind. The theories this hypothesis is derived from, often called semantic network theories, have a common assumption. The representation of knowledge, at least in adult members of a culture, is presumed to be static and not subject to substantial fluctuation by recent experience (Collins & Quillian, 1969; Collins & Loftus, 1975; Glass & Holyoak, 1974; Smith, 1978; and Tulving, 1972). Concepts are assumed to be linked to one another in this stable structure. Thus, in semantic networks, concepts form intensional relationships with one another rather than extensional ones, that is, the important relationships are between the stored units or words themselves rather than between words and their uses (Johnson-Laird, Chaffin, & Hermann, 1984). The goal of semantic memory theories, then, is to specify how knowledge is stored and how access relies on that knowledge. Once this is accomplished, this approach expects that the question of how knowledge is accessed during a task such as reading becomes trivial. The assumption of semantic network theory, then, is that world knowledge is accessed according to how knowledge about the underlying concepts is structured in the first place. One consequence of this view is that little importance is assigned to context-dependent variations in knowledge.

Semantic network models adopt the point of view that knowledge can be specified in a highly structured and closed system. These models are consistent with a philosophical

tradition dating back to Aristotle (Kintsch, 1980). Aristotle wanted to specify proper definitions of words and to do it from a logical point of view. The implicit assumption in the modern psychological models, however, is that an intensionally structured system of knowledge is psychologically valid; in other words, the models assume that their description of the structure of knowledge is similar to the way in which knowledge is actually represented in the human mind.

One of the first models of knowledge representation which emphasized the structure of logical relations was proposed by Collins and Quillian (1969). They suggested that noun concepts are stored in a hierarchy so that a concept such as "canary" is lower in the hierarchical structure than the concept "bird" which, in turn, is lower in the structure than the concept "animal". These noun concepts are joined to one another by labeled relations, that is, "a canary *is a* bird" and "a bird *is an* animal". Similarly, noun concepts and their properties are also joined by labeled associations such as "a canary *can* sing", "a bird *has* wings", or "an animal *has* skin". Properties of noun concepts are represented in an economic manner such that they are stored directly at only one location in the hierarchy. This assumption is called the principle of cognitive economy. For example, the property "has skin" is stored with "animals" but the property "can sing" is stored with "canaries". In order to decide whether or not a canary has skin, an inference has to be computed by going up the hierarchy because the property "has skin" is not directly stored with "canaries". The retrieval mechanism in this model is directed search of the hierarchical network.

The assumptions of hierarchical structure and cognitive economy of storage lead to several testable predictions. One prediction is that it should take less time to understand a sentence such as "Canaries are birds" than a sentence such as "Canaries are animals". The search process used to decide that the latter sentence is true must traverse more levels in the hierarchy than the search process for the former sentence. In other words, the more levels

that must be searched, the longer it takes to decide if a particular statement is true. Second, the application of the principle of cognitive economy leads to the prediction that properties which are directly stored with their nouns will be more readily accessed than will properties stored at a higher level in the hierarchy. In other words, sentences of the type "Canaries can sing" should be verified as being "true" more quickly than a sentence such as "Canaries have skin".

Conrad (1972), however, suggested that the structure of semantic networks is not based on the cognitive economy of logical relations. She questioned the principle of cognitive economy of storage on the basis that frequency of occurrence was confounded with hierarchical level in all experimental tests of the model. For example, "can fly" is a much more salient or frequent property of birds than is "has skin", but property salience is confounded with proposed level in the hierarchy in these examples. Conrad independently varied property frequency and hierarchical level in order to test her prediction that frequent properties of noun concepts are stored directly with those noun concepts regardless of hierarchical level. She found that property frequency was a better predictor of verification speed than was hierarchical level. Although Conrad questioned the principle of cognitive economy of logical relations, she did not question the existence of a highly-ordered conceptual network. The network, however, could be assumed to be structured such that frequent properties of noun concepts are directly stored with those noun concepts.

Conrad's structural assumptions are consistent with the processing assumptions made by Glass and Holyoak's semantic marker model (1974). They proposed that production frequency provides an indication of the order in which knowledge is retrieved. For example, more people complete the sentence "Chickens are ?" with the word *poultry* than with the word *birds*. On this basis, Glass and Holyoak's semantic marker model assumes that the semantic marker *poultry* is always retrieved before the semantic marker *birds*. This invariant order of

retrieval is assumed to occur regardless of whether the subject has to read the sentence *Chickens are poultry* or the sentence *Chickens are birds*. According to Glass and Holyoak (1974), frequency-based search of the network accounts for why the latter sentence takes more time to verify than the former sentence. However, search order in this type of model is still invariant and dependent on underlying conceptual structure. These assumptions lead to the idea that world knowledge is accessed in a predictable manner which is dependent on stable structure and fixed processing paths and, therefore, is not affected by context.

The spreading activation network model proposed by Collins and Loftus (1975) is the model that has had the most influence on how psychologists think about the representation and retrieval of knowledge. There are two structural assumptions in this semantic network model. First, there are short links between strongly associated concepts and long links between less strongly related concepts. Second, the more strongly associated two concepts are, the greater the number of proposed links there are between them. The important processing assumption in this model is that knowledge is accessed by the automatic spread of activation between related concepts. The more closely or strongly related two concepts are, the faster activation will spread from one to the other. If, for example, the word *zebras* was read, activation would spread to concepts such as *stripes, animals, horse, Africa* and so on. Spreading activation, then, should make some information about a word more available just by having read that word. The model assumes that spreading activation lowers the recognition threshold for words semantically related to the word that is read. Again, however, the structure of knowledge is assumed to be static and the relationships between concepts in the network are assumed to be invariant in the fluent adult reader. This model was designed to account for results already obtained from many prior semantic memory studies, but it is not specified enough to make new testable predictions. As a result, the principle of spreading activation in a conceptual network has more frequently been used as a heuristic to help

explain experimental results than as a testable model.

The assumption in semantic memory theory and especially in semantic network models, then, is that access to knowledge is context-independent. This idea that knowledge is accessed in an obligatory manner which is not constrained by context is similar to the view expressed by some linguistic theories of meaning or semantics. Katz and Postal (1964) for example, suggest that words are decomposable into primitive semantic features. It is these features which are activated whenever a word is read, and these features make up a word's core or meaning. The notion of stability is couched in a slightly different language. It is the *meanings* of words which are static and which are activated when words are read, rather than whole groupings of semantically related concepts. Some models of the reading process have used a similar notion to explain reading comprehension. La Berge and Samuels (1974), for example, suggest that with practice, words come to automatically elicit their dictionary meanings. The meanings of words in text are assumed to be accessed one by one. Actual comprehension occurs when the separate word meanings are organized into an overall interpretation of the sentence. Comprehension is assumed to be effortful, that is, it does not occur automatically as does access to word meaning.

In summary, the plausibility of context-independent access to knowledge rests on the tenability of one basic assumption which semantic memory theories and related linguistic theories of meaning make. Because access to knowledge is dependent on the way in which that knowledge is structured, the way in which knowledge is accessed can be known only to the extent that one of these models of static representation is veridical with how knowledge is actually structured.

B. THE CONTEXT-DEPENDENT HYPOTHESIS

Context-dependent views of access to knowledge are derived from theories of

language comprehension and memory that consider the linguistic models and semantic network models discussed above inadequate for explaining much of natural language comprehension. The view is similar to one held by Wittgenstein (1953) who argued that a word's meaning is defined by how it is used rather than by its place in a structure or by what it refers to in the world. The view is also similar to that held in semantic field theory where a word's meaning is assumed to be specified by its relationship with its context (Kintsch, 1980).

In criticizing the adequacy of linguistic and semantic memory models for explaining language comprehension, many theoreticians stress the notion that comprehension is a cognitive event rather than a linguistic one. Language comprehension, therefore, cannot be adequately characterized by theories which take only the relations between words into account. Olson (1970) stresses that theories of language comprehension must be able to capture relations between words and what those words are being used to communicate, that is, extensional relationships are crucial to natural language comprehension. The problem with having only intensional relations is best illustrated by an analogy with a dictionary. Dictionaries do not carry meaning, for they are completely tautological systems. Rather, it is the people using the dictionary who carry meaning (Bransford, Barclay & Franks, 1972). Olson points out that words convey meaning in the ways that they are used; that is, words do more than simply stand for objects in the world. Instead, words in contexts provide information about an event by excluding alternative interpretations. Thus, for example, the fact that "zebras have stripes" is relevant information when discriminating zebras from horses, but is irrelevant to characterizing the relationship between zebras and lions.

Similarly, Kintsch (1980) and Johnson-Laird et. al. (1984) argue that semantic networks cannot handle a range of phenomena which are integral to explaining reading comprehension. Not only can the models not handle relations between words and their extensions, they become unruly when forced to handle relations between words and their

intensions. For example, a network could contain information about tomatoes, such as the facts that they are red when they are ripe and green when they are not ripe, as well as information that ripe fruit is more "squishable" than unripe fruit. The network, however, must store many other other types of relations between words in order to represent the knowledge that frozen ripe tomatoes are less "squishable" than unfrozen unripe tomatoes. The beauty of semantic network theories, as they were conceived, is that they are committed to parsimony by storing knowledge in a tightly organized manner. But, in order to account for the range of relationships that a simple noun such as *tomato* can enter into with other words, the network would have to contain many more links than proposed.

The major weakness of the semantic network theories for the purpose of this thesis, however, has to do with the fact that networks were not designed to deal with extensional relationships. The ability to handle extensions is crucial to any theory which hopes to explain how knowledge is accessed during reading. For example, the noun *zebra* can be instantiated in many different ways in a text depending on what aspect of zebras is being communicated. In a story, a zebra can be hunted, give birth, be used as a rug or a wall hanging, be part of a painting, be in a zoo, be a character in a book, eat, drink, run, be doctored, be friendly, scared, nasty, young, old, a grandparent, a child, be compared to horses, fish, pianos, other zebras and so on and so on. There are potentially an infinite number of ways that a zebra and the word *zebra* can be extended or instantiated . Consequently, semantic networks would become unwieldy if forced to accommodate the range of general knowledge needed in understanding natural language. Indeed some semantic memory theorists are well aware of the limitations of their models (see Smith, 1978) and opt for representing dictionary-like knowledge rather than encyclopedic-like knowledge. Kintsch (1980) points out, however, that these limitations restrict the range of phenomena explicable in semantic memory terms. This severely constrains the usefulness of these models for accounting for most of human cognition.

The heavy emphasis that critics of linguistic theories of meaning and semantic network theories place on a word's reference and its extension or use leads to a context-dependent hypothesis about access to knowledge during reading. According to this view, there is no such thing as a set of knowledge which is accessed on all occasions in which a word is read. Instead, adequate comprehension is afforded by the way in which the context constrains and selects the information appropriate to the way in which a word is being used. The importance of context in access to knowledge during reading, therefore, is seen as a necessary consequence of the number of potential ways in which a single concrete noun can be instantiated in prose. To put it another way, the logic behind the idea that access to knowledge is dependent on context rests on the assumption that words convey information, and as such the role of context is to narrow or specify an interpretation which is distinct from alternative interpretations. Contrast this view that comprehension is achieved by a narrowing of focus to the implicit assumption of semantic network models that comprehension is achieved by the activation of information which spreads or radiates from an original focus of a single noun.

C. THE FREQUENCY-BASED HYBRID

Although semantic memory models can be criticized in terms of their inadequacy in accounting for the process by which comprehension is achieved, these models can also be criticized from another standpoint. Several researchers have questioned whether or not memory is structured in as highly stable a manner as that proposed by semantic network theories. Barsalou (1987), Jacoby and Brooks (1984) and Kahneman & Miller (1986) have argued that the assumption of highly stable representation and retrieval of knowledge is questionable. William James made a similar point many years ago by arguing that there were no such things as permanent ideas (James, 1890, reprinted in 1950). Barsalou's work is particularly interesting in this regard, because he has used the tools developed by semantic

memory theory (eg. categorization tasks, production frequency, typicality ratings) to show that this most basic assumption of stability is unwarranted. Barsalou has found that not only is there little stability in the representation of knowledge between individuals in a culture, there is also a great deal of instability within individuals over relatively short times periods.

The consequence of Barsalou's findings is that questions about the retrieval of general knowledge are likely to reveal more than questions about structure. In other words, the focus of the questions posed shifts from asking how human knowledge is structured and how that structure determines access in everyday experience, to how experience influences the availability of human knowledge. Barsalou (1987) poses an interesting possibility that derives from this focus on retrieval. He suggests that the highly practised or very frequent retrieval of a concept in conjunction with a particular property may cause that noun-property relationship to become well-integrated so that this larger integrated concept can then be retrieved as a unit. For example, if the property *stripes* is referred to in most contexts in which zebras are encountered, then the knowledge that zebras have stripes may come to be retrieved whenever zebras are mentioned. In other words, frequent retrieval of the same information across varied contexts could result in the construction of some stable subsets of knowledge. This knowledge about a noun will be accessed independent of what aspect of the noun the context emphasizes. On the other side of the coin, less frequent retrieval of some knowledge leads to more variability in the representation of that knowledge. Its retrieval, then, is dependent on a context which either reminds readers that they have this knowledge or which forces readers to make an inference. For example, *hooves* may have been mentioned with reference to zebras for a particular individual on a few occasions. Thus a context about zebras' feet serves to remind the reader of this fact. On the other hand, an individual may never have experienced the property *lungs* in conjunction with zebras. The reader could make the inference that zebras have lungs, however, if the context mentioned that a parasite

had invaded the zebra's organs, making it difficult for the animal to breathe.

The simple prediction which follows from the idea that some properties of nouns are frequently retrieved across many processing episodes in which that noun has been encountered is that this frequently retrieved knowledge is accessed independent of contextual emphasis. The notion that other properties of nouns are infrequently retrieved during processing episodes in which that noun has occurred, however, leads to the prediction that access to this less frequently retrieved knowledge is dependent on appropriate contextual emphasis. Barsalou (1982) extends these predictions by suggesting that one's knowledge about objects and their nouns falls on a continuum such that access to knowledge at one end of the continuum is totally context-dependent but access to knowledge at the other end of the continuum is totally context- independent. This alternative hypothesis, proposed by Barsalou, that context affects access to less frequent knowledge but does not affect access to very familiar knowledge will be referred to as the Frequency-Based Hybrid or FBH[1].

The FBH, then, combines both context-independent and context-dependent hypotheses of access to knowledge by focusing on frequency of usage or retrieval. To the extent that the FBH provides a good characterization of how knowledge is retrieved, it is crucial to understanding the process by which world knowledge is accessed during reading. It is important, then, to test the ability of the FBH to adequately describe access to knowledge during reading. The major goal of this thesis, then, is to provide a test of the FBH in a task requiring the comprehension of written materials. The second but related aim of the research is to explore the generality of the FBH as the experimental task is made to contain more of the components found in a normal reading situation. This latter goal originates from the concern

1. The term FBH was not used by Barsalou, but is used in this thesis to capture Barsalou's distinction between access to high and low frequency properties of nouns.

that the experimental paradigms used in reading research partially determine the results obtained which, in turn, determine the way in which the process of comprehension is hypothesized to operate. If our goal is to understand reading comprehension, then we must be sure that the results we obtain lead to a realistic characterization of the actual process we have set out to study. Before the thesis research is discussed, Chapter 2 presents both a review of the studies which provide a test of the FBH and a critique of the methodologies used in these studies.

CHAPTER 2

This chapter is divided into three sections. Section A discusses results from experimental tasks in which the criterion measures do not assess comprehension. Sections B and C consider studies which look at access to knowledge when comprehension is measured. Section B deals with results from memory studies and section C with results from sentence verification studies. Because Barsalou's (1982) distinction between context-independent and context-dependent access is an important one, the studies in each section are discussed with this distinction in mind.

A. NON-COMPREHENSION MEASURES: Stroop and lexical decision tasks

The Stroop task is used to find out what other words the presentation of a lexical item activates or makes more available. In this task, the subject has to respond to a word printed in coloured ink by naming the colour of the ink but not the word. Subjects typically find that it is difficult to ignore the word itself and, therefore, the word name is said to compete for output with the name of the ink colour. The result of this response competition is that it takes the subject longer to name the ink colour of a word stimulus, for example, than the ink colour of a non-word stimulus such as a square. For the sake of convenience, this response competition in colouring naming of word stimuli will be referred to as interference. The logic, then, is that colour-naming will be interfered with to the extent that the stimulus activates a code other than the name of the ink colour.

A common extension of the paradigm has been to study the structure of relationships in memory. For example, there is greater colour-naming interference to the test word "butter" if it is preceded by a related word such as "bread" than if it is preceded by an unrelated word such as "nurse". The assumption that is made from this type of finding is that the word

"bread" activates several semantically related words so that when the related word "butter" is presented, its code has already received some activation from the prior context word, making colour-naming difficult. The following two studies investigated access to world knowledge by using a further variation of this Stroop task.

The modification of the Stroop paradigm in these two studies is similar. A sentence is presented auditorially after which a test word printed in coloured ink appears on a screen. The subject is then required to name the ink colour. If colour naming is interfered with then the assumption is that the code or representation of the test word has been activated by the prior context. In one condition, the context emphasizes a high frequency property of a noun, for example, the sentence, *The man played the piano*, implies that pianos are musical. In a different condition, the context emphasizes a low frequency property of a noun, for example, the sentence *The man lifted the piano* implies that pianos are heavy. The test word for both conditions would be the word *music* or *heavy* printed in coloured ink. According to a context-independent view of access to knowledge, colour-naming of both test words should be interfered with regardless of which context about pianos was presented. According to the FBH, colour-naming of the high frequency property *music* should be interfered with after either context about pianos. Colour-naming of the low frequency property *heavy*, however, should be interfered with only when it follows the context about lifting pianos. According to the context-dependent view, colour-naming should be interfered with only when the test word matches the property implied by the context, that is, there should be interference to *music* only when it follows *The man played the piano*, and there should be interference to *heavy* only when it follows *The man lifted the piano.*

Whitney, McKay, Kellas & Emerson (1985) conducted a study to see whether initial access to world knowledge is context-independent, context-dependent or a combination of the two. There are three important methodological points to note about this experiment. First,

the target noun in the context was always the last word of the sentence. Second, the baseline from which interference was measured was an unrelated baseline, that is, the test word was semantically unrelated to the last word or target noun in the sentence context. For example, a context such as *The man played the game* was followed by the test word *music* or *heavy*, where *music* and *heavy* are unrelated to the word *game*. Third, the time between the last word in the context and the presentation of the test word was varied. This interval is called the stimulus onset asynchrony or SOA. A 0 millisecond SOA, a 300 millisecond SOA, and a 600 millisecond SOA were used in this experiment.

The results supported the context-independent hypothesis of access to knowledge as colour naming of both high and low frequency properties was interfered with regardless of contextual emphasis. This held only for the 0 millisecond SOA condition, however. After delays of 300 and 600 milliseconds, there was colour naming interference for the high frequency properties regardless of context, but there was colour naming interference for the low frequency properties only when they matched the property implied by the context. Whitney et. al concluded that all properties of nouns are initially accessed independent of context and that high frequency properties remain active regardless of contextual emphasis.

This initial context-independent access of properties is similar to the findings in the literature on homographs. A homograph is a word that has two distinct meanings with identical orthography and phonology. The word "bowl" and the word "pipe" are two examples. Findings from the homograph literature suggest that initial access to both meanings of a homograph is independent of context (Onifer & Swinney, 1981; and Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982), and that eventually the context selects the appropriate meaning. Some investigators have found a slightly different pattern, however, where in the absence of a context, or in the presence of an context which provides no bias, only the more frequent meaning of the homograph may be accessed and remain active (Simpson, 1981; and

Yates, 1978). The results of the Whitney et. al. study are interesting in comparison to the results from the homograph studies because they suggest that even nouns with one dictionary meaning have several "shades of meaning" which are also initially accessed independent of context. This study is different from many of the homograph studies, however, in one important way. The results from this study suggest that the high frequency property of a noun may constitute its core meaning which remains active over time even in contexts which emphasize a different property of the noun. Thus, the context-independent hypothesis describes initial access of a noun's properties in this experiment, but the FBH describes subsequent instantiation of a noun's properties.

There are several problems associated with this interpretation of the results of the experiment, however. First, an analysis of the materials used in this experiment reveals that the properties labeled low frequency properties may not actually be of a low frequency. Instead, these properties are best characterized as being of moderate frequency. It is possible, therefore, that some of these moderately frequent properties may be initially accessed or retrieved differently from actual low frequency properties. Barsalou's notion of a continuum of context-dependence is important here. Whitney et. al. argue that the properties that Barsalou refers to as being context-dependent are actually inferences about objects rather than perceptual properties of the objects. They suggest that the low frequency properties tested should be less salient properties of objects but should not be properties derived from inferential processes. Of course, the retrieval notions that Barsalou (1987) developed assume that the important factor in access is how frequently a property has been retrieved in conjunction with its noun. This is a simple testable assumption, and properties are not excluded from the context-dependent continuum simply because they are not perceptual properties of objects.

In fact, Whitney et. al's. criticism of the choice of low frequency properties in other

experiments is curious in that many of the low frequency properties they used are also inferential. For example, the property of "storage" for "shelves" or "lumber" for "oak" are not properties which are intrinsic to the objects that they modify. Instead, they are properties of those nouns because of how the object is used. There is no special perceptual quality of shelves that would tell one that shelves are sometimes used for storage or that oak is sometimes used for lumber. It is useful, in this respect, to remember Olson's (1970) point that words convey information and as such they are not necessarily synonymous with the perceptual object that they name or refer to in the world. In summary, it is difficult to determine whether the 0 millisecond SOA results show that low frequency properties are also initially accessed independent of context, when those "low" frequency properties may actually be of a much higher frequency than assumed in this experiment.

A second problem with the experiment has to do with the baseline condition used. The implicit assumption is that the unrelated baseline is neutral in its effects. The interpretation that initial access to a noun's properties is context- independent relies on the assumption that the unrelated baseline has no effect on colour naming. This may not be a safe assumption to make as other investigators have shown that even a row of X's interferes with the processing of a target word compared to no context or the word "blank" before the target (deGroot, Thomassen & Hudson, 1982; Kahneman & Treisman, 1986). One consequence of these observations is that colour naming of the test word in the unrelated condition may actually be facilitated compared to colour naming when the test word is preceded by no context. Although this was not tested in the experiment, the possibility exists that the unrelated baseline may overestimate colour naming interference in the other conditions.

A third criticism concerns the type of contexts used and the way in which these contexts were presented. First, the contexts were very short and, as a result, were sparse in the information they provided compared with many of the sentences one experiences in

normal text. Because the informative content of these contexts may be minimal, they may not be used by the reader in the same way as richer contexts are normally used. Second, in order to control the SOA, the target noun was always the last word in the context sentence. Because the noun and the tested property share an exceedingly close temporal relationship at the 0 millisecond SOA, the noun-property pair may be processed together apart from the rest of the sentence. This could occur without any intent on the part of the subject to process the noun and property in this way. The possible strong effects of close temporal contiguity on processing mode should not be overlooked (see Kiger & Glass, 1983, and Koriat, 1981, for similar arguments).

Using examples from the materials in this experiment, one can see that pairs such as *robin-flies* or *robin-sings* are very different from pairs such as *burglar-flies* and *train-sings*. In this experiment, *flies* was considered to be a high frequency property of *robins* and *sings* was labeled the low frequency property of *robins*. The second member of the first two pairs is more likely to show interference in colour naming compared to the second member of the last two pairs because the first two pairs each form a semantically related unit but the words in the other two pairs are not semantically related to one another. This is simply a prediction based on evidence from several word recognition studies using pairs of words in which the second member of a pair can be processed more quickly if the first member of the pair is related to it. For example, recognition of the word *nurse* is faster if it is preceded by the word *doctor* than if it is preceded by the word *bread* (Meyer & Schvaneveldt, 1975). It should be noted that had Whitney et. al. used actual low frequency properties of the target nouns, a low frequency pair such as *robin-skin* may have been processed differently than their low frequency pair *robin-sings*.

Importantly, however, it has been found that some of the effects obtained with pairs of words in isolation or with lists of words are not the same as the effects obtained when those

same words appear in larger units of meaningful text (Auble & Franks, 1983; Foss, 1982; Kintsch & Mross, 1985; and Merrill, Sperber & McCauley, 1981). Kintsch and Mross, for example, found that both senses of a homograph were activated regardless of context when the homograph was presented as the last word of the sentence, similar to the format used in the Whitney et. al. experiment. When the presentation of the reading materials was self-paced, however, as it presumably is during normal reading, only the thematically-appropriate sense of the homograph was found to be active. This suggests that the results of any task in which some of the constituents can be processed as isolatable units must be generalized to the natural reading situation with caution.

An experiment in which the criticism raised above may pose less of a problem was conducted by Conrad (1978) who used a Stroop task similar to that used by Whitney et. al. with the exception that, for the subject, the critical noun was not always the last word in the context. This was accomplished by using filler trials on which the presentation of a noun in any position in the sentence was followed by the test word which was then followed by the remainder of the sentence. The trials which were actually analyzed, however, were the ones in which the critical noun was the last word in the sentence, so that the complete sentence context was heard before the colour naming task was required. The noun and property may be less likely processed together apart from the rest of the sentence when this type of testing strategy is used. At 0 millisecond SOAs, however, the tendency to process the temporally contiguous pairs may be difficult to override regardless of where in the sentence the noun-property pair is tested. Unfortunately, Conrad did not report what delay she used between noun and tested property. This means that no firm conclusions about initial access versus maintained activation can be drawn from this experiment.

Conrad did, however, test both high and actual low frequency properties. For example, the word "string" is a high frequency property of "piano" and "heavy" is a low

frequency property of "piano". The context sentence could either be "The man tuned the piano" or "The man lifted the piano" and a sentence with a noun unrelated to either property was used as the control. The results showed that colour-naming of the high frequency property was interfered with regardless of the property of pianos the context emphasized. Colouring naming of the low frequency properties, however, was interfered with only when the context emphasized that property of pianos. If it is assumed that the SOA in this experiment was 300 milliseconds or greater, then the results are similar to those found by Whitney et. al. even though Conrad used properties of a much lower frequency. On the other hand, if it is assumed that there was a 0 millisecond SOA, the results would suggest that only high frequency properties are initially accessed independent of context and low frequency properties are accessed somewhat later (ie. by 300 milliseconds) in appropriate contexts. This type of interpretation would suggest that only very frequent properties constitute some kind of core aspect of a word's meaning.

Such an interpretation, of course, rests on the assumption that the testing procedures used in one or both Stroop experiments do not cause the processing of nouns to differ from that during the normal reading situation. To reiterate, in the Stroop task, nouns could be processed differently than during normal reading for two reasons. First, at a 0 millisecond SOA, the noun and tested property may be processed as an isolated but semantically related unit. Second, at longer SOAs, because the critical noun is made explicit to the subjects, their attention may be drawn to the critical noun with the result that the way in which that noun is processed differs from the way in which that noun is processed when it is embedded in a text. Furthermore, these problems may be unavoidable, as they are artifacts of the Stroop paradigm itself.

The final experiment to be considered in this section is one reported by Greenspan (1986) in which the criterion task was lexical decision. In the lexical decision task, the subject

has to decide whether a letter string forms a real word or not. The subject is required to press one response key when the letter string forms a real word and to press another response key when the string does not form a real word. The measure of interest is response time and error rates may also be taken into consideration. In this experiment, a sentence context emphasizing a high frequency property of a noun or a low frequency property of a noun preceded the test item. The noun was always the last word in the auditorially presented context, and a letter string was presented visually one second after the last word in the sentence was spoken. Interestingly, two different baseline conditions were used. One was the standard unrelated baseline in which the noun in the context was unrelated to the test word, and the other was a neutral baseline in which the sentence *Please be ready to respond* preceded the presentation of the test word. Greenspan found that, regardless of the baseline used, lexical decisions to high frequency properties were facilitated independent of what property of the noun the context emphasized, but that decisions to low frequency properties were facilitated only in the appropriate context. He interpreted these results as support for the FBH.

Two points must be raised, however, before these conclusions can be drawn. First, a similar problem arises here as was encountered in the Whitney et. al. study in that the critical noun in the context was always completely predictable. Thus, there is the possibility that the last noun in the sentence and the property are processed as a unit separate from the rest of the sentence. Second, the relatively long delay between noun and property raises the possibility that the high frequency property of the noun could be generated by the subjects with some degree of success despite the emphasis in the context. The low frequency property is, of course, guessable only from the appropriate contexts. In other words, *a priori* distinctions between the two types of property could account for these results as opposed to the idea that the two types of properties are instantiated during reading in functionally different ways.

In addition, the one second delay between the noun and the property suggests that some of the facilitation effects in the experiment could be due to strategic processing. As Neely (1977) has shown, strategic effects work on the basis of an expectation being fulfilled. In Greenspan's lexical decision experiment, facilitation could result from an appropriate emphasis in the context for both high and low frequency properties and, in addition, subjects could build predictions based on property frequency. Because the critical noun in the context is predictable, that noun's high frequency property can also be predicted with some accuracy. If this line of reasoning is valid, the results for high frequency properties should show a larger facilitation effect for appropriate contexts than for inappropriate contexts. This would occur because facilitation for high frequency properties comes from two sources, expectation and appropriate emphasis in the context. Facilitation for low frequency properties, however, would come only from the appropriate emphasis provided by the context. The facilitation effects roughly follow this proposed pattern, assuming that facilitation from different sources is additive. The largest facilitation effect was for high frequency properties after appropriate contexts (59 milliseconds). The facilitation effects for high frequency properties after inappropriate contexts and low frequency properties after appropriate contexts, however, were smaller and similar to one another (34 milliseconds and 42 milliseconds respectively). The results of this study, then, do not provide unequivocal support for the FBH because of the problems associated with presenting the critical noun as the last word of the sentence.

In conclusion, the findings from the two Stroop studies and the lexical decision study suggest that high frequency properties, and perhaps some moderately frequent properties, may be initially accessed regardless of contextual emphasis, and that these properties may form invariant aspects of a word's meaning. In addition, high frequency properties appear to be instantiated regardless of contextual emphasis but low frequency properties and moderately frequent properties are instantiated only in appropriate contexts. These conclusions, however,

must be tempered by the possibility that the methodologies used in these studies cause the processing of the nouns to differ from how they are processed during the course of normal reading. This is a problem which occurs as an artifact of the Stroop and lexical decision paradigms themselves, but may be aggravated by presenting the critical nouns at the end of every sentence. Only Conrad's Stroop experiment tried to take this problem into account, but comparisons with the Whitney et. al. study are difficult to draw because the delay between noun and tested property was not reported.

A more general criticism, however, can be leveled against these studies. If we assume, methodological problems aside, that these studies reveal something about early access to knowledge, then there may be some theoretical significance to the findings. There may, however, be little practical significance of these results for understanding reading comprehension processes.

Greenspan (1986) argues, however, that early context-independent access to and sustained activation of high frequency properties of nouns does have practical significance for reading comprehension. He gives the following example: *John lifted the piano onto his van and moved it, along with his other furniture, to his new apartment. Later that evening, he was able to enjoy Chopin.* The first sentence emphasizes a low frequency property (heaviness of pianos) but the second implies that the piano was later used to play Chopin even though *piano* is not explicitly mentioned in the second sentence. John could just have easily enjoyed Chopin by listening to it on his stereo which was probably also moved that day. At first glance, however, most readers probably infer that John played Chopin on his piano. Greenspan suggests that the second sentence is easy to understand because the high frequency property of pianos is also instantiated when piano is read in the first sentence. One has only to turn this example around, however, to see that comprehension is not dependent on high frequency properties being instantiated independent of context. The following example illustrates this point. *John*

was able to enjoy Chopin on his piano in his new apartment. He wondered if he had strained his back earlier in the day during the move. Although the high frequency property of pianos is explicitly instantiated in the first sentence, it does not preclude that an inference about a low frequency property of pianos will be made. Readers may be just as likely to make the inference that John strained his back from moving his heavy piano, even though he could have as easily strained his back moving his stereo or his stove. There may be no necessity for the pragmatics of comprehension, then, in having obligatory access and continued activation of just the high frequency property regardless of contextual emphasis. McKoon and Ratcliff (1981) have demonstrated, though, that inferences between two highly related concepts are more likely to be made during processing than are inferences between two weakly related concepts. The slightly different notion, however, that comprehension is facilitated to a greater extent if high frequency properties are always instantiated versus if they are not is an empirical question requiring further research.

The question of initial access to knowledge, then, is still an open one. Its answer will depend on evidence from experiments that control the delay between noun and tested property over a range of time and materials, that make the critical noun less predictable in the context and less able to be processed separately from the rest of the context, that test properties of different frequencies, and that explore the consequences of initial access on later comprehension. An important study to conduct, with reference to the last point, is one in which initial access to a noun's properties is investigated by testing after the second occurrence of the noun in a context rather than after the first occurrence. If initial access to high frequency properties is obligatory upon reading the noun, then early access to high frequency properties should occur whenever the noun is mentioned in a text. It is possible, however, that emphasizing a low frequency property of the noun slows access to the noun's high frequency property when that noun is encountered for a second time. A finding of this

nature would impose important boundary conditions on initial access mechanisms. The next section explores the opposite end of the temporal processing spectrum by discussing cued recall studies which measured memory for what was read as a function of the knowledge assumed to be instantiated at study.

B. COMPREHENSION MEASURES: Cued Recall Studies

A series of early studies suggested that the instantiation of properties of objects is context-dependent. Barclay, Bransford, Franks, McCarrell, & Nitsch (1974) conducted a series of cued recall studies in which subjects studied sentences emphasizing different properties of objects. For example, subjects studied sentences such as *The man lifted the piano* or *The man tuned the piano.* At test, subjects were given recall cues appropriate to the studied emphasis or inappropriate to the studied emphasis. For example, the recall cue could be *pianos are heavy* or *pianos have strings.* Cues appropriate to the emphasis in the studied sentence were more effective in recall than cues inappropriate to contextual emphasis. These results suggest that the world knowledge which is instantiated when one reads a sentence is the knowledge one needs to understand the sentence. Property frequency, however, was not manipulated, so the hypothesis that there may be context-independent instantiation of high frequency properties cannot be evaluated from the results of this experiment.

A number of other experiments also suggest that the way in which words are instantiated depends on context (Anderson, Pichert, Goetz, Schallert, Stevens, & Trollip, 1976; Anderson & Ortony, 1975; Garnham, 1979). Anderson et. al. (1976) found that a cue such as *actress* was more effective than one such as *woman* for recalling the last word of a sentence such as, *The woman was outstanding in the theatre.* Evidence that this effect occurred during study rather than at recall comes from the fact that *actress* was not particularly effective for recalling the sentence, *The woman worked near the theatre.* Thus, the cue word *actress* was not

being used merely to generate associates from which the target word *theatre* could be recognized. Importantly, the fact that the specific cue *actress* was a more effective cue than the noun actually used in the studied sentence suggests that activation and instantiation of some core meaning of the studied word *woman* may not be relevant for sentence comprehension. Other cued recall studies dealing with instantiation of knowledge about nouns in context (Anderson & Ortony, 1975) and verbs in context (Garnham, 1979) have produced similar findings.

Two criticisms of these cued recall studies can be made. First, the results of cued recall studies often cannot distinguish between effects which take place at study or encoding and effects which take place at test or recall. The results from the Anderson et. al. study (1976) suggest that the effects are due to instantiation during study. It is unclear, however, whether the results of the study conducted by Bransford et. al. (1974) reflect encoding or recall effects. Cued recall studies conducted by Barnes & Levy (1988), however, suggest that the locus of the effects in these studies may indeed take place during study. These experiments will be discussed later in this section. The second problem with the cued recall studies reported above is that property frequency in the Bransford et. al. studies and exemplar frequency in the Anderson et. al. study were not controlled. This means that the FBH cannot be evaluated by evidence from these studies.

Anderson et. al. (1976) did, however, report one experiment (Experiment 3) in which exemplar frequency was included as a factor. The results of the experiment suggested that the most common exemplar of a general term is not instantiated independent of context. For example, subjects studied sentences such as *The manager removed the box of fruit from his pocket* or *The manager removed the box of fruit from his truck.* The low frequency exemplar *raisins* was a better cue for recalling the former sentence. When no particular exemplar was implied as in the second sentence, the high frequency exemplar *apple* was a better recall cue

than *raisins*. These results suggest that under some circumstances, the high frequency exemplar will be instantiated even if not explicitly referred to.

Although exemplar frequency has been included as a factor in cued recall studies, property frequency of simple concrete nouns was not included as a factor in cued recall studies until recently. Greenspan (1986, Experiment 1) reported an experiment similar in many respects to the one conducted by Barclay et. al. (1974). Subjects studied sentences which emphasized either a high frequency property of the final noun in the sentence or a low frequency property of that noun. For example, subjects read sentences such as, *While she drank the coffee Mary looked through the newspaper*, or *On the bottom of the bird cage John placed some newspaper*. The recall cues were the high frequency property *print* and the low frequency property *lining*. Both cues were given at recall even though only one of the sentences pertaining to newspapers was studied. Greenspan found that a high frequency cue such as *print* was effective in recalling whichever sentence about newspapers had been studied, but a low frequency cue such as *lining* was effective in recalling only the studied sentence implying that property. The high frequency recall cue was somewhat better at recalling the sentence emphasizing that property than the sentence emphasizing the low frequency property. This latter result fits with Tulving and Thomson's (1973) principle of encoding specificity which is simply the idea that recall will be best when the cue given at recall was part of the studied event. In Greenspan's study, there is encoding specificity for both high and low frequency properties, but the frequency variable diminishes the encoding specificity effect in recall when the high frequency property is used as the cue.

Greenspan interpreted the results as support for the FBH by suggesting that high frequency properties are instantiated regardless of contextual emphasis, but low frequency properties are instantiated only in appropriate contexts. In addition, Greenspan argued that the finding of context-independent instantiation of high frequency properties in the cued

recall paradigm suggested that continued attention need not be focused on the noun for its high frequency property to remain accessible, Results from a set of cued recall experiments by Barnes & Levy (1988), however, question these interpretations. Barnes & Levy suggested that the particular methodology used by Greenspan may have contributed to the pattern of findings.

Barnes and Levy hypothesized that the high level of recall of the sentence emphasizing the low frequency property of the noun by the high frequency cue was due to factors operating at recall rather than at study. The logic behind this claim is that if frequent properties of nouns are high associates of those nouns (eg. newspaper-print; cow-milk; lake-water; tree-wood), then a high frequency cue could be used to generate the most likely noun having that property. Importantly, the target noun was always the last word of the studied sentence, and at recall subjects were explicitly asked to try to remember the last word of each sentence they had studied. Once the noun was generated from the high frequency cue it could then be examined to determine if it was the last word in one of the small set of studied sentences. If the last word of the sentence was retrieved by this process, the remainder of the sentence might be more likely to be remembered. In other words, a high frequency property cue may have its advantage because its referent noun can be generated from it, thus redintegrating part of the to-be-recalled sentence. Because high frequency property cues are often strong associates of the nouns, they are effective in generating their related nouns. Low frequency properties of objects, however, are not effective in this respect. It should be noted that the distinction between the effectiveness of high frequency properties versus low frequency properties in generating the nouns they modify is an *a priori* distinction between the two types of property. What the experiment was designed to test, however, was whether or not this distinction has any psychological validity for assessing what knowledge is instantiated during reading.

Support for this reinterpretation of Greenspan's results is provided by the results of two cued recall experiments in which Barnes & Levy demonstrated that Greenspan's results are replicable only when the property alone is given as the recall cue. When the noun was included in the recall cue, (eg. *Newspapers have print* or *Newspapers are used for lining*), however, the advantage of the high frequency cue was abolished. The results showed that the most effective cue for recalling the sentence was the cue related to the emphasis in the studied sentence. Low frequency cues were as effective in recalling the sentence with the high frequency emphasis as high frequency cues were in recalling the sentence with the low frequency emphasis. These results are consistent with the idea that the properties of nouns which are instantiated are the properties that were studied. Barnes and Levy report one interesting result, however, which qualifies the idea that property instantiation is always context-dependent. They found that recall of sentences emphasizing no particular property of a noun was better if the high frequency cue was given than if the low frequency cue was given at test. This result suggests that high frequency properties may be instantiated by default during study if no property is referred to. The instantiation of high frequency properties may occur, then, in some circumstances in which that property is not emphasized. This result is analogous to the Anderson et. al. finding that high frequency exemplars were instantiated only when the context did not imply any one particular exemplar.

In summary, the findings from the cued recall studies presented in this section suggest first, that what is remembered about something that is read is specific to what the context emphasized. This appears to be the general case, that is, when the context emphasizes a particular property or an exemplar. When the context does not modify the noun, however, the high frequency property may be instantiated and later recalled as part of what was read. Second, the discussion of the cued recall studies revealed similar general problems as those encountered in the discussion of the Stroop and lexical decision experiments. Again, the

methodology used is very important, as is the distinction between high and low frequency properties.

In addition to the methodological problems discussed previously, two other aspects of the cued recall paradigm can be criticized. First, sentences in cued recall paradigms are usually studied for much longer than it normally takes to read the sentences. Thus, it is unclear whether or not the results from cued recall paradigms can be generalized to what is remembered about what is read under more natural reading conditions. Second, it may well be that what is remembered during reading are those things emphasized by the context, but reading comprehension is not synonymous with remembering what is read. Instead, comprehension is an on-line process and does not always involve having to explicitly recall what was read.

The important question that needs to be addressed, then, is how knowledge is accessed during the reading comprehension process itself. As Barsalou (1982) suggests, continued activation of a noun's high frequency properties may depend on the noun being in working memory, but working memory has a much shorter time boundary than that encountered in cued recall experiments. The following section deals with studies which provide a closer approximation to the on-line reading process. The experiments to be discussed used property verification or sentence verification paradigms which is also the experimental method used in the thesis research.

C. COMPREHENSION MEASURES - Verification Studies

The verification paradigm is similar to that used in the studies on semantic memory representation discussed in Chapter One, with the difference that the role of context in access to world knowledge is explicitly tested. In the verification paradigm, the subject reads a context which is followed by the item to be verified. In property verification, a context such as *The skunk stunk up the entire neighbourhood* is followed by a property such as *has a smell.*

The subject has to respond whether or not that property is actually a property of the underlined or highlighted noun in the context (see Barsalou, 1982). Speed and accuracy in responding "yes" or "no" are measured. In question answering, the same context, without the noun underlined, is followed by a question such as *Do skunks smell?*. The subject has to respond "yes" or "no" and again speed and accuracy are measured (see Tabossi & Johnson-Laird, 1980). In sentence verification, a context is followed by a sentence such as *Skunks are smelly.* The subject has to respond "true" or "false" and response time and accuracy are measured (see McKoon & Ratcliff, 1982).

Tabossi (1982), McKoon and Ratcliff, (1982), and Tabossi and Johnson-Laird (1980) obtained results consistent with a context-dependent view of access to knowledge during reading. Tabossi and Johnson-Laird found that a sentence context which emphasized a particular property of a noun speeded question-answering about that property relative to a context emphasizing no particular property of the noun. For example, it took less time to respond "Yes" to *Are diamonds brilliant?* after the context, *The mirror dispersed the light from the diamond* than after the neutral context, *The film showed the person with the diamond.* In addition, question answering was slower relative to the neutral context baseline when the context emphasized a property other than the one tested. For example, it took longer to respond "Yes" to *Are diamonds brilliant?* after the context, *The goldsmith cut the glass with the diamond* than after the neutral context. The context sentences were presented for five seconds and the tested noun could appear at any position in the sentence, so the subject could not always predict which noun would be tested. The question appeared on the screen one second after the context went off.

Tabossi and Johnson-Laird concluded that the results demonstrated that knowledge about an object or the meaning of a noun is made available during reading only when the context implies that knowledge. In addition, they concluded that access to some knowledge is

actually inhibited if the reading context emphasizes a different property of the noun. Tabossi (1982) obtained similar results using verbs instead of nouns.

Tabossi and Johnson-Laird's study has the methodological advantage of testing nouns which are not totally predictable from the context, but the major problem with the study is that property frequency was not included as a factor. Thus, the FBH cannot be evaluated from the results of this experiment. A second possible problem with the interpretation of the results has to do with the baseline used - the neutral context condition. The cued recall results reported by Barnes and Levy suggested that high frequency properties may be instantiated by default in neutral contexts. This raises the possibility, as Greenspan (1986) has also noted, that the use of the neutral context baseline overestimates the negative effect of inappropriate context on access to high frequency properties and overestimates the facilitory effects of appropriate context on access to low frequency properties. In other words, if the neutral context is instantiated with a high frequency property, it becomes functionally similar to an appropriate context with respect to the availability of high frequency properties, but functionally similar to an inappropriate context when it comes to the availability of low frequency properties.

McKoon and Ratcliff's (1982) study is slightly different from the Tabossi and Johnson-Laird study but similar conclusions can be drawn from it. Short two sentence paragraphs were used as context and sentence verification was measured. For example, a paragraph about a painter painting a picture of a ripe tomato was followed by the sentence *Tomatoes are red* or *Tomatoes are round*. Likewise, a paragraph about a child rolling a tomato on the floor with her nose was followed by one of the two test sentences about tomatoes. McKoon and Ratcliff found that verifications were faster to the sentence about tomatoes which was consistent with contextual emphasis than they were after the paragraph emphasizing the other property of tomatoes. McKoon and Ratcliff, however, did not control

for property frequency, nor did they compare their experimental conditions to a baseline measure. Therefore, their results cannot be used to evaluate the FBH and they are difficult to compare to other studies in which baseline conditions were used.

In 1982, Barsalou used a property verification procedure to test the FBH. The contexts were single sentences which stayed on the screen for six seconds, followed immediately after by a property to be verified. Barsalou tested verification to high frequency properties of some nouns after appropriate contexts versus after neutral contexts. He also tested verifications to low frequency properties of other nouns after appropriate contexts versus after neutral contexts. For example, the high frequency property *has a smell* was tested after the appropriate context, *The skunk stunk up the entire neighbourhood* or after the neutral context, *The skunk was under a large willow.* Likewise, the low frequency property *can be walked on* was tested after the appropriate context, *The roof creaked under the weight of the repairman* or after the neutral context, *The roof had been renovated prior to the rainy season.*

Barsalou found that verification of high frequency properties took the same amount of time after an appropriate context as after a neutral context. On the other hand, verification of low frequency properties took less time after an appropriate context than after a neutral context. These results suggest that high frequency knowledge about a noun is available independent of contextual emphasis, but that low frequency knowledge about an object is available only in appropriate contexts. In other words, the results provide support for the FBH.

There are, however several problems associated with the interpretation of these results. First, as noted previously, the neutral context baseline may not be the best way to test the FBH. If high frequency properties are instantiated by default in neutral contexts, then neutral contexts are functionally equivalent to appropriate contexts for high frequency items (the FBH predicts this) but are functionally equivalent to inappropriate contexts for low

frequency properties. Inappropriate contexts, then, must also be tested to see if high frequency properties are as accessible in contexts which emphasize a low frequency property of a noun as they are in neutral and appropriate contexts.

A second problem has to do with the materials used to test the FBH. A strong test of the hypothesis that any one noun may have some context-independent properties and some context-dependent properties means that high and low frequency properties of the same noun must be tested. In this experiment, however, different types of properties were tested for different nouns. A third problem is that the tested noun was always made explicit in the context because the tested noun has to be highlighted or underlined in the property verification task. As suggested previously, it is important to realize that the effects obtained when the target nouns are made explicit may differ from how properties of nouns are instantiated in the normal reading situation.

A general criticism which can be leveled at most of the studies discussed in this chapter also comes from a consideration of how the experimental paradigms differ from the normal reading situation. deGroot et. al. (1982) propose that readers make congruency assumptions when confronted with reading material, that is, readers assume that what they read is congruent with what they read before. Most of the experimental paradigms used in this area, however, have a high degree on incongruency built into them. Because up to half of the trials in timed tasks are either false or nonsensical, they are incongruent by definition. Add to this the fact that at least half of the true trials are inappropriate context trials and the overall degree of incongruency between context and test item ranges anywhere from 75% to 85%. This high degree of incongruency is certainly much greater than that which occurs in natural text; therefore, it is possible that the effects of context are different when many of the trials in an experiment are incongruent versus when more of the trials are congruent. This is an important question to ask, but as yet, it has not been addressed in this literature.

D. THE EXPERIMENTAL HYPOTHESES - An Overview of the Thesis Research

The studies in the thesis were conducted in order to explore several questions which the literature leaves unanswered. The experimental paradigm used in all the studies was verification of world knowledge. This world knowledge was presented in the form of sentences such as *Zebras have stripes* or *Zebras have hooves* preceded by a context in the form of a short two sentence paragraph. After reading the paragraph, the subject decided whether the sentence was true or false. The dependent measures were response time and errors on the true/false decisions.

Three factors were tested in Experiment 1. First, because high and low frequency properties of the same nouns had not been tested in the verification paradigm, they were tested here so that the FBH could be properly evaluated. The second factor that was tested was whether highlighting the target nouns in the contexts produces results similar to when the nouns are not highlighted. The only verification experiment which controlled for property frequency also highlighted the target nouns in the context by underlining them (see Barsalou, 1982). Because nouns are not usually underlined in text, however, the possibility exists that effects obtained when the tested nouns are made explicit are not generalizable to the natural reading situation. It is crucial, therefore, to test the FBH when the target nouns are not highlighted in the contexts compared to when they are highlighted. The third factor tested by Experiment 1 was the effect of inappropriate contextual emphasis on the availability of high and low frequency properties of nouns. Barsalou did not use contexts in which the tested property differed from the property emphasized in the context. Tabossi and Johnson-Laird did include this condition, but did not include property frequency as a factor. The strong prediction that high frequency properties are available regardless of contextual emphasis implies that these properties should also be available in inappropriate contexts.

Experiment 2 tested two further factors. First, this experiment tested the effect of the target noun being explicit or implicit in the context in a different way from that in Experiment 1. For one group of subjects in Experiment 2, the target nouns were made explicit by being foregrounded in the contexts in much the same way that important nouns may be foregrounded in normal text. The manipulation of naturally foregrounding the target nouns was compared to a manipulation for a second group of subjects who read contexts in which the target noun was not foregrounded. The second idea tested was whether the FBH can account for results when a different baseline measure is used. In this experiment, a no-context baseline was used to remedy some of the problems associated with using a neutral context baseline.

Experiment 3 pursued the idea that when the experimental paradigm more closely resembles the normal state of affairs in reading, different effects may be obtained than when the paradigm is less like the natural reading situation. This was accomplished by comparing the case in which most of the trials in an experiment are incongruent to the case in which more of the trials are congruent. The results of such manipulations might impose important boundary conditions on the generalizability of the FBH.

If the results from the three experiments are in keeping with those predicted by the FBH, then the FBH will be an important addition to any model of the reading comprehension process. If the results differ from those predicted by the FBH, however, it is important to be able to determine why and what the consequences of these differences are for understanding reading. Specific predictions are presented in the overview to each experiment. Chapter Three presents Experiment 1, Chapter Four contains Experiment 2, and Chapter Five is composed of Experiment 3.

CHAPTER 3

In Experiment 1 the three factors tested were: 1) access to high and low frequency properties of the same nouns; 2) the effects of neutral, appropriate and inappropriate contextual emphasis on access to knowledge; and 3) the effects of highlighting versus not highlighting the target nouns in the contexts. Examples of the conditions in this experiment can be found in Table 1 on page 45.

The assumptions of the strong form of the FBH lead one to expect a particular pattern of results. High frequency properties should take the same amount of time to verify regardless of the type of context they follow, and the effects obtained when the target nouns are highlighted should not differ from those obtained when the nouns are not highlighted. Barsalou (1982), however, has proposed a weaker form of the FBH, suggesting that inappropriate contexts might eventually slow access to high frequency properties if attention is focused away from those properties. At the very least, then, verifications to high frequency properties should be similar after neutral and appropriate contexts. Second, if inappropriate contexts eventually slow access to high frequency properties, they should also slow access to low frequency properties so that verification of low frequency properties should take longer after inappropriate contexts than after neutral contexts. A third prediction derived from the FBH is that access to low frequency properties should be facilitated by appropriate context so that verifications after appropriate contexts should be faster than after neutral contexts. Again, highlighting or not highlighting the target nouns should make little difference to the results.

The criticisms of the studies discussed in Chapter 2, however, lead to the formulation of an alternate set of outcomes. When discussing the results from other experimental

paradigms, it was suggested that if a subject's attention is drawn to a particular word, that word may be processed differently than it would normally be processed in text. In addition, it was suggested that high frequency properties of nouns are sometimes instantiated by default in neutral context. It is possible that when there are several nouns in a neutral context, the noun which the reader interprets as the focus of the context is instantiated with its high frequency property. When one of the nouns is highlighted, this noun is obviously the focus of the context, and is, therefore, instantiated with its high frequency property if no other property is implied. When none of the nouns are highlighted, however, the subject may or may not choose the target noun as the focus of the context, and, therefore, the high frequency property of the target noun or the high frequency property of a different noun may be instantiated when no property of either noun is implied by the context. In other words, when nouns are highlighted in neutral contexts they may be processed differently than when they are not made explicit to the subject.

These ideas lead to the proposal of a different set of outcomes than those derived from the FBH. First, assuming that high frequency properties of highlighted nouns are instantiated in neutral contexts, the neutral contexts should be functionally similar to *appropriate* contexts when *high frequency* properties are verified. On the other hand, when the target nouns are not highlighted, the high frequency property may not always be instantiated in the neutral contexts so that verifications to high frequency properties should be faster after appropriate contexts than after neutral contexts. When the nouns are highlighted, then, verifications to high frequency properties after neutral and appropriate contexts should be similar and should be faster than verifications after inappropriate contexts. When the nouns are not highlighted, however, verifications to high frequency properties after appropriate contexts should be faster than after neutral contexts. In addition, verifications after inappropriate contexts might take longer than after neutral contexts if it is assumed that the

high frequency property of the non-highlighted target noun in the neutral context is instantiated only some of the time.

According to this alternative framework, neutral contexts should also be functionally similar to *inappropriate* contexts for verifying *low frequency* properties of highlighted nouns. The logic behind this statement is that the high frequency property is instantiated in both types of context, by default in the neutral context, and by explicit emphasis in the inappropriate context. Consequently, verifications to low frequency properties should be similar after neutral and inappropriate contexts when the nouns in the contexts are highlighted. Verifications in both these conditions, then, should take longer than verifications to low frequency properties after appropriate contexts. When the target nouns are not highlighted, a similar pattern of results should be obtained but for slightly different reasons than those outlined above. In the neutral context, either the high frequency property of the target noun or the high frequency property of a different noun in the context might be instantiated, but in the inappropriate context, the high frequency property of the target noun will be instantiated. Because properties other than the low frequency property are instantiated in both types of context, verification of the low frequency property should be similar after both neutral and inappropriate contexts. Verification of low frequency properties after neutral and inappropriate contexts, therefore, should be similar and should take longer than after appropriate contexts.

The FBH and the alternative framework proposed here make some of the same predictions for the results of Experiment 1, but for different reasons. The two frameworks, however, predict different patterns of results for some conditions in the experiment. The test of these two frameworks, then, relies on whether such results provide support for the FBH or for the alternative formulation.

Method

Design. In order to make the verification task meaningful for the subject, some of the trials were true and some were false. For the "true" verification trials, the target nouns were either modified by a high frequency property or a low frequency property. The context presented before each verification trial was either neutral, appropriate or inappropriate with respect to the tested sentence. The two presentation formats for the target nouns in the contexts were a highlight format and a no highlight format. Therefore, the design in this verification task was 2 Property Frequencies (high and low) x 3 Context Conditions (neutral, appropriate, and inappropriate) x 2 Presentation Formats (no highlight and highlight) where the first two factors were tested within-subjects and the third factor was tested between-subjects. Estimates of correct response time for each cell were based on the means for a possible 8 measures per subject per condition.

For the "false" verification trials, the target nouns were accompanied by a false modifier. The context presented before each verification trial either had a neutral emphasis, emphasized a high frequency property of the noun in the target sentence, or emphasized a low frequency property of the noun in the sentence. The two presentation formats for the target nouns in the contexts were a highlight format and a no highlight format. Therefore, the design for the false trials in this task was 3 Context Conditions (neutral, high frequency emphasis, and low frequency emphasis) x 2 Presentation Formats (highlight and no highlight) with repeated measures on the within-subjects factor of context and where the second factor was tested between-subjects. Estimates of correct response time for each cell were based on the means for a possible 12 measures per subject per condition.

True and false trials were presented in a random ordering with the one constraint that no two trials from the same true or false condition could appear successively.

Materials. The experiment consisted of the presentation of 84 trials, 48 in which the target sentence was "true", and 36 in which the target sentence was "false". The 48 "true" trials consisted of 8 instances testing each of the 6 conditions in which two types of property frequency were crossed with the three types of context. The 36 false trials consisted of 12 instances testing each of the three context conditions.

The target sentences for the true trials consisted of 48 pairs of sentences, constructed from 48 target nouns. Each pair consisted of one sentence in which the noun was modified by its high frequency property and one sentence in which the noun was modified by its low frequency property. Examples are ZEBRAS HAVE STRIPES and ZEBRAS HAVE HOOVES respectively. The syntactic structure of the two sentences containing each target noun was identical. Wherever possible, both high and low frequency properties contained an equal number of letters. Only a few different sentence structures were used. They were as follows: 1) object x has property y (eg. Zebras have stripes or hooves). There were twenty-three such pairs of sentences; 2) object x is property y (eg. Mice are small or pets). There were thirteen such pairs of sentences; and 3) object x contains, wears, chases, uses or makes something (eg. Birds eat worms or fish). There were twelve such pairs in total.

The high frequency properties were obtained from a norming study using 130 volunteers, but none of these subjects took part in any of the experiments reported in the thesis. Subjects were given a list of sentence stems such as Zebras have _____ _____ _____. They were asked to complete the first blank with the first word that came to mind and then to complete the next two blanks with the next two words that came to mind. Subjects were instructed to fill in the first blank first for all the sentences and then to go back and fill in the second and third blanks. A word was chosen as the high frequency property of a noun if over 50% of the subjects completed the sentence with that word, the only qualification being that no other word was used to complete the sentence as frequently.

The low frequency properties were obtained by choosing a word that could meaningfully complete the sentence, but which was either mentioned by ten subjects at the most or was generated by the experimenter. The only restriction on the selection of low frequency properties from the subject-generated materials was that none of the ten or fewer subjects who generated that property included it as their first completion. The 48 pairs of high and low frequency property sentences used in Experiment 1 are included in Appendix A.

The 48 pairs of sentences were divided into 6 lists of 8 pairs of sentences each. The lists were matched as closely as possible so that each list contained an approximately equal number of pairs from each of the previously described syntactic forms. The 6 conditions in the experiment resulted from the factorial combination of 2 levels of property frequency (high and low) and three levels of context (neutral, appropriate and inappropriate). The 6 lists were cycled through each condition so that the 48 target nouns appeared an equal number of times in each of the 6 conditions. Thus the materials were counterbalanced across subjects such that no target noun was repeated for any one subject, but so that each target noun was tested equally often in each condition across subjects.

A further twenty subjects, who participated in neither the norming study nor in the experiments reported below, took part in an untimed verification task using the high and low frequency sentences. These subjects were tested in order to confirm that the low frequency sentences were accepted as being true. The results revealed that the low frequency properties used in this experiment are part of the world knowledge of most first year university students.

The target sentences for the false trials were 36 false sentences constructed such that each one matched the syntactic structure of a true sentence. For example, there were false sentences such as PORCUPINES HAVE FINS. The nouns and properties in the false sentences never appeared in the true sentences. Therefore, the experimental materials were not counterbalanced across type of verification (ie. true or false). The false sentences are

included in Appendix A. The 36 false sentences were divided into 3 lists of 12 sentences each. The lists were matched so that each contained an approximately equal number of sentences from each syntactic form. The three false conditions in the experiment resulted from having each sentence tested after each of the 3 levels of context (neutral, high frequency emphasis, and low frequency emphasis). The 3 lists were cycled through each condition so that the 36 target nouns appeared an equal number of times in each of the three conditions across subjects.

The contexts for the true trials were composed of 144 two sentence paragraphs. One third of these emphasized the high frequency property of each of the 48 nouns, one third emphasized the low frequency property of the nouns and the other third emphasized no particular property of these nouns. The paragraphs were constructed so that all were between 28 and 34 words in length and they were composed such that the target noun appeared twice in the paragraph, once in each sentence. A second noun was also mentioned twice so that subjects in the no highlight group would not always be able to guess which noun would be tested in the subsequent verification task. The highlight and no highlight groups, however, received exactly the same contexts except that both occurrences of the target noun in the context appeared between slashes for the highlight group. All of the paragraphs were coherent and internally consistent so that they resembled brief narratives. Examples can be found in Table 1 and the full set is included in Appendix B.

The contexts for the false trials were constructed in the same way as for true trials. For a false trial such as PORCUPINES HAVE FINS, three different context paragraphs were constructed. One emphasized a high frequency property of porcupines, a second emphasized a low frequency property of porcupines and a third emphasized no particular property of porcupines. The target noun was mentioned twice in each paragraph, as well an another noun but the highlight group received contexts in which the two occurrences of the target noun

TABLE 1. Conditions and Sample Materials for Experiment 1 (No Highlight Format)

	Relation of Test Sentence to Context		
Frequency of Association between Noun and its Property	Neutral	Appropriate	Inappropriate
HIGH Zebras have stripes.	The children at the zoo smiled in delight as they watched the zebras running in their corral. Some of the children wanted to open the doors of the corral and set the zebras free.	The African gamehunter had several zebra pelts hanging on the wall in his study. The zebra pelts, with their bands of black and white fur, livened up the otherwise dull decor.	The African gamewarden looked at the zebra's injured ... etc
LOW Zebras have hooves.	The children at the zoo ... etc	The African gamewarden looked at the zebra's injured foot. The limping zebra had managed to step on a sharp piece of metal which had worked its way into its tough horse-like foot.	The African gamehunter had several zebra pelts ... etc

appeared between slashes. All paragraphs for false trials were internally consistent mini-stories analogous to the paragraphs for the true trials. The contexts for the false trials are included in Appendix B.

Procedure. The experiment was conducted on an Apple IIe computer which presented the materials, timed responses, and recorded whether a true or false response had been made. The subjects were tested individually and were first given instructions for a

practice phase. After the practice phase was completed they were given instructions for the experimental phase. At the beginning of the practice phase, subjects were told that they would have to decide whether sentences expressed ideas which were true or false. They were asked to ignore the syntax of the sentences and to base their judgement on the message communicated by the sentence. If the sentence expressed something that could be true, they were required to press one response key with their right index finger, and if the sentence expressed something they thought was false, they were instructed to press a different response key with their left index finger. Right and left response keys were not counterbalanced across type of verification, that is, all subjects were instructed to press the right key on true trials and the left key on false trials. Subjects were instructed to make each response as quickly but as accurately as they could and to keep their fingers resting against the response keys at all times. They were told that the sentence would go off the screen as soon as they made their response and a new trial would be presented 2.5 seconds later. They were also told that they could not correct their errors, and if they made an error, they should forget about it and prepare themselves for the next trial.

The practice phase consisted of 8 true sentences with no context and 8 false sentences with no context. Half of the true trials contained nouns modified by their high frequency property and the other half of the true trials contained nouns modified by their low frequency property. Subjects were given feedback after each practice trial and any problem encountered during the practice set was resolved before moving on to the experimental phase. None of the items in the practice set appeared in the experimental phase.

In the experimental phase, subjects were told that their task would be the same as it was in the practice phase except that they were to read a short paragraph before making their decision. They were told that a short two sentence paragraph would come on the screen and stay on for 8 seconds and then go off the screen after which the test sentence would appear

half a second later. The subjects were asked to respond to this sentence in the same manner as they did in the practice set. They were told that they could either use the information in the paragraph to help them make their decision or their own general knowledge, whichever was applicable. In addition, the highlight group was told that one of the nouns in each context would be highlighted by appearing between slashes and this noun would occur twice in each paragraph. They were informed that the highlighted noun would be the one tested in the subsequent target sentence. All subjects were informed that the first 6 trials of this phase of the experiment were additional practice or "warm-up" trials where a context was presented to read followed by a test sentence. These practice trials used different nouns and properties from those used in the actual experimental trials and there was no pause between these practice trials and the experimental trials.

At the end of the experiment, subjects were told about the trials on which they made errors. They were asked to classify each error on "true" trials as belonging to one of three classes: 1) knew it was true immediately after responded false; 2) think it is true now, but not at the time responded false; or 3) still think it is false.

Subjects. Seventy-two students at McMaster University participated in the experiment for credit in an undergraduate psychology course. Thirty-six subjects were randomly assigned to the highlight group and another 36 were assigned to the no highlight group.

Results and Discussion

For all the experiments to be discussed, the data for the "true" trials are presented first. The data for correct response times are followed by the data for errors. Any response times greater than 2500 milliseconds (ms) were removed from the analyses. In all

experiments, this resulted in the exclusion of less than 1% of the trials overall. Many of the comparisons made in the experiments are between the baseline condition (neutral context in Experiment 1 and no context in Experiments 2 and 3) and the other conditions (appropriate context and inappropriate context). Thus, difference scores were derived by subtracting the means for the other conditions from their respective baseline condition. The logic behind making these comparisons is that a baseline is used as a standard against which other effects are measured. When verifications in one condition are slower than verifications in the baseline condition, the difference between the two is signified by a minus sign in the tables. For example, -100 ms means that the mean response time for that condition was 100 ms longer than the mean response time for its baseline.

The errors were always analysed without respect to how the errors were classified by the subjects, as referred to in the method section above. This procedure was adopted because most of the subjects classified most of their errors as being ones on which they responded "false" and immediately realised that they should have responded "true". The number of errors each subject made in each condition were the data used in the analyses of variance. This procedure yields overall means which represent the mean number of errors per condition. For example, the mean number of errors for a condition might be 1.2 errors out of a possible 8. Because errors are usually reported as error rates (% errors), the mean number of errors were converted to percentages in the post-hoc tests to yield more meaningful comparisons. After the analyses of errors, the data for false trials are presented. Response times greater than 2500 ms were also removed from these analyses.

True Trials - Response Times. The means for each condition for each format are presented in Table 2. An analysis of variance (ANOVA) with the between-subjects factor of Presentation Format (highlight vs no highlight), and the two within-subjects factors of Property Frequency (high vs low) and Context Condition (neutral, appropriate, inappropriate)

was performed on the correct mean response times for each condition for each subject. A main effect of Presentation Format was found, $F(1,70) = 4.139$, $MSe = 237655$, $p < .05$. This reflected that fact that the highlight group responded more quickly overall compared to the no highlight group. A main effect of Frequency was also obtained, $F(1,70) = 540$, $MSe = 10875$, $p < .001$, as was a main effect of Context, $F(2,140) = 76.8$, $MSe = 35652$, $p < .001$. These effects were qualified by a Frequency by Context interaction, $F(2,140) = 24.497$, $MSe = 6145$, $p < .001$. The only other significant effect was a Presentaion Format by Context interaction, $F(2,140) = 3.386$, $MSe = 10529$, $p < .05$.

TABLE 2. Mean Response Times (RT) and Error Rates: Experiment 1

Mean RT (ms) [sd] Error Rate (%)						
	HIGHLIGHT GROUP			NO HIGHLIGHT GROUP		
	Context					
Property Frequency	Neutral	Appr.	Inappr.	Neutral	Appr.	Inappr.
High	891 [180] 1.7	897 [198] 1.7	995 [237] 1.7	1006 [154] 1.0	942 [146] 1.0	1088 [193] 1.4
Low	1187 [276] 5.6	1054 [254] 2.7	1209 [274] 8.0	1314 [202] 8.0	1130 [209] 3.1	1325 [230] 11.5

Although the three-way interaction was not significant, it was considered important to compare verifications to high and low frequency properties for the two presentation formats separately so that a comparison of this experiment with Barsalou's experiment could be conducted. Tukey tests were used to compare the means of interest. Any difference between the means greater than 60.4 ms is significant at $p < .05$. The difference scores are presented in Table 3.

Similar to Barsalou's experiment, verification of high frequency properties after

TABLE 3. Difference Scores: Experiment 1

Difference Scores (Neutral Context - Context)				
	HIGHLIGHT GROUP		NO HIGHLIGHT GROUP	
	Context			
Property Frequency	Appr.	Inappr.	Appr.	Inappr.
High	-6	-104	64	-82
Low	133	-22	184	-11

appropriate contexts did not differ significantly (-6 ms) from those after a neutral context for the highlight group. In addition, verification of low frequency properties was significantly faster after appropriate contexts than after neutral contexts for the highlight group (133 ms). This pattern of results, which is illustrated in Figure 1, replicates Barsalou's findings which were used to support the FBH. In other words, with highlighting, the availability of high frequency properties was similar whether the context was appropriate or neutral, but low frequency properties were more readily available in appropriate contexts than in neutral contexts.

The effects of appropriate context were different, however, for the no highlight group. Verifications to high frequency properties were facilitated by appropriate contexts compared to neutral contexts by 64 ms. Verifications to low frequency properties were also facilitated by appropriate contexts compared to neutral contexts by 184 ms. These effects are illustrated in Figure 2. When the reading materials were presented in a more natural format, then, the effects of context on access to knowledge were different from when reading materials were presented in a less natural format. These results for the no highlight group suggest that access to both high and low frequency knowledge is dependent on context when the reading materials appear in a format resembling normal text. Thus, access to both high

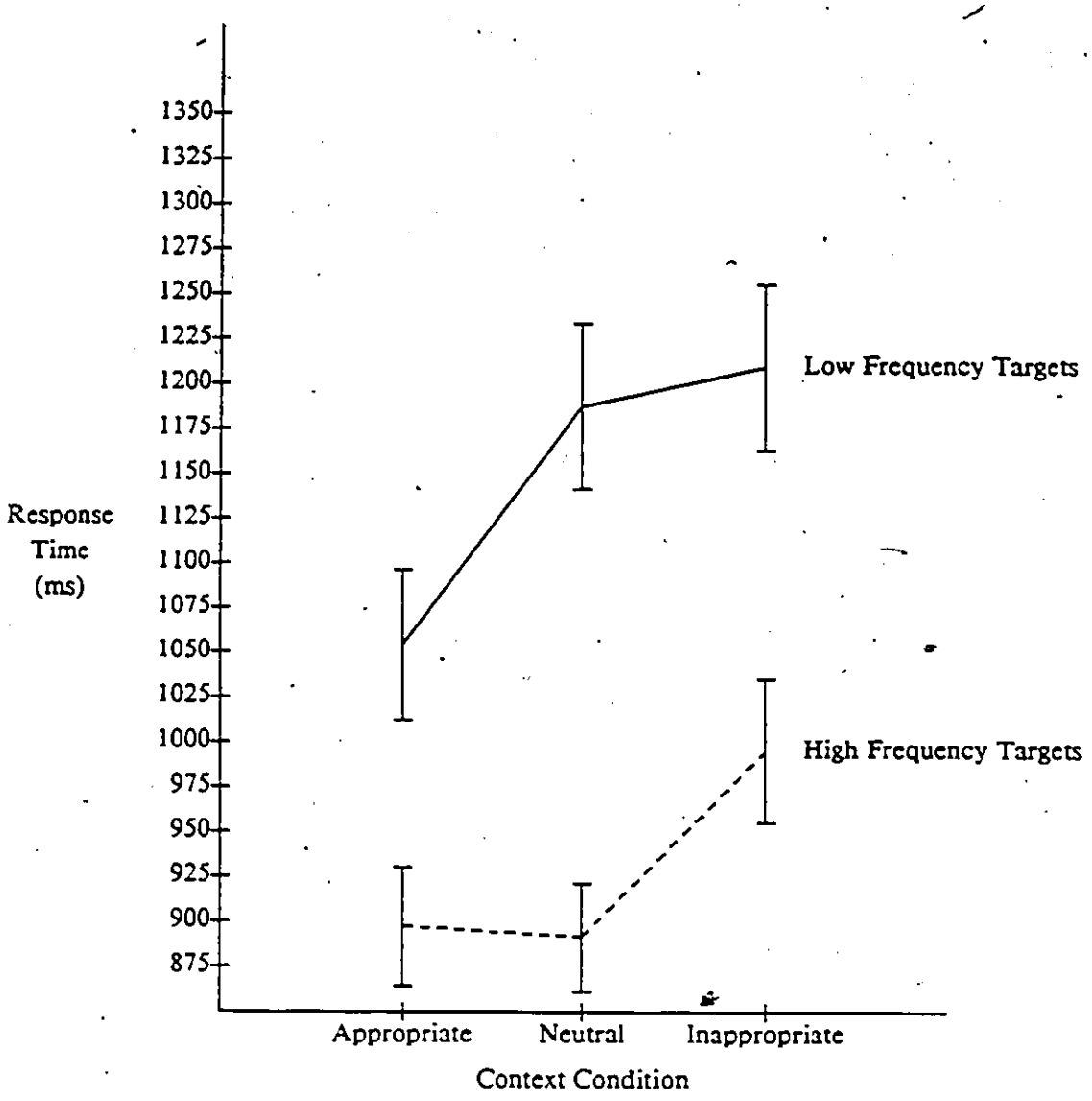

Figure 1. Response Time (milliseconds) as a function of Context for the Highlighted Format in Experiment 1.

and low frequency properties is similar in nature if not in degree. The combined results for the effects of appropriate contexts for the two presentation formats are in keeping with those expected by the alternative framework, but are inconsistent with the FBH.

The second set of results of interest are the effects of inappropriate context on access

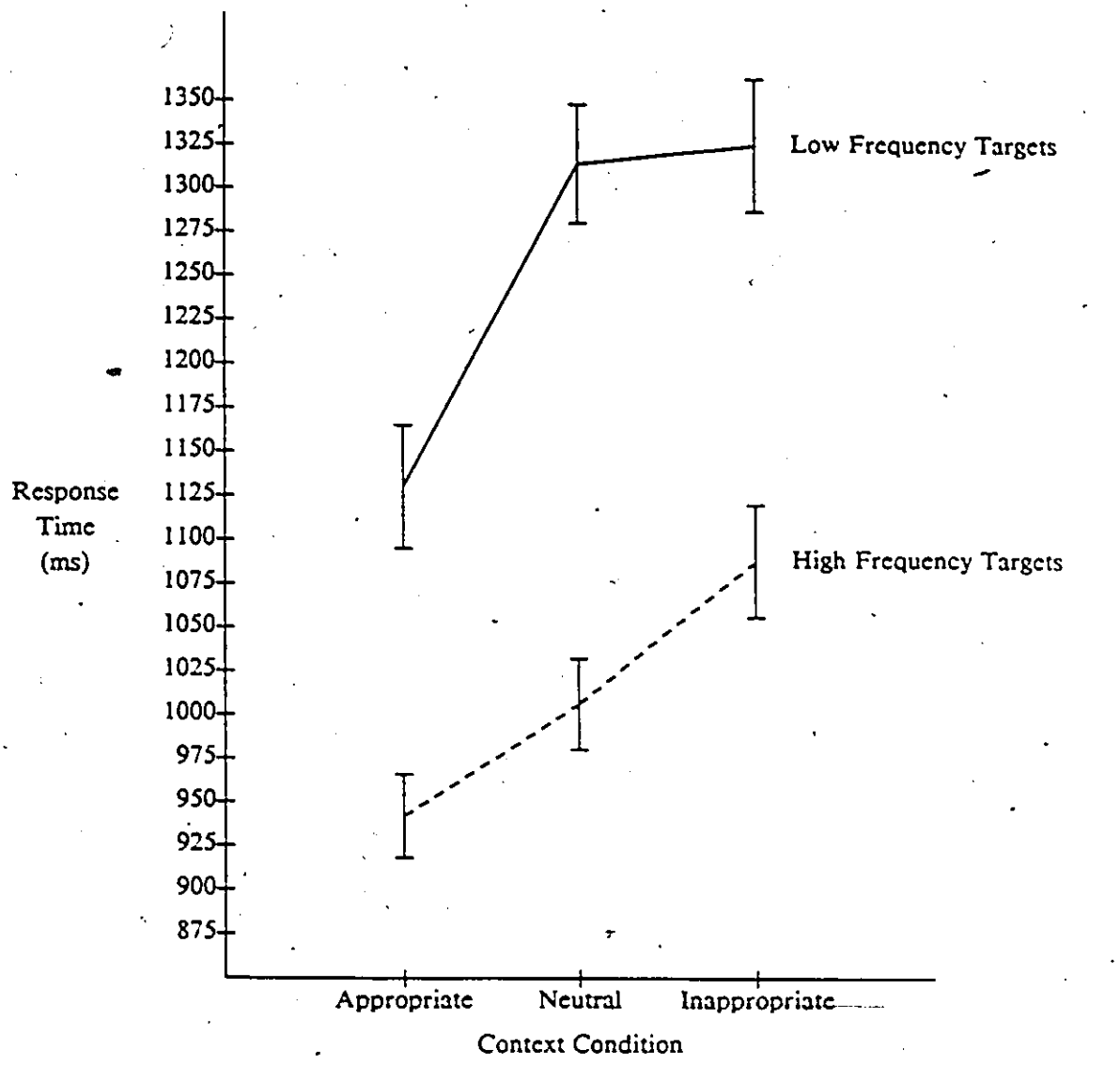

Figure 2. Response Time (milliseconds) as a function of Context for the No Highlight Format in Experiment 1.

to knowledge. Verifications to high frequency properties were slower after inappropriate context than after neutral context for both groups. Verifications after inappropriate context were 82 ms slower than verifications after neutral contexts for the highlight group, and 104 ms slower for the no highlight group. These effects are illustrated in Figures 1 and 2 respectively. Therefore, even when the noun in the context was made explicit, access to high frequency

properties was slowed to a similar extent as when the nouns were not highlighted.

These results do not support the strong form of the FBH which says that access to high frequency properties should be equally available in all contexts. These findings are consistent, however, with the idea that access to high frequency properties may be slowed if the context continues to emphasize a different property of the noun (Barsalou, 1982). The results for access to high frequency knowledge after inappropriate contexts, therefore, are consistent with the weaker form of the FBH, but they are also in keeping with the outcome expected by the alternative framework.

Verification of low frequency properties after inappropriate contexts did not differ significantly from access after neutral contexts for either group (-22 ms for the highlight group and -11 ms for the no highlight group). These effects are illustrated in Figures 1 and 2 respectively. These findings do not support the idea that the availability of low frequency properties should be negatively affected by inappropriate context as expected by the FBH. The results are consistent, however, with those expected by the alternate framework.

The results of this experiment, overall, are consistent with the idea that highlighting nouns in contexts is synonymous with drawing attention to those nouns. Consequently, the way those nouns are processed may differ from the way the nouns are processed when attention is not focused on them. The high frequency property which is instantiated by default in neutral contexts, therefore, may belong to the noun which the subject reads as the focus of the paragraph. When the noun is highlighted, the subject has no doubt as to what the focus of the paragraph is, but when no noun is highlighted the subject may or may not treat the tested noun as the focus of the paragraph. The neutral paragraph about zebras, for example, could be interpreted in several ways. One subject may interpret the paragraph by focusing on the fact that there were zebras in the corral rather than horses, in which case the property "stripes" might be instantiated. On the other hand, another subject might interpret

the paragraph by focusing on the fact that children get upset when animals are in captivity in a corral. The properties of zebras or any other noun in the paragraph which could be instantiated in this interpretation will be different from those instantiated in the first interpretation.

In summary, the effects obtained in the response time data are interpretable, for the most part, by assuming that high frequency properties of target nouns are instantiated in neutral contexts especially when those nouns are highlighted in the contexts. Therefore, the point is not that high frequency properties are readily available regardless of context and low frequency properties are not. Instead, contexts are interpreted by the reader, and contexts without any particular emphasis are often interpreted by instantiating the high frequency property of one of the nouns. This emphasis is very different from the idea that high frequency properties are automatically activated regardless of what property the context does or does not emphasize. Bransford and McCarrell (1974) succinctly capture the ideas presented above by arguing that semantic content is something that is created rather than something that is stored. The consequences of finding experimental support which is more consistent with the alternative framework than with the FBH are discussed later in the chapter.

True Trials - Errors. The error rates for each condition for each group are presented in Table 2. A 2x3x2 ANOVA was conducted on the number of errors per condition per subject. The first two factors, Property Frequency and Context Condition, were measured within-subjects, and the third factor, Presentation Format, was measured between-subjects. There was a main effect of Frequency, $F(1,70) = 62.92$, $MSe = .266$, $p < .001$ and a main effect of Context, $F(2,140) = 7.143$, $MSe = .302$, $p < .001$. These main effects were qualified by a Frequency by Context interaction, $F(2,140) = 6.778$, $MSe = .302$, $p < .001$. No other effects were significant.

So that the interaction could be further investigated, Tukey tests were used to compare several means. The differences compared were error rates (% errors) for the six conditions collapsed over group. The error rates being compared here, then, are simply the averages of the two groups for each condition. Any difference greater than 3.15% is significant at $p < .05$. Collapsed across group, the error rates for high frequency properties after neutral contexts was 1.5%, after appropriate contexts, 1.38%, and after inappropriate contexts, 1.56%. The error rates for the corresponding low frequency conditions were 6.75%, 3.31%, and 9.25% respectively. The error rates for high frequency items did not differ between conditions. The error rate for low frequency items after neutral contexts was significantly higher than the error rate after appropriate contexts (6.75% vs 3.31%), but did not differ significantly from the error rate after inappropriate contexts (6.75% vs 9.25%). This latter finding lends further support to the idea that neutral contexts are functionally similar to inappropriate contexts for verification of low frequency properties. The error rate for low frequency items after appropriate contexts did not differ from the error rates for high frequency items (3.5% vs 1.5%, 1.38% and 1.56%). This finding lends support to the idea that appropriate contexts are facilitory, and especially so for access to low frequency properties.

False Trials - Response Times. Table 4 shows the mean response times and error rates for false trials for each condition for each group. An analysis of variance with one between-subjects factor (Presentation Format - no highlight vs highlight), and one within-subjects factor (Context - neutral vs high frequency vs low frequency) was performed on the correct mean reaction time for each subject for each condition. There was a main effect of Presentation Format, $F(1,70) = 4.796$, $MSe = 131237$, $p < .03$, such that the response times were faster for the highlight group overall than for the no highlight group. There was also a main effect of Context, $F(2,140) = 3.034$, $MSe = 8636$, $p < .05$, but the interaction was not significant. The main effect of Context shows that although verifications after neutral and

TABLE 4. Mean Response Times (RT) and Error Rates for False Trials: Experiment 1

Mean RT (ms) [sd] Error Rate (%)					
HIGHLIGHT GROUP			NO HIGHLIGHT GROUP		
Context					
Neutral	High Freq.	Low Freq.	Neutral	High Freq.	Low Freq.
1191 [246] .69	1156 [229] 1.39	1186 [253] 1.56	1301 [208] 2.40	1264 [193] 1.39	1292 [200] 1.04

low frequency contexts were similar for both groups (1191 ms vs 1186 ms for the highlight group and 1301 ms vs 1292 ms for the no highlight group), verifications after high frequency contexts were faster than after neutral contexts for both groups (1191 ms vs 1156 ms for the highlight group and 1301 ms vs 1264 ms for the no highlight group).

A subject appears to be able to decide that a sentence is false more quickly if it is preceded by a context emphasizing a high frequency property of a noun as opposed to either no property or a low frequency property. Thinking of a high frequency property in the high frequency context may provide a powerful standard against which the false property can be compared and quickly rejected as being true. The low frequency context, however, may remind the subject that the noun has many possible properties, and, therefore, the subject may double check to make sure that the false property is not just some very low frequency property of the noun. This introduction of a degree of uncertainty in responding may act to increase verification time after low frequency contexts.

The puzzling finding, however, is that verifications after neutral and high frequency contexts for the highlight group are not equal. This finding is somewhat at odds with that expected by the alternative framework which proposes that the high frequency property of a highlighted noun is instantiated in a neutral context. A possible explanation for this

discrepancy is that most of the nouns used for the false trials were ones which either were not included in the norming study or were included in the norming study but for which no high frequency property was found. It is possible, therefore, that some of the nouns used in the false trials do not have high frequency properties which could be instantiated by default in neutral contexts. Therefore, making those nouns explicit in the context by highlighting them would have no effect. This possibility cannot be ruled out, as the target nouns in the false trials were not chosen by the same criteria as the nouns in the true trials.

General Conclusions. To summarize, the results from Experiment 1 lead to three conclusions. First, when the context materials are presented in a natural format (no highlight), the availability of both high and low frequency properties changes as a function of context. Appropriate contexts facilitate access to high and low frequency properties, suggesting that access to both types of properties is context-dependent. Access to high and low frequency properties of nouns, then, could be said to differ in degree but not in nature.

Second, when the nouns are made explicit in the context (highlight format), high frequency properties are equally available in both neutral and appropriate contexts. This finding suggests that under some circumstances, access to high frequency properties is context-independent. If it can be assumed that highlighting a noun in a context is analogous to a reader focusing attention on a particular noun in normal text, then this result has some psychological validity. The highlight condition may be similar to giving a story a title, for instance, "The Zebra" or to foregrounding a topic in a context. For example, when a writer is providing information about a topic, that topic may appear as the subject of most of the sentences or may be demarcated as being important in some other way. An author may communicate information about zebras, for instance, in the following manner: *The zebra is an animal that is in danger of becoming extinct. Zebras are hunted indiscriminantly in some countries. If nothing is done, the zebra does not have a promising future.* These are the cases in

which the high frequency property may be instantiated if the context does not explicitly suggest that a different property of zebras should be focused on. High frequency properties of nouns, then, may be instantiated in neutral contexts when the noun is clearly the topic of the discussion. This idea is similar, in some respects, to Minsky's (1975) frame theory and Schank and Abelson's (1977) notion of scripts. These authors suggest that, in the absence of evidence to the contrary, people fill in default values as they are reading.

The third important finding was that inappropriate contexts slowed access to high frequency properties regardless of the format those contexts were presented in, but that inappropriate contexts did not slow access to low frequency properties. It was found that the alternative framework could handle these results for both high and low frequency properties, but the FBH could not handle the results for the low frequency properties.

The results from the experiment as a whole were found to be best interpreted by adopting the alternative framework which suggests that neutral contexts are functionally similar to appropriate contexts for high frequency properties but functionally similar to inappropriate contexts for low frequency properties. This raises the question of whether the neutral context is the best baseline to use if its effects are, in fact, not neutral. Of course, it is important to note that the use of the neutral baseline in this experiment has permitted the delineation of the circumstances under which "context-independent" access to high frequency properties is accomplished. The results impose an important limitation on the generality of context-dependent access to knowledge. The results also have pragmatic consequences for models of the reading comprehension process. The formulation of these models will have to deal with the possibility that how knowledge is accessed also depends on global contextual factors, such as literary form.

The purpose of Experiment 2, in the next chapter, is twofold. First, the problems posed by the use of the neutral context baseline suggest that a different baseline condition be

used, and consequently, in Experiment 2, a no context baseline was employed. The no context baseline for high frequency conditions is simply the verification of the high frequency sentences, such as *Zebras have stripes*, with no prior context and the no context baseline for low frequency conditions is the verification of the low frequency sentences, such as *Zebras have hooves*, with no prior context. The effects of appropriate and inappropriate contexts can then be compared to the availability of that same high and low frequency knowledge in the absence of a biasing context. The second goal of Experiment 2 is to compare the availability of high and low frequency properties of nouns when different literary forms are used. The two presentation formats used in Experiment 1 may simulate how knowledge is accessed in different literary forms. Because access to knowledge was found to differ in the two presentation formats, it is important to explore the analogy by using the two different literary forms themselves. Experiment 2 uses the descriptive form called the recital and the story form called the narrative which was used in Experiment 1.

CHAPTER 4

Experiment 2 was designed to explore two issues. First, access to world knowledge after different types of context was compared to access to the same knowledge in the absence of a prior reading context in order to evaluate the FBH without the confounding effects associated with using the neutral context baseline. The only investigation of the FBH in which a no context baseline was used employed a lexical decision task (Greenspan, 1986, Experiment 3). In this experiment, the unrelated baseline condition yielded the same results as the no context baseline using the prompt "Please be ready to respond". The no context condition has not been used in the sentence verification studies, however, except of course, in the original semantic memory studies. In these studies, though, the only condition of interest was the no context condition because verification times were thought to reveal something about the structure of knowledge. The no context condition is also the baseline of preference over the unrelated baseline because unrelated contexts may be negative in their effects rather than neutral. The no context baseline avoids this complication precisely because no biasing context is presented prior to verification of the target sentence.

The second issue explored in Experiment 2 was how knowledge is accessed in two literary forms - the recital and the narrative. Recitals are contexts which have an informative purpose and which emphasize accuracy and details of facts (The Random House College Dictionary, Revised Edition, 1981). The operational definition of a recital context is that there is an obvious topic about which information is given. For example, a topic noun such as *zebras* is foregrounded in the context by appearing as the subject of each sentence. Examples can be found in Table 5 and the complete set of contexts is included in Appendix C. Narrative contexts are ones in which a story is told and nouns are embedded in sentences for the purpose of describing some event. The contexts used in Experiment 1 are narratives, and

these same paragraphs were used in Experiment 2 with the exception of the neutral contexts. In Experiment 2, however, none of the target nouns were highlighted in the contexts.

As discussed in Chapter 3, it is important to investigate access to knowledge in different literary forms, as these global contextual factors may be important determinants of how knowledge is accessed. Any account of accessing knowledge during reading would be incomplete if it did not take such factors into consideration. It should not be assumed, in other words, that effects obtained in one type of prose generalize to effects obtained in another type of prose, any more than it is safe to assume that effects obtained in some experimental paradigms generalize to effects obtained during reading of text. This study, then, explores access to knowledge after no context, appropriate context, and inappropriate context in two literary forms - the recital and the narrative.

According to the FBH, it is expected that access to high frequency knowledge should be similar in all three context conditions. It was demonstrated in Experiment 1, however, that access to high frequency knowledge after appropriate context was faster than after inappropriate context. Therefore, the question of interest, in this experiment, is whether high frequency properties are as accessible in the absence of context as they are after appropriate contexts. Verification of high frequency knowledge, then, might be expected to be similar after no context and after appropriate contexts. On the other hand, the FBH assumes that access to low frequency knowledge should be speeded by appropriate context compared to no context, and slowed by inappropriate context compared to no context. If access to high frequency knowledge was found to be facilitated by appropriate context, however, this would provide further evidence for the hypothesis that access to knowledge is largely context-dependent as was suggested by the results from Experiment 1. The question of interest would then become what the effects of inappropriate contexts are; that is, can an inappropriate context actually hinder access to knowledge compared to retrieving that knowledge in the

absence of a biasing context. A finding of this [redacted]ure would be interesting as several investigators have argued that inappropriate information does *not* interfere with processing (see Greenspan, 1986; and Reder, 1983).

The FBH itself does not address the possible differences in access to knowledge depending on literary form. The results from Experiment 1, however, suggest that there should be differences between access to knowledge in the two forms. In Experiment 1, the highlight group responded more quickly in all conditions compared to the no highlight group. This suggests that when the topic of the context is made explicit, information about that topic can be more readily accessed than when the topic is not made explicit. In Experiment 2, the recital form, itself, makes the topic explicit, but the narrative form does not. One possible effect of literary form, then, might be to make access to knowledge faster in the recital context conditions than in the corresponding narrative context conditions. In addition; if the recital and narrative groups are similar, except for the manipulation of literary form, they should take about the same amount of time to respond in the no context conditions which are identical for both groups.

Method

Design. The design for the true trials was 2 Literary Forms (recital and narrative) by 2 Property Frequencies (high and low) by 3 Context Conditions (none, appropriate and inappropriate), with between-subjects measures on the first factor and within-subjects measures on the second and third factors. There were 8 observations for each subject for each condition. There were equal numbers of true and false no context trials (16), and an equal number of true and false context trials (32). The true and false no context trials were presented before the context trials for all subjects[1]. Hence, there were two blocks of trials in

this experiment, a no context block or phase, and a context block or phase. The false trials were divided into two logical classes, No Context false trials and Context false trials. Because the materials for false trials were not counterbalanced across context conditions, any findings from the false trials must be interpreted with caution.

Materials. For the "true" target sentences, the same pairs of high and low frequency sentences used in Experiment 1 were also used here. The 48 pairs of sentences were divided into 6 lists of 8 pairs each. These 6 lists were cycled through the 6 experimental conditions so that each topic noun was represented an equal number of times in each of the six conditions. Any one subject, therefore, received a particular topic noun in only one condition.

The paragraphs differed for the recital and narrative forms. The recital contexts each contained two sentences where the topic noun was the subject of each sentence. Each sentence described a fact about the topic noun. Examples of these paragraphs can be found in Table 5 and the full set is included in Appendix C. The narrative paragraphs were the same as those used in Experiment 1 and were presented in the no highlight format.

A set of 16 false sentences which contained different nouns from the 48 pairs of true sentences were used in the No Context phase of the experiment. The same 16 false sentences were presented to all subjects. An additional set of 32 false sentences which contained different nouns from those in the 16 false sentences used in the No Context phase were presented in the Context phase. The nouns in these 32 sentences matched the topic nouns in a set of 32 paragraphs used for the false trials in the Context phase of the experiment. Some of the paragraphs for the false trials emphasized a high frequency property of a noun and others emphasized a low frequency property of a noun. There was a set of 32 recital paragraphs for

1. Pilot studies demonstrated that it made no difference to the pattern of results whether the no context trials were presented before the context trials or vice versa.

TABLE 5. Conditions and Sample Materials for Experiment 2 (Recital Contexts)

	Context		
Frequency of Association between Noun and its Property	None	Appropriate	Inappropriate
HIGH Zebras have stripes		Zebras have striking, contrasting fur which sets them apart from other animals. Zebras, with their alternating black and white fur, are valued for their pelts.	The zebra is similar ... etc
LOW Zebras have hooves		The zebra is similar to the horse in most of its leg and foot structure. The zebra's feet are hard and thick enabling the animal to trot over most terrain.	Zebras have striking ... etc

the false trials and a set of 32 narrative paragraphs. None of the 32 false context trials had the same topic as any of the 48 pairs of true sentences. The same 32 false sentences were presented to all subjects and half of the subjects received recital contexts on their false trials while the other half received narrative contexts on their false trials. The false trials for the no context and context conditions are included in Appendices A and C respectively.

Procedure. The experiment was run on an Apple IIe computer and subjects were tested individually. They were given a set of 14 practice sentences to verify, followed by a block of No Context trials, and then a block of Context trials. After the Context trials subjects were told what mistakes they had made and were asked to classify their errors according to the same categories used in Experiment 1. The instructions given to the subjects

were the same as those given to the no highlight group in Experiment 1.

Subjects. Seventy-two subjects participated in this experiment for credit in an undergraduate psychology course. Thirty-six subjects were randomly assigned to the recital condition and 36 subjects were assigned to the narrative condition.

Results and Discussion

True Trials - Response Times. A 2x2x3 ANOVA was carried out on correct mean reaction times for the conditions for the true trials, comparing two Literary Forms (recital vs narrative), by two types of Property Frequency (high vs low) and three types of Context (none, appropriate and inappropriate). The means for the six conditions for each group appear in Table 6, along with the error rates. A main effect of frequency was obtained, $F(1,70) = 485.586$, $MSe = 11009$, $p < .001$, as well as a main effect of Context, $F(2,140) = 96.651$, $MSe = 15590$, $p < .001$. These effects were qualified by a Frequency by Context interaction, $F(2,140) = 23.019$, $MSe = 7910$, $p < .001$ and a Literary Form by Context interaction, $F(2,140) = 3.352$, $MSe = 15590$, $p < .05$. No other effects were significant.

To further investigate the Frequency by Context interaction, Tukey tests were used to compare several means. Any difference greater than 43 ms is significant at $p < .05$. The means per condition were collapsed across Literary Form and difference scores were derived from these means. The difference scores collapsed across Literary Form are presented in Table 7. The difference scores not collapsed across Literary Form are given in Table 8 for comparison. There was a significant facilitory effect of appropriate context on access to high frequency properties (133 ms) as well as for low frequency properties (239 ms). The facilitation effect for low frequency properties, however, was much larger than for high frequency properties. This result provides a replication of a similar finding in Experiment 1,

with the added advantage that the no context baseline is free from the confounding effects of the neutral context baseline. These results suggest that there is a functional distinction between high and low frequency properties. The distinction, however, is not that high and low frequency properties differ in whether access to them is affected by context or not. Instead, the distinction involves the extent to which access to the two types of property is affected by context. Verifications to high and low frequency properties after inappropriate contexts, however, did not differ from their respective baseline condition (35 ms and 5 ms respectively). These results, then, provide no support for the assumption of the FBH that access to high frequency properties is different in kind from access to low frequency properties.

TABLE 6. Mean Response Times (RT) and Error Rates: Experiment 2

Mean RT (ms) [sd] Error Rate (%)						
	RECITAL GROUP			NARRATIVE GROUP		
	Context					
Property Frequency	None	Appr.	Inappr.	None	Appr.	Inappr.
High	1105 [173] 3.5	954 [169] 1.4	1041 [200] 1.4	1147 [199] 3.7	1031 [230] 1.4	1141 [227] 2.4
Low	1366 [212] 9.7	1080 [184] 3.8	1323 [233] 19.1	1381 [206] 10.8	1189 [225] 5.2	1415 [286] 16.6

The Literary Form by Context interaction was explored further by using Tukey tests to compare several means. Any difference greater than 60 ms is significant at $p < .05$. For this analysis, the means per condition were collapsed across Frequency. The difference scores for the means collapsed across Frequency are presented in Table 9. There was a significant facilitory effect of appropriate context for the recital group (219 ms) as well as for the narrative group (154 ms). The effect was larger, however, for the recital group than for the

TABLE 7. Difference Scores: Experiment 2 - Collapsed Across Literary Form

Difference Scores (No Context - Context)		
	Context	
Property Frequency	Appropriate	Inappropriate
High	133	35
Low	239	5

TABLE 8. Difference Scores: Experiment 2

Difference Scores (No Context - Context)				
	RECITAL GROUP		NARRATIVE GROUP	
	Context			
Property Frequency	Appr.	Inappr.	Appr.	Inappr.
High	151	64	116	6
Low	290	43	192	-34

narrative group. This result provides support for the idea that the more explicit the topic noun is, the larger the facilitory effects of appropriate context will be.

There was a marginally significant facilitory effect of inappropriate context for the recital group (54 ms, $p < .10$)[2]. Verification after inappropriate context and no context did not differ for the narrative group, however (-14 ms). In addition, Table 8 shows that these results hold across property frequency. For the recital group, for example, verification of high

2. A similar trend was obtained in a series of pilot studies, suggesting that this effect is reliable. The effect could be explored further by providing a stronger manipulation of literary form, perhaps by providing a title (eg. The Zebra) along with the recital context.

frequency properties was 64 ms faster after inappropriate context than after no context. Likewise, verification of low frequency properties was 43 ms faster after inappropriate context than after no context. For the narrative group, however, verification of high frequency properties was only 6 ms faster after inappropriate context than after no context, and verification of low frequency properties was 34 ms slower after inappropriate context than after no context.

TABLE 9. Difference Scores: Experiment 2 - Collapsed Across Property Frequency

Difference Scores (No Context - Context)		
	Context	
Literary Form	Appropriate	Inappropriate
Recital	219	54
Narrative	154	-14

A possible explanation for the tentative difference between access to knowledge after inappropriate contexts in the two literary forms is also related to how subjects may use contexts in which the topic is explicit versus contexts in which the topic is not explicit. For recital contexts, the target noun is clearly the topic of the paragraph. This means that even when the property tested does not match the property emphasized in the context, the noun in that test sentence will still match the context. Therefore, the inappropriate recital context will be inappropriate in terms of the property tested, but not in terms of the noun tested. The test sentence, then, might be perceived as being related to or congruent with the context in some way. For narrative contexts, however, the target noun is embedded with other nouns in a story. The topic of the paragraph, in this case, may be the event described by the context rather than one of the nouns in that context. Therefore, when the test sentence does not match the property emphasized in the context, the sentence may be perceived as being totally

unrelated to or incongruent with the theme in the story. These proposals are only speculative, however, as more research is needed to confirm the marginally significant finding that inappropriate recital contexts have different effects on access to knowledge than inappropriate narrative contexts.

It should also be noted that the general differences between recital and narrative literary forms, which were proposed in the introduction to the experiment, were confirmed. Collapsed across Frequency, the differences between the no context conditions for the two literary forms was only 28 ms (1236 ms for the recital group vs 1264 ms for the narrative group). The differences between the appropriate context conditions and the inappropriate context conditions for the two groups, however, were significant. The recital group were 93 ms faster than the narrative group at verifying sentences after appropriate contexts (1017 ms for the recital group vs 1110 ms for the narrative group), and were 96 ms faster at verifying sentences after inappropriate contexts (1182 ms for the recital group vs 1278 ms for the narrative group). Making the topic of a reading context explicit, then, allows the reader to access knowledge about that topic more quickly than if the topic of the reading context is embedded in a story.

One explanation for these effects is that the facilitory effect for appropriate recital contexts comes from two sources, appropriate contextual emphasis and the special way in which the topic noun is processed. If these two sources are additive, then appropriate recital contexts should be more facilitory than appropriate narrative contexts. Because the topic is not singled out in the appropriate narrative contexts, facilitation may come only from the appropriate contextual emphasis and not from any special processing that the target noun receives. This explanation is similar to the one given in Chapter 2 for the results of Greenspan's lexical decision experiment.

From the subject's point of view, recitals and narratives may differ in the way in which these different literary forms are used. For example, the recital is used to communicate facts about a topic but the narrative is used to communicate a story. In the former, the reader's ability to identify the topic may be crucial to deriving information, but in the latter, it may not be necessary to identify a topic in order to understand the gist of the story. Therefore, understanding how a reader uses different literary forms may be important both to understanding how knowledge is used during reading and also to how knowledge is gained through reading. This issue is discussed in more detail in Chapter 6.

True Trials - Errors. The error rates for each condition for each literary form are presented in Table 6. A 2 (Literary Form - recital vs narrative) x 2 (Property Frequency - high vs low) x 3 (Context Condition - none, appropriate, inappropriate) ANOVA was carried out on the number of errors per subject per condition. The analysis yielded a main effect of Frequency, $F(1,70) = 105.7$, $MSe = .473$, $p < .001$, and a main effect of Context, $F(2,140) = 22.563$, $MSe = .481$, $p < .001$. These effects were qualified by a Frequency by Context interaction, $F(2,140) = 19.235$, $MSe = .540$, $p < .001$. No other effects were significant.

In order to further investigate the interaction, Tukey tests were used to compare several means. The differences reported are between mean error rates collapsed across Literary Form. Any difference greater than 4.44% is significant at $p < .05$. The error rates collapsed across Literary Form for high frequency sentences are 3.5% for no context, 1.56% for appropriate context, and 1.88% for inappropriate context. The corresponding error rates for low frequency sentences are 10.06%, 4.56% and 17.86% respectively. The error rates for high frequency sentences did not differ from one another, nor did the error rate for low frequency properties after appropriate context differ from any of the error rates for high frequency items. The error rate for low frequency sentences with no context was significantly higher than for the same items after appropriate context (10.06% vs 4.56%), and the error rate

for low frequency sentences after inappropriate context was significantly higher than for the same items with no context (17.86% vs 10.06%).

These results suggest that appropriate contexts facilitate access but inappropriate contexts interfere with access to low frequency knowledge. The facilitory effects of appropriate context are consistent with the response time data, but the hindering effects of inappropriate context are not. Because the response times for the no context and inappropriate context conditions are similar for low frequency sentences, but the error rates are not similar, it is possible that subjects made speed-accuracy trade-offs. The presence of speed-accuracy trade-offs make results of experiments difficult to interpret because response times must be analyzed with respect to errors. In order to investigate this issue, supplementary analyses were conducted in which response times and errors were analysed with respect to one another[3].

Supplementary Analyses - Response Times and Errors. Similar patterns of results where the response times for two conditions are equal but the error rates are not have been found in other studies (see Reder, 1983). One interpretation of such a pattern is to say that comprehension can be facilitated by appropriate context but that it cannot be disrupted by inappropriate context. A similar argument could be made for the results of Experiment 2, that is, appropriate context facilitates access to world knowledge but inappropriate context does not hinder access. This interpretation of the results is only valid, however, if subjects did not make speed-accuracy trade-offs.

Because speed-accuracy trade-offs are best interpreted in terms of an incorrect

3. Speed-accuracy trade-offs were not a problem in interpreting the results from Experiment 1. First, the error rates for low frequency items in neutral vs inappropriate context conditions did not differ statistically. Second, a similar error groups analysis which was performed on the data from Experiment 1 failed to reveal speed-accuracy trade-offs in the response times.

response being made before enough evidence has accrued to produce a correct response (Wickelgren, 1981), error reaction times in the inappropriate context condition should be faster than the correct reaction times (see Pachella, 1974). This was the case for the low frequency conditions, suggesting that subjects did make speed-accuracy trade-offs. For the recital group, the mean correct response time for low frequency properties after inappropriate context was 1328 ms, but the mean error reaction time was 1255 ms. For the narrative group, the corresponding mean correct reaction time was 1415 ms., and the mean error reaction time was 1245 ms. The same was not true for the no context low frequency conditions in either group. In both groups, the mean correct response time and mean error response time for the no context conditions were similar. For the recital group, the mean correct response time was 1366 ms and the error response time was 1364 ms. For the narrative group, the mean correct response time was 1381 ms and the error response time was 1399 ms.

Because the pattern of results presented above suggest that subject did make speed-accuracy trade-offs to low frequency properties after inappropriate contexts, the issue was explored by dividing the subjects within each literary form into two groups each. For the recital group, subjects who made two or fewer errors (0 to 2.1% errors) over the course of the whole experiment were assigned to a low error group. There were 9 subjects in this group. Subjects who made six or more errors overall (6.3% to 9.4% errors) were assigned to a high error group. There were 8 subjects in this group. For the narrative group, there were 13 subjects in each error group. In the low error group, the errors ranged from 0% to 2.1% and in the high error group, the errors ranged from 6.3% to 20%. Only one subject had an overall error rate of 20%. Without this subject, the error rate for the high error group ranged from 6.3% to 10%.

An ANOVA with two between-subjects factors (Literary Form and Error Group) and with repeated measures on the within-groups factors of Property Frequency and Context

TABLE 10a. Mean Response Times (RT) Experiment 2: Recital Contexts - Error Groups

Mean RT (ms) [sd]						
	LOW ERROR GROUP			HIGH ERROR GROUP		
	Context					
Property Frequency	None	Appr.	Inappr.	None	Appr.	Inappr.
High	1083 [174]	1034 [216]	1123 [253]	1069 [167]	966 [126]	1009 [145]
Low	1371 [279]	1113 [221]	1410 [221]	1354 [142]	1059 [115]	1258 [177]

was performed on the correct mean response times. The times for each condition for each error group for recital contexts are presented in Table 10a. The corresponding response times for narrative contexts are presented in Table 10b. The analysis yielded main effects of Frequency, Context, and a Frequency by Context interaction similar to the general analysis for Experiment 2. In addition, there was an Error Group by Context interaction, $F(2,78) = 3.65$, $MSe = 12212$, $p < .01$.

TABLE 10b. Mean Response Times (RT) Experiment 2: Narrative Contexts - Error Groups

Mean RT (ms) [sd]						
	LOW ERROR GROUP			HIGH ERROR GROUP		
	Context					
Property Frequency	None	Appr.	Inappr.	None	Appr.	Inappr.
High	1170 [223]	1087 [242]	1200 [233]	1117 [234]	1002 [253]	1084 [259]
Low	1389 [196]	1220 [207]	1541 [317]	1348 [246]	1167 [228]	1347 [253]

Tukey tests were used to investigate the Error Group by Context interaction. Any difference greater than 101 ms is significant at $p < .05$. This interaction is illustrated by Figure 3. Collapsing over Property Frequency and Literary Form, one finds that the baselines

are similar for both high and low error groups (1222 ms vs 1253 ms respectively). The 65 ms difference between the appropriate context conditions for high and low error groups is not significant (1048 ms vs 1113 ms respectively). The 143 ms difference between the inappropriate context conditions for high and low error groups, however, is significant (1175 ms vs 1318 ms respectively). These results suggest that the subjects who are more accurate are slowed by inappropriate context compared to the less accurate subjects, but the speed-accuracy strategy adopted does not affect performance in the no context and appropriate context conditions.

Although the four-way interaction was not significant, it is informative to look at the effects of inappropriate context on access to properties of different frequencies in the different literary forms. This is important in order to fully evaluate the boundaries of the FBH. For example, it may be more difficult to slow access to high frequency properties than it is to slow access to low frequency properties even though there may be circumstances under which both will be interfered with. Tables 11a and 11b show the difference scores for the two error groups for each literary form. These difference scores are interesting because they do suggest that access to low frequency properties may be more easily hindered than can access to high frequency properties. For the subjects in the recital group who made few errors, there were small negative effects of inappropriate context on access to both high and low frequency properties (-40 and -39 ms respectively). For the narrative group, there was a small negative effect of inappropriate context on access to high frequency properties for the accurate subjects (-33 ms), but a large negative effect on access to low frequency properties for these same subjects (-152 ms). Thus, for the accurate responders in the recital group, the negative effects of inappropriate context on access to both high and low frequency knowledge were relatively small. For the accurate responders in the narrative group, the negative effect of inappropriate context on access to high frequency knowledge was also small, but the negative

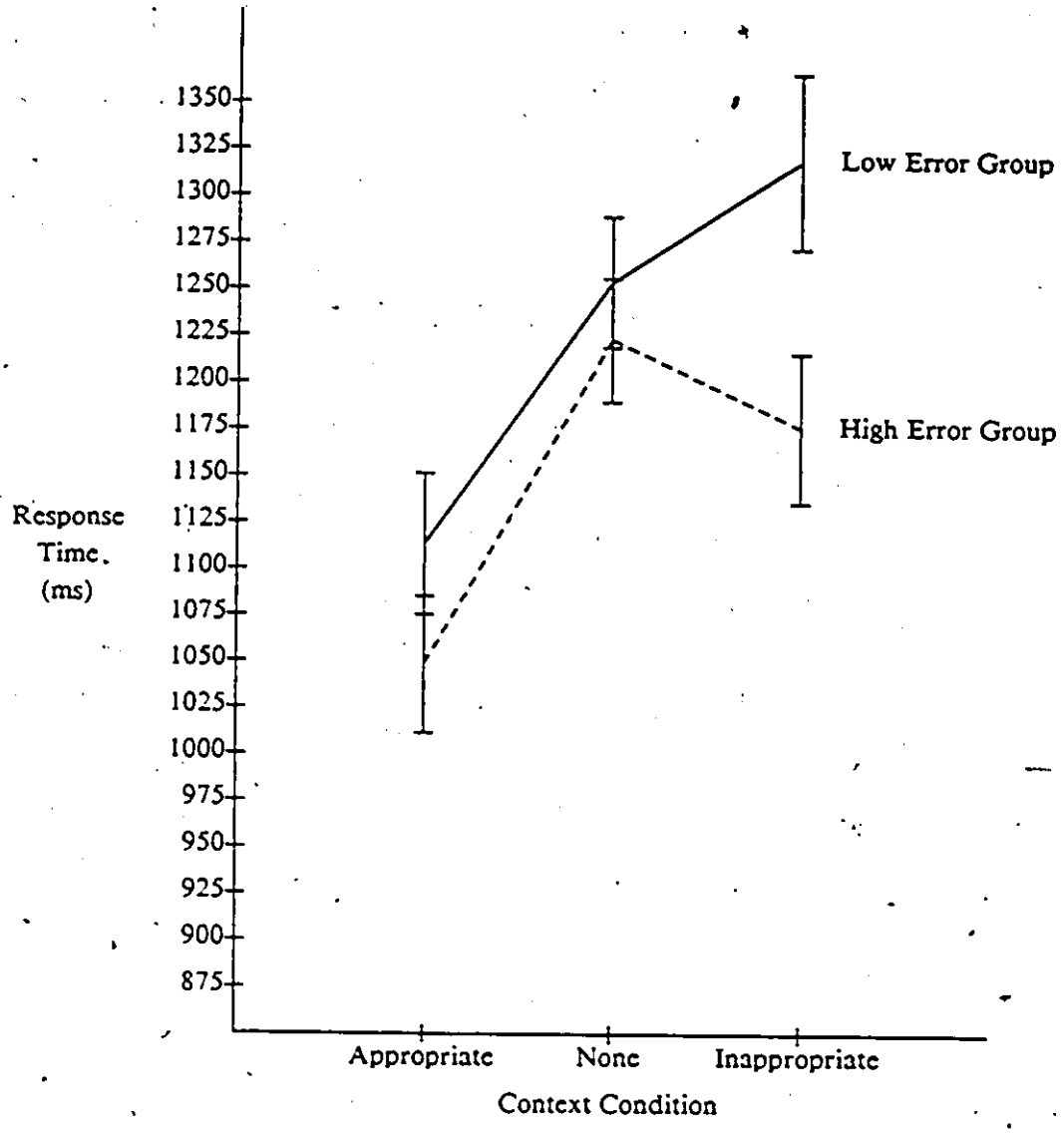

Figure 3. Response Time (milliseconds) as a function of Context for the High and Low Error Groups in Experiment 2.

effect on access to low frequency properties was large.

The perspective one gets from comparing the size of the effects for high versus low frequency properties compared to their respective baselines suggests that the distinction between the two types of property may be useful in determining whether or not access to high

TABLE 11a. Difference Scores: Experiment 2 - Error Groups for Recital Contexts

Difference Scores (No Context - Context)				
	LOW ERROR GROUP		HIGH ERROR GROUP	
	Context			
Property Frequency	Appr.	Inappr.	Appr.	Inappr.
High	49	-40	103	60
Low	258	-39	295	96

TABLE 11b. Difference Scores: Experiment 2 - Error Groups for Narrative Contexts

Difference Scores (No Context - Context)				
	LOW ERROR GROUP		HIGH ERROR GROUP	
	Context			
Property Frequency	Appr.	Inappr.	Appr.	Inappr.
High	86	-30	115	33
Low	169	-152	181	1

versus low frequency knowledge can be hindered. In other words, access to high frequency properties may be slowed to a small extent by inappropriate recital and narrative contexts, but access to low frequency properties may be hindered a great deal by inappropriate narrative contexts, if not by inappropriate recital contexts. As relatively few subjects were in each error group, especially for the recital contexts, these ideas are merely suggestive.

One way to experimentally test these hypotheses, however, is to compare results from experiments using different speed-accuracy instructions for responding. Results from a deadline procedure in which subjects must respond within a certain time limit could be compared to results from a procedure in which accuracy is stressed. If access to

unemphasized low frequency properties is slowed more than access to unemphasized high frequency properties, the following pattern should be obtained. In the deadline procedure, access to unemphasized high and low frequency properties should not be slowed, although there may be many errors on low frequency items. Under accuracy instructions, access to unemphasized high frequency properties might be slower than access after no context, but access to umemphasized low frequency properties should be much slower than access after no context. If the differences in the effects of inappropriate context between the two literary forms are reliable, then these same differences should be obtained in this procedure.

False Trials - Response Times. The mean response times and error rates for the false trials for the two literary forms are given in Table 12. A 2 (Literary Form - recital vs narrative) x 2 (Context Condition - none vs context) ANOVA was carried out on the correct mean response times per subject per condition. There was a main effect of Context, $F(1,70) = 118.1$, $MSe = 11195$, $p < .001$, which was qualified by a Literary Form by Context interaction, $F(1,70) = 5.90$, $MSe = 11195$, $p < .05$. No other effects were significant.

TABLE 12. Mean Response Times (RT) and Error Rates for False Trials: Experiment 2

Mean RT (ms) [sd] Error Rate (%)			
RECITAL GROUP		NARRATIVE GROUP	
Context			
No Context	Context	No Context	Context
1369 [228] 3.47	1135 [181] 1.13	1402 [228] 5.2	1253 [222] 2.0

In order to investigate the interaction, Tukey tests were used to compare several means. Any difference greater than 66 ms is significant at $p < .05$. The response times for false trials after context were shorter for both groups compared to no context. There was a

234 ms facilitory effect of context for the recital group and a 149 ms facilitory effect for the narrative group. The facilitory effect of context, however, was greater for the recital group than for the narrative group. This parallels the findings for response times on "true" trials in which facilitory effects of recital contexts were greater than the facilitory effects of narrative contexts.

These results suggest that a context provides a standard against which a false sentence can be evaluated and rejected relatively quickly. No Context false trials may take longer to judge because the subject extends processing to make sure that the false property is really not just a very low frequency property of the noun in the sentence. This conclusion must be treated with caution, however, as the materials for the false trials were not counterbalanced across conditions. Further, the results suggest that the effects of literary form are similar for both true and false decisions. The explicitness of the topic in recital contexts seems to allow for both faster "true" verifications after appropriate context and for faster "false" verifications after a context. The error rates for false trials did not differ between literary form or context condition. These error rates for false trials are included in Table 12.

General Conclusions. In summary, five major conclusions can be drawn from the results of Experiment 2. First, access to both high and low frequency properties is facilitated by appropriate context. Second, appropriate contexts facilitate access to low frequency properties relatively more than they facilitate access to high frequency properties. Third, appropriate recital contexts produce larger facilitation effects than do appropriate narrative contexts. This was explained by suggesting that recital contexts make the topic of the context explicit and when the topic or target noun is explicit, it is processed differently than when it is not explicit. Foss (1982) suggests that as long as the topic in a context remains in working memory, knowledge about that topic is rapidly accessible during reading. It is possible that the recital context keeps the topic in working memory over the course of a reading encounter.

Fourth, inappropriate recital contexts may, on average, slightly facilitate access to unemphasized properties but inappropriate narrative contexts, on average, appear to neither facilitate nor hinder access to unemphasized properties. Foss' (1982) ideas are also relevant here. In recital contexts, the topic may be kept active over the course of reading but in the narrative contexts, because the topic is not so explicit, it may not be kept active in the same way. Therefore, one might speculate that unemphasized information is more easily accessed in recital contexts than it is in narrative contexts. Finally, despite the difference in the number of errors that high and low error groups made, the effects of appropriate context remained stable. The strategy a subject adopted did, however, affect access to knowledge after inappropriate contexts. The suggestion was made, though, that inappropriate contexts might not affect access to high frequency knowledge as much as they affect access to low frequency knowledge. Importantly, it was demonstrated that inappropriate contexts can hinder access to low frequency knowledge in two measurable ways. If a subject adopts a strategy in which accuracy is important, inappropriate contexts slow the speed with which low frequency knowledge can be accessed. If a subject adopts a strategy which emphasizes speed rather than accuracy, inappropriate contexts reduce the probability that accurate access to low frequency properties will be achieved. Attention to the strategies of individual subjects, then, can yield alternate explanations which would be missed by attending only to data which are averaged across subjects. An averaged result allows one to draw general conclusions, but a more careful analysis of the data of individuals can sometimes reveal that different subjects approach the experimental task differently. In turn, the strategies they adopt in approaching the task can affect the researcher's interpretation of how knowledge is accessed during reading.

The issue explored in Experiment 3 was derived from the concern that there are several aspects of the verification task which differ from the normal reading situation. One of

the differences between the two is the degree of overall congruency that the reader experiences. The question of interest in Experiment 3, then, was what the effects of increasing the degree of congruency in the verification task would be. Specifically, do the effects of context on access to knowledge change as the experimental paradigm begins to more closely resemble the normal reading situation?

CHAPTER 5

...there are clever design features in our processing mechanisms (eg. activation threshold) so that inappropriate information rarely interferes.
Reder, 1983, p.201.

The standard sentence verification paradigm differs from the normal reading process in a number of ways. One difference between this paradigm and the normal reading situation is the overall degree of congruency. In most sentence verification experiments, the proportion of trials in which the target sentence matches the emphasis in the context is less than the proportion of trials in which the target sentence is inappropriate to what is emphasized by the context. This occurs because all "false" target sentences do not match the context, and up to half the "true" target sentences are not consistent with what the context emphasizes. Normal text does not have this same high degree of incongruity. It is important, then, to see whether the effects of context on access to knowledge, where incongruity is prevalent, generalize to the normal reading situation where congruity is predominant.

Studies from two different literatures lend support to the idea that the degree of congruency used in experimental materials has important consequences. Studies from the story grammar literature show that children and adults have trouble comprehending stories in which the normal event structure is violated (Hinchley & Levy, 1987; Thorndyke, 1977). When propositions in a narrative are scrambled, congruency is decreased. These scrambled stories, which violate the hypothesized structure of good stories, take longer to read and are poorly remembered.

Similarly, in letter recognition experiments (Posner & Snyder, 1975b) and word recognition experiments (Tweedy, Lapinski & Schaveneveldt, 1977) increasing the proportion of congruent trials led to faster processing on those congruent trials and slower processing on

the incongruent trials. In the letter recognition tasks, for example, subjects were required to identify a target letter following the presentation of a context letter. The context letter and target letter could match either 80% of the time or only 20% of the time. When 20% of the targets matched the context, there was some facilitation on congruent or matching trials, and processing on incongruent or mismatching trials was not slowed. When 80% of the targets matched the context, however, there was even more facilitation on congruent trials and some slowing on incongruent trials.

The results from letter and word recognition experiments, coupled with the observations from the story grammar literature, demonstrate that different effects are obtained when the degree of congruency in the materials in an experiment is manipulated. These findings suggest that the effects of context on access to knowledge in the sentence verification paradigm might also depend on overall degree of congruency. If readers normally assume that what they read is congruent (deGroot et. al., 1982), then it is important to determine whether the results obtained in paradigms where congruency is minimal generalize to situations where congruency is the norm.

Experiment 3 was designed to explore the idea that access to knowledge during reading might differ as more trials become congruent - a situation closer to the constraints of normal text. In the experiment 25% of the context trials were congruent for half the subjects (25% congruency group) and 50% of the context trials were congruent for the other subjects (50% congruency group). All subjects were tested on sentences after no context, appropriate context, and inappropriate context. The narrative contexts were used.

The findings from the letter and word recognition experiments suggest a larger facilitory effect of appropriate context for the 50% congruency group compared to the 25% congrueny group, and a negative effect of inappropriate context for the 50% congruency group but not for the 25% congruency group. The suggestion made in the discussion of Experiment

2, however, was that although access to high frequency properties can be facilitated by appropriate context, access to these properties may not be hindered by context. If this is correct, then the congruency manipulation should make no difference to the effects of inappropriate context on verifications to high frequency properties, but should affect verifications made to low frequency properties after inappropriate contexts. The effect of degree of congruency on access to low frequency properties after inappropriate context, however, is difficult to predict because of possible speed-accuracy trade-offs. It is conceivable that access to low frequency properties will be inhibited to a greater extent for the 50% congruency group compared to the 25% congruency group. These negative effects could be revealed by an increased error rate or in longer response times.

Experiment 3 also permits the evaluation of an additional hypothesis. Each congruency group was further divided into two groups. Half of each group received high frequency sentences on their "true" trials and the other half received low frequency sentences. This design affords a strong test of the idea that appropriate contexts speed access to low frequency knowledge to a greater extent than they speed access to high frequency knowledge. If this functional distinction between the two types of property is robust, it should occur even though different subjects verified the different types of property across differing degrees of congruency.

Method

Design. The term "critical trials" is used to refer to the 48 high frequency sentences which were identical for both congruency groups and to the 48 low frequency sentences which were identical for their respective congruency groups. There were two levels of Contextual Congruency manipulated between subjects so that there was a 50% congruency

group and a 25% congruency group. There were 2 types of Property Frequency also tested between subjects and nested within each congruency group. Thus there was a 50% congruency group who received high frequency targets, a 50% congruency group who received low frequency targets, a 25% congruency group who received high frequency targets and a 25% congruency group who received low frequency targets. Each of these four groups verified sentences in three context conditions - no context, appropriate context, and inappropriate context. Therefore, the design of this experiment was a 2 Congruency (25% and 50%) x 2 Property Frequency (high and low) x 3 Context (none, appropriate, inappropriate) design where the first two factors were tested between-subjects and where the third factor was tested within-subjects. The trials were blocked so that all of the no context trials were presented before the context trials. Estimates of correct response time for each cell were based on the means for a possible 16 measures per subject per condition. These 16 measures for each condition were based on the "critical trials" which were the same for subjects across congruency group.

Although the critical trials were identical for the 25% and 50% congruency groups, the different degrees of congruency were obtained by using different filler trials for the two groups. For the 50% congruency group, 8 additional "true" sentences were used as filler trials in the no context phase, and an additional 16 appropriate context trials were used as filler trials in the context phase. These subjects also received 8 "false" sentences in the no context phase and 16 "false" trials in the context phase. Thus 50% of the context trials for these subjects were congruent, but three-quarters of their trials were true and one-quarter were false. For the 25% congruency group, 16 "false" sentences were presented in the no context phase and 32 "false" trials were presented in the context phase. No "true" fillers were used. Thus, 25% of the context trials for these subjects were congruent, but half their trials were true and half were false.

Materials. The target sentence and context materials for the 25% congruency groups were the same as the materials used in Experiment 3 for the narrative group. The only difference was that half of the 25% congruency group verified the high frequency sentences, and the other half verified the low frequency sentences. The 48 pairs of target sentences were divided into three lists of 16 pairs each. These three lists were cycled through the three context conditions with half of the group receiving the high frequency members of each pair, and the other half receiving the low frequency members of each pair. Thus the 48 high and low frequency sentences appeared an equal number of times in each context condition. In this way, the high and low frequency materials were counterbalanced across the subjects within each frequency subgroup, so that no target sentence was repeated for any one subject. The no context false trials and the context false trials were identical to those used for the narrative group in Experiment 2.

The materials for the 50% congruency groups differed in one way from those for the 25% congruency groups. Half of the no context false trials were made "true" by changing the property in those sentences and half the false context trials were made "true" by changing the property of the target sentence so that it matched the emphasis in the context. These additional "true" trials were used as fillers in order to make more of the context trials congruent. The filler trials contained sentences from a range of frequencies. The filler trials were identical for the subjects who verified the 48 critical high frequency sentences and for the subjects who verified the 48 critical low frequency sentences.

Procedure. The procedure for this experiment was identical to that of Experiment 2.

Subjects. Ninety-six subjects participated in the experiment for credit in an undergraduate psychology course. Twenty-four subjects were randomly assigned to each of the four groups.

Results and Discussion

True Trials - Response Times. Table 13 presents the mean response times for each condition for each group. A 2 (Congruency - 25% vs 50%) x 2 (Property Frequency - high vs low) x 3 (Context Condition - none, appropriate, inappropriate) ANOVA was carried out on the mean correct response time per subject per condition. There was a main effect of Frequency, $F(1,92) = 7.609$, $MSe = 110376$, $p < .01$, and a main effect of Context, $F(2,184) = 125.017$, $MSe = 8633$, $p < .001$. These effects were qualified by a Frequency by Context interaction, $F(2,184) = 8.786$, $MSe = 8633$, $p < .001$, and a Congruency by Context interaction, $F(2,184) = 4.207$, $MSe = 8633$, $p < .05$. No other effects were significant.

TABLE 13. Mean Response Times (RT) and Error Rates: Experiment 3

Mean RT (ms) [sd] Error Rate (%)						
	25% CONGRUENCY GROUP			50% CONGRUENCY GROUP		
	Context					
Property Frequency	None	Appr.	Inappr.	None	Appr.	Inappr.
High	1123 [192] 2.7	993 [161] 1.8	1106 [193] 4.5	1090 [205] 3.3	977 [222] 1.3	1154 [247] 4.2
Low	1237 [204] 6.5	1022 [180] 1.6	1235 [201] 15.4	1254 [217] 10.4	1034 [184] 2.1	1311 [251] 10.9

The difference scores for each group are given in Table 14. The interactions were further investigated using Tukey tests to compare several means. Any difference greater than 54 ms is significant at $p < .05$. The Frequency by Context interaction was explored by collapsing the response times across congruency group. This interaction is illustrated by Figure 4. Collapsed across Congruency, the mean response time for high frequency properties was 1107 ms after no context, 985 ms after appropriate context, and 1130 ms after

TABLE 14. Difference Scores: Experiment 3

Difference Scores (No Context - Context)				
	25% CONGRUENCY GROUP		50% CONGRUENCY GROUP	
	Context			
Property Frequency	Appr.	Inappr.	Appr.	Inappr.
High	130	17	113	-64
Low	215	2	220	-57

inappropriate context. The corresponding mean response times for low frequency properties were 1245 ms., 1028 ms, and 1273 ms. Comparing no context and appropriate context, one finds that appropriate context sped verification of high frequency properties by 122 ms and of low frequency properties by 217 ms. Averaged across congruency, the small negative effects of inappropriate context are not significant for high or low frequency properties (-23 ms and -28 ms respectively).

Thus appropriate context affects access to low frequency properties to a greater degree than it affects access to high frequency properties. This relationship between the two types of property is a robust one, as it occurs when different subjects make decisions to the different types of property, and regardless of the overall degree of contextual congruency. This is demonstrated by referring to Table 14 where the facilitation effect for high frequency properties is 130 ms for the 25% Congruency Group and 113 ms for the 50% Congruency Group, and where the facilitation effect for low frequency properties is 215 ms for the 25% Congruency Group and 220 ms for the 50% Congruency Group.

Another interesting finding from this experiment is that verification of low frequency properties after appropriate contexts is significantly faster than verification of high frequency properties after no context (1028 ms vs 1107 ms). Of even greater importance, however, is the

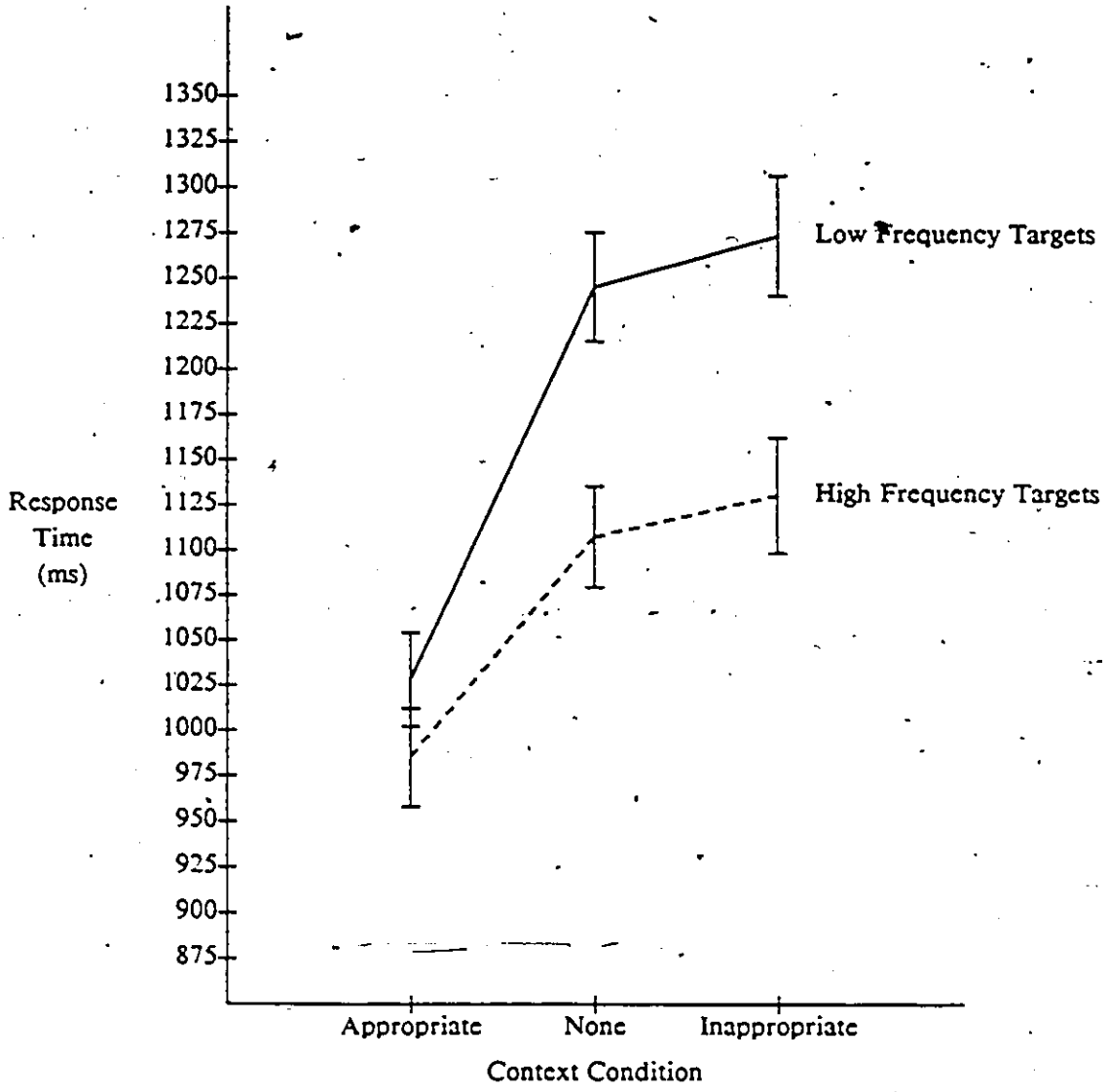

Figure 4. Response Time (milliseconds) as a function of Context collapsed across degree of congruency in Experiment 3.

fact that verification of low frequency properties after appropriate contexts does not differ statistically from verification of high frequency properties after appropriate contexts (1028 ms vs 985 ms). These findings indicate that in some circumstances (ie. when the items in an experiment are high or low frequency targets), low frequency knowledge can be verified as quickly as high frequency knowledge under the same conditions. It should be noted that the

subjects who received low frequency properties were not merely faster responders than those subjects who received high frequency properties given that the no context baseline for the high frequency properties (1107 ms) was significantly faster than the no context baseline for the low frequency properties (1245 ms). Any model of human knowledge representation that has static representation and fixed retrieval paths would have a difficult time accounting for this pattern of results.

The Congruency by Context interaction addressed the issue of whether increasing overall congruency affects access to knowledge. This interaction is illustrated in Figure 5. Collapsing across Property Frequency, the mean response time for the 25% congruency group for verifications was 1180 ms after no context, 1008 ms after appropriate context, and 1171 ms after inappropriate context. For the 50% congruency group, the corresponding response times were 1172 ms, 1005 ms, and 1232 ms. Again, any difference greater than 54 ms is significant at $p < .05$. First, the effect of appropriate context was similar for both groups. There was 172 ms facilitation for appropriate context for the 25% congruency group and a 167 ms facilitation effect for the 50% congruency group. This finding suggests that, unlike the letter and word recognition experiments, an increase in congruency is not accompanied by an increase in facilitation. The effect of inappropriate context, however, *was* dependent on congruency. There was an overall 9 ms facilitation effect of inappropriate context for the 25% congruency group but a significant -60 ms negative effect for the 50% congruency group. This result is consistent with the findings from the letter and word recognition studies. Possible reasons for why the effects of inappropriate context, but not the effects of appropriate context, match those obtained in the letter and word recognition studies are discussed later in the chapter.

The data show that the congruency manipulation made no difference to responses made to targets after no context. The response time to targets after no context was 1180 ms

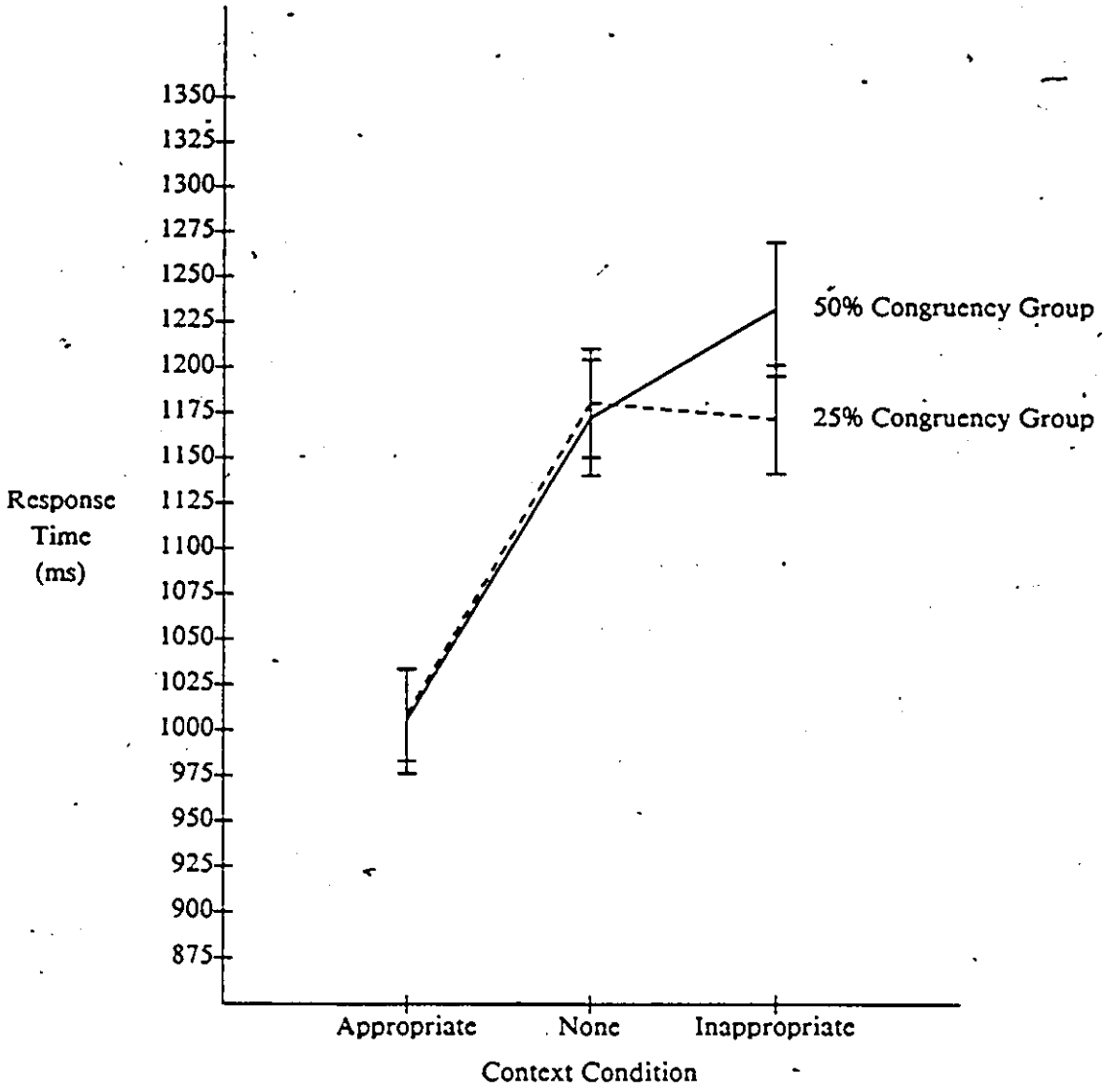

Figure 5. Response Time (milliseconds) as a function of Context collapsed across Property Frequency in Experiment 3.

for the 25% congruency group, and 1172 ms for the 50% congruency group. The congruency manipulation also made no difference to responses made to targets after appropriate context. The response time to targets after appropriate context was 1008 ms for the 25% congruency group and 1005 ms for the 50% congruency group. The effect of congruency, then, lies totally in the way in which knowledge after inappropriate context is accessed.

Even when the effects are examined for each type of property frequency, as shown in Table 14, the conclusions do not change. The facilitory effects of appropriate context for high frequency properties are similar for both degrees of congruency as are the effects for low frequency properties. Congruency affects only verifications after inappropriate context whether they are verifications made to high or low frequency properties. When 25% of the trials were congruent, there was a 17 ms facilitation effect for high frequency properties and a 2 ms facilitation effect for low frequency properties after inappropriate context. When 50% of the trials were congruent, however, it took 64 ms longer to verify high frequency properties, and 57 ms longer to verify low frequency properties after inappropriate context compared to no context.

An unreported study in which 63% of the context trials were congruent provides additional support for the results reported here. In this study, 18 subjects were tested using high frequency properties. The facilitation effect for appropriate context was 128 ms, which is similar in size to the corresponding effects for the 25% congruency group (130 ms) and the 50% congruency group (113 ms). The negative effect of inappropriate context in this experiment, however, was -59 ms, similar to the corresponding effect for the 50% congruency group (-64 ms).

The results presented above are not consistent with the idea that access to high frequency properties cannot be hindered. Access to high frequency properties appears to be slowed when the overall degree of contextual congruency is increased. In addition, the following analyses of errors demonstrate that an increase in congruency seems to affect access to high and low frequency properties after inappropriate context in a similar manner and to about the same extent.

True Trials - Errors. The error rates for each condition for each congruency and frequency group are presented in Table 13. A 2 (Congruency - 25% vs 50%) x 2 (Frequency -

high vs low) x 3 (Context Condition - none, appropriate, inappropriate) ANOVA was carried out on the errors per subject per condition. There was a main effect of Frequency, $F(1,92) = 37.03$, $MSe = 1.014$, $p < .001$, and a main effect of Context, $F(2,184) = 30.931$, $MSe = .943$, $p < .001$. These effects were qualified by a Congruency by Context interaction, $F(2,184) = 3.987$, $MSe = .943$, $p < .05$, and a Frequency by Context interaction, $F(2,184) = 13.192$, $MSe = .943$, $p < .001$. The three-way interaction was marginal, $F(2, 184) = 2.684$, $p = .069$.

The Frequency by Context interaction was investigated by collapsing error rate across Congruency. Collapsed across Congruency, the error rates for high frequency sentences were 3.66% for no context, 1.97% for appropriate context and 4.31% for inappropriate context. The corresponding error rates for low frequency sentences were 8.47%, 1.8% and 13.16% respectively. Tukey tests were used to compare several means. Any difference greater than 3.53% is significant at $p < .05$. Similar to Experiment 2, the error rates in the high frequency conditions are lower than those in the low frequency conditions overall, and do not differ statistically from one another (3.66% vs 1.97% vs 4.31%). The error rate for low frequency targets after appropriate context also did not differ from the error rates in any high frequency condition (1.8% vs 3.66%, 1.97%, and 4.31%). Also similar to Experiment 2, was the finding that the error rate for low frequency targets with no context was significantly higher than after an appropriate context (8.47% vs 1.8%) but significantly lower than the error rate after inappropriate context (8.47% vs 13.16%).

In order to further investigate the Congruency by Context interaction, the error rates were collapsed across Property Frequency. Collapsed across Property Frequency, the error rates for the 25% congruency group were 4.8% for no context, 2.34% after appropriate context, and 9.9% after inappropriate context. The error rates for the 50% congruency group for the same conditions were 7.3% , 1.44% and 7.56% respectively. Tukey tests were used to compare several means. Any difference greater than 3.53% is significant at $p < .05$. For the

25% congruency group, the error rates for no context and appropriate context did not differ statistically (4.8% vs 2.4%) but the error rate for inappropriate context was significantly higher than the error rate for no context (9.9% vs 4.8%). For the 50% congruency group, however, the error rates for no context and inappropriate context did not differ (7.3% vs 7.56%) but both were significantly higher than the error rate for appropriate context (7.3% and 7.56% vs 1.44%).

Because the three-way interaction was marginal, it is informative to compare the error rates for the two congruency groups with respect to property frequency. As Table 13 and Figure 6 illustrate, in the 25% congruency group, there is the usual pattern of higher error rates for low frequency targets after inappropriate contexts than after no context (15.38% vs 6.5%). This general pattern, however, is in contrast to that found for the 50% congruency group. For this group, the error rate for low frequency targets after no context and after inappropriate context are the same (10.44% vs 10.94%). This was the only case in which the error rate for low frequency targets was not higher after inappropriate context than after no context. In addition, the change in the pattern of error rates to low frequency items for the 50% congruency group appears to be due to the lowering of the error rate in the inappropriate condition and not to an increase in errors in the no context condition. It should be noted, in this regard, that the 6.5% error rate for low frequency items after no context in the 25% congruency group is uncharacteristically low in comparison to the results from Experiment 2 and in comparison to the results from pilot studies similar in nature to Experiment 2.

The findings from the error analyses in combination with the response time data demonstrate that an increase in congruency led to an increase in response times to low frequency properties as well as to a decrease in errors after inappropriate context. An explanation for this pattern of results is presented later in the chapter.

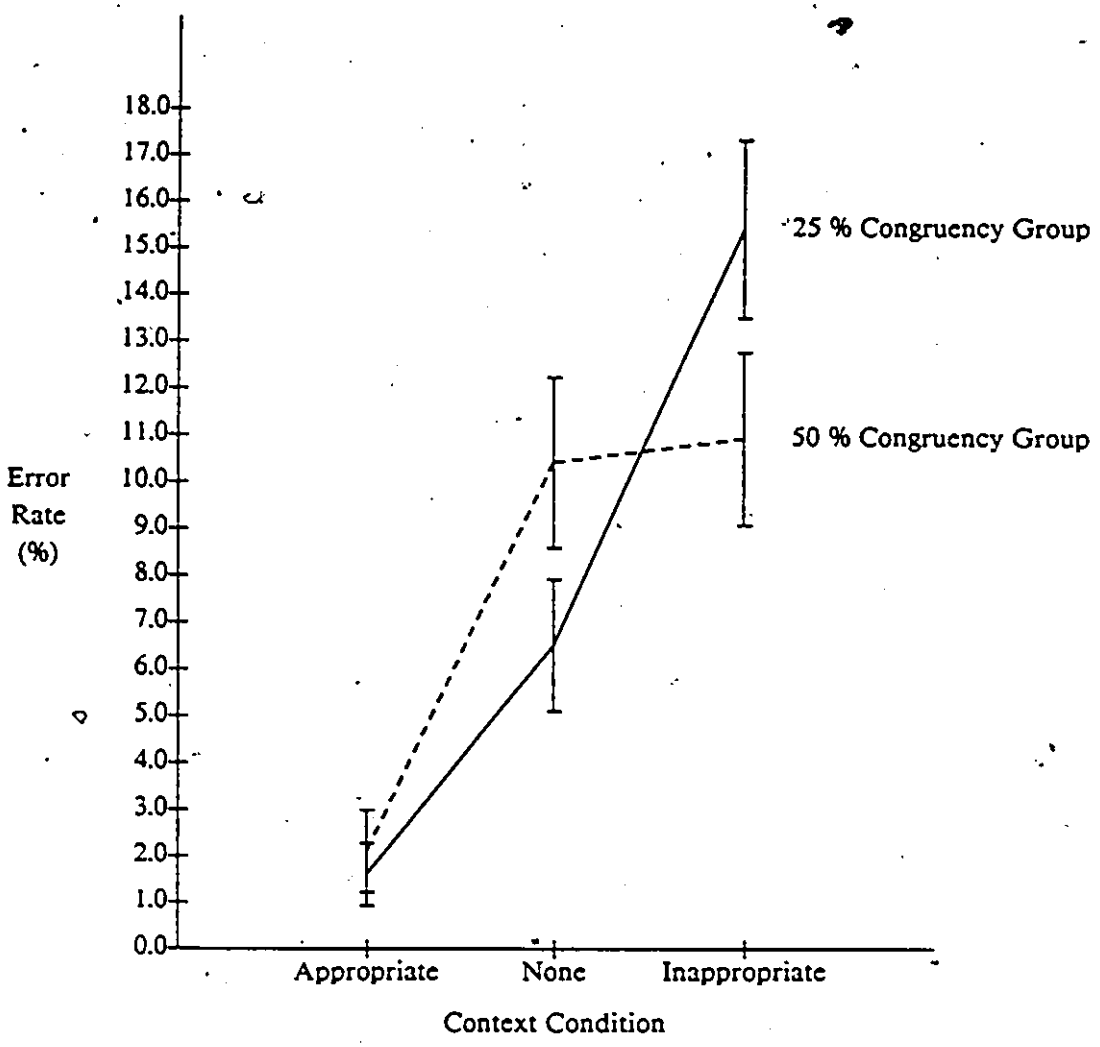

Figure 6. Error rate as a function of Context for low frequency targets in Experiment 3.

False Trials - Response Times. The false trials for only the 25% congruency groups will be briefly discussed. The false trials for the 50% congruency groups will not be discussed because these trials were a subset of those used for the 25% congruency group. Thus these trials were neither counterbalanced across condition nor with respect to the larger set used for the 25% congruency group. Statistical analyses are not provided for the response times reported below. The mean response times are simply given so that the pattern of responding

can be compared with the pattern obtained in Experiment 2 with the same materials for false trials. Both 25% congruency groups received the same false trials and the same trials as the narrative group in Experiment 2. Thus the results for the two 25% congruency groups should be similar to one another and to the narrative group in Experiment 2. The results show that this was the case. For the subjects who received mostly high frequency targets, the mean response times to false sentences with no context and after context were 1416 ms and 1248 ms respectively. For the subjects who received mostly low frequency targets, the mean response times to false sentences with no context and after context were 1356 and 1162 ms respectively. In both cases, context speeded verifications to false sentences to a similar degree. These findings are also consistent with those from Experiment 2.

General Conclusions The results of Experiment 3 lead to three major conclusions. First, the effects of appropriate context seem to be stable in nature and magnitude despite changes in overall congruency. Second, the effects of inappropriate context seem to be variable, hindering access as overall congruency increases. Third, the larger facilitory effect of appropriate context for access to low frequency knowledge is stable across different groups of subjects and different response speeds.

The fact that the effects of appropriate context are stable for access to both high and low frequency properties regardless of congruency is important. First of all, it suggests that the results one obtains when using pairs of letters and pairs of words may not generalize to the case in which more natural reading materials are used. In these experiments (Posner & Snyder, 1975b; and Tweedy et. al., 1977), increasing the congruency between the letter or word context and the succeeding letter or word target led to increases in facilitation. This was not the case, however, for Experiment 3, in which text materials were used. The possibility exists, of course, that an even higher degree of congruency could produce larger facilitory effects of appropriate context. In the experiment mentioned previously where 63% of the

context trials were congruent, however, facilitory effects of appropriate context were similar to those found in Experiment 3. The different results obtained in different experimental paradigms suggests that if one wants to find out about the processes which operate in reading comprehension, one must use tasks and materials appropriate to tapping into these processes. Some aspects of reading may be similar to those obtained in single word paradigms, but others are certainly not.

The second important aspect of the data for appropriate contexts has to do with the stability of these effects. The results from the error groups analyses in Experiment 2, along with the results from Experiment 3, demonstrate that the effects of appropriate context are not determined by a subject's strategy or by manipulations of overall congruency. The stability in these results across experiments, subjects' strategies, and manipulations in task variables, may tell us something about the role of congruency in reading comprehension. de Groot et. al. (1982) suggest that, by default, readers assume that reading material is congruent. Thus, comprehension may proceed in a relatively automatic fashion as long as the reading material is congruous. Comprehension is facilitated to the extent that what is read is consistent with what was previously read.

The use of the word "automatic" here is not meant to imply that the reader is unaware of what he is reading or that reading comprehension requires no attention. Instead, the word is meant to imply that fluent reading comprehension may result from extensive practice with congruous reading material, so that congruity becomes the default assumption. Support for the idea that congruency may be a default assumption comes from reports subjects gave after each experiment. At the end of each experimental session, subjects were asked whether they thought any of the contexts helped or hindered their decisions. Most subjects said that the contexts did not help them but some hindered them. This, of course, is despite the experimenter's choice of baseline from which appropriate contexts were assumed to be

facilitory.

This general view of congruency also has important implications for the role of incongruency in reading. As the level of congruency in the experimental materials increased, so did the negative effects of inappropriate context. This sort of result suggests that incongruity could serve an important function in reading. Incongruity may be rare enough, that when it does occur, it is noticed. The idea here is that more attention may be directed towards material which is incongruous with what was read previously. The data from Experiment 3 are consistent with this view. For high frequency knowledge, processing after inappropriate contexts was slowed, and for low frequency knowledge, processing was slowed and was more accurate. In other words, paying more attention to something can slow processing, and for low frequency properties can slow processing to the point where errors are less likely to be made. Because readers expect congruity, they may slow processing on incongruous material in an attempt to connect it meaningfully to previous text. Dooling and Christiaansen (1975) report that when a subject is instructed to congruently process text, that is, when their attention is drawn to integrate each sentence with the preceding sentence, reading times increase. This finding suggests that fluent readers may not intentionally process for congruity, but when attention is required to integrate incongruous material, they will read more slowly. Attending to incongruity may have important consequences for gaining knowledge through reading. This issue will be more fully discussed in Chapter 6.

The third major conclusion derived from Experiment 3 is that access to low frequency knowledge is facilitated relatively more by appropriate context than is access to high frequency knowledge. This relationship between two types of knowledge proved to be robust across several experiments and conditions within each experiment. First, the relationship endured even though different subjects verified high versus low frequency knowledge. Second, the relationship persisted even though subjects responded more quickly

when the lists had high or low frequency targets as in Experiment 3 compared to when property frequency was mixed as it was in Experiment 2. This difference between high and low frequency knowledge, then, is not a spurious one, but is reliable in a variety of circumstances. Thus, the distinction between the two types of world knowledge to which the FBH originally drew our attention, is an important one to make. The functional consequence of this distinction, then, might be that quick access to high frequency knowledge may not be as dependent on context as is quick access to low frequency knowledge. There is no evidence in this experiment, however, to suggest that the availability of high frequency properties is not affected by context at all.

Finally, it should be noted that the results of Experiment 3 need to be replicated before strong claims about the function of congruency and incongruency in reading comprehension can be made. The ideal way to do this is to vary congruency but not response bias. This could be accomplished by simply changing the filler trials in the 50% and 25% congruency groups. For the 50% congruency group, the target sentences on the filler trials would all be congruent with the context. For the 25% congruency group, the target sentences on the same filler trials would all be incongruent with the emphasis in the context. A similar pattern of results from this sort of experiment would suggest that the results obtained in Experiment 3 are reliable and due to manipulations in degree of congruency itself.

The following chapter presents a summary of the experimental data and attempts to evaluate the data with respect to the three original hypotheses of access to knowledge discussed in the introduction. Special attention is paid to how the data obtained in all three experiments constrain considerations of the way in which world knowledge is accessed during reading. Finally, directions for research which follow from the views presented in the thesis are discussed.

CHAPTER 6

> *In reading, when I come upon an unfamiliar word or phrase I have a sensation of derailment. Some process that usually flows along smoothly has been interrupted. Some expected click of my mechanism has failed to occur. It has always seemed to be the principal task of psychology to discover the nature of this click.*
>
> *(Brown, 1958, p. 82)*

The research presented in the thesis has addressed two major issues. First, the experiments provided an evaluation of the three hypotheses characterizing access to knowledge during reading - the context-independent hypothesis, the context-dependent hypothesis, and the FBH. Second, each experiment demonstrated that the methodology used to study access to knowledge influences the interpretation given to experimental findings. Section A in this chapter presents a summary of the data pertaining to the first issue, and section B presents a summary of the experimental evidence pertinent to the second issue. Section C discusses the relevance of the findings for future research in reading comprehension.

A. AN EVALUATION OF THE THREE HYPOTHESES

All three experiments provided evidence for the hypothesis that access to knowledge during reading is context-dependent. Experiment 1 showed that when reading materials are presented in a natural format (no highlight) access to both high and low frequency knowledge is facilitated by appropriate context compared to when the context is neutral. The facilitory nature of appropriate contexts was found to be reliable in Experiments 2 and 3 when access to knowledge after appropriate contexts was compared to access to the same information when no context was provided. These results are similar to those reported by Tabossi and Johnson-Laird (1980) even though they did not control for property frequency. The only exception to

the general pattern of results discussed above was found in Experiment 1 where access to high frequency knowledge was similar after neutral and appropriate contexts but only when the target nouns in the contexts were highlighted or made explicit. This finding replicates results obtained in an experiment by Barsalou (1982) in which the target nouns were underlined in the contexts. It was suggested that the high frequency property of a highlighted noun may be instantiated by default in neutral contexts. This issue is discussed in greater detail in Section B.

Although appropriate contexts facilitated access to both high and low frequency knowledge, the degree to which appropriate contexts were facilitory differed for the two types of knowledge. All of the experiments revealed that appropriate contexts facilitated access to low frequency knowledge to a relatively greater extent than they facilitated access to high frequency knowledge. This was a robust finding which proved to be stable across different literary forms, changes in subjects' strategies, manipulations in overall congruency, and variations in speed of responding. The distinction between access to different types of knowledge, then, may be a quantitative one rather than a qualitative one. In other words, both types of knowledge are context-sensitive, but rapid access to low frequency knowledge may be more dependent on appropriate context than is rapid access to high frequency knowledge. This point of view is in contrast to the FBH which assumes that access to high frequency knowledge differs in nature from access to low frequency knowledge, that is, high frequency knowledge is readily available independent of context, but low frequency knowledge is readily available only in appropriate context.

The only factor which influenced the magnitude of the facilitory effect of appropriate context was literary form. Appropriate recitals were more facilitory than appropriate narratives. Although literary form affected the overall amount of facilitation, it did not influence the differential effect of appropriate context on access to high versus low frequency

knowledge. Access to both high and low frequency knowledge, then, is largely context-dependent as both types of world knowledge can be more quickly accessed in appropriate contexts.

The effects of inappropriate context on access to knowledge are more variable than the effects of appropriate contexts. In Experiment 1, inappropriate contexts appeared to slow access to high frequency knowledge. It was suggested that this effect was obtained because neutral contexts tend to be functionally similar to the appropriate contexts for high frequency items. This statement also implies that neutral contexts are functionally similar to the inappropriate contexts for low frequency items. The data were consistent with this inference as access to low frequency knowledge after neutral and inappropriate contexts was similar. Tabossi and Johnson-Laird (1980) also found that inappropriate contexts slowed access to knowledge compared to neutral contexts. This may suggest that a number of items they tested were actually high frequency properties of nouns.

In Experiments 2 and 3, the effects of inappropriate context were found to vary with changes in subjects' strategies and with manipulations of a task variable such as degree of overall congruency. In Experiment 2 it was noted that the error rates for low frequency items in the inappropriate context condition were much higher than the error rates for the same items in the no context condition, suggesting that subjects made speed-accuracy trade-offs. When the response times for accurate subjects and less accurate subjects were compared, it was found that the more accurate subjects were slowed by inappropriate contexts to a greater extent than were the less accurate subjects. Inappropriate contexts, then, can impede access to low frequency knowledge either by slowing down access or by lowering the probability that accurate access will be achieved before a response is made. It was also noted, in Experiment 2, that inappropriate context did not impede access to high frequency knowledge to as great an extent as it interfered with access to low frequency knowledge. Experiment 3, however,

demonstrated that access to both high and low frequency knowledge could be slowed to a similar extent by inappropriate context when the number of congruent context trials was increased to more closely resemble the degree of congruency experienced in normal reading situations. This issue in discussed further in section B.

In conclusion, access to both high and low frequency knowledge can be facilitated and slowed by context. The effects of appropriate contexts are stable and facilitory. On the other hand, the effects of inappropriate context are variable. Inappropriate contexts may slow access, may have no effect on access, and, in the case of recital contexts, may sometimes even slightly facilitate access. All the evidence presented in this section, then, can be taken as support for the context-dependent hypothesis of access to knowledge during reading.

B. THE IMPORTANCE OF METHODOLOGY IN THE INTERPRETATION OF EXPERIMENTAL FINDINGS

The persistent theme that runs through both the review of the literature in Chapter 2 and the research presented in Chapters 3, 4, and 5 is that methodological variables are very important in determining the interpretation of experimental results. The materials used, the manner in which these materials are presented, and the way in which subjects are tested, all have important consequences for interpreting the results of the experiments one conducts. This issue can be explored at three different levels. The first has to do with the extent to which the findings from Stroop, lexical decision, and cued recall studies generalize to the reading comprehension process. The second level is related to how the conditions under which reading materials are presented in the verification paradigm affects the way in which that material is processed. The third level pertains to a hypothetical question about the generalizability of results from sentence verification experiments to the actual reading process.

In Chapter 2 it was suggested that the results obtained in Stroop and lexical decision tasks may be a product of the features intrinsic to those tasks, and as such, results from these studies may not provide good analogies for processes which normally operate during reading. First, nouns and their tested properties may be processed as units separate from the rest of the context, especially at zero millisecond SOAs. In natural text, however, the units of analysis may not be at the level of single words or pairs of words (Auble & Franks, 1983; and Foss, Girilo, & Blank, 1979). Second, the contexts used in these experiments are impoverished in comparison to sentences experienced in normal reading situations. Thus, the effects of these contexts and how subjects use these contexts may differ from the way in which readers normally use context (Becker, 1985). Third, the criterion measures in these tasks are not measures of on-line comprehension. The results, therefore, may be of theoretical significance for elucidating representational structure (but see Flores d'Arcais, Schreuder, & Gazenborg, 1985; and Wickelgren, 1981, for an example of and a discussion of the methodology thought to be necessary for revealing aspects of representational structure), but may be of little practical significance for understanding the reading comprehension process itself (Kintsch & Mross, 1985). Similarly, results from cued recall studies demonstrate that subjects can recall studied sentences when properties of the nouns in the sentences are used as cues, but this does not guarantee that these properties were instantiated during the reading comprehension process itself (see McKoon & Ratcliff, 1981). Therefore, it cannot be inferred that the results from Stroop, lexical decision or cued recall studies provide conclusive evidence for any hypothesis about how world knowledge is accessed in the process of comprehension.

The important findings from the thesis research, however, have to do with the factors that affect access to knowledge in a situation requiring immediate comprehension - the sentence verification task. The thesis research has revealed six factors which affect the interpretation of results from verification experiments.

Experiment 1 demonstrated that the format in which the reading context is presented can determine whether access to high frequency knowledge is interpreted as being independent of context or not. When target nouns were highlighted in the contexts, access to high frequency knowledge appeared to be context- independent, but when the nouns were not highlighted, access to high frequency knowledge appeared to be context-dependent. Highlighting nouns sets up a situation in which those nouns are processed differently than when they are not highlighted. This point is similar to the suggestion made earlier that when the testing situation isolates some words from the rest of the context, those words may be processed differently from the way they are normally processed in text. The finding presented above is an important one because it highlights the idea that if the purpose of an experiment is to discover something about reading, it is necessary to present materials in a format similar to that normally encountered during reading.

Experiment 1 revealed a second finding of significance. The inclusion of the inappropriate context condition further demonstrated that access to high frequency knowledge is not insensitive to context. In addition, the incorporation of this condition provided an important clue in determining that the effects of neutral contexts are not, in fact, neutral. A comparison of neutral and inappropriate context conditions led to the formulation of an alternate explanation for the pattern of results obtained in this experiment. The explanation was developed from the assumption that high frequency properties tend to be instantiated by default in neutral contexts because the reader provides an interpretation of an objectively neutral text.

The consequences of this explanation are twofold. First, the adoption of such a view affects the explanation used to account for similar access to high frequency properties after neutral and appropriate contexts. The FBH assumes that a high frequency property of a noun is made available by virtue of having read that noun whether it is highlighted in the context or

not. The alternate explanation proposed here is that because neutral contexts do not supply an interpretation of the noun in the context, the reader must do so. When the noun is highlighted and the context is not helpful, a frequent property of that noun will be instantiated by default (Anderson et. al., 1976). Such an interpretation which is based on frequency need not imply the existence of static representations, however, for when the target noun is not highlighted, the neutral context may be interpreted in a different way than that outlined above. The second, but related consequence of comparing the neutral and inappropriate context conditions resulted in the use of a different baseline condition in the other two experiments. If neutral contexts are interpreted, and possibly interpreted differently by different subjects, then they do not serve their supposed neutral function.

This dissatisfaction with using the neutral context as a baseline and the subsequent adoption of the no context baseline led to a third finding of importance. The no context baseline has been used in only one earlier study which evaluated the FBH, but this study used a lexical decision task (Greenspan, 1986). The use of the no context baseline in Experiments 2 and 3, however, was useful for confirming the finding that appropriate contexts facilitate access to both high and low frequency properties. The no context baseline also provided a stable measure of the difference between access to high and low frequency properties without having to worry about confounding effects of the baseline itself. In addition, the no context baseline was useful in Experiment 2 because it meant that the effects of different literary forms could be directly compared, as identical comparison conditions were used for the different forms.

A fourth factor important to understanding access to knowledge during reading came from the comparison of access to knowledge in two different literary forms. This comparison suggested that any adequate model of the reading comprehension process will have to take global contextual factors, such as literary form, into account. The findings of interest

suggested that knowledge can be rapidly accessed in appropriate recitals and may be relatively easily accessed even in inappropriate recital contexts. It was suggested that recitals foreground the topic in a text, and in doing so, permit the integration of any information compatible with that topic. Only information related to the gist of a narrative, however, may be easily integrated during reading. This hypothesized difference between access to knowledge in the two literary forms suggests that readers use different literary forms in different ways, possibly in order to accomplish different ends. As textbooks, at most levels in the education system, are usually written in a recital format, these preliminary findings and inferences about the source of these findings need to be followed up in subsequent research. Important questions to ask might be: a) Do some readers acquire knowledge more efficiently by encountering new information in the form of a recital rather than a narrative and vice versa? b) Are there different ages at which the narrative form would be more conducive to learning than the recital and vice versa? c) Are there different academic subjects which are more easily learned by using one form or the other?

The fifth finding of importance is how the interpretation of context effects can change when two sources of data, response times and errors, are taken into account. Several researchers make the assumption that inappropriate information rarely interferes with processing (Greenspan, 1986; and Reder, 1983). Indeed, when only response time data are analyzed, this assumption seems valid. The error groups analyses conducted in Experiment 2, however, demonstrated that processing can be slowed by inappropriate information, as accurate responders were significantly slowed by inappropriate contexts. The importance of this demonstration is that effects of context can be obscured when the experimenter is not sensitive to the fact that different subjects may approach an experimental task in different ways. If one wants to generalize the results of reading experiments to the normal reading situation, one must be aware of the source of the effects obtained in an experimental

paradigm. Speed-accuracy trade-offs are artifacts of the verification procedure and as such they may have little to do with what happens during reading. The realization that context effects cannot always be taken at face value underscores the necessity of finding converging evidence from other reading tasks to validate the findings derived from the verification paradigm. Practical solutions to this issue are discussed in Section C.

The final message that can be derived from the thesis research is also related to the concern with the generalizability of the results from the standard verification procedure to the normal reading process. The concern about differences between the verification paradigm and the normal reading situation prompted the manipulation of overall congruency in Experiment 3. When the degree of overall congruency in an experimental task more closely resembled that in a normal reading situation, inappropriate contexts slowed access to knowledge compared to when incongruent trials outnumbered congruent trials. The results from Experiment 3 are promising for two reasons. First, the effects of appropriate context remained stable across changes in congruency. This stability is important because it suggests a possible mechanism by which fluent comprehension may work. The basis of this mechanism and how it could be explored are detailed in Section C.

Second, the fact that inappropriate contexts slow access to knowledge to a greater extent when more of the context trials are congruent leads to the proposal that incongruency may play an important role in the acquisition of knowledge during reading. The logic, here, is that incongruency may slow processing because the incongruent information is not easily integrated with what was previously read. Consequently, the reader may have to find a way to integrate the material, possibly by making an inference. This "checking" and "inferencing" process may take time. Note that this is precisely the dilemma faced by the reader from the 22nd century referred to in Chapter 1. Upon encountering the sentence about zebra pelts clashing with a checkered sofa, the reader from the future century might have difficulty

integrating this sentence, given that he and most other people in his culture think that stripes and checks are quite acceptable next to one another. The reader might, therefore, stop and infer that his ancestors had some strange tastes before he continues reading. By making this inference, however, the reader has learned something new. Schank's (1982) idea that we use our knowledge in order to read and we read to gain knowledge is important here. The suggestion I am making is that part of gaining knowledge through reading comes about when information cannot be easily assimilated with either the reader's representation of what he has just read or with the reader's general knowledge. Section C suggests ways in which this issue could be explored.

In conclusion, the issues raised in this section emphasize the importance of exercising caution in generalizing the results from experimental paradigms to the normal reading situation. The important consequence of such an emphasis is that it paves the way for the exploration of ideas in a framework which is likely to reveal interesting insights into the reading comprehension process.

C. DIRECTIONS FOR THE FUTURE

Kintsch (1980) points out that we need general, broad theories to adequately characterize the reading process. This is in contrast to models of semantic memory which are often invoked in an attempt to account for several aspects of reading comprehension. Recent evidence has favoured Kintsch's view. Several studies have demonstrated that although semantic networks can handle results from some experimental paradigms, they cannot handle results from experiments which follow the same logic but which present text materials in a normal reading format (see Auble & Franks, 1983; Foss, 1982; Kintsch & Mross, 1985). In keeping with Kintsch's philosophy and with the points made in section B, I propose that congruency is a general principle important to understanding the reading comprehension

process. Congruency is a default assumption of fluent readers (deGroot et. al., 1982) possibly gained through years of experience listening to and reading congruent material. Fluent comprehension proceeds when one idea follows from the previous one and when information does not violate the reader's present state of knowledge. When an idea is not congruent with what came before or when previously unknown information is presented, fluency is disrupted. These ideas are similar to those expressed by Nelson (1977) who proposed that learning proceeds with departures from prior expectations. Thus, surprise and disconfirmation lead to learning. These ideas are also similar to Foss' (1982) notion of updating a discourse model. Foss assumes that new material which fits the model of the story being constructed will be more rapidly processed than material which does not fit the ongoing discourse model.

This framework leads to the generation of several interesting experimental hypotheses. Two of these hypotheses are outlined below. First, the effects of congruency and incongruency must be tested in situations in which the degree of congruency approaches that encountered in normal text. One way to accomplish this goal is to use a task other than verification such that the majority of trials would be congruous trials. One such measure is reading time, that is, the amount of time it takes to read and understand a sentence such as *Zebras have stripes* after various contexts. The advantages of this procedure are that a major source of incongruency, the false trial, is eliminated and, because verification is not used, errors and possible speed-accuracy trade-offs are not an issue.

An experiment could be conducted in which one group of subjects receives 80% congruent context trials and a second group of subjects receives 20% congruent trials. If the results of Experiment 3 are generalizable to the normal reading situation, then one might expect to obtain similar facilitory effects of appropriate context for both congruency groups. The 80% congruency group, however, should take longer to read the sentences on the incongruent trials than the 20% congruency group should. Results of this nature would

provide converging evidence for the conclusions derived from the thesis research.

There is a second experiment which follows from the concern with constructing an experimental situation which resembles the normal reading situation. This experiment also follows from the desire to explore some of the assumptions made about the roles of congruency and incongruency in reading. Subjects could be presented with passages to read, one sentence at a time. When the subject has read and understood the sentence he would press a response key to see the next sentence in the story. Reading times for each sentence would be recorded. The target sentence, from the experimenter's point of view, could appear as any one of the several sentences in the story. An example of a high frequency target might be *The children who were visiting the zoo looked at the zebra's stripes.* A low frequency target might be *The children who were visiting the zoo looked at the zebra's hooves.* If the target sentence appeared as the first sentence of the story, this sentence would belong to the baseline condition, that is, the sentence would be read in the absence of any prior information. If the target sentence appeared as the second sentence of the story, it could come after one of two types of sentence, one with which it is congruent and the other with which it is incongruent. In the congruent case, the first sentence might emphasize zebra's fur and be followed by the high frequency sentence about zebras. In the incongruent case, however, the first sentence might emphasize zebra's feet and be followed by the high frequency sentence. In a similar fashion, the target sentence could appear even later in the story and be preceded by several sentences with which it is either congruent or incongruent.

This experiment would be an interesting one to conduct for several reasons. First, it allows one to explore access to knowledge in a way in which the target item is not singled out as far as the subject is concerned. In other words, the target sentence is merely one of several sentences which make up a story. Second, this method of testing allows one to test whether or not facilitory effects increase with the accumulation of congruent information. Likewise, this

method also allows one to test whether or not it takes longer to comprehend an incongruent sentence if many of the previous sentences had been congruent with one another than if only one sentence had been presented before the target. In other words, the methodology suggested in this experiment would allow one to chart the course of access to knowledge as the reader is actually comprehending and constructing a model of the story he is reading.

The congruency framework also affords the testing of a second experimental hypothesis which explores the consequences of congruency and incongruency for individuals at different levels of reading skill. Merrill, Sperber, and McCauley (1981) found that good and poor comprehenders showed similar patterns of colour naming interference in a Stroop task using pairs of words, but showed different patterns of responding in a Stroop task using sentence contexts. In the word task, subjects showed colour-naming interference to properties such as *fur* and *claw* after a semantically related context word such as *cat*. In the sentence task, however, the good comprehenders showed colour-naming interference only for the property emphasized by the sentence context. Poor comprehenders, on the other hand, showed colour-naming interference to properties emphasized by the sentence context but also to properties not emphasized by the context.

Merrill et. al. explained these results by suggesting that context determines word meaning for good comprehenders but that poor comprehenders may encode at the single word level. These findings, however, also suggest that good comprehenders may use contexts in such a way that only knowledge relevant to comprehension is accessed during reading. Poor comprehenders, on the other hand, may access some knowledge which is irrelevant to understanding what they are reading. In a similar vein, Foss et. al. (1979) have argued that an important source of the difference between good and poor comprehenders has to do with those aspects of reading which are under attentional control. In other words, an important difference between good and poor comprehenders may be in the way they use context.

It is interesting, then, to speculate about how congruency and incongruency affect the comprehension of readers of different skill levels. The effects of congruency may be qualitatively if not quantitatively similar for both good and poor comprehenders. The effects of incongruency, however, might be different for readers at different levels of reading skill. Incongruency may affect good comprehenders more than it affects poor comprehenders. This possibly disruptive effect of incongruency is beneficial to readers, however, rather than detrimental. If something does not fit or does not make sense, it is beneficial for the reader to *notice* the inconsistency and to try to remedy it in order to facilitate the integration of succeeding material. One should note that this hypothesis is in direct opposition to the view expressed by Reder (1983) that one component of reading fluency involves the ability to *ignore* inappropriate information.

In summary, the adoption of a general principle such as congruency can lead to the generation of several interesting experimental hypotheses. General principles such as congruency, however, are likely to be derived only when close attention is paid to the ways in which psychological phenomena are studied. Just as the reading context determines access to knowledge, the context in which cognitive psychologists conduct their experiments is likely to determine what knowledge can be gained from them.

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APPENDIX A

Target Sentences Used In Experiments 1, 2, and 3

High Frequency Sentences / Low Frequency Sentences:

SHARKS HAVE TEETH / BABIES
TREES HAVE LEAVES / NEEDLES
THE SUN IS HOT/ DISTANT
BLOOD IS RED / TYPED
ELEPHANTS HAVE TRUNKS / WRINKLES
BANANAS ARE YELLOW / GREEN
MICE ARE SMALL / PETS
FLOWERS HAVE PETALS / SCENT
ZEBRAS HAVE STRIPES / HOOVES
DOGS HAVE TAILS / TAGS
THE SKY IS BLUE /GREY
BOOKS HAVE PAGES /PICTURES
PIANOS HAVE KEYS / LEGS
KANGAROOS HAVE POUCHES / EARS
SUGAR IS SWEET / BROWN
THE DESERT HAS SAND / PLANTS
VIOLINS HAVE STRINGS / CASES
SKIN HAS PORES / OIL
BIRDS EAT WORMS / FISH
LAKES HAVE WATER / ALGAE
BERRIES MAKE JAM / DYES
SKUNKS HAVE SMELL / FEET
GRAPES MAKE WINE / RAISINS
NURSES WEAR UNIFORMS / WATCHES
BANKS HAVE MONEY / COMPUTERS
APPLES MAKE PIES / JELLY
SHEEP HAVE WOOL / NOSES
FARMERS USE TRACTORS / OXEN
BEES MAKE HONEY / NOISE
PARKS HAVE BENCHES / CAMPERS
THE EARTH IS ROUND / ROTATING
BALLETS HAVE DANCERS / PROPS
POLICE USE GUNS / RADIOS
AIRPLANES HAVE WINGS / MOVIES
RABBITS HAVE FUR / BURROWS
HOTELS HAVE ROOMS / SHOPS
STARS ARE BRIGHT / ROUND

MOUNTAINS ARE HIGH / SNOWY
BULLS HAVE HORNS / TEMPERS
HORSES EAT HAY / SUGAR
CHAMPAGNE IS BUBBLY / FRENCH
AIR CONTAINS OXYGEN / POLLEN
SNOW IS WHITE / THROWN
KINGS HAVE CROWNS / SUBJECTS
BEARS ARE BROWN / WHITE
WHALES ARE BIG / HUNTED
LEATHER MAKES SHOES / SADDLES
CATS CHASE MICE / BALLS

Alternate Target Sentences
Used in Experiment 2 Only:

GIN IS A DRINK / GAME
OWLS ARE BIRDS / HUNTERS
DOGS CHASE CATS / COWS
NUNS WEAR HABITS / CROSSES

False Sentences for Experiment 1:

MIDGETS ARE TALL.
ANTIQUES ARE NEW.
PORCUPINES HAVE FINS.
WATER IS DRY.
PEACHES HAVE COBS.
OPERAS HAVE SKATERS.
BRASS MAKES MATCHES.
SQUIRRELS EAT PENGUINS.
OYSTERS HAVE RUBIES.
GIRAFFES HAVE GILLS.
SHOES HAVE LIPS.
CAKES HAVE GRAVY.
DOCTORS USE BOMBS.
PIGS EAT PARROTS.
DESKS HAVE BATHTUBS.
ROSES HAVE ACORNS.
TRUCKS HAVE EYEBROWS.
TROUT HAVE ANTLERS.
MOOSE HAVE SCALES.
THE ARCTIC HAS MONKEYS.
CANDLES HAVE DENTISTS.
LEMONS ARE SALTY.
LIVER CONTAINS GOLD.

COAL IS PINK.

False Sentences for No Context
Trials in Experiments 2 and 3

LEOPARDS HAVE QUILLS.
WORMS MAKE CHEESE.
NITROGEN IS A MEAT.
DRUMS HAVE NOSES.
WAITRESSES WEAR HELMETS.
COCAINE IS A CONTINENT.
BATS EAT TIGERS.
SALADS HAVE SOAP.
PLANTS HAVE CHINS.
SKUNKS ARE INSECTS.
ROCKS ARE EDIBLE.
MINERS USE LOOMS.
SALMON HAVE THUMBS.
FIRE IS COLD.
COBRAS ARE FISH.
CANDLES HAVE FLOORS.

False Sentences for Context False
Trials in Experiments 2 and 3:

GRASS IS PURPLE.
PEANUTS MAKE WOOL.
POTATOES HAVE ARMS.
MIDGETS ARE TALL.
ANTIQUES ARE NEW.
THE ARCTIC HAS FLAMINGOS.
PORCUPINES HAVE FINS.
WATER IS DRY.
MOOSE HAVE SCALES.
TOMATOES MAKE BEER.
SQUIRRELS EAT CROCODILES.
OPERAS HAVE SKATERS.
PEPPER IS SALTY.
JUNGLES HAVE PENQUINS.
TOKYO IS A PLANET.
LIVER HAS GOLD.
BRASS MAKES MATCHES.
GIRAFFES HAVE FEATHERS.
TRUCKS HAVE EYEBROWS.
SNAKES HAVE ANTLERS.

PEACHES HAVE ELBOWS.
WATERMELON HAS BONES.
OYSTERS HAVE RUBIES.
LOBSTERS HAVE BEARDS.
SHEEP MAKE RUM.
SHOES HAVE FINGERS.
CAKES HAVE GRAVY.
DOCTORS USE BOMBS.
PIGS EAT PARROTS.
DESKS HAVE STEEPLES.
ORGANS HAVE BATONS.
DENIM IS A LIQUID.

APPENDIX B

Narrative Contexts Used in Experiments 1, 2, and 3.

Contexts Emphasizing a High Frequency Property for True Trials:

The fisherman hauled the shark onto the shore, thankful he had not been bitten. The fisherman stood over the shark and marvelled at how sharply studded its jaw was.

Our yard contains many maple trees which are beautiful when their foliage turns colour. Our yard has to be raked several times during the autumn because of all the trees in it.

The explorers sweated as the sun burned down on their backs. One of the explorers could stand it no more as he collapsed onto the steaming sand and shook his fist at the sun.

Tom cut his finger and the bright blood dripped onto the carpeting. Unfortunately the carpeting was a light colour and the blood left a deep stain on the rug.

The dead trees were uprooted by the largest elephants to make a path to the river. Soon the river was reached and the elephants played and squirted cool water on each other.

Before Janet started her still-life painting, she placed a few ripe bananas into the bowl. For her painting she searched for the right shade to paint the bright bananas.

The hole in the floorboards was just big enough for the mice to scurry into. Cecile tried to shove a broomhandle into the hole after the mice but the handle was too wide to fit the opening.

The gardener picked the flowers with the brightest blossoms and put them in a vase. In a few days when the blossoms faded and fell off, the gardener picked some fresh flowers.

The African gamehunter had zebra pelts hanging on the wall in his study. The gamehunter thought that the black and white pelts of the zebras added to the study's decor.

The kind priest stopped to pet the friendly dog which jumped onto his lap and started wagging excitedly. The legs of the priest began to sting from the dog's fervent wagging.

The sailors were glad that the sky was clear and bright. The sailors set out on their trip and it was a beautiful day with the sky and the water the same brilliant shade.

Jan flipped through the long chapters of the book. To her dismay she found that several parts of an important chapter in the book had been ripped out by someone else.

The musician moved his fingers up and down the length of the piano. The musician played the notes so quickly that the piano was a blur of black and white beneath his fingers.

The youngster peeped out from the mother kangaroo's protective sack. The baby didn't want to leave the warmth of his mother's body to go and play with the other kangaroos.

Jamie had a craving for the taste of sugar. He couldn't find any candies to satisfy his craving so he gulped down a teaspoon of sugar and savoured the taste of it.

The caravan of nomads made its way slowly across the monotonous landscape of the large desert. The nomads scrambled over the dunes and braved the desert's blinding wind storm.

The virtuoso artfully plucked her violin as she played the concerto. The virtuoso produced beautiful sounds with every stroke of the bow and every note she played on her violin.

Sheila exercised so hard she was sure sweat was coming out of every opening on her skin. She wiped her face but the sweat kept coming out of every little hole on her skin.

The slimy creature would make a good dinner for the young birds. The creature broke in two and half of it crawled back into the moist earth as the mother bird tugged on it.

Jeff donned his swimming trunks and dove into the lake. Jeff splashed and swam until he'd had enough and then he dragged himself from the lake, wet and dripping and exhausted.

Jill likes to visit her grandmother because she gets to eat homemade berry preserves with her toast. Jill spreads a heaping spoonful of the mixture of berries on her toast.

The silly hound circled the skunk who raised its tail into the air in warning. The hound howled and bounded off as the skunk shot its foul spray into the air.

John and Joan went to Italy at the time when the grapes were being pressed. On their last evening in Italy they drank too many bottles of the newly fermented grapes.

The pregnant woman thought that the white-clothed nurses on the ward all looked the same. The pregnant woman wondered how the nurses ever kept their outfits clean and their caps on straight.

Fiona was excited because she was opening her first account at the bank. She deposited fifty dollars in the bank and watched as the teller counted out the bills.

Laura likes to do alot of baking so she freezes bags of sliced and peeled apples. To do her baking she just makes the pastry, thaws the apples and adds sugar and cinnamon.

The herdsman sheared his sheep and gathered their curly coats to take to the market. This year his sheep's coats were long and healthy and the spinners would pay him a good price.

The old farm equipment soon had to be replaced by the farmer or he would have trouble plowing and moving hay. A shiny new red machine would make the farmer very proud.

The daffodils were covered with bees as they collected the nectar to make their sweet food. The nectar from the daffodils would be made into sweet sticky food by the bees.

The office workers took their lunch to the park and found an empty seat. They ate and watched the noon time joggers but soon left as the hard wooden park seats were uncomfortable.

The astronauts looked out into space at their home planet, the Earth. The astronauts thought that the Earth looked like a huge blue and white beach ball suspended in space.

Roger's legs were shaking as he stood in line waiting to audition for the ballet. Finally his legs steadied and he executed the twirls and jumps for the famous ballet.

The shots rang in the air as the police fired into the crowd. Several days later the chief of police was forced to resign because he had ordered his men to fire shots at the protestors.

The pilot thought airplanes looked like beautiful steel birds when

they were in flight. The pilot felt a rush of excitement as the airplane glided through the air.

The youngsters on the farm tour smiled happily as they petted the soft rabbits. The youngsters liked the rabbits best because they got to stroke their downy coats.

The family checked into the hotel and picked up their keys. When they opened their door they were pleased to find that the hotel had thick carpeting and comfortable beds.

The astronomer was overjoyed that the night sky was so clear and that the stars were so shiny. The astronomer looked at the twinkling gleaming stars with his telescope.

The climbers looked at the far off peak of the mountain and wondered if they would ever reach the top. The climbers had never scaled such a lofty mountain before.

The famous matador collected the heads of all the bulls who had succeeded in spearing him. We had to wonder how the matador had ever survived being impaled by so many strong bulls.

The farmer tossed the bale into the barn and divided it amongst his horses. The long stiff grass which the farmer laid out for them to eat was soon devoured by the horses.

Diane popped the cork and the champagne frothed all over the place. She caught the cork and then drank the sparkling champagne which tickled her nose as it went down her throat.

The cabin of the plane was no longer pressurized and the air was impossible to breathe. The plane's stewardess instructed the passengers to breathe the air from their gas masks.

The hard brown ground was being covered like a clean fresh sheet by the softly falling snow. Even the dirty city streets looked pure and bleached as the snow covered them.

The bishop placed the symbol of power on the head of the young king. "After the ceremony, the king removed the heavy jewelled adornment and rested his weary head.

The trapper knew that the tawny bears he had trapped would fetch a good price on the fur market. The fur from these bears would make many rich looking dark coats and hats.

The oceanographers estimated that the whale was sixty feet long and weighed tons. The oceanographers soon spied more whales who joined

the others and left a rolling sea in their wake.

Tom went to several stores to look for good quality leather footwear. Finally he went to a specialty store and found a black pair in his size that had both leather uppers and soles.

The rodent was not aware of the cat which was sneaking up on him. The rodent scurried off as the cat pounced after the pest and chased it around the livingroom in a frenzy.

Contexts Emphasizing a Low Frequency
Property for True Trials:

The deep Pacific ocean provided an ideal place for the mother shark to bring up her youngsters. The mother stayed with her children until the young sharks could fend for themselves.

The beautiful decorations hung from the branches of the Christmas tree. Julie had pricked her finger on the sharp spines of the tree as she was putting up the decorations.

The space probe was traveling through millions of miles of space towards the sun. It would be many lifetimes before the probe would even reach the atmosphere of the sun.

The doctor told Judy that her son would have to have a blood transfusion. Judy was afraid that the hospital would not have enough of her son's rare kind of blood to keep him alive.

The little girl told the zoo keeper that she thought the elephants were old because their skin was creased. The zoo keeper explained that even baby elephants have sagging skin.

Janet put the fruit bowl on the table but noticed that the bananas were far from ripe. She removed the leafy coloured bananas and put some oranges in the fruit bowl instead.

Marg brought her little brother two mice to play with. She showed her brother how to handle the mice and soon the three of them were the best of friends.

The perfume maker chose a combination of fragrant flowers to make her new cologne. For her new cologne she mixed roses, carnations, lilies and a few other flowers.

The African gamewarden looked at the zebra's injured foot. The

gamewarden saw that the zebra had stepped on a sharp piece of metal had worked its way into its tough horse-like foot.

The mayor suspected that the dog which had been following her was lost. The mayor knelt down and to her relief noticed that the dog was wearing some identification around his neck.

The sailors looked at the overcast sky in dismay. The sailors knew it was going to be a dull day and if the sky was any indication it would probably rain at some point in the day.

Jan looked through the colourfully illustrated fairy tales in the children s book. Each fairy tale in the book was accompanied by several illustrative drawings.

Gail praised the craftsman who had carved the ornate supports of the old piano. This craftsman had fashioned the piano's wooden supports, carving beautiful decorations on them.

There was a noise in the bush and the kangaroos turned their heads to listen to it. The aborigines had tried to sneak up quietly but the kangaroos had heard them.

Mary told Kent that he should be using a darker heavier sugar if he was interested in health foods. She said that like most health foods, the darker less-refined sugar is best.

We went to a cactus show the other day and saw some beautiful desert vegetation. Amongst the displays from the desert were several varieties of cacti, shrubs and flowers.

The concert musician placed her precious violin in its stiff leather container. The musician grabbed the handle and to her dismay the buckle gave way and out dropped the violin.

Alex was annoyed that at his age his face was a problem because he had greasy skin. He washed his face several times a day but still his skin was badly blemished.

The lake showed the reflection of the bird as it swooped down looking for food. A flash of movement caught the bird's eye and it dove into the lake, emerging with dinner in its claws.

Jeff didn t want to walk through the green scum which was on the surface of the lake near the shore. His sister said not to worry since the scum on lake was merely tiny harmless plants.

The Aztec potter picked the brightest red and blue berries so that he could use them to stain his pottery. He gave the left over

berries to his wife so she could colour the material for a dress.

The naturalist had been following the tracks of the skunk for almost an hour. The naturalist had to give up when he came to the edge of a stream and the tracks of the skunk disappeared.

The workers picked the grapes and laid them out in the sun to dry. A few days later the workers hardly recognized the brown shrivelled fruit which had once been grapes.

The patient's pulse had to be timed every half hour by the concerned nurse. The patient's pulse was timed accurately because the nurse used the second hand to count the beats.

The tellers at the bank were getting annoyed because the new system was frequently going down. This meant that none of the daily transactions of the bank could be keyed in.

Lucy added the gelatin and sugar to the juice she had strained from the crab apples. When the gelatin had set, Lucy bottled the translucent pinkish apple preserves.

The shepherd watched quietly as the mother sheep sniffed the younsters looking for her lost child. Finally the mother sheep recognized the smell of her child and dragged him home.

The two powerful animals were hitched to the wooden plow by the Indian farmer. The plow team was urged on by the farmer who tapped the animals with a long stick when they stopped or slowed down.

The hive resounded with the loud sound of the buzzing bees. The buzzing was so loud that few other sounds penetrated the steady droning of the colony of bees about the hive.

The Browns drove through the gates of the provincial park and set up their tent on a flat land. By early evening several other families had pitched tents and the park was full.

The astronaut looked out from the window of the skylab at the slowly turning Earth. Hours later when the astronaut looked, he noticed that the Earth had made half a revolution.

The carpenters took great pride in designing the sets for the ballet. The carpenters created authentic looking scenery and beautiful furniture to be used in the ballet.

For some reason it was difficult to tune in the precinct station and the police wanted to contact their chief. Finally, the chief of police came on the air and asked what was wrong.

The trip would not be so boring once they started to show the film on the airplane. Gord was surprised that the film on the airplane was one he had seen recently at the theatre.

The hikers watched as the mother shooed all her baby rabbits into the hole. The hikers watched as the rabbits gingerly peeked out from the safety of their hillside home.

Joanna was pleased that she could get most of what she wanted right in the lobby of the hotel. The luxurious hotel had places to buy clothing, artwork, and perfumes.

The astronomer set up his telescope to get a better look at the multitude of orbs called the stars. The telescope magnified the stars so they looked like round peas rather than like pinpoints.

The skiers were ecstatic that there had been several heavy storms on the mountain the week before. The skiers skied all day through the mountain's deep fluffy layers of powder.

The rancher cautiously approached the territory of the ornery bulls who were stamping their feet. The rancher was cautious because he knew it didn't take much to set bulls off.

Betsy took the sweet cubes out of her pocket and held them out for the horses. Soon the cubes were all gone as the horses nibbled up the tasty treat Betsy had brought them to eat.

Tom thought his wife would enjoy having authentic champagne on their anniversary. His friend Pierre who was from Paris helped him to read the labels on the champagne bottles.

Joe has such bad hayfever that he finds it difficult to breathe the air sometimes. His worst hayfever season is spring when the air bears natural allergens from trees and plants.

The playing children hurled balls of snow at each other. Ed, the youngest of the children, got knocked right off his feet by the force of the ball of snow that Jim hurled at him.

The loyal citizens cheered as their young king waved to them. The king thought he was fortunate to have so many of his citizens who trusted him and obeyed all his orders.

The hunters could barely see the polar bear because he blended in so well with the ice floes. The hunters thought the polar bear's pelt would make a luxurious rug.

The fishermen sighted the whales and prepared to launch the long automatic harpoon. The fishermen caught and speared the whales and were pleased at their catch.

Todd bought a brand new leather seat for riding his horse. When he put it on his horse's back the animal bucked and Tom slid right off the slippery leather seat.

The round toy only bounced once as the young cat jumped into the air and caught it. Joyce rolled the rubber toy on the floor and the cat soon chased after it.

Contexts Emphasizing a High Frequency
Property for False Trials
in Experiment 1:

The children looked in astonishment at the stature of the midget in front of them. The midget was an old man but he didn't even reach up to the chin of the youngest child.

The vase was a very important antique because it had belonged to an Egyptian Pharaoh. The antique vase was in good shape considering its owner had been dead for centuries.

The fox backed away from the porcupine which it had been pursuing. The porcupine shot its barbs into the fox's muzzle and the fox yipped in agony as he made a hasty retreat.

Julia needed a glass of water after having walked along the dusty road all day. She drank one full glass of water and then poured another glass over her head.

Peter was fussy about how he liked to eat his peaches. He couldn't stand to eat the fine hairs so he peeled the peach and would only eat the peeled fruit.

Laura stood in line nervously clearing her throat while waiting to audition for the opera. She warmed up her voice and forgot her nervousness as she sang the music of the famous opera.

The marching band took up their brass instruments and started to march in the parade. It was a bright day and the brass from their instruments gleamed in the sun.

As Donna was walking under the oak tree a squirrel dropped a nut on her head. The hungry squirrel went right on eating the nuts.

oblivious to the dirty stares in his direction.

The young diver came up with a bucketful of the precious oysters. He split them open with a knife and in the middle of several oysters lay the cream coloured gems the diver wanted.

The children watched as the giraffe at the zoo reached high into the tree and munched on some leaves. When the children called to him, the giraffe turned his head and looked down at them.

The jogger had forgotten to tie up his shoes tightly before going running. It was not long before the runner's shoes came undone and he tripped and fell flat on his face.

Coreen's mother decorated a rich chocolate cake for her daughter's birthday. Coreen bit into the cake and everyone laughed when they saw her chocolate-smeared face.

The doctor bent over his patient and listened for a heartbeat. Soon the doctor removed the instrument from his ears and shook his head in despair at his patient's death.

Leslie tossed a basketful of the yellow cobs into the troughs for the pigs to eat. The troughs were soon empty as the ravenous pigs gulped down the kernels and cobs.

The spy sat down behind the desk and pulled the top handle towards him. To the spy's delight, the wooden compartment of the desk was filled with important secret documents.

The florist cried out in pain as she picked up the roses by their stems. The florist threw the roses down and ran her finger under cold water until the bleeding stopped.

The men watched in disdain as the truck slid deeper into the snow. The driver of the truck hit the gas but all he got for his efforts was the smell of burning rubber.

The fisherman hauled the slimy rough skinned trout into the boat. When the fisherman got home his wife told him that he would have to clean and skin the trout himself.

There was a loud crash in the bush as the two male moose charged at each other. The females watched to see which moose would win the battle and gain control of the herd.

The Arctic explorers looked out at the huge expanse of frozen wasteland which they had to cross. The explorers slowly trekked across the cold and lonely Arctic landscape.

Nancy ruined the tablecloth by letting the candle drip onto it. She tried to scrape the hardened material off the tablecloth but the candle had already done its damage.

Larry's friends bet him that he could not bite into a lemon without puckering his face. Larry lost the bet as he bit into the lemon and couldn't control his expression.

Sara's mother made her eat liver once a week. She maintained that the liver prevented the family from becoming anemic since the meat has essential nutrients.

The miners returned from the coal mine with a layer of dark soot on their clothes. Their clothes had to be washed separately so that the coal would not soil the other laundry.

Contexts Emphasizing a Low Frequency Property for False Trials in Experiment 1:

The travelling circus had many midgets who were part of their acts. The midgets did everything from singing and dancing to trapeze swinging and tightrope walking.

The auction of antiques was in deep financial difficulty until the special chair was put up for sale. Many wealthy people came to bid on this very special antique.

The porcupine could see the fox as it tried to sneak up on it. It was a good thing for the porcupine that he had good enough vision to see the fox from a distance.

The chemists took water samples from the dirty lake and analyzed them. The chemists found that the water had industrial and sewage wastes which made it unsafe to drink.

No matter how hard he tried, Peter could not eat a peach without making a mess. Each bite into the peach would start a sticky trickle down his chin and onto his shirt.

The famous opera company thought themselves fortunate to have such competent artistic leadership. With Becker in command, the opera could have alot of confidence.

The brass was melted and poured so that it could be moulded into the

likeness of people and animals. Many people bought the brass trinkets to give to their friends as presents.

The squirrel sat on the branch of the tree and munched on the sweet fruit. Soon the squirrel had eaten all the fruit except the seeds and he threw the core away.

The diners ordered oysters because they were their favourite shellfish. The oysters tasted so delicious that the customers decided to return to the restaurant in the near future.

The children admired the splotchy coloured giraffes at the zoo. The children thought that the giraffes looked like they had splotches of orange paint on their light fur.

Matthew felt like he had walked for years as he looked for new padding for the inside of his shoes. The old padding in his shoes had worn out some months ago.

Coreen took a mouthful of her birthday cake and found a quarter wrapped in waxed paper. Coreen's mother had put quarters, dimes and nickels throughout the cake's layers.

The doctor cleansed his patient's wound and tore off a long piece of gauze. The man held out his arm and the doctor wrapped the gauze around it and taped it in place.

Leslie tossed a basketful of greens into the troughs for the pigs to eat. The ravenous pigs gulped down the leafty green vegetables which were considerably wilted.

The spy tried to pull open the desk but to his dismay it would not open. He looked all over the desk for the key, finally found it and smiled when it fit.

The gardener wanted to transplant his rose bush so he dug deep into the soil and pulled the whole plant out. The gardener dug a hole and covered the base of the roses with soil.

Mark had waited two weeks until payday to buy the velvet coverings for the interior of his truck. Now maybe Judy could sit comfortably in his truck and would go to the dance with him.

Mona ordered baked trout at the fine restaurant. She was disappointed to find that the chef of the restaurant had not filleted the trout and so she had to pull out the spine herself.

The hunter stalked the moose and shot it through the chest several times. The moose staggered and collapsed as the bullets ruptured

the animal's pulmonary artery.

The Greenpeace boat left California and sailed for weeks until they reached the Arctic. The protestors thought that their presence was much needed in the Arctic.

Lee couldn't make up his mind about whether to buy the blue or the mauve candles. Lee finally decided that the blue candles would go better with the decor in his home.

The French chef prepared the salmon on a platter and arranged slices of lemon around it. The chef stepped back to admire his creation of lemon decorated salmon.

During the autopsy the coroner inspected the liver of the alcoholic who had just died. The alcoholic's liver which was very sickly looking had been dysfunctioning for weeks.

The miner's union was pleased that the medical inspectors had declared the coal mines unsafe. The medical inspectors claimed that the goal could cause cancer and other lung ailments.

Neutral Contexts for True Trials
in Experiment 1:

The children had an educational trip to the aquarium where they got to see sharks and other creatures. The aquarium was set up so that the children could view the sharks in their natural habitat.

The hikers had to walk through many stands of trees before they reached the river. Along the way, the hikers stopped to take a picture of some of the trees in the forest.

There was a strong wind but the sun had started to peek through the clouds.
The presence of wind and sun would make it a perfect day for the windsurfers to enjoy their sport.

The grandmother wiped the blood off her grandson's scraped knee. Then she bandaged his knee with gauze and told the boy that a little bit of blood and a few scrapes never hurt anyone.

The hunters chased the elephants in their noisy jeeps. The hunters chased the elephants to the banks of a large pond and cursed when the wheels of the jeeps got stuck in the mud.

Cindy took out the beautiful old glass bowl and arranged some bananas in it.She placed the fruit bowl on the diningroom table and thought that the bananas looked very nice in it.

The animal keepers cleaned the cages of the mice almost every day. The animal caretakers took the mice out and put them in other cages while they did the cleaning and filled the food trays.

Tim went into the shop and bought a bouquet of flowers to give his girlfriend along with the ring. He thought the flowers would add a nice touch when he gave her the ring.

The children at the zoo smiled in delight as they watched the zebras running in their corral. Some of the children wanted to open the doors of the corral and set the zebras free.

The old man fed the hungry dog two full cans of food before it was full. The man set the cans on the counter and the dog leapt up on the counter to lick the last morsels from the tins.

The pilot saw another helicopter in the sky flying straight towards him. The pilot tried to get out of the way but he was too late and the sky burst with the flames of the crash.

The student carried the stack of books back to the library before they could be overdue. The student took the books to the front counter in the library and asked to renew them.

The musician surveyed his room full of pianos with great pride. He had a special place in the room for each of his pianos which he had bought from different countries around the world.

The tourists took out their cameras to photograph the kangaroos who were in front of them. One tourist dropped his camera and didn't get a good picture before the kangaroos moved on.

The tired mother piled a bag of sugar into her shopping cart along with the
rest of the baking supplies. The mother baked for her family every day and
so she went through alot of sugar.

The school children were fascinated by the book about the desert that their teacher had given them to read. They thought that the nomads who lived in the desert were very special people.

Joseph was going to try out for the symphony so he bought a new violin. When the day for his audition came, he was nervous as he stood with his violin in the symphony hall.

Bernie found a band-aid and put it over the scratch on his skin. The next time he pruned the hedges he would wear gloves so he would not get his skin so scratched up.

The naturalists took out their binoculars and observed the birds while they were eating. One of the naturalists dropped his binoculars which startled the flock of birds.

Lisa and Martin drove through the valley which was lined with fences bordering apple orchards. They stopped the car and climbed over a fence to pick the best of the apples in the orchard.

The willow tree was the favourite resting place for the family of skunks. The willow tree provided shade for the skunks during the hot months of the summer.

Our backyard is special because it has grapes growing along the fence. Every summer we sit in our backyard and watch as the grapes and other vegetation grow to maturity.

Amy looked forward to the convention so that she could see the nurses she had gone to college with. Amy enjoyed the convention and got to visit with many of the nurses there.

As we were walking down the city block we encountered several banks. "Being from a small town, we were surprised that the city had so many banks so close to one another.

The Miller's finally found their dream home situated near a small lake not far from town. Their dream home by the lake was the perfect place for them to raise a family.

As the Indians trekked through the forest they passed several bushes filled with berries. The Indians did not stop and went right on past the berries.

The meadow was was covered with wildflowers and several sheep. The wildflowers blew in the faint breeze and the sheep played and rested on the picturesque meadow.

The young boy loved to go into the barber shop and listen to the stories that the old farmers told. He could listen to the stories the farmers told for hours on end.

As we walked through the field on the warm summer day there were bees perched on the wildflowers. The colourful wildflowers and the bees in the air were a glorious sight.

The young lovers strolled through the park at an unhurried pace. The lovers stared into each others eyes and noticed no other people as they walked in the park.

The organizers of the famine relief fund were overjoyed that people from all over the Earth had donated money. They thought famine could be obliterated from Earth.

Ray was happy she lived in the city because the entertainment such as the opera and the ballet were great. The city Ray lived in boasted its own high quality ballet company.

The hockey arena had ushers in the stands and police stationed at ice level. Fortunately none of the fans at the hockey game got out of hand and the police were not needed.

Joyce went to the airport very early to wait for the airplane she was scheduled on. While Joyce waited to board the airplane, she got a novel from the airport shop.

There were many animals on the farm including the multitudes of rabbits. The farm was in a run-down state and the rabbits and other animals tended to run around wild.

Every second building on the long beach was a large hotel. The beach stretched on for several miles and so did the many hotels that were on its border.

We tried to find the comet as we gazed up into the stars. We finally gave up when we couldn't distinguish the comet from the stars in the sky.

Douglas's lifelong dream was to be able to live in the mountains of British Columbia. When Douglas retired he was able to move to the mountains just as he wished.

The cattle rancher was very upset when he discovered that his only bull had been taken by the russlers. He hunted down the cattle russlers and rescued his bull.

The old wooden barn was filled with horses who were eating. The wooden barn was so old that it creaked but the preoccupied horses paid no attention.

Mike's friends gave him a party and served champagne and finger foods. The graduation party went on until all the champagne and all the snacks were devoured.

Vivien had been sick for so long she coulon t wait to get out into

the fresh air. When she got out into the fresh air, Vivien felt as if she'd never been sick.

The weather man reported that it was going to snow almost all week. The weather man knew that his forecast of snow would be welcomed by some but not by others.

The teacher read the children the fairy tale about the kings that lived long ago. The fairy tales about these kings were filled with details about ancient times.

The helicopters made so much noise that the mother bear was afraid for her cubs. One of the helicopters spotted the bears and meanly started to chase after them.

The biologist had a tremendous respect for the whales which he had studied for most of his life. The retiring biologist would miss the whales he had come to know.

The tanner hung the animal hides to dry before making them into leather. The tanner knew that he would get a good price for the leather he wanted to sell.

Fred laughed as his frisky cat chased all around the house. When Fred went to the pet shop and bought his cat he picked the most active one of the litter.

Neutral Contexts for False Trials
in Experiment 1:

Grace couldn't figure out why her friend the midget hadn't called her recently. Grace found out later that her friend the midget had been in a car accident.

The actress saw the antique in the window of the little shop. The actress entered the shop and spent the afternoon looking at all the antiques.

The naturalists watched as the family of porcupines followed one another across the path in the woods. The naturalists took notes on the porcupine family.

The barrel full of water was sitting in the field close to the barn. The farmer's son collided into the barrel of water as he raced around the barn.

The company hired summer students to pick the peaches this year. The peaches were picked in record time and the company was pleased with their summer help.

The opera company were excited when they found out that they had been invited to Paris. They knew that this trip could put Canadian opera on the map.

Paul finally got a job working in a factory that makes brass. Paul had looked for a job for a long time so he was happy when the brass company made him an offer.

The tiny fish swam above the bed of oysters on the ocean floor. The ocean floor was the home of the oysters and much other sea life as well.

The African safari group could see many giraffes grazing on the Savanaha. The safari edged closer but the giraffes saw them and turned away from the group.

Liane was a shoe fanatic and she went on a shopping spree every week. Soon Liane's closets were so full of shoes that she had to build another closet.

Ginny believes that birthdays are special and everyone should have a cake. Ginny always bakes a cake and throws a party when she knows it is someones birthday.

The doctor ran up the hospital steps and into his patient's room. The patient smiled when he looked up and saw that his doctor had finally arrived.

The farmer's daughter never had to call the pigs over when she filled their trough. No sooner would she fill the trough than the pigs would eat it all.

The head of the corporation sat behind her desk and looked her employee up and down. The employee leaned on the desk and apologized for having been dishonest.

The gardener looked out in the yard at his many rose bushes. The gardener donned his hat and went outside to look after the roses in his extensive garden.

Douglas wanted to buy a truck so he went to the showroom and tried to strike a deal with the salesman. The salesman was able to sell Doug a truck for a good price.

The spring-fed lake was filled with many trout this year. The

lake had not had so many trout in it for several years and many people wondered why this year was different.

The swamp was filled with bullrushes and two moose were standing in the middle of it. The two moose stayed standing in the swamp while the flies buzzed all around them.

The school teacher pointed out where the Arctic was on the map. The teacher then gave each pupil a pencil and paper and asked them to draw their own map of the Arctic.

When Joel walked into the room there were two candles on the dining room table. Joel took a third candle out of the cupboard and put it on the table too.

Roberta had several things to buy at the market including some lemons. She bought a dozen lemons from the nice man at the market who put them in a shopping bag.

The meat market ordered several pounds of liver for one of their customers who had requested it. The owner of the meat market packaged the liver himself.

The workers loaded the boxcars of the train with tons of coal. The train would take four days to deliver the coal to its final destination.

Gord looked up at the squirrel who was busily eating and who was oblivious to anything else. Gord whistled but the squirrel kept right on eating his dinner.

Contexts Used for False Trials for
the Narrative Group in Experiment 2
and for Experiment 3:

The Jamisons wanted to have the nicest looking grass in their neighbourhood. They watered it every day and by midsummer their grass was a healthy rich colour.

Rob went to the health food store and bought some peanuts which he ground fresh. He couldn't wait to get home so he could plaster some toast with the peanut spread.

Beth refuses to peel potatoes because she says they are better for you if they are only scrubbed. Beth's sister refuses to eat potatoes Beth has prepared unless they are new.

The children looked in astonishment at the stature of the midget in the circus. The midget was an old man but he didn't even reach up to the chin of the youngest child.

The vase was a priceless antique because it had belonged to an Egyptian Pharaoh. The antique was in good shape considering its owner had been dead for centuries.

The cold Arctic air seemed not to bother any of the animals which were diving in and out of the frigid water. The explorers realized that few species would be able to survive in the Arctic.

The fox backed away from the porcupine which it had been pursuing. The porcupine shot its barbs into the fox's muzzle and the fox yipped in agony as he made a hasty retreat.

Julia needed a glass of water after having walked along the dusty road all day. She drank one full glass of water and then poured another glass over her head.

There was a loud crash in the bush as the two male moose charged at each other. The females watched to see which moose would win the battle and gain control of the herd.

Herbert went to the market and bought the ripest tomatoes he could find for his sauce. He was sure that these tomatoes would make his guests think that he was a great Italian cook.

As Donna was walking under the oak tree a squirrel dropped a nut on her head. The hungry squirrel went right on eating the nuts, oblivious to the dirty stares in his direction.

Laura stood in line nervously clearing her throat while waiting to audition for the opera. She warmed up her voice and forgot her nervousness as she sang the music of the famous opera.

The toddlers had gotten into the spice rack and were tasting the pepper and the nutmeg. When they put the pepper on their tongues it burned so badly that they started to cry.

The jungle was filled with the sound of the screeching animals. They were swinging from tree to tree using the long vines which grew in their lush jungle habitat.

Jan found herself stranded in the middle of a busy Tokyo street. She'd lost sight of Ed who seemed to have disappeared into the continuous flow of Tokyo commuters.

Sara's mother made her eat liver once a week. She maintained that the liver prevented the family from becoming anemic since the meat has essential nutrients.

The marching band took up their brass instruments and started to march in the parade. It was a bright day and the brass from their instruments gleamed in the sun.

The children watched as the giraffe at the zoo reached high into the tree and munched on some leaves. The giraffe turned towards the calling children and looked down at them.

The men watched in disdain as the wheels of their truck slid deeper into the snow. The driver of the truck hit the gas but all he got for his efforts was the smell of burning rubber.

The rancher shot the long slimy snake and proceeded to skin it. If he was lucky he might be able to sell the snake skin to the man in town who made belts and boots.

Peter was fussy about how he liked to eat his peaches. He couldn't stand to eat the fine hairs so he peeled the peach and would only eat the peeled fruit.

Lisa bit into the juicy pink and black watermelon. The watermelon was delicious but she was constantly spitting out the flat black kernels since they were so plentiful.

The young diver came up with a bucketful of the precious oysters. He split them open with a knife and in the middle of several oysters lay the cream coloured gems he was looking for.

The tiny fish tried to escape but the quick pincers of the lobster grabbed him before he could swim away. The lobster held on tightly and moved his dinner towards his mouth.

The sheep rancher sheared his animals and gathered their curly coats to take to the market. This year his sheep's coats were long and healthy and the spinners would pay him a good price.

The jogger had forgotten to tie up his shoes tightly before going running. It was not long before his shoes came undone and he tripped and fell flat on his face.

Coreen's mother decorated a rich chocolate cake for her daughter's birthday. Coreen bit into the cake and everyone laughed when they saw her chocolate-smeared face.

The doctor bent over his patient and listened for a heartbeat. Soon

the doctor removed the instrument from his ears and shook his head in despair at his patient's death.

Leslie tossed a basketful of the yellow cobs into the troughs for the pigs to eat. The ravenous pigs gulped down the vegetables kernels and cobs included.

The spy sat down behind the desk and pulled the top handle towards him. To his delight, the wooden compartment of the desk was filled with important secret documents.

The choirmaster sat down at the huge organ and the music wafted out of the tubing and filled the church. The music was very loud as the air passed through the tubing of the organ.

The seamstress cut the denim to make the designer jeans. The strong cotton denim was at times difficult for her to work with as it was such a thick weave.

Alternate Contexts Used in Experiment 2 Only:

The Smiths enjoy the taste of gin, especially on hot days. They can make many cool thirst-quenching cocktails from one bottle of good gin.	The Smiths had their friends over to play gin. They dealt several hands before they all got tired of playing gin and decided to call it a night.
The children watched as the owl flew past them and perched itself on a bough of the fir tree. The children looked up and saw a nest of baby owls	Nighttime closed in and it was time for the owl to stalk its dinner. The owls soon spotted a mole in the grass and zeroed in to carry the creature away.
The dog spotted his target who was curled up on the porch lazing in the sun. The dog leapt forth and chased the hissing ball of fur up a tree.	The dog was a great help to the farmer because he herded the stray animals into the corral. When one of the animals strayed, the dog chased after it.
The nuns in the church were all wearing the same long black and white gowns and hoods. The novices donned the outfits which, as nuns, they would wear until they died.	The nuns were given crucifixes to wear when they were accepted into the order. When they took their vow of poverty the nuns could keep one ring and this necklace.

APPENDIX C

Recital Contexts Used in Experiment 2

True Trials: Contexts with a High Frequency Emphasis

Sharks are ferocious sea animals whose jaws are heavily studded with rows of sharp incisors. Sharks are well equipped to tear, grind and chop even the toughest food.

Trees in North America start to bud in the Spring and by May they are covered with abundant foliage. Trees in the forest often form shady canopies with their thick growth.

The sun is like a large ball of fire with the temperature on its surface in the thousands of degrees celcius. The sun's presence is felt the most in the torrid equatorial countries.

Blood is the colour it is due to the presence of iron and hemoglobin. Blood can stain most materials and it is very difficult to completely wash out its rich hue.

Elephants are well-adapted to be able to grab hold of vegetation and shovel it into their mouths. Elephants also keep themselves cool by squirting water over their backs.

Bananas are best for eating when they have ripened just enough. Bananas in ads are painted so that their colour portrays them as being at the peak of ripeness.

Mice are just the right size to be able to crawl into spaces which larger animals cannot. Mice often disappear into crevices too minute to have been noticed previously.

Flowers often have beautiful blossoms which unfold with the proper sunshine and rain. Most flowers bloom for a few weeks before they start to lose their blossoms.

Zebras have striking contrasting fur which sets them apart from other animals. Zebras, with their alternating bands of black and white fur, are valued for their pelts.

Dogs let people know when they are happy or excited just by wagging fervently. Some dogs such as poodles who are operated on when they are pups have very little left to wag with.

The sky is a very beautiful shade on sunny clear days. The sky can be a very bright colour any time of the year, especially in the summer on days when there are no clouds.

Books can be so long that they use up alot of paper. Books that are very thick are often flipped through by impatient readers and often discarded for a thinner one.

The piano is a complex musical instrument which has a large range of notes spanning several octaves. Pianos are played by compressing the black and white musical board.

Kangaroos are unusual animals since the females have a loose fold of skin on their abdomens. Kangaroos nurse and carry their babies in these sacks.

Sugar is the universal flavouring used to make desserts and candies and to flavour drinks. Sugar also occurs naturally in the tasty juice of most fruits and berries.

Large deserts have monotonous landscapes composed of dune after dune as far as the eye can see. Deserts thus often resemble a vast brown ocean complete with ripples.

Violins can be plucked or stroked with a bow to produce sound. Violins produce the music they do because the catgut vibrates when it is plucked or stroked.

Skin is an elastic substance which is covered with tiny holes which allow it to breathe. Skin allows the body's moisture or sweat to escape through these holes.

Birds can often be seen poking at the earth in search of something juicy to eat. Birds often have to tug to get their slimy dinners out of the ground.

Lakes are constantly replenished since several rivers empty into each one. Lakes are also replenished in the spring when the snow melts and runs into their basins.

Berries can be boiled with sugar and a thickening agent. Berries prepared in this way make tasty preserves which can be spread on toast and muffins.

Gin can be bought in bottles of various sizes from the liquor store. Gin comes in twenty-six ounce bottles and in a smaller size called a Mickey.

Grapes from France and Italy are considered the best in the

world. Grapes from these regions have a long hot growing season which makes them perfect for pressing.

Nurses are most often dressed in white and sometimes in pale pastels. Nurses must always dress in this type of clothing so that patients know who they are.

Owls often build their nests in barns or in fir trees. Owls of different species have different coloured feathers, different wing spans and lay different coloured eggs.

Apples are often used inbaking. Apples tend to go very well with pastry and taste best when served hot from the oven with a scoop of ice cream.

Dogs, like other animals, are said to have a natural enemy. Dogs can often be seen in the chase and sometimes they get hissed at and badly scratched.

Farmers use powerful machinery to run their farms. Farmers need their machines to lift and move hay and to drive plows and pull the wagons the harvest is loaded on.

Bees provide us with a tasty natural sweetener. Bees produce this substance from the nectar which they collect from the flowers of many plants.

Parks are a good place to sit down and relax while enjoying nature. Parks are often used at noon hour by people who want to sit down to eat lunch or to read.

The Earth was once thought to be the shape of a plate. The Earth, in fact, looks more like a big blue and white beach ball suspended in space.

Ballets have to have the best people performing in them if they want to make money. Ballets hire people who have spent many years of their life in training.

Police most often carry at least one weapon whenever they are on duty. Police are sometimes forced to fire their weapons if their lives are endangered.

Airplanes are basically modelled on the shape of a bird while it is soaring. An airplane's parts, however, do not flap the way a bird's do.

Rabbits are very soft animals to pet. Rabbits are used to make soft coats and hats and they are also used to make

strokable good luck charms.

Nuns in conservative orders must always wear the same outfits throughout the year. Nuns are usually dressed in black and white or grey and white.

Stars are beautiful and shiny on a clear night. Stars look like shiny points of light in the sky and they often appear to sparkle and twinkle.

Mountains rise majestically from the land and reach far into the [redacted] Mountains are sometimes so lofty that their peaks are surrounded by clouds.

Bulls can be dangerous beasts especially when they lower their heads and start chasing you. If a bull gets close enough he can spear you badly.

Horses are usually fed from the bales which farmers harvest in the summer. Horses eat this long stiff grass as their main source of food in the winter.

Champagne is fun to drink because of it's sparkling quality. Champagne has to be opened carefully since it has a tendancy to froth all over.

Air is a mixture of elements which surrounds the Earth. Air contains an abundant gas which is necessary to the survival of life on this planet.

Snow, after a recent fall, covers the ground like a clean fresh sheet. Snow can even make dirty city streets sparkle and gleam.

Kings traditionally wore robes and jewelled adornments on their heads. A king, during his coronation would have the symbol of his power placed on his head.

Bears have beautiful tawny fur which is made into expensive hats and warm coats. Bears are sometimes difficult to see as they blend in with the forest underbrush.

Whales are gigantic ocean-going mammals. Whales have often been called the kings of the ocean because of their immense size and length.

Leather is used to make all sorts of footwear. Leather is used to make both the uppers and the soles of most fine footwear.

Cats are good at ridding houses of rodents. Cats can often be seen chasing these pests and sometimes when they catch them they eat them.

True Trials: Contexts with a Low Frequency Emphasis

Sharks give birth to their young just as other fish do. The tiny sharks stay with their mother until they are able to fend for themselves.

Some trees such as the pine, the spruce and the fir keep their foliage year round. These trees' growth is stable even over the winter months.

The sun is over ninety-three million miles away from the Earth. The sun would take many of our lifetimes to travel to in our fastest spaceship.

Blood is an important thing to donate especially if you have a kind which is rare. Blood banks supply needy patients with blood which matches their own.

Elephants are strange-looking creatures with their baggy grey skin. Elephants tend to look old even when they're young because their skin sags.

Bananas are sometimes bought when they are not ripe. These bananas are hard to peel, they are bitter and they are usually a bright leafy colour.

Mice are fairly tame animals and are quite harmless if handled properly. Mice take very little looking after and can be good companions for children.

Some flowers smell very pretty, especially roses and carnations. Flowers have been used for many centuries in the making of perfumes and colognes.

The zebra is similar to the horse in most of its leg and foot structure. The zebra's feet are hard and thick, enabling the animal to trot over most terrains.

Dogs should always wear some identification around their necks. Many dogs are lost every year because their owners don t put an address on their pet's collar.

The sky often turns a dull colour just before it is going to rain. When the sky is dismal, it is not much fun to go sailing or to sit outdoors.

Some books, especially those written for children, are nicely illustrated. Books sometimes have photos or drawings of people, place and things in them.

Pianos are raised off the ground and stand on either two or three supports. The piano's supports are sometimes made out of curved wood and can be ornately carved.

Kangaroos have very good hearing and they tend to startle even when a sound is far away. The kangaroo will sit up and cock its head when it hears something.

Sugar can be bought in a less refined and healthier form than usual. This sugar is dark, heavy and moist and has a very distinct taste to it.

The desert is a perfect environment for cacti and succulents to grow in. The desert supports a range of unusual large and small vegetation.

Violins must be carefully protected if they going to be carried anywhere. Violins most often come with their own stiff leather container.

Skin can be blemished if it is very greasy. Skin, though, is normally moisturized with the natural lubrication which it produces on a daily basis.

Some birds get their food by diving into lakes and rivers. These birds swoop down when they see movement in the water and eat their catch.

Lakes are filled with aggregates of tiny chlorophyll-containing plants. Lakes are sometimes covered with this green scum which accumulates on the shore.

Berries were used as colouring agents before the advent of synthetic colouring. Red and blue berries were used to tint fabrics and pottery.

Gin is only one of several ways to play cards. Gin players often form clubs and they get together on a regular basis to participate in this pastime.

Grapes are fruit which darken and shrivel up when dried in the

sun. These dried grapes are often used in baking and are eaten for snacks.

Nurses need to time the pulses of their patients in a precise manner. Nurses often look at their second hands in order to ensure their timing is accurate.

The owl is a carvnivore which stalks its game during the night. Owls are adept at spotting quick animals such as mice and catching them in their sharp grip.

Apples can be peeled, seeded, mashed and boiled with gelatin and then bottled. Apples prepared in this way can be spread on bread and muffins.

Some dogs are useful on farms and ranches since they are good at herding up the livestock. These dogs chase the animals from the pasture and into the barn.

Farmers have traditionally used animals to do the heavy work on their farms. Farmers in India still yoke powerful animals together to do the plowing and carting.

Bees are industrious insects who are always buzzing around. Bees can somtimes make so much of a racket that it is difficult to hear even the birds singing.

Parks in Ontario are often filled up every night during the summer. Many parks provide cleared sites, firewood and showers for their temporary visitors.

The Earth not only orbits the sun, it also spins on its own axis. The Earth takes twenty-four hours to complete one revolution on its own axis.

Ballets have to have the right articles on stage to make the story seem realistic. Ballets often use furniture and scenic backdrops to do this.

Police must always keep in touch with their fellow officers and with the station. Police receive their orders and relay information while in their cars.

Airplanes can be a pleasant way to travel since entertainment is usually provided on long flights. Airplanes often show first rate pictures on their flights.

Rabbits dig holes in the sides of hills where they store their food and bear their young. Rabbits often use these holes to escape

down when they are being chased.

Nuns usually have only two pieces of jewellery. Nuns wear plain gold or silver rings and a metal or wooden crucifix around their necks.

Stars are really like large balls of fire in the universe. A star's spherical shape can be seen if one looks through a powerful telescope.

Mountains are a great source of recreation for skiers. Mountains are best for skiing on when they have a good base and several inches of powder.

Bulls can get very angry for no apparent reason. When approaching a bull it is always best to be cautious especially if the bull is stamping its feet.

Horses will follow you anywhere if you tempt them with sweets. Horses will eat the cubes right out of your hand without biting you.

Champagne is made in only one European country. Real champagne comes from the region bearing the same name which is only about a hundred miles from Paris.

The air is full of several substances which people are allergic to. The air can be the carrier of allergens from sources such as plants and trees.

Snow is fun to roll into small balls and pitch at your friends. Snow can actually hurt if it is hurled with great force or if it has stones in it.

Kings must rule over and assume responsibility for many people. Kings have an easier time if their citizens are loyal to them.

Bears in the Arctic are hard to see because they blend in so well with the ice floes. These bears are often hunted for their beautiful light fur.

Whales are caught by fishermen of several countries. These whales are killed by using automatic machines which release long harpoon-like shafts.

Leather is used to make seats so that horseriders do not have to ride bareback. This leather has to be stiff enough to stand up to constant riding.

Cats like to run after anything which you throw. Cats especially like to chase after things that roll on the floor or bounce in the air.

False Trials: Contexts

Peanuts can be ground fresh to provide a delicious smooth spread. Peanuts prepared in this fashion provide a protein-rich source of food.

The grass at a good golf course is kept in top-notch condition. This grass is well-watered, especially the grass around the putting area.

Potatoes are often peeled before they are cooked. Potatoes can also be prepared without peeling them as long as they are well scrubbed.

Midgets fail to reach adult height because they have an absence of the hormones needed for normal growth. Midgets stop growing at a young age.

Antiques are priced according to their present condition and their age. Antiques can be priceless especially if they are from an ancient civilization.

The Arctic supports a small number of animal species. The Arctic's wildlife consists mainly of aquatic and semi-aquatic animals.

Porcupines can be ferocious animals when they are cornered. The porcupine has one of the best defense systems in the animal kingdom.

Water is a liquid which is essential to life. Water quenches thirst and provides the body's cells with enough fluid to keep them alive.

Moose sometimes fight for the female of their species. The male moose charge at each other and do combat by bashing each others heads.

Tomatoes are a very versatile food for cooking. Tomatoes can be used to form the base of many sauces and are very often used in Italian cuisine.

Squirrels can often be seen gathering and eating their food in oak trees. Squirrels break the shells with their teeth and let them fall to the ground.

Operas hire those people who have the best voices. Operas usually have several sopranos and tenors and a few altos and basses to perform the music.

Pepper is a strong spice used to add flavour to many foods. Pepper adds quite a bite to most foods especially if it is freshly ground.

Jungles are filled with many animals who live in the trees. Jungles are rich in long vines and creepers which enable animals to swing from tree to tree.

Tokyo is a very busy and very large centre in Japan. Tokyo is noted for its advanced public transit system and its modern manufacturing sector.

Liver is an important source of essential minerals. Liver is helpful in enriching the blood which aids in the prevention of anemia.

Brass is the material used to make several musical instruments. Brass is mostly used to make the horns used in all school bands.

The giraffe is an odd looking, tall animal. Giraffes are able to reach high into trees and nibble on buds and leaves other animals cannot reach.

Trucks are sometimes fitted with wheels which have deep treads. Trucks use these strong rubber wheels to get across rough terrain.

Snakes have somewhat slimy skin covering their whole body. Snakes are sometimes skinned and then used to make belts, shoes and purses.

Peaches are covered with thousands of fine little hairs. Peaches are peeled by many people before they are eaten because they don t like these hairs.

Watermelon appears to be pink and spotted with black dots when sliced. Watermelon is a pain to eat because these black dots have to be spit out.

Oysters are highly valued for the precious gem they yield. Oysters produce these gems as a reaction to irritants which enter their shells.

Lobsters are bottom-feeders which grab their food in their pincer-like appendages. Lobsters are able to open and close these appendages very rapidly.

Sheep are sheared and their curly hair is taken to be spun. Sheep provide us with the material to make sweaters, socks and other clothing.

Shoes need to be well tied if they are used for jogging or for playing sports. Shoes generally stay tightly tied if they have several eyelets.

Cakes are delicious when they are covered with a sweet spread. Cakes must cool down first, however, before the spread can be applied.

Doctors use several different instruments in the care of their patients. Doctors often use a device that lets them listen to their patients' heartbeats.

Pigs have voracious appetites but their main staple is a yellow vegetable. Pigs eat not only the kernels but also the cobs as well.

Desks are most useful if they have several places to store files and writing materials. Desks sometimes have locks on these compartments.

Organs in churches look very impressive due to the large amount of metal tubing. Organs make sound when air is pushed through this tubing.

Denim is very strong and tightly woven cotton. Denim is used to make all sorts of clothing such as jeans, skirts, and jackets.