THE EFFECTS OF CONTEXT ON SPEECH UNDERSTANDING IN NOISE

by

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ABSTRACT

Twelve normal-hearing subjects (22 to 29 years) listened to passages of text in the presence of a twelve-speaker babble background noise. The passages were presented in a line-by-line fashion and subjects were asked to repeat each line as accurately as they could. The present study investigated whether three text types differing in macrostructure (narrative, descripitive, and procedural) would differentially effect how speech is perceived in the presence of background noise. Also, the number and types of errors (deletions, additions, substitutions, and exchanges) that ocurred as signal-to-noise conditions decreased from 0dB to -12dB were examined. The degree to which a subject's response matched the target at three linguistic levels (auditory, syntactic, and semantic) was analyzed as either a partial match, total match, or no match at all. It was found that when listening to narratives, significantly fewer errors were made than when listening to descriptions. It was also shown that if only the number of auditory errors are counted and used as a means by which to assess the listening abilities of an individual in noise, then the robustness of syntactic and semantic information is not appreciated.

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CHAPTER 1

INTRODUCTION

Rationale

In the past audiologic evaluation and rehabilitation have largely been based on measures of how individuals hear single words or non-speech signals (Olsen & Matkin, 1991). Traditionally, when speech materials have been used, audiologists have assessed communication impairment by having their clients repeat single monosyllabic words presented in quiet. This type of evaluation, however, is not a valid means by which to assess an individual's ability to understand speech in everyday communication situations (c.f., CHABA, 1988; Noble, 1983). Ideal conditions for communication consist of two-talkers in a quiet environment using language that is familiar, simple, and clearly articulated. Unforunately, most situations are less than ideal. We often need to understand an unfamiliar message spoken with less than perfect articulation in a noisy environment amidst other competing distractions. To more accurately represent an individual's ability to understand speech in real-life situations requires that we employ speech materials and test procedures which are more representative of listening in everyday situations. For example, a more ecologically valid speech assessment tool might employ connected discourse materials presented in noisy, reverberant, binaural situations whose administration are under the control of the client herself and which require the client to demonstrate her comprehension of the topic being presented (c.f., CHABA, 1988).

Since everyday speech understanding typically involves the reception of continuous discourse which is supported by situational context (i.e., speaker, background activities, general setting), previous knowledge both about the topic, and of the underlying text structure of the discourse, research needs to be directed at investigating the contribution that

each of these sources of information makes in speech comprehension. Different text types have been identified and shown to have differential effects on recall and reading comprehension . It is the intention of this study to examine whether different text types effect the ease with which discourse is perceived in the presence of background noise.

As long ago as 1955, Miller and Nicely demonstrated that the perceptual confusions of consonants in nonsense syllables presented in noise are not random errors. They tabled their results in confusion matrices that identified which phonemes were presented and which phonemes were perceived in particular signal-to-noise ratios. This study was the first of its kind to perform a perceptual error analysis on the phonemic confusions which occur in a range of signal-to-noise conditions. It was the belief of those researchers that by describing the types of errors that were made knowledge about the nature of speech perception would be increased, with the possibility that communication could be improved. Following the logic of Miller and Nicely (1955), the present study is motivated by the belief that an understanding of the pattern of errors that occur when listening to discourse in noise will shed light on the process of speech understanding in difficult listening situations, and will also provide insight for the development of effective communication strategies to teach in aural rehabilitation programs.

Goals

The first goal of the present study is to determine if text types which differ in macrostructure differentially effect how speech is perceived in the presence of background noise.

The second goal of the present study is to determine the types and number of errors that occur when texts are listened to in different signal-to-noise conditions.

Hypotheses

Hypothesis 1: The number and types of errors that occur when a listener repeats a passage of text with a predictable macrostructure (e.g., a narrative) will not be significantly different from the number and types of errors that occur when a listener repeats a passage of text with a less predictable macrostructure (e.g., a description or a procedure).

Accompanying research hypotheses:

The number of errors a listener makes when repeating a narrative will be less than the number of errors made when repeating a description (e.g., restaurant review) or a procedural sequence (e.g., recipe).

The types of errors a listener makes when repeating a narrative will be significantly different from the types of errors made when repeating a description (e.g., restaurant review) or a procedural sequence (e.g.,recipe).

Hypothesis 2: As the signal to noise ratio decreases, and listening conditions become less favorable, the number of errors and the types of errors that occur when a listener repeats a passage of text will not be significantly different from the number and types of errors observed under more favorable signal-to-noise conditions.

Accompanying research hypotheses:

The number of errors a listener makes will increase as the listening conditions become less favourable.

As signal-to-noise ratio decreases, the number of deletion errors will increase, the number of substitution errors will increase, the number of addition errors will increase, and the number of exchange errors will increase

As signal-to-noise ratio decreases, the number of auditory errors will increase, the number of semantic errors will increase, and the number of syntactic errors will increase with auditory errors out-numbering semantic errors, and semantic errors out-numbering syntactic errors.

CHAPTER 2

REVIEW OF THE LITERATURE

Speech Understanding

The comprehension of spoken language requires the rapid construction of meaning from a transitory acoustic signal. Speech understanding is accomplished through the action and interaction of 'bottom-up' and 'top-down' processes. 'Bottom-up' processing has been referred to as the processing of an acoustic signal from the level of the acoustic waveform to the recognition of word elements and words to the level of semantic representations (e.g., Brown & Yule, 1989; CHABA, 1988; Marslen-Wilson & Tyler, 1981; Stine, Wingfield & Poon, 1989). In contrast, 'top-down' processing has been used to mean the influence of world knowledge and context in the interpretation and comprehension of the speech signal (e.g., Brown & Yule, 1989; Marslen-Wilson & Tyler, 1981; Stine, Wingfield & Poon, 1989). To gain an appreciation for how top-down and bottom-up processes contribute to language comprehension, it is useful to consider a model of language comprehension. One such model will be presented and then the operation of top-down and bottom-up processes will be discussed.

Language Comprehension Model

In describing a model of speech processing, we are faced with three questions: First, is linguistic processing autonomous or is it part of an individual's general cognitive processing abilities; second, how do the phonetic, lexical, structural, and semantic components of a language processor interact ; and finally, is the speech signal analyzed continuously from the moment acoustic input impinges on the peripheral hearing system or is it processed in finite chunks ?

The Issue of Autonomy

The autonomous versus non-autonomous positions on language processing have generated great debate. Those who assert an autonomous view believe that a linguistic processing system exists which is distinct from more general cognitive systems (e.g., Fodor, Bever, & Garrett, 1974; Forster, 1979). The global processing position purports that linguistic processes are not separate and are operated on by a central system which operates on all kinds of information (e.g., Marslen-Wilson & Tyler, 1981). This global model allows world knowledge to influence and assist in linguistic processing. In their extreme, these earlier views are mutually exclusive and one allows no room for the other.

In a more recent model, Cairns (1984) proposes a model of language comprehension that appears to strike a compromise. In her model, Cairns (1984) describes two sets of processors which operate in an independent fashion. One set of processors includes a lexical processor and a structural processor. Each of these sub-processors has access to the lexicon but not to world knowledge. Cairns (1984) proposes that these processors analyze only the purely linguistic properties of the speech input and respond only to linguistic information[1]. The lexical processor retrieves lexical items from the lexicon using only phonological information and is involved in the process of checking the contents of the lexical entry against the speech input to assess the accuracy of the retrieval operation. Along with phonological information, each lexical entry has associated with it its form class and the sentence frames into which it can be inserted. The structural processor creates a formal structural analysis of the speech input. It can only use syntactic information to create its analyses, and can perform no operation which cannot be described in purely formal syntactic terms. In this way, it cannot access world knowledge or perform any operations for which world knowledge is required. The collective output from these two subprocessors depicts the structural organization of individual lexical

[1] Cairns (1984) takes the position that semantics and pragmatics are not pure linguistic forms and thus are not part of the linguistic system proper.

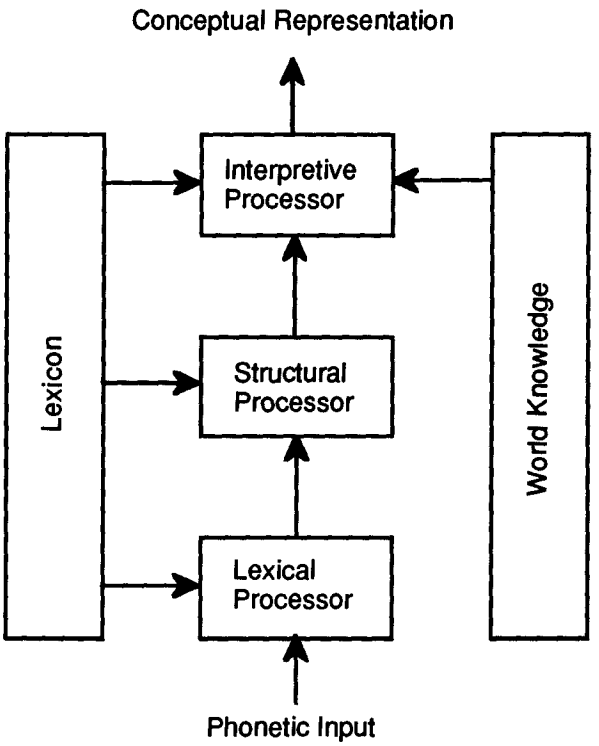

Figure 1. Language comprehension model after Cairns (1984).

items and serves as input to the interpretive processor.

The interpretive processor receives input separately from the lexicon and in turn from the structural processor. In addition, it has simultaneous access to real-world knowledge, thereby having the capability of generating inferences and assessing the plausability of relationships between and within sentences. According to Cairns (1984), it is through the actions of this processor that both linguistic (i.e., syntactic and phonological) and nonlinguistic information are used to generate a coherent, meaningful representation of incoming discourse (denoted in Figure 1. as 'conceptual representation').

Cairns (1984) assigns the interpretive processor two primary functions: First, the construction

of a nonlinguistic conceptual representation of the current speech input through the process of integrating information from the individual lexical items (via input from the lexicon) based on their structural organization (via input from the structural processor) together with inferences based on real-world knowledge; and second, the integration of individual sentences into a conceptual representation incorporating the linguistic and nonlinguistic contexts in which they occur. Since semantics and pragmatics are typically considered to be not merely a part of general world knowledge, it seems to me that the operation of the semantic and pragmatic components of language processing is inherent in the functions ascribed to the interpretive processor.

While Cairns (1984) states that her model is an autonomous one, this is only true if one excludes semantics and pragmatics as part of the linguistic system. If, however, one includes these components within the realm of the linguistic system then the model presents as a hybrid between a modular language processing system and a global language processing system. It is modular in the sense that initial lexical retrieval is dependent solely upon phonological information and does not involve world knowledge (see Fodor, 1983). It is also modular in that the assignment of a formal syntactic organization of the lexical items is achieved without input from world knowledge (see Fodor, 1983). The model is global in that it allows for language processing to be a part of a broader general cognitive processing scheme.

If one considers semantics and pragmatics to be a part of the linguistic system then this model cannot be said to describe an autonomous view of language processing because the semantic and pragmatic components interact with world knowledge. In this way, Cairns' (1984) model of linguistic processing can be said to be autonomous prior to the involvement of semantics and at the level of semantics, language processing ceases to be autonomous.

As one would expect, the way in which lexical access is achieved is dependent on whether a modular or non-modular approach is taken. The non-modularists believe that the influence of context and world knowledge results in only one lexical item being retrieved, whereas the modularists believe that an exhaustive retrieval is made of all lexical items which are phonologically appropriate. The correct item is selected when context and world knowledge participate in a post-lexical access stage. Numerous experimental studies have been cited which support the former (see Marslen-Wilson, & Tyler, 1981) as well as the latter (see Cairns, 1984). The critical factor that differentiates these two approaches is the point in time at which world knowledge is introduced into the system. This is perhaps best highlighted by an examination of how both perspectives use cohort theory as the primary mechanism of initial lexical access and describe the generation of similar end-products, but rely on different operatonal pathways to achieve the final output.

Both Cairns (1984) and Marslen-Wilson and Tyler (1981) discuss lexical access within the framework of cohort theory. Cohort theory states that incoming phonological information activates a cohort of lexical items, the initial syllables of which phonetically.match the input. Members of the cohort deactivate as further phonetic information produces a mismatch. In the absence of context or world knowledge, a lexical item will be selected as soon as it is uniquely determined by the incoming information. In this theory, contextual information can be recruited to deactivate semantically ineligible members of the cohort after they have been activated by phonetic information.

Marslen-Wilson and Tyler (1981) discuss the operation of the word-initial cohort within a general cognitive processing framework. They refer to a series of experiments (Marslen-Wilson, 1973, 1975, 1976; Marslen-Wilson and Tyler, 1980) which employed shadowing tasks as a means to evaluate the speed of on-line speech recognition. Subjects were required to

repeat back continuous speech as it was heard. Repetition delays were then measured between the onset of the target word in the material they were listening to and the onset time of the repetition of that word. After the application of a correction factor for the time taken to actually make the response, word recognition time was estimated to be 200 milliseconds. This measurement indicates that words were being recognized before the listener could have determined what the word was solely on the basis of the acoustic-phonetic information. With regards to cohort theory, Marslen-Wilson and Tyler (1981) propose that since spoken words can be recognized when many words are still compatible with the available sensory input, then it must be the influence of context which aids in the selection process. To accomplish this Marslen-Wilson and Tyler (1981) state that it is critical that the active subset of word initial cohorts be sensitive to not only the continuing sensory input but also to the compatability of the words they represent within the available structural and interpretive context. A mismatch with either source of constraint would cause the lexical item in question to be excluded from the pool of potential lexical selections.

Cairns (1984) states that since cohort theory postulates activation processes which are sensitive to only phonetic information and selection processes that are sensitive to other types of information then "[such a] theory is not necessarily nonautonomous (p.221)". She suggests the need for a cohort theory containing a passive lexicon and selection processes that actively employ other types of information (i.e., syntactic, semantic, and world knowledge). In this way the modularity of lexical access is maintained without losing the facilitory actions of context.

It seems to me that each of these approaches defines the same set of processes with the critical difference being the specific time when lexical access stops and post access selection and verification begins. Within the processing system of Marslen-Wilson and Tyler (1981),

context is said to operate at the level of lexical access, whereas within the processing system of Cairns (1984) context operates at a post-access stage. In the former model the lexical item is available to further processing during the access stage and therefore only one item is part of the output into the post-access stage, whereas in the latter model further processing can not occur until the item has been retrieved. As a consequence, numerous lexical items are pulled into the post-access stage for further analyses before any one item is singled out. Thus, how the cohorts are operated on once they become available seem not to differ.

Deciding whether lexical selection processes are autonomous or not is dependent on experimental research which elaborates the kinds of information which are necessary for lexical access and the time frame within which processes operate on the information. As stated previously, Marslen-Wilson and Tyler (1981) have found word recognition to occur by 200 milliseconds. These results have been confirmed by a series of experiments in which subjects were presented with the first 50 msec of a word and asked to identify it (Grosjean, 1980). If the subject was unable to do so then they were given the first 100msec, then the first 150 msec and so on until they identified the word. Grosjean (1980) found that words in context could be recognized within 175 to 200 msec of onset. He also found that words out of context took on an average 333 msec to identify. Cairns (1984), however, reports that previous research by herself and her colleagues has found retrieval and post-retrieval processes to be completed within 500 milliseconds. Based on these findings, it is evident that while both views recognize lexical access as time-dependent, they differ on the time window within which these processes occur.

The Issue of Continuous vs. Discrete Processing

Marslen-Wilson and Tyler (1975) present evidence that speech input is continuously analysed by the listener with respect to its implications for a message-level interpretation. They

conducted an experiment in which three types of prose materials were used: normal prose which contained normal utterance strings; anomolous strings which were syntactically correct in form but contained no coherent semantic interpretation; and scrambled strings which were both semantically and syntactically anomalous. Subjects were presented these strings in either the presence or absence of a preceding context sentence. The task of the subject was to listen to the test materials for a target word specified in advance, and respond as rapidly as possible when they detected it. The idea underlying this approach was that the different types of processing (e.g., syntactic, semantic) would interact with the word recognition processses upon which the target words depended and by measuring response times at different points across the test materials it was possible to determine when syntactic and semantic information became available. Results showed that normal sentences yielded significantly faster response times than anomolous and scrambled strings. This was said to indicate that the extra-processing information that normal prose provides is developed by the listener from the earliest moments of speech input. It was found, however, that this early advantage of normal sentences over the other word strings was present only when a context relevent sentence preceded the sentence of interest. Based on this finding, it was then said that the effects observed with the context sentence were evidence that the first words of an utterence were evaluated in relation to their discourse context. In this way it was argued that the listener attempts to construct a discourse relevant representation of the incoming speech signal as soon as it is received.

The model proposed by Cairns (1984) is compatible with the notion proposed by Marslen-Wilson and Tyler (1981) that the speech signal is processed continuously and not in discrete units. The operation of the processors within Cairns' (1984) model is assumed to be independent but not necessarily serial. An example of a serial operation within this model would be that before the structural processor can begin its analysis it must have information

about the form class of the items it will be processing therefore it must wait for lexical retrieval to occur. An example of parallel processing within this model would be that the interpretive processor could be developing expectancies based on world knowledge, that has been recruited on the basis of preceding linguistic input, at the same time the lexical and structural processing is proceeding. These expectancies in turn play a role in the integration of the most recently processed speech input into the developing conceptual representation. The concept that message level interpretation of the speech input is initiated right from the beginning of the utterance (i.e., with the utterance of the first phonemes) differs significantly from the original observations and proposals which have emphasized syntactic or functional clauses as units of speech perception (Fodor, Bever, & Garrett, 1974). Perhaps the most contemporary view put forth for these processing mechanisms is that of a temporally continuous, on-line analysis of the speech stream which involves a knowledge-driven search for the completion of functional semantic relationships (e.g., Stine, Wingfield, & Poon, 1989). This type of processing has been supported by by Marslen-Wilson, & Seidenberg (1978, as cited in Cairns, 1984), who demonstrated that the ideal segmentation units are not only functionally complete but also informationally complete. It has been in this way that the 'clause-effect' was explained to be the natural outcome of higher level processes integrating semantically cohesive units on a preferential basis (Cairns, 1984). If informational completeness underlies higher-level processing, then the role of discourse structure to drive higher cognitive processes to construct coherent representations of incoming discourse becomes apparent.

Bottom-up and Top-down Processes

The initial set of analyses performed on the speech input are assumed to be 'bottom-up'. That is, the members of the word-initial cohort are determined by properties of the sensory input. Once the system receives the output of this initial 'bottom-up' processing, a characteristic set of operations ensue. Marslen-Wilson, and Tyler (1980) demonstrated this when they asked

subjects to focus their attention on only the acoustic-phonetic properties of the input and found that the subjects were not able to avoid identifying the words involved. These results imply that the kind of processing involved in spoken-word recognition are mediated by automatic processes (Marslen-Wilson, & Tyler 1981). Based on this work, it has been proposed that this same type of automatic processing holds true for operations throughout the language processing system (Marslen-Wilson, & Tyler, 1981). Such a position subsequently implies that 'top-down' processing (i.e., involvement of contextual expectations) is not involved in initial or normal 'first pass' processing. Marslen-Wilson and Tyler (1981) propose that the apparent interaction of word recognition processes with top-down influences are an illusion. They state that what is really occurring is the incorporation of the correct word, based on phonetic input and syntactic constraints, into the interpretive representation of the utterance. This is similarly demonstrated by Cairns' (1984) model in which the output of the lexicon and structural process feed directly into the interpretive processor. The benefit of a system operating in this manner is that it ensures that the analysis of the input will always be developed as far and as fast as it can. If one subscribes to this type of obligatory bottom-up processing then one is forced to allow the recruitment of top-down processes only after the automatic flow of the bottom-up proceses have been interrupted. Within this perspective top-down processes are recruited in the 'second pass' after bottom up processes have failed to achieve complete comprehension on the first pass.

Another way of differentiating bottom-up and top-down processing is to say that bottom-up processing involves only the perceptual processes that result in the activation of the phonologically appropriate lexical items in the lexicon and that all subsequent processes are top-down because they involve structures and processes that are integral components of higher-level human cognition. Within this perspective first pass and second pass processing is a moot issue.

For our present purposes it is important to be aware that where bottom-up processes end and where top-down processes begin have not been universally agreed upon, however, it seems to be unanimous that the initial speech input is acted upon by bottom-up processes and that top-down processes do involve the recruitment of context and world knowledge in achieving comprehension. It is beyond the scope of this discussion to review all the experimental research that has accumulated on this topic, but since the current experiment manipulates the quality of the acoustic-phonetic signal, it is relevant to discuss some of the studies which have examined the the facilitory effects of top-down processing on the perception of lower-level information when the acoustic signal is degraded.

In 1963, Pollack and Pickett conducted an experiment in which they isolated words from tape recorded samples of normal converstaional speech and presented them individually. They found that the words were not intelligible in isolation, but were readily understood when reinserted into the fluent speech. In isolation the articulatory precision of each of the individual words was extremely poor and, as a consequence, could not be understood. Also in 1963, Miller and Isaard demonstrated that a word imbedded in noise is more intelligible if it is framed by a normal sentence then if it is framed by a semantically anomolous sentence, and is least intelligible when it is framed by a syntactically anomolous string of words. This result was interpreted to mean that the intelligibilty of strings of words depends partially on their conformity to the linguistic rules of the listener.

The phonemic-restoration effect as described by Warren (1970) also demonstrates the operation of top-down processes. This effect was found when subjects heard a speech signal as normal when a phoneme in the speech signal had been replaced by white noise and even when they were told in advance that they would be listening to a speech signal in which a phoneme had been replaced.

Wingfield, Poon, Lombardi, and Lowe (1985) have demonstrated the facilitory effects of context on the speech signal when it has been compressed in time. Using normal sentences, semantically anomolous sentences, and syntactically random strings they showed that when speech was speeded up to 425 words per minute (e.g., more than twice the rate at which normal conversations occur) young and old subjects showed excellent recall with normal sentences and significantly poorer recall with syntactically anomolous strings.

Together the studies described above demonstrate that when bottom-up processing at the perceptual level is less than ideal, top-down processing is recruited to facilitate construction of a coherent message. This point is relevant to this experiment since it is the intention of this study to perform an error analysis on the types of responses people produce when they experience listening conditions in which the signal is systematically degraded. By evaluating the responses in relation to the semantic, syntactic, and phonetic characteristics of the target message insight into the actions of bottom-up and top-down processsing may be gained.

Cognitive Considerations

The effectiveness of top-down processing is a function of the higher-level cognitve structures and processes that comprise it. For the purposes of this study, it is relevant to discuss some of the relevant cognitive structures and processes: coherence, inference, world knowledge and schemata. It is also important to consider how working memory affects comprehension. This is the cognitive space where these processes interact and produce the final output of the comprehension process.

Coherence and Inference

After the speech signal impinges on the comprehension system of a listener, during processing

each word, phrase, clause, and/or sentence is integrated into a conceptual representation. The property which confers a sense of relatedness on a passage of discourse and which differentiates a text from a sequence of unrelated sentences or ideas is known as coherence (Brown & Yule, 1989). Coherence is computed by the listener with the aid of a collection of knowledge sources: knowledge of the prevailing situation, or the situation being referred to; knowledge of the causal and logical relations among the described events; knowledge and use of the explicit cues provided by the discourse to guide the integrative processes; and knowledge of the discourse structure (Just & Carpenter, 1987).

Brown and Yule (1989) identify two principles of interpretation that are available to the listener and which form the basis of his or her assumption of coherence. These are the principle of local interpretation and the principle of analogy. The principle of local interpretation dictates that the listener not construct any text larger than he or she needs to arrive at an interpretation. It is the listeners knowledge of the world which constrains his or her local interpretation. This is related to the notion that it is an individual's experience of past events that will generate expectations about what are likely to be relevant aspects of context. The principle of analogy states that the listener will assume that everything will remain as it was before unless specific information is given otherwise. It is this principle that underlies the idea that human beings try to interpret any text they encounter (Brown & Yule, 1989).

If the discourse or text does not explicitly indicate how the clauses or sentences are related to one another then the listener must engage a second strategy that aids in generating an understandable and interrelated interpretation of what they are hearing or reading: Inference. According to Just and Carpenter (1987) the integration of sentences of a text is particularly dependent on inferences. Inferences are based on the comprehender's knowledge of the world, knowledge of his or her language, and knowledge of the preceding portions of

discourse already received.

World Knowledge & Schemata

In a discussion of speech and text processing it is necessary to consider the knowledge that a reader/listener contributes to the comprehension process. To any listening situation the listener brings with him or her a body of knowledge which has been acquired through either direct experience with objects, people, and events in the real world or through indirect experience with a world described by a text or another person. This prior knowledge influences and shapes the comprehender's interpretation of every aspect of his or her experience in the world, including his or her experiences with text (see de Beaugrande, 1980).

The issue of how 'prior knowledge' functions in language comprehension is at the heart of schemata based theories of comprehension. Schema theories have focused on outlining the interaction of old knowledge with new incoming knowledge. A schema is a stereotyped internal representation of elements and their relations (Mandler & Johnson, 1977) and summarizes what is known about a variety of cases that differ in their detail (Anderson & Pearson, 1984). A schema provides a means by which incoming information can become integrated into existing knowledge structures. These highly organized generic knowledge structures contain a set of slots, where each slot defines a particular type of information. These slots are instantiated with the content of incoming information (Anderson, Spiro, & Anderson, 1978). Different schema-constructs have been identified: Schemas (Bartlett, 1932), scripts (Schank & Abelson, 1977), and frames (Minsky, 1975). Each of these contains highly organized structures and conventionalized information about a set of elements and their relations. Perhaps the most frequently cited example of a schema is that of going to a restaurant to eat. Individual occurrences have much in common but may differ in specific details. There is a common goal structure (i.e., getting something to eat for a price), there is a common

setting (i.e., a place of business which earns money through the preparation and sale of food), there is a common set of roles and instruments which tend to be present (i.e., customer, waiter, kitchen, tables, menus, plates) and the actions are standard (i.e., ordering, eating, paying). What the waiters are wearing, what is on the menu, how expensive the food is are some of the details that are likely to vary from restaurant experience to restaurant experience. In the interpretation of a particular situation the elements in the situation are matched with the elements that are part of the generic characterizations in the schematic knowledge structure itself. It is in this way that the slots of the schema are instantiated with the semantic content of a particular situation.

Evidence has been presented which supports the use of schemata in the comprehension and memory of text materials (see Kintsch, 1977; Mandler and Johnson, 1977; Rumelhart, 1977; Thorndyke, 1977). These researchers have focused on demonstrating that text comprehension, encoding and retrieval processes rely heavily on the activation and use of schemata. For each passage of text a comprehender encounters, a schema consisting of a frame with labelled but unfilled slots is evoked/activated. When a schema is activated its slots are subsequently instantiated with the contents of the incoming information.

The literature on schema recognizes that, in addition to schemata for routine events (i.e., going to the proverbial restaurant), there are also schemata for structural aspects of text (Just & Carpenter, 1987; Minsky, 1975; Rumelhart & Ortony, 1977). Just & Carpenter (1987) describe a schema for a fable as containing slots for setting and characters as well as for an initial event, a complication, a resolution, and a moral. They suggest that a schema would indicate aspects of the temporal relations among the components as well

When a highly structured schema is evoked highly organized macrostructures are generated.

Well organized macrostructures facilitate comprehension processes of text, thereby, making them more efficient and effective. It is the contention of Kintsch & Young (1984) that some texts invite the construction of efficient well-defined macrostructures and others do not, depending on the schema that is activated by a particular text. The finding that narratives are recalled better than other texts can be interpreted within this framework: When listening to or reading a narrative the comprehender brings with him or her a well worked out schematic structure with which to organize the text during comprehension. This permits the development of a stable macrostructure which consists of elements in the text that are essential for the understanding of the text. Kintsch & Young (1984) contrast comprehension and recall performance of narratives with that of expository texts. They suggest that because expository texts lack a strong inherent organizational structure, the schemata that are evoked are poorly defined and as a consequence the macrostructures which are formed by the reader/listener are loosely constrained. In their 1984 study Kintsch and Young found that recall was better for a narrative text type than for an expository-descriptive text type. Similarly, Kintsch and Yarbrough (1982) observed that subjects were better able to answer questions for texts that were clearly organized according to a familiar rhetorical form than for terxts which contained identical content but lacked organozation. Thereby supporting the idea that the generation of well defined macrostructures leads to better performance in comprehension measures.

Also, Just and Carpenter (1987) cite that when a story does not permit a schema to be evoked readers rate the story as difficult to comprehend and demonstrate poor recall. Findings such as these demonstrate that comprehenders rely on schemata to organize the information contained in a text. When a familiar text is encountered, either because of its content or structure, the schemata which the comprehender possesses facilitates the speed of interrelating sentences, formulating expectations and drawing inferences. In this way comprehension is facilitated because the schema helps the reader impose an organization on the incoming information,

providing her with a ready made structure into which she can insert the new information she acquires from the text

Schemata & Prediction

Schemata guide the interpretation of explicit input, the generation of inferences, and the formation of expectations (Anderson & Pearson, 1984; Kozminsky, Kintsch & Bourne, 1981). Over time and experience the individual comprehender recognizes regularities and generalizes over his or her experience. In this way it becomes possible for the individual to recognize incoming experiences as being of a particular type (e.g., a job interview, a lecture, a narrative, a recipe). This process of drawing generalizations is what underlies the development of schemata. Equipped with templates for particular events and/or for particular linguistic structures it becomes possible to predict what is likely to happen, and what are and are not likely to be relevant features of a situation. In fact, schemata play such a strong role in the development of our expectations and abilities to predict what is a probable component in a given situation that the phrase "structures of expectation" has been used to characterize the influence of schemata on our thinking (Tannen, 1979 as cited in Brown & Yule, 1989). According to den Uyl and van Oostendorp (1980) an expectation is any kind of readiness to accept one course of events as more likely, more natural than another. Research studies have shown that readers do use a schema as a set of expectations for predicting the structural aspects of text (Mandler & Johnson, 1977, Kintsch & Van Dijk, 1978; Stein & Glenn, 1979).

Working Memory

When we read a book or listen to a lecture or conversation, our cognitive systems must integrate the incoming information in such a way that coherent semantic units are constructed which permit the passage or lecture to be understood. For the most part, the input an individual receives when reading or listening is serial in nature. As the input is

received it is related to and integrated with concepts that have just preceded it and prior knowledge housed in long term memory. In the process of manipulating the incoming information both partial and final products of comprehension are generated. It is a consequence of the sequential nature of language input that, in order for these computational products to be integrated with one another to effect successful comprehension, the comprehender must be able to temporarily store information from early parts of a sequence in order to be able to integrate and relate them to later parts. What is typically referred to as 'understanding' is in essence the processing, integration, and temporary storage of interrelated concepts.

The site where information can be both processed and temporarily stored during complex cognitive tasks such as language comprehension has been identified as a single central system called working memory (WM) (Baddeley & Hitch, 1974; Carpenter & Just, 1989; Just & Carpenter, 1987). Through the allocation of its processing and storage capabilities it is the role of working memory to manage incoming information from perceptual encoding processes, retrieval from long term memory, and/or from the output of a comprehension process (i.e., a partial or final product) (Daneman & Carpenter, 1980).

In a complex cognitve task, such as language comprehension, an individual receives and must process information across time. For example, when listening to a lecture an effective listener must 'take in' the topic of the lecture, the representation of the ideas presented, the major propositions from preceding sentences and their interdependencies, as well as a running multi-level representation of the most current statement. It is information of this type that WM must manage and allocate its storage and processing resources to. For an idea to be be housed in WM it must be actively maintained if successful integration is to occur (Carpenter & Just, 1989). It has been proposed that information is kept active in

working memory through its participation in the comprehension process (Daneman and Carpenter,1980). That is, if a piece of information is not actively integrated into the existing "chunks" of structure that are being maintained in working memory and subsequently stored within that chunk in working memory, then that concept is lost from working memory.

Working memory is assumed to have a limited capacity (Miller, 1956). The limits of working memory have been demonstrated to be seven chunks (Miller, 1956), out of this research finding has arisen the question of how large a chunk is (Simon, 1974): Is a chunk a single item (e.g., one digit) or is it a hierarchical structure (e.g., a propositional network). Contemporary thought is that the set of seven chunks refers to seven pointers that index relational data structures (Carpenter & Just, 1989). By possessing "chunks" which can be quite large it becomes possible to more fully understand how people can reason and understand language in spite of the limitations of WM.

Even though complex cognitive processes can be carried out, WM is not infinite and both the processing and storage functions must share this limited resource (Baddeley & Hitch, 1974; Daneman & Carpenter, 1980). As a consequence of this sharing, tradeoffs occur between the storage and processing components of WM; it is assumed that the processing function takes priority over the storage function. Daneman and Carpenter (1980) designed a comprehension task to demonstrate the tradeoffs between the storage and processing components of WM. In the task, a subject is presented with sets containing two to seven unrelated sentences. The subject is required to read each of the sentences in a set aloud and at the end of each set of sentences recall the final words of each sentence. The largest set size from which all of the sentence final words can be recalled is defined as that individual's reading span. Based on the hypotheses that information is kept active through

its participation in the comprehension process and that maintaining even a small number of extraneous unrelated words in WM places considerable burden on WM because their maintenance is not a natural part of the comprehension proceses, together with the notion that processing takes precedence over storage, Daneman and Carpenter (1980) reasoned that individuals with more efficient processing would have more storage space to dedicate to the maintenance of the extraneous word than would indiviudals with less efficient processing, and would therefore demonstrate greater WM spans. Their results supported this hypothesis: subjects with greater WM spans were better readers than those with smaller WM spans (Daneman & Carpenter, 1980). Other research findings have supported this hypothesis: It has been demonstrated that individuals with larger WM spans are more efficient readers or listeners than those with smaller WM spans (Daneman & Carpenter, 1980; Daneman & Green, 1986).

It is important to note that WM does not possess a set capacity. Rather the capacity of WM varies as a function of how efficient the individual is at the specific processes demanded by the task to which WM is being applied (Daneman & Green, 1986). Also, storage capacity is only traded away to provide additional processing resources in those situations in which an individual is close to or above his or her WM span (Carpenter & Just, 1989). Thus, exactly when processing becomes a burden is different for different memory load conditions and is different for different individuals.

WM capacity is a crucial source of individual differences in language comprehension. The capacity of WM is determined by the efficiency with which the processing and storage functions are coordinated with one another. Individuals with less efficient processes must dedicate more of their WM resources to processing functions and as a consequence are left with a functionally smaller storage space (Daneman & Carpenter, 1980).

A discussion of WM is relevant to the current study because the constraints imposed by WM may account for individual differences in listening to speech in noise. A listener with less efficient WM processes may demonstrate poorer abilities to understand speech-in-noise than an individual with more efficient WM processes. In very poor signal-to-noise conditions the resources dedicated to perceptual (or bottom-up processing) are greater than in ideal listening conditions. This may have the effect of significantly reducing bottom-up processing. Using this line of reasoning, individual's with more efficient WM systems will have more available resources to dedicate to higher-level cognitve processsing and therefore will be more successful in difficult listening situations than those individuals with less efficient WM systems.

If WM is the site where bottom-up meets top-down processing, then the interactions between these two processing systems will be constrained by the capacity and limitations of the WM system. As previously mentioned, processing demands take precedence over storage demands. Therefore if a given task requires a great deal of processing, then storage capacity will be reduced. If storage is seriously degraded, then an individual will have a more difficult time integrating and interrelating incoming information. Consequently comprehension will become very difficult. In the case of listening to speech in noise , if the noise is so great that almost all the resources of WM are devoted to processing, then storage will be reduced and it becomes difficult to construct a coherent message.

Evaluation of Speech Understanding

Everyday Communication

Ideal conditions for commuication consist of two-talkers in a quiet environment using language that is familiar, simple, and clearly articulated. Everyday listening , however, typically involves situations that are less than ideal. We often need to understand an unfamiliar message

spoken with less than perfect articulation in a noisy environment amidst other competing distractions. The stimuli and procedures used in traditional audiological evaluations are not designed to assess individuals in everyday listening conditions.

Stimuli Used in Communication Evaluations

Results from pure-tone tests do not provide an accurate means by which to assess an individual's ability to understand speech in everyday communication situations (e.g., Elliott,1963; Marshall & Bacon, 1981; Young & Gibbons, 1962). As a consequence, standard audiologic procedures have employed suprathreshold speech stimuli to evaluate speech understanding (see Penrod, 1985). These stimuli have included words and sentences, primarily.

Speech Signals Used in the Evaluation of Speech Understanding

Word-Level Speech Signals

Monosyllabic word tests are perhaps the most widely employed audiological means of assessing an individual's speech understanding. In North America, the CID Auditory Test W-22 (Hirsh et al., 1952) and the Northwestern University Auditory Test No. 6 (Tillman & Carhart, 1966 as cited in Penrod, 1985) are two such tests which receive widespread use. They contain lists of fifty single-syllable words that are balanced for word familiarity and either phonetic or phonemic distribution. The primary function of monosyllabic word tests is the assessment of an individual's ability to make correct phonemic judgements based on acoustic information (see Brewer & Resnick, 1983). Performance on these tests is often considered as a means by which to assess daily communication effectiveness and an individual's social adequacy in hearing (e.g., Hodgson, 1980; Penrod, 1985). Such tests, however, do not incorporate the syntactic, semantic, pragmatic, contextual, suprasegmental and cognitive information that are readily available in everyday speech: they assess only the

perceptual and word-level hearing abilities of an individual . For these reasons, performance on monosyllabic word tests clearly falls short of being an adequate reflection of an individual's functional communication abilities.

Sentence-Level Speech Signals

In an effort to ensure the individual could access cues normally available in an everyday listening environment, suprathreshold sentence tests were developed. Silverman and Hirsh (1955) created a set of sentences which consisted of ten lists of ten sentences with fifty key words contained in each list. In the design of these sentence-level tests, word familiarity, phonetic balance, word length, free variation in syllabic stress, phonetic distribution within each sentence, number of words per sentence, redundancy and abstraction were all considered. Also in an effort to overcome some of the shortcomings of the monosyllabic word tests, Speaks & Jerger (1965) introduced the test of Synthetic Sentence Identification (SSI). This test used sentences which followed the rules of English syntax but were semantically anomolous. It was proposed that although the SSI is a closed-set identification test, these materials were a better approximation of everyday speech understanding than monosyllabic tests because intonation patterns were preserved and responses were reliant on a closed set of information (i.e., knowledge of syntax and limited response set).

The speech perception in noise (SPIN) test was developed by Kalikow, Stevens, and Elliott (1977) as a means to assess a listener's ability to understand everyday speech. It was their contention that since speech understanding depends upon both the function of the peripheral hearing system (i.e., bottom-up processing) and the employment of cognitive processes (i.e., top-down processing) then any test of speech understanding necessitates that both of these kinds of processing be assessed. To accomplish this, they created a test which was sensitive to two types of information contained in the speech signal: the acoustic phonetic and the

syntactic-semantic (i.e., context dependent information). In the SPIN test, each test item is in the form of a sentence. The listener is required to report the sentence-final word after hearing each sentence. The original test was comprised of ten forms of fifty sentences each. Each form contained twenty-five high-predictability and twenty-five low-predictability sentences. A sentence-final word is considered high in predictability if it can be identified through the use of syntactic, semantic and prosodic cues available in the sentence (e.g., *A zebra has black and white stripes*). A sentence is defined as being low in predictability when the only means of identifying the last word in the sentence is through the recognition of the acoustical properties of that word (e.g., *The man talked about the stripes*). On the basis of studies of normal-hearing subjects, Kalikow et al. (1977), concluded that each of their forms was equivalent to one another with respect to phonetic content, average intelligibility, predictability of key words, and word familiarity. Instead of using a sample of normal-hearing subjects, Bilger, Neutzel, Rabinowitz, and Rzezkowski (1984) conducted a study to standardize the SPIN test on hearing impaired-listeners. They found the SPIN test as devised by Kalikow et al. (1977) to contain one weakness: the ten forms demonstrated statistically significant differences in their equivalence. Based on this finding, they revised the lists to be equivalent for hearing-impaired listeners. By this process they reduced the number of lists from ten to eight, but maintained the ratio of high to low predictability sentences.

According to Martin (1986), sentence tests have not gained a popular following because "their very construct enables the better guesser to make more meaning of a sentence than another patient with a similiar speech discrimination problem " (p.135). While it is true that the use of carefully balanced and well standardized sentences containing no inherent predictability will differentiate good discriminators from poor discriminators these tests will not differentiate effective from ineffective communicators.

To date, the SPIN sentences are one of the best attempt at measuring speech understanding They not only assess the perceptual abilities of the peripheral hearing mechanism, but they also consider the contribution of higher-level linguistic/cognitive processing to speech understanding. Although the advent of this test moves standardized suprathreshold speech testing in a direction which allows for a more valid evaluation of speech understanding than traditional speech discrimination tests, it does not account for the roles of cohesion, coherence, inference, prior knowledge, and memory in everyday speech understanding behavior. Discourse or text materials would involve these components and therefore would be the most appropriate material to use in assessing functional speech understanding abilities.

Discourse-Level Speech Signals

In an effort to create a test of speech understanding that possessed a high degree of face validity, the Connected Speech Test (CST) was developed (Cox, Alexander, & Gilmore 1987). Underlying this test was the rationale that since continuous discourse is the type of speech typically encountered in everyday listening situations, then tests of speech understanding should use continuous discourse. The test consists of forty-eight passages of connected speech, each with twenty-five scoring words. Each passage is about a familiar topic and consists of ten sentences and word describing the topic is presented prior to the presentation of a passage. The sentences are presented to the listener one at a time and the listener is required to repeat each sentence exactly as it was heard. Performance is defined in terms of the percentage of scoring words correctly repeated. A multi-talker babble, whose levels are adjustable depending on the goals of a given evaluation, is used as a competing signal. The presence of speechreading cues is optional, again depending on the goals of the evaluation (Cox, Alexander, Gilmore, & Pusakulich, 1989).

Although this test incorporates continuous discourse, thereby involving the processes of

cohesion, coherence, inference, prior knowledge, and memory, its potential for capturing and quantifying how effectively an individual really understands speech has not yet been exploited. Performance on the CST is based on the percentage of correct word repetitions. This type of measure does not evaluate speech understanding, rather it is yet another test which appears to be assessing speech understanding but is not. The CST was primarily developed as a tool with which to evaluate hearing aid benefit: The hearing aid yielding the best CST score was selected as the hearing aid providing the greatest degree of communication benefit (i.e., speech understanding). When speech understanding is evaluated in this manner, it is not possible to evaluate what processes (i.e., bottom-up or top-down) are engaged or how well the message is comprehended. If we are to evaluate speech understanding in a way that allows us to make judgements about communication abilities, then the assessment of each of these processes must be included.

In the typical clinical setting, discourse or text materials are not employed in the assessment of communicative impairment. The traditional focus on rigid test standardization and the need to eliminate useful redundancies in the test signal have created tests which are efficient at identifying perceptual difficulties but have prevented the evolution of clinical materials which are ecologically representative of everyday speech understanding. Before such clinical materials can be developed, a knowledge of different discourse/text structures and an understanding of how different text structures interact with speech understanding are necessary.

Text Structure

Text structure, text genre, text type, and rhetorical form are a few of the terms used to refer to the supra-organization that unites a text. This global organization is not dependent on syntactic relationships but rather on underlying semantic relations which yield the overall interpretaion of

a text. Kintsch and van Dijk (1978) characterize the semantic structure of discourse at two levels: The microstructural and macrostructural. The microstructure of a text refers the structure of the individual propositions and their relations, whereas the macrostructure is more global and characterizes the text as a whole. The macrostructure of a text expresses the gist, overall organization, and main points of a text (Kintsch and Yarbrough, 1982). It is the macrostructure that provides a text with overall coherence and it is this facet of text structure that is relevant to this discussion.

Standard text structures are thought to underlie all texts (Fayol, 1991; Hiebert, Englert, & Brennan, 1983; Horowitz, 1985; Kintsch & Yarbrough, 1982; Kintsch & Young, 1984; Meyer, 1975) and a number of researchers have sought to describe and classify each of these templates. Mandler and Johnson (1977) and Rumelhart (1977) describe the structure of simple stories. Thorndyke (1977) characterizes single-goal, single-protagonost narratives. Kintsch and van Dijk (1978), Meyer (1975,1977) and, Meyer and Freedle (1984) consider the text structure of expository writing.

Even from this short listing it can be seen that a text structure is typically categorized as either a narration or an exposition. Narrative structures consist of more temporal and causal relations, whereas expository text is more loosely defined in its semantic relations. Once a text has been identified as either narrative or expository, it is then often analysed further using a story grammar (Mandler & Johnson, 1977; Stein & Glenn, 1979) or an analysis technique specific to expository texts. The best known of these macrostructure analysis techniques are those of Meyer (1975) and Kintsch and van Dijk (1978). Analysis of rhetorical structure is not a goal of this study and therefore a detailed discussion of text analysis will not be covered here.

Several researchers have identified and defined categories of text types which involve more

than a simple assignment of a text to either just the narrative or expository category. Meyer (1975) organizes text types into five basic categories: Collection, description, causation, problem/solution, and comparison. Kintsch and Yarbrough (1982) describe four different rhetorical forms: Argument, comparison and contrast, definition, and procedural descriptions. Horowitz (1985) identifies five types of text types found in school texts: temporal order, attribution, adversative, covariance, and response.

Despite the differences in nomenclature each of these classification systems encompasses text genres of a relatively similar nature. Meyer's collection structure refers to a list of elements associated in some manner. Meyer's description structure has only one organizational component: elements within the text are subordinate to the topic. Horowitz's category of attribution is somewhat akin to both these organizational structures; whereas Kintsch and Yarbrough's category of definition is more similar to Meyer's description structure. Kintsch and Yarbrough and Horowitz each describe explicit categories for events associated with a specific temporal order: procedural description and temporal order. Meyer does not have such a category, although through the sequencing of either a collection or a description a similar category of text type is defined. The categories of causation and covariance are equatable, and the structure type they represent is more organized than either the collection or description forms. Elements in a causation structure are grouped within a time frame and are causally related. Meyer's comparison structure, Horowitz's adversative structure, and Kintsch and Yarbrough's comparison-contrast structure are all representative of the same category: the text is organized on the basis of similarities and differences, not on time or causalities. The categories of problem/solution, and response are also equatable. The text type they represent is perhaps the most organized of the schemes. According to Meyer (1975) it has all the organizational components of the causation structure with the addition of overlapping content

between propositions in the problem and the solution. Since the text analysis systems used by each of the above researchers is based on expository rather than narrative writings, they do not specifically categorize the structure of stories. Meyer and Freedle (1984), however, state that stories contain a combination of these categories and as an example cites folktales as containing description, causation, and collection within an overall problem/soultion organization where the protagonist confronts and resolves a problem.

Each of these discourse types can be found to occur in a variety of familiar contexts: Political speeches (comparison); grocery lists (collection); recipes (procedural descriptions); and stories (any number or combination of the categories). Kintsch and Yarbrough (1982) and Meyer and Freedle (1984) describe most texts as containing more than one of these basic organizations. It may in fact be the case that pure text types do not occur in everyday reading or listening. It is more typically the case that individual pieces of text possess a combinatiuon of text types within which a particular text type may or may not dominate. In fact all the various combinations and permutations of text types within a piece of discourse may be representative of separate and individual text types, which to date have not yet been fully delineated because of the complexity of such a task.

It has been demonstrated that the text types have differential effects on recall and comprehension. Recall for passages organized as descriptions have been shown to be poorer than recall for passages organized within a problem-solution structure (Meyer & Freedle,1984; Meyer & McConkie, 1973), comparison or causation structure (Meyer & Freedle, 1984). Narrative texts have been shown to be more effective in facilitating comprehension and recall than expository texts (Graesser, 1981; Graesser, Hauft-Smith, Cohen, & Pyles, 1980; Kintsch & Young, 1984; Kozminsky, 1977; Tun, 1989). It is thought that the the additional organizational components found in the the comparison, causation, problem-solution, and

narrative structures facilitate encoding, efficient use of memory, and retrieval processes (e.g., Kintsch & Yarbrough, 1982; Meyer & Freedle, 1984).

Within each of the three clasification systems described above it becomes apparent that there is a continuum across which the organization of a text varies. Meyer and Freedle (1984) express this contimuum with description at the least organized end and problem/solution at the most organized end of the continuum. Similarily, Kintsch and Young (1984) identify narratives as possessing more organizational cues than descriptions.

Some text types possess a conventional ordering, which results in their associated macrostructures being highly predictable: In a procedural description the order in which a series of steps are to be executed prescribes the order in which they are to be given; in a definition the most general information precedes more detailed attributes; and in a story the problem to be confronted and resolved is presented before the solution. For other text types cues to organization are much looser, such that there is no pre-ordained sequence to which the information contained in a text must conform ; for example, in a simple description the information presented is not dependent on a particular position in the text, or on its position relevant to that of another piece of information.

It is the intention of this study to capitalize on the inherent predictability conferred on certain text types in examining how different text structures affect an individual's ability to listen to discourse in noise. It is expected that when listening to a passage of text whose organization dictates a macrostructure of a highly predictable form, performance in noise will be superior to that of listening to a passage with a less predictable macrostructure. This hypothesis is based on the idea that when a text structure is well-defined, predictable and organized in a manner that promotes top-down processing (see Mandler & Johnson, 1977), then performance in noise

will be optimal, since reliance on perceptual properties of the incoming speech stimulus are less beneficial than engaging higher level cognitive processing.

Competing Signals used in the Evaluation of Speech Understanding

We typically listen to speech in the presence of background noise yet, with the exception of the SSI and SPIN tests described above, suprathreshold speech materials were initially designed to be presented in quiet. Testing in quiet does not accurately reflect the discrimination problems encountered in everyday life. If we are to evaluate the everyday speech understanding of an individual then we must consider their performance in the presence of noise. In listening to speech, the auditory system must separate the information bearing components of the acoustical signal from the unwanted background noise.

Low-pass filtered noise (Cohen & Keith, 1976), a single speaker (Speaks & Jerger, 1965), a mixture of noise plus one or two speakers (Carhart, Tillman & Greetis, 1969), a babble of one to three speakers (Carhart, Johnson & Goodman, 1975 as cited in Martin, 1986) , or a babble of two and four talkers (Young, Parker & Carhart, 1975) have all been used as competing signals in speech discrimination testing. For young normal-hearing subjects it has been shown that speech recognition thresholds are lower when the competing signal is speech, than when the competing signal is noise with the same long-term average spectrum as the speech stimuli itself (Duquesnoy, 1983).

Summary of the Shortcomings of Current Evaluation Stimuli

Speech discrimination tests are valuable tools in determining the extent of an individual's discriminatory difficulties in a very controlled setting and this is an initial step in evaluating an individual's overall hearing function, but there is a need to recognize the difference between an evalution of the discriminatory abilities of the peripheral hearing mechanism and an evaluation

of functional communication abilities.

The speech signal is highly redundant: Acoustic, phonemic, linguistic, contextual, and suprasegmental cues often overlap in the information they convey. As a consequence, a reduction in one or several of these may not significantly impair the effective communication of a message. It is the ability of a listener to use higher-order contextual structures to frame and interpret lower-order phonetic information that enables a listener to contend with a degraded speech signal and understand a conversation. Given this case, simply testing an individual's perceptual abilities with single word tests or testing an individual's abilities to receive sentences in isolation or in quiet are not adequate tools on which to base judgements of communication impairment or effectiveness.

Procedures Employed in the Evalution of Speech Understanding

Reception Tasks

In suprathreshold tests the required response is often a verbal or written repetition of the stimulus presented (e.g., a word). If the listener is not provided with a specific set of items from which to select the response, the test is said to be 'open-ended' and the task required of the subject is one of recognition. If the listener is provided with a visually displayed list from which to select a response, then the test is said to be 'closed-response' and the task required of the subject is one of identification. In either of these cases, the task required of the subject is a receptive one: a word is presented and the subject responds. Everyday communication interactions involve at least two people, therefore an evaluation method which employs a unidirectional flow of speech can not adequately represent communication effectiveness.

Tracking

In 1978, DeFilippo & Scott introduced a method with which to evaluate the reception of

ongoing speech. This method, known as tracking, was aimed at overcoming two limitations of more traditional speech procedures: It was developed around the use of connected speech and it aimed to address the issue of correct speech reception (rather than having only a single opportunity to respond). In this task a speaker transmits connected discourse to a listener by reading short segments of a text. The listener is then required to repeat back verbatim what was read. If the listener repeats the segment back correctly, the speaker moves onto the next segment. When the listener fails to provide a verbatim response, the speaker proceeds to use one or more of a series of strategies to help the listener achieve 100% recognition. The speaker determines the segment length presented; based on her decision of what a logical linguistic segment should be and what segment length will not exceed memory constraints. The listener is also free to interrupt the speaker at any time, therby shortening the segment to be repeated. Thus a two-way, albeit somewhat restricted, interaction is achieved. The goal in tracking is to elicit a repetition that matches the text verbatim without the use of non-speech related cues (e.g., gesture or facial expression). A typical tracking session lasts from five to ten minutes and the session is scored by calculating the average number of words correctly repeated per minute.

Although the tracking procedure involves the use of discourse materials in an interactive fashion between the sender and the receiver, it is still no more a reflection of normal conversation than sentence-level tests. (Tye-Murray & Tyler, 1988). Tracking requires that the receiver repeat words verbatim and this requirement is no different than sentence tests which also require verbatim responses. Comprehension of a conversation requires that the receiver go beyond identification of the words being spoken. Comprehension involves 'getting the gist' of a message as opposed to each word (van Dijk & Kintsch, 1983), and it also requires the listener to make inferences because all the information conveyed in a conversation is not always stated explicitly. Although an individual may not be able to identify or remember all the

words presented, he or she may still comprehend the meaning of the message. Tye-Murray & Tyler (1988) pointed out that in the case of slow tracking, the procedure actually possesses less face validity than sentence tests because a slow rate involves multiple repetitions of syllables and words by both the sender and the receiver; which is not at all like normal communication.

Summary of the Shortcomings of Speech Evaluation Procedures

If the goal of assessing speech understanding is to obtain a measure of how well an individual functions in everyday life, then it is imperative that assessment protocols employ procedures which approximate day-to-day communication situations. For this reason reception tasks and tracking are not adequate assessment tools. Reception tasks exclude the speaker from the communication process entirely. And while, tracking does require the interaction of the speaker with the listener, the interaction is limited and not natural. Erber (1988) advocates the conversational process itself as the vehicle for communication training. In his model (Erber, 1988),depicts the interaction between the two communication partners in such a way that neither the beginning nor the end of the communication interchange is specified. In more traditional models of communication, the partners are identified as the 'listener' and the 'speaker' thereby implying that the communication process is unidirectional. This of course is not representative of real-life. As Erber (1988) makes clear, real communicators take turns, give and/or get informtion, and exchange ideas and feelings. These aspects of the communication process need to be considered in speech evaluation procedures.

In the procedures described above, the listener is not required to understand what has been spoken. There is a need for the scoring of speech evaluation measures to be based not on the number of words accurately repeated but rather on the degree to which the meaning of the message has been communicated. Without a requirement for a demonstration of comprehension, suprathreshold speech tests makes no measure of speech understanding. In

order to assess the degree to which the message was understood, the use of a scoring procedure which analyzes the semantic match of a response to its target is desirable. As well, the use of questionnaires which include questions that require the listener to demonstrate both explicit and implicit knowledge about the discourse (or conversation) would provide information about an individual's ability to understand speech.

CHAPTER 3

Methods

Participants

Twelve participants, eight women and four men between the ages of 22 and 29, were recruited for this study. All subjects presented with normal hearing as demonstrated by a hearing screening test; with normal sensitivity defined as thresholds lower than 25dBHL from 500 to 3000 Hz (see Appendix A). The number of years spent by the participants in post-secondary education ranged from 5 to 9 years with a mean of 6.3 years. All participants were native speakers of english. One subject reported previous experience with listening to speech in noise in an experimental situation and the remaining eleven reported no such prior experience.

Materials

In the text in noise portion of this study nine passages were employed. Each of the nine passages was recorded by a female speaker of English with intonation patterns appropriate for each of the text types at an average rate of 170 words/minute or 4.1 syllables per second. Real life everyday speech is produced in rapidly articulated strings without much attention to articulatory production patterns. In traditional speech tasks the speech employed is typically spoken with unnatural stress, intonation and articulatory precision. In the current study, approximating natural speech was a goal.

Using the NeXT Soundworks software program, each of the passages was digitally recorded in its entirety into a single sound file. Simultaneously, a twelve speaker babble was recorded from audiocassette onto the second channel of the same sound file. Each of these master soundfiles was subsequently edited into smaller soundfiles which were then fed into a

computer program developed locally to run these materials in the fashion to be described below. Recording of the speech signal was conducted in a sound attenuating booth using a Madsen Electronics microphone.

The nine passages consisted of three text types (i.e., stories, restaurant reviews, and recipes) (adapted from Davies, 1982; Schultz, 1985; Schwartz, 1985; & Wadden, 1990) that were chosen to be representative of three different text structures or genres (i.e., narrative, description, and sequence) (see Appendix B).

The passages were equated for readability (Flesch, 1948). Each of these texts was judged to be at a grade seven level using the Grammatik III software program which bases its operations on Flesch's formula for readability (see Appendix C). This formula does not take vocabulary into account but, rather, analyses sentences and syllable length and uses these measures as an index to judge pieces of writing. This level was chosen so that materials would be appropriate for individuals with a wide range of educational backgrounds. The passages were also equated for overall number of syllables. Across the nine passages the number of syllables ranged from 502 to 587, and from 502 to 553, 533 to 587 and 529 to 570 for the stories, restaurant reviews and recipes respectively. The number of lines per passage (see below for the definition of a line) ranged from 41 to 48, and from 45 to 55, and 54 to 62 for the stories, restaurant reviews and recipes respectively. The passages were not equated for vocabulary. Foreign words were not used unless explicitly defined in the passage.

Each of the passages was divided into clauses, noun phrases, and/or verb phrases, using the following criteria: The ideal division was to split the passages into clauses as per the experimental evidence of Wingfield and his colleagues (Wingfield, Lahar, & Stine, 1989; Wingfield & Nolan, 1980) who have shown that subjects most frequently divide passages at

clause boundaries when given the opportunity. To divide the passages only at clause boundaries is too limiting a rule and is not likely an accurate representation of how we process speech (Cairns, 1984). This is also demonstrated by Wingfield and Nolan's 1980 data in that their subjects also divided passages into noun, verb, and prepositional phrases some of the time. For this reason portions of the passage that appeared awkward and unnatural if placed into clauses were broken down into noun phrases or verb phrases. Consideration was also given to the intonation patterns that accompanied a given sentence, clause, noun or verb phrase. If dividing a sentence into a clause, or a clause into a noun or verb phrase appeared to disrupt the intonation pattern then the sentence was not subdivided. In light of the fact that these divisions were made on the intuitions of the experimenter, a pilot subject was asked to listen to each of the passages in their entirety and divide them into manageable parts (see Wingfield & Nolan, 1980). The pilot subject introduced divisions at the identical boundaries as the experimenter for almost all lines. In those instances in which the pilot subject introduced a boundary where the experimenter did not, the boundary was changed to match that of the pilot subject when the division was inter-sentential or inter-clausal, but was not changed when the pilot subject's boundary fell to include an extra clause, noun, or verb phrase (see Appendix D for examples).

A breakdown of the number of lines per passgae and a frequency count of the words per line across text is provided in Appendix E. The number of words in a given line range from 1 to 19 across all the passages.

Procedures

The study required each participant to attend three sessions. In the first session a hearing screening test and the first of three text in noise tasks was administered. In the second session a second text in noise task and in the third session the final text in noise task were

administered. A hearing and language case history was also obtained.

Hearing Screening

A hearing screening was conducted to assure that each participant presented with normal hearing. Hearing sensitivity was defined as normal if hearing thresholds were 25dBHL or better from 500 to 3000 Hz. Speech recetion thresholds, speech discrimination thresholds, and a babble threshold were also obtained. Standard audiometric measurements and procedures were employed.

Text in Noise Task

The text in noise task required each participant to listen to a passage of text in twelve speaker babble noise presented monoaurally to the right ear. The signal was presented at 50dB above the babble threshold for the right ear. Each participant listened to three exemplars of three different text text for a total of nine passages of text: three narratives, three restaurant reviews, and three recipes. In a given session a participant listened to three exemplars of only one text type (e.g., narrative). Three text types can be presented in six different orderings. Two subjects listened to each of the six possible orderings of the text types. Within a session, the first exemplar was always presented at 0dB S:N, the second at -6dB S:N, and the third at -12dB S:N. These S/N values were selected on the basis of pilot experiment in which it was determined that most subjetcs performed nearly perfectly at 0dB S:N and had extreme difficulty perceiving discourse at -12dB S:N. This rigid S/N presentation regime provided participants with the opportunity to become familiar with the task in the best of listening conditions first. In this way, it could be said that some of the errors observed in the 0dB S/N condition are in part a consequence of learning a new task.

For this task each participant was seated in a sound attenuating IAC booth and was fitted with TDH-39P headphones. The participants were asked to repeat back as accurately as possible

each line of a passge they were about to hear and were encouraged to revise their responses at any time during the course of listening. They were also instructed to provide multiple responses if they were unsure of what they heard (see Appendix F).

In the report by CHABA (1988), it was recommended that a subject's response serve as the catalyst to trigger presentation of subsequent speech materials. In this way pacing is appropriate in that the subject is provided with the necessary time to organize and make a response. To accomodate this a participant signalled his or her request for subsequent lines of a passage through the press of a button.

Using a NeXT computer and an OB 802 clinical audiometer, the experimenter presented each of the passages in a line by line fashion to the participant. After each line was presented, and the participant repeated back as accurately as possible what they has just heard and/or took the opportunity to make revisions and/or additions to previous responses, the experimetner coded the response and/or revision as correct and/or incorrect. If correct the experimenter went on to present the next line of the passage and if incorrect the experimenter entered the error and/or revision and then presented the next line of the passage.

After the presentation of the passage, the participant was required to answer ten multiple choice questions about the passage (see Appendix G). Five of which were requests for explicit information and five were requests for implicit information. Participants were made aware in the initial instructions that they would be required to answer questions following each passage. It was thought that if participants were aware that they would be required to answer questions, then they would be more likely to engage in deeper comprehension processes more often than if they thought the task was simply to repeat back each line as they heard it without consideration of the contents of the passage as a whole (Craik, 1983; Craik & Lockhart, 1972).

Also, after the presentation of each passage, the participant was required to rate their familiarity with recipes, restaurant reviews, or stories in terms of their personal experience with these (Appendix H).

CHAPTER 4

RESULTS

Effect of Signal-to-Noise Ratio and Text Type on Number of Errors

The total number of errors observed for all subjects for each of the three text types (narrative, restaurant review, and recipe) for each of the three signal-to-noise (S:N) conditions (0 dB, -6dB, -12dB) are plotted in Figure 2.

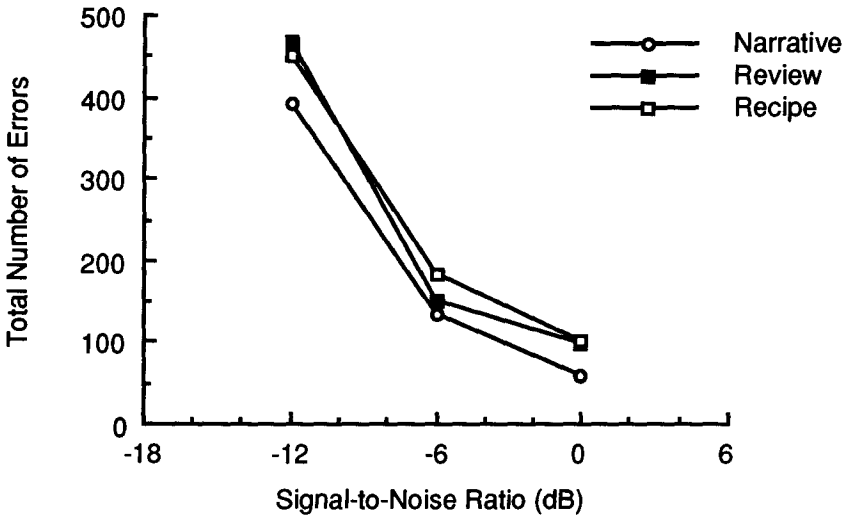

Figure 2. Total number of errors observed for each of the text types in each signal-to-noise condition.

The number of errors increased as the S:N ratio decreased, with the fewest errors being made at 0dB S:N, more errors at -6dB S:N, and even more at -12dB S:N. Fewer errors were made in the text type narrative than in either the text types restaurant review or recipe across all three S:N conditions. An analysis of variance confirmed this description with a significant effect of S:N condition, $F(2,22) = 270.05$, $p<.01$, a significant effect of text type, $F(2,22) = 5.23$, $p<.01$, but no significant interaction of S:N condition with text type, $F(2,22) = .862$,

$p>.05$. This analysis of variance was conducted after the data were subjected to a square-root transformation in order to reduce heterogeneity of variance, thereby satisfying the assumption of homogeneity of variance underlying the test (Hartley's $F_{max}(9,12) = 3.66$, $p < .01$) (Kirk, 1982). A Student-Newman-Keuls test of multiple comparisons confirmed that the three S:N conditions differed significantly from each other, with errors increasing as S:N ratio decreased from 0 to -6dB, ($p<.05$), and with an even greater increase in errors as S:N ratio decreased further from -6 to -12dB S:N, ($p<.01$). A second Student-Newman-Keuls test of multiple comparisons indicated a significant difference between the text type narrative and the other two text types, ($p<..05$), but no significant difference was indicated between the text types recipe and restaurant review, ($p>.1$)

Effect of Familiarity

The relationship between a subject's sense of familiarity with a text type and the number of errors observed was considered. Subjects who rated themselves as very familiar with a text type were separated from those who did not rate themselves as very familiar with a particular text type. The mean error frequency for each of the text types are plotted in Figure 3 according to whether the text type was rated as very familiar or not familiar. The number of errors observed within each S:N condition seems not to be affected by a subject's sense of familiarity with the text types narrative and restaurant review . Furthermore, the number of errors observed at 0dB S:N for the text type recipe is not related to a subject's sense of familiarity . In contrast, the number of errors observed at -6 and -12dB S:N for the text type recipe appears to be related to the subject's familiarity rating. It is worth noting, that the number of subjects reporting that they were familiar with recipes (n=5), was approximately equal to the number reporting that they were unfamiliar (n=7), suggesting that these results cannot be attributed to unusual behavior by a small number of subjects. Furthermore, while it is difficult to know how subjects interpreted "familiarity", it seems that this notion was

more easily understood with respect to recipes, a rather specialized text type, in comparison to the more general narrative and description types. Further discussion of the possible reasons for this pattern of results will be dicussed later.

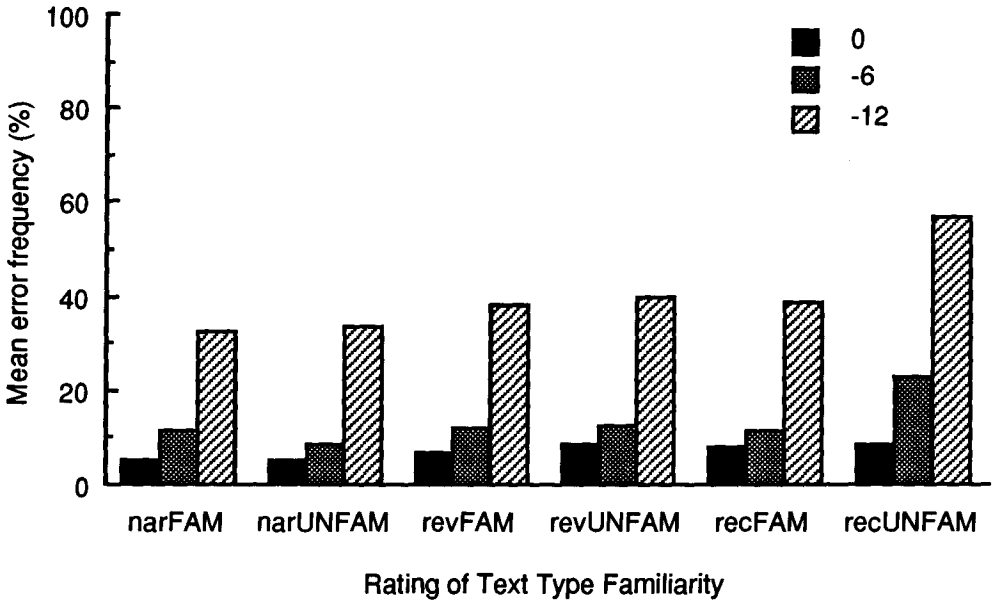

Figure 3. Frequency of errors observed for each of the text types in each of the signal-to-noise conditions as a functin of subjects' familiarity ratings for each text type.

Effect of Signal-to-Noise Ratio and Text Type on Error Type

Classification of Response Error Types

In an effort to understand the nature of the errors observed, each error was categorized as a deletion, addition , substitution, or exchange. A deletion was defined as the omission of any part of the target (bound morpheme, word, phrase, clause, or sentence). An addition was defined as the addition of any information that was not present in the target (bound morpheme, word, phrase, clause, or sentence). A substitution was defined as information that was used in place of information that was given in the target. An exchange referred either to

metathesis of portions of the target or to instances where a portion of the target (bound morpheme, word, phrase,clause, or sentence) was repeated correctly but not in the original target position.

Effect of Signal-to-Noise Ratio on the Error Type 'Exchange'

The number of exchange errors that occurred in each of the text type conditions in each S:N condition are plotted in Figure 4. Overall, few errors of this type were observed, and the number of errors did not vary with either S:N or text type condition. A Chi-square test confirmed this description with no significant effect of S:N condition, X^2 (df=2) = .19, $p > .05$, no significant effect of text type, X^2 (df=2) = 4.71, $p > .05$, and no significant interaction of S:N condition with text type, X^2 (df=4) = .71, $p > .05$.

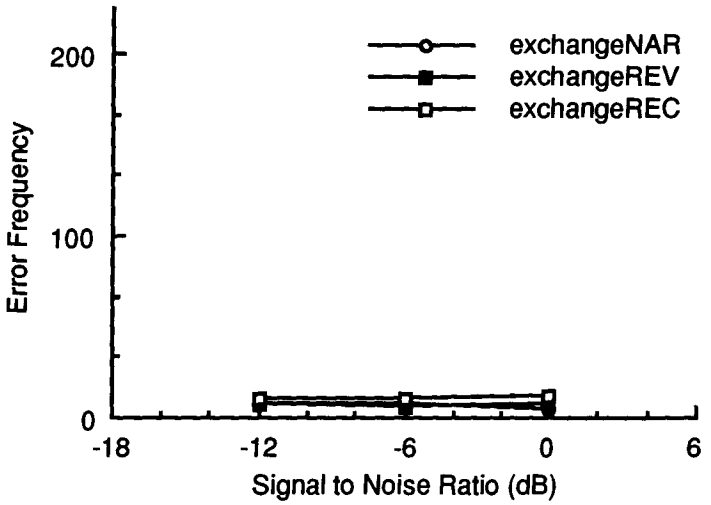

Figure 4. Frequency of the error type exchange for each of the text types as a function of signal-to-noise ratio.

Effect of Signal-to-Noise Ratio on the Error Type 'Addition'

The number of addition errors that occurred in each of the three text type conditions in each S:N condition are plotted in Figure 5. More addition errors were made then exchange errors. For addition errors, the number of errors does increased as the S:N ratio decreased but it did not vary much with text type. A Chi-square test confirmed that the three S:N conditions differed significantly from one another, X^2 (df=2) = 65.08, $p < .005$, with errors increasing as S:N decreased. There was no significant difference between the three text types, X^2 (df=2) = 2.05, $p > .05$ and no significant interaction, X^2 (df=4) = 4.88, $p > .05$

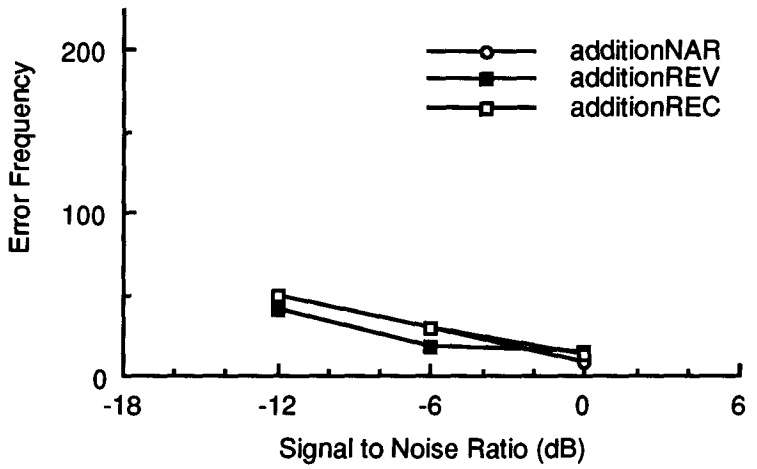

Figure 5. Frequency of the error type addition for each of the text types as a function of signal-to-noise ratio.

Effect of Signal-to-Noise Ratio on the Error Type 'Substitution'

The number of substitution errors that occurred in each of the three text type conditions in each S:N condition are plotted in Figure 6. Far more substitution errors were made than addition or exchange errors. The number of errors increased as S:N ratio decreased, with a gradual increase in errors from 0 to -6dB S:N and a much steeper rise in errors from -6 to -12dB S:N. The number of errors does not appear to vary with text type except that there

were slightly fewer errors for narratives than for the other two text types at 0dB S:N. A Chi-square test confirmed the first part of this description, with a significant effect of S:N condition, X^2 (df=2) = 484.73, p <.005. However, there was no significant effect of text type, X^2 (df=2) = 2.59, p > .05., and no significant interaction, X^2 (df=2) = 5.99, p > .05.

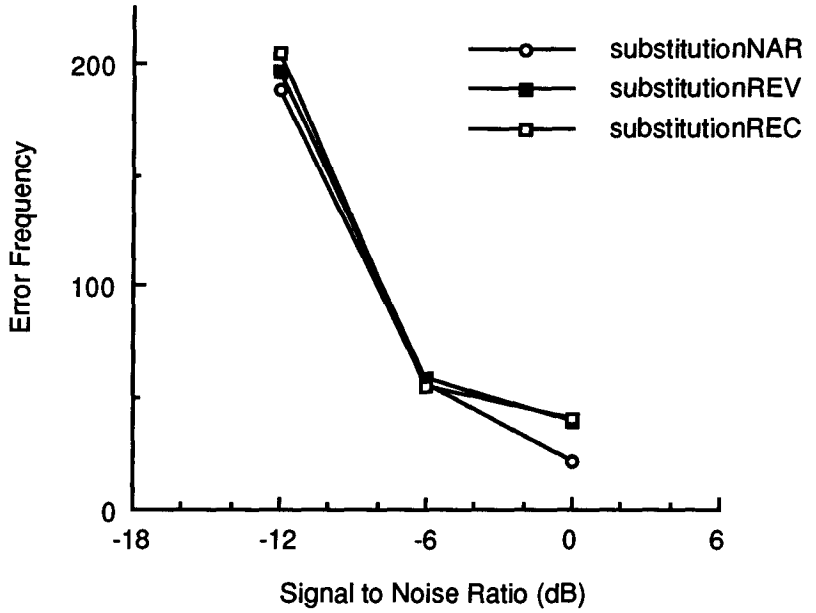

Figure 6. Frequency of the error type substitution for each of the text types as a function of signal-to-noise ratio.

Effect of Signal-to-Noise Ratio on the Error Type 'Deletion'

The number of deletion errors that were observed in each of the three text type conditions in each S:N condition are plotted in Figure 7. In comparison to substitution errors, deletion errors were about as numerous and also increased markedly as S:N ratio decreased. In contrast to substitution errors, deletion errors did vary with text type. While the number of deletion errors observed for each of the text types at 0dB appears to be similar, at -6 and -12dB S:N, differences were evident. At both -6 and -12 dB S:N, the number of errors for

the text type narrative were less than the number of errors for the other two text types. Furthermore, at -6 dB S:N, the number of deletion errors for the restaurant review were less than those for the recipe , and at -12 dB S:N this relationship reversed. A Chi square test confirmed this description with a significant difference between text types, X^2 (df=2) = 24.04, p <.005, a significant difference between S:N conditions, X^2 (df=2) = 433.47, p <.005, and a significant interaction between text type and S:N condition, X^2 (df=2) = 9.98, p < .05.

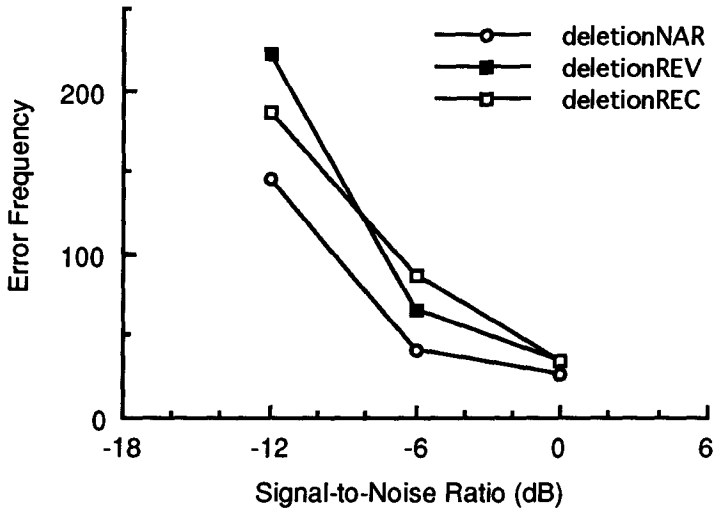

Figure 7. Frequency of the error type deletion for each of the text types as a function of signal-to-noise ratio.

Summary of the Effect of Signal-to-Noise Ratio on the Error Types

The number of exchange, addition, deletion, and substitution errors that were observed across all three text types in each of the S:N conditions are summarized in Figure 8. Exchange errors were fewest and occurred in similar proportions in each of the three S:N conditions. Addition errors occurred more often than exchange errors, but less often than either deletion or substitution errors. The number of addition errors increased at a steady but gradual rate as the S:N ratio decreased. Substitution and deletion errors occurred in near-equal numbers in

each of the S:N conditions. From 0 to -6dB, the number of substitution and deletion errors increased at a rate similar to the addition errors, but from -6 to -12dB S:N the number of substitution and deletion errors increased at a much greater rate than the rate of increase of addition errors. A Chi-square test confirmed this description with a significant difference between the types of errors, X^2 (df=2) = 969.35, $p<.005$, a significant difference between S:N conditions, X^2 (df=2) = 917.35, $p <.005$, and a significant interaction between error type and S:N condition, X^2 (df=6) = 52.93, $p <.005$.

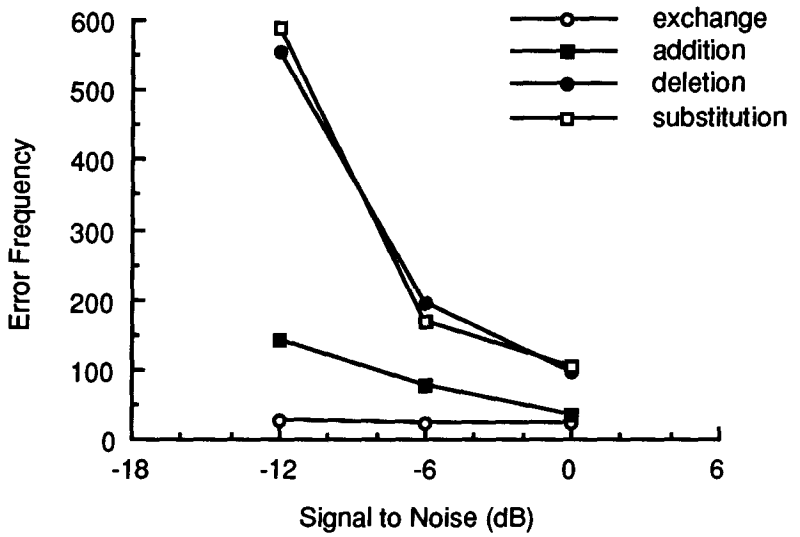

Figure 8. Summary of error frequencies across text types as a function of signal-to-noise ratio.

Effect of Signal-to-Noise Ratio on Errors According to Linguistic Level and Degree of Error

Error Classification by Linguistic Level

Subsequent to classifying errors as additions, deletions, substitutions, or exchanges, each error was coded as a total, partial, or no match to the target at each of three linguistic levels (auditory, syntactic, or semantic). For example, if the following target and response

occurred:

(1) Target: "and bounced downstairs to the basement"

Response: "and bounced downstairs to the cellar"

then the response error was classified as a substitution which was not an auditory match,but was a total semantic match, and a total syntactic match. For another example,

(2) Target: "and bounced downstairs to the basement"

Response: "and bounced down the stairs to the basement"

the error would be classified as a substitution (of a phrase for a lexical item), which was further classified as a partial auditory match, a total semantic match, and no syntactic match" (see Appendix I for more examples).

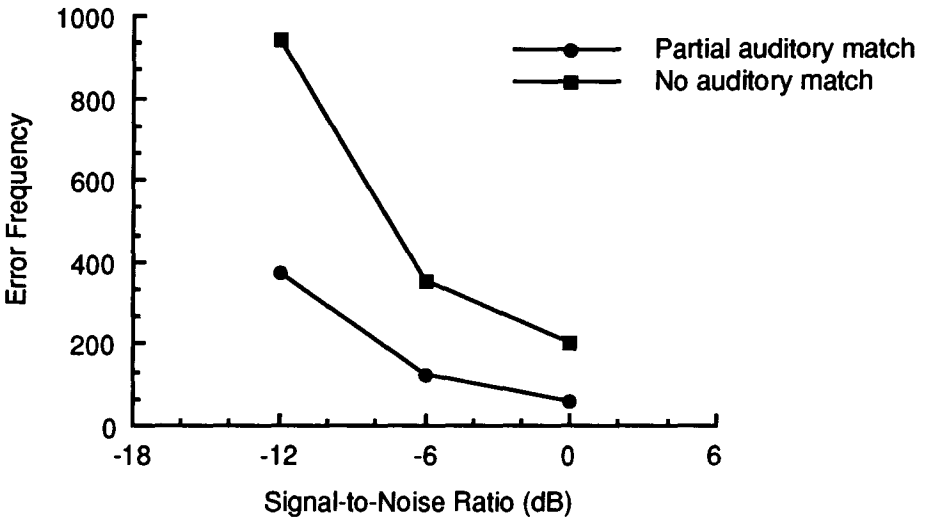

Figure 9. Frequency of response errors which were a partial or complete auditory matches to the target.

Effect of Signal-to-Noise Ratio on the Auditory Level

By definition, errors were always responses which failed to match the target auditorily (either partially or totally). Errors classified as partial or no matches have been plotted in Figure 9. Across all three S:N conditions, there were fewer partial matches than no matches. In both cases, errors increased with decreasing S:N ratio. A Chi-square test confirmed this description with a significant difference between the two degrees of auditory match X^2 (df=1) = 430.89, $p < .005$, and a significant difference S:N conditions, X^2 (df=2) = 901.31, $p < .005$, but no significant interaction between degree of match and S:N condition, X^2 (df=2) = 4.48, $p > .05$.

Effect of Signal-to-Noise Ratio on the Semantic Level (Partial Auditory Match)

Addition and substitution errors that were classified as partial auditory matches were then categorized according to the degree (partial, total, no) of semantic match between response and target (see Figure 10). (It was only meaningful to evaluate addition and substitution errors because, by definition, for deletion errors, no semantic or syntactic information was present, and for exchange, synactic and semantic information was perfectly preserved). Most of the responses did not semantically match the target, with the percentage of no matches being similar at 0 and -6dB S:N, and slightly greater at -12dB S:N. While total semantic matches slightly exceeded partial semantic matches at 0dB S:N, the reverse was true at -6dB S:N, and at -12 dB S:N, partial semantic matches far exceeded total semantic matches. A Chi-square test confirmed this description with a significant effect for degree of semantic match, X^2 (df=2) = 166.92, $p < .005$, a significant effect for S:N condition, X^2 (df=2) = 301.99, $p < .005$, and a significant interaction between degree of semantic match and S:N condition, X^2 (df=2) = 10.62, $p < .05$.

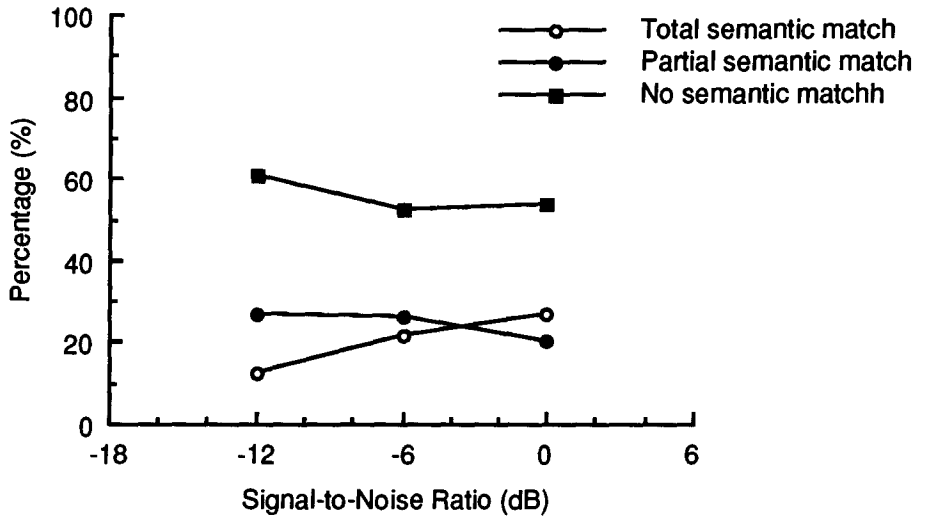

Figure 10. Percentage of addition and substitution errors (partial auditory match to target) classified as total, partial, or no semantic match as a function of signal-to-noise condition

Effect of Signal-to-Noise Ratio on the Syntactic Level (Partial Auditory Match)

Addition and substitution errors that were classified as partial auditory matches to the target were also categorized for degree (total, partial, no) of syntactic match (see Figure 11). In each of the three S:N conditions, most responses that partially matched the target auditorily totally matched the target syntactically. The percentage of total syntactic matches dropped steadily as S:N ratio decreased. Furthermore, partial matches out-numbered no matches at 0dB S:N and -6dB S:N. However, at -12dB S:N, there were equal percentages of partial and no matches. A Chi-square test indicated a significant effect for degree of match, X^2 (df=2) = 69.60, $p < .005$, a significant effect for S:N condition, X^2 (df=2) = 298.46, $p < .005$, and a significant interaction between the degree of syntactic match and S:N condition, X^2 (df=4) = 30.99, $p < .005$.

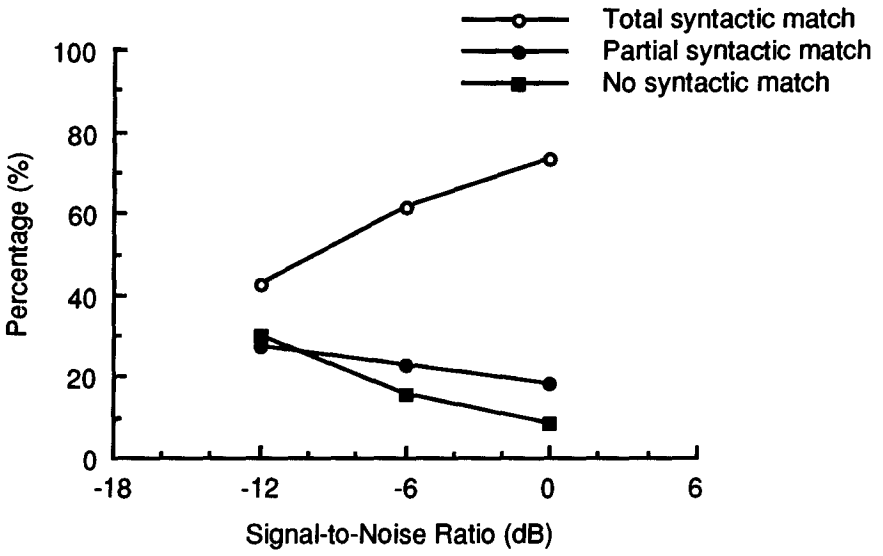

Figure 11. Percentage of addition and substitution errors (partial auditory matched target) classified as total, partial, or no syntactic match as a function of signal-to-noise condition.

Effect of Signal-to-Noise Ratio on the Semantic Level (No Auditory Match)

Addition and substitution errors that were classified as not matching the target auditorily were categorized for degree of semantic match (see Figure 12). In all three S:N conditions virtually all errors failed to match the target semantically. A Chi-square test indicated a significant effect of degree of semantic match, X^2 (df=2) = 378.34, $p < .005$, significant effect of S:N condition, X^2 (df=2) = 301.99, $p < .005$, but no significant interaction between degree of semantic match and S:N condition, X^2 (df=4) = 10.62, $p > .05$.

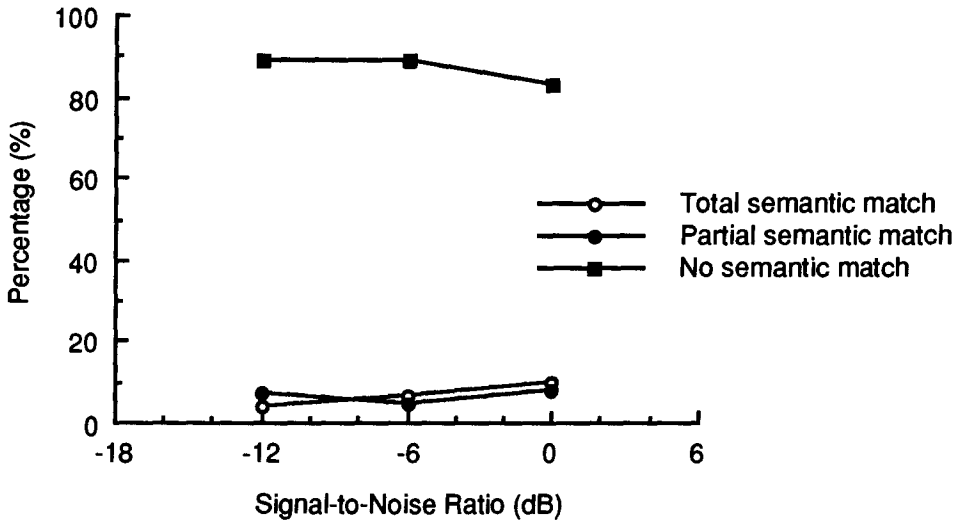

Figure 12. Percentage of addition and substitution errors (no auditory match) classified as total, partial, or no semantic match as a function of signal-to-noise condition.

Effect of Signal-to-Noise Ratio on the Syntactic Level (No Auditory Match)

Addition and substitution errors that were classified as failing to match the target auditorily were categorized for degree(total, partial, no) of syntactic match (see Figure 13). In each of the three S:N conditions, the vast majority of errors failed to match the target syntactically with most of the remaining errors totally matching the target syntactically. A Chi-square test indicated a significant effect of degree of syntactic match, X^2 (df=2) = 142.962, $p < .005$, significant effect of S:N condition, X^2 (df=2) = 213.31, $p < .005$, and a significant interaction between the degree of syntactic match and S:N condition, X^2 (df=4) = 19.03, $p < .005$.

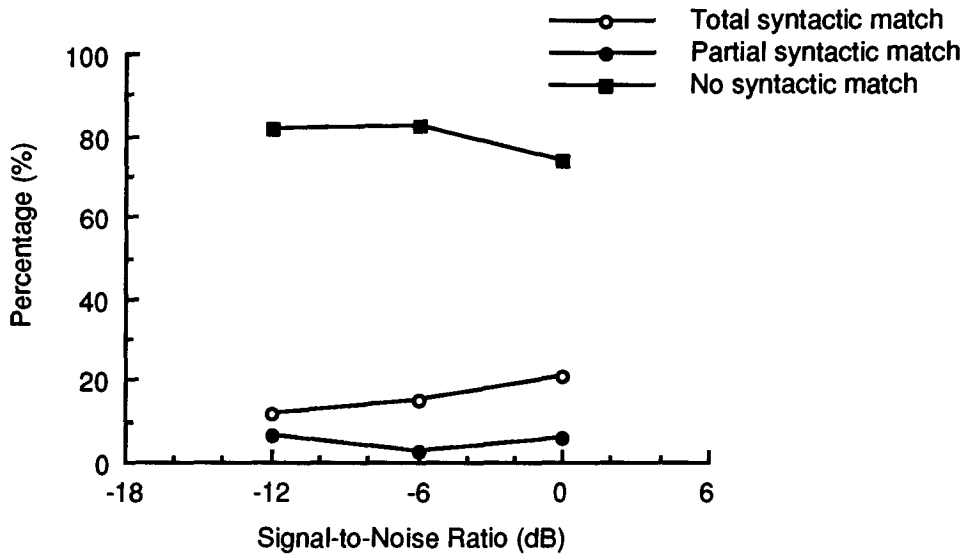

Figure 13. Percentage of addition and substitution errors (no auditory match) classified as total, partial, or no syntactic match as a function of signal-to-noise condition.

Preservation of Semantic and Syntactic Information

For substitution errors, the responses classified as total or partial semantic matches were collapsed into one category called some semantic match likewise the responses classified as total or partial syntactic matches were collapsed into one category called some syntactic match. (Addition errors were excluded from this analysis because, by definition, they would never match the target either syntactically or semantically.) This re-grouping facilitated an evaluation of how the preservation of semantic information was, if at all, related to the preservation of syntactic information.

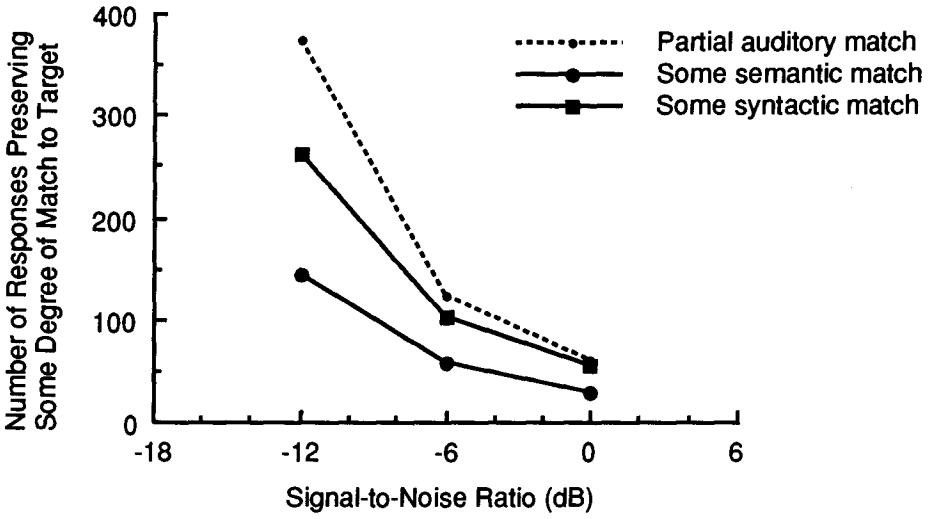

Figure 14. Substitution errors (partial auditory match) preserving some syntactic or some semantic information.

For errors that partially matched the target auditorily, the new categories are plotted in Figure 14. More syntactic information was preserved than semantic information. As a function of S:N ratio, there was a slight decrease in the percentage of errors where semantic and syntactic information were preserved. A Chi-square test confirmed this description with a significant difference between the category of some semantic match and the category of some syntactic match, X^2 (df=1) = 54.87, p <.005 and a significant difference at each of the three S:N conditions, X^2 (df=2) = 263.56, p <.005. No significant interaction was observed, X^2 (df=2) = .14, p >.05

As can be seen in Figure 15, errors preserving syntactic information alone were approximately equal in number to errors preserving both syntactic and semantic information. That is, in virtually half of the cases in which syntactic information was preserved, semantic information was also preserved. There were almost no cases in which semantic information was preserved without preservation of syntactic information. Errors where neither syntactic

nor semantic information was preserved were few in number except at the -12dB S:N condition. Overall, even when there was only a partial auditory match to the target, there was great preservation of syntactic information and considerable preservation of semantic information.

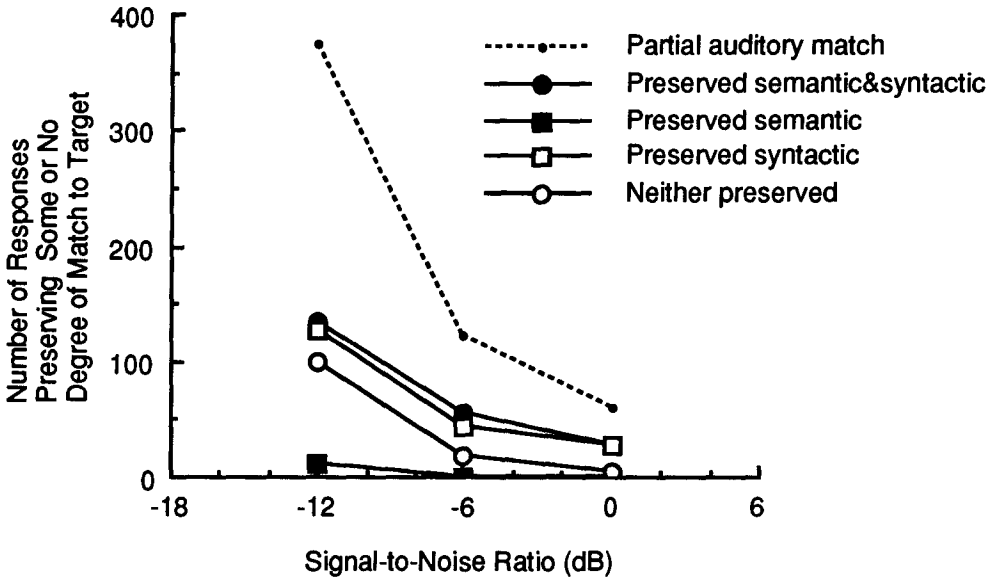

Figure 15. Substitution errors (partial auditory match) preserving both semantic and syntactic, only syntactic, only semantic, or neither level of information.

For substitution errors that failed to match the target auditorily, the new categories, some semantic match and some syntactic match, are plotted in Figure 16. Again syntactic information was better preserved than semantic information. As a function of S:N ratio again there was a slight decrease in the percentage of errors where semantic and syntactic information were preserved. A Chi square test confirmed this description with a significant difference between the category of some semantic match and the category some syntactic match, X^2 (df=1) = 21.14, $p < .005$ and a significant difference at each of the three S:N

conditions, X^2 (df=2) = 162.51, p <.005, no significant interaction between S:N and degree of semantic match was observed, X^2 (df=2) = 75, p >.05.

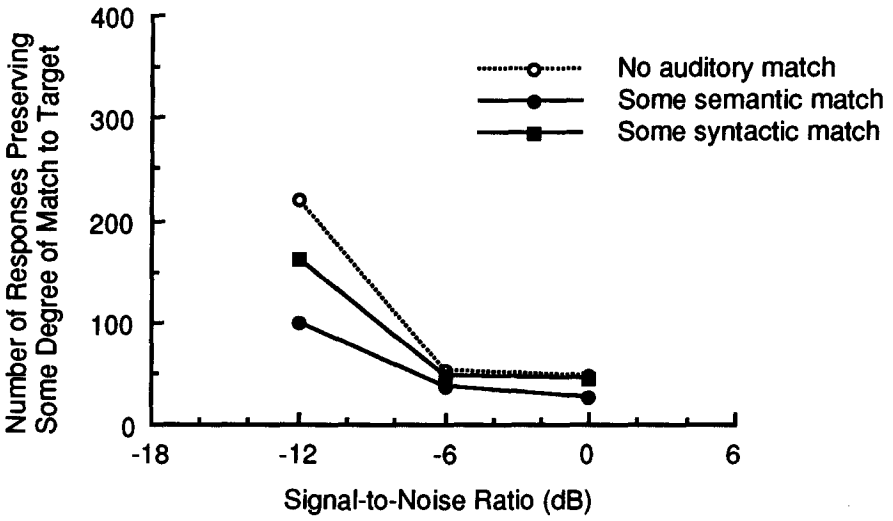

Figure 16. Substitution errors (no auditory match) preserving some syntactic or some semantic information.

As can be seen in Figure 17, in all S:N conditions, substitution errors preserving both syntactic and semantic information slightly out-numbered substitution errors preserving only syntactic information. That is, in over half the cases in which syntactic information was preserved semantic information was also preserved. Again there were almost no cases in which semantic information was preserved without preservation of syntactic information. And agin, errors where neither syntactic nor semantic information was preserved were few in number, except in the -12dB S:N condition. Even when the response completely failed to match the target auditorily, neverthelesss there was great preservation of syntactic information and semantic preservation.

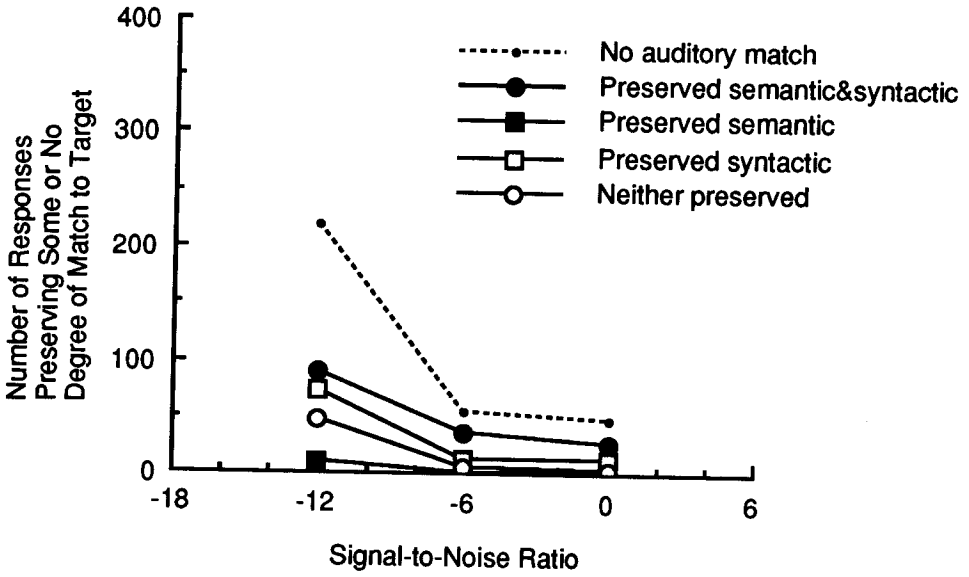

Figure 17. Substitution errors (no auditory match) preserving both semantic and syntactic, only syntactic, only semantic, or neither level of information

CHAPTER 5

DISCUSSION

In this study two hypotheses have been tested:

(1) the number and types of errors a listener makes when repeating a narrative will be no different than the number and types of errors made when repeating a restaurant review or a recipe; and

(2) as the signal to noise ratio decreases and listening conditions become less favorable, the number of errors and the types of errors that occur will not be significantly different from the number and types of errors observed under more favorable signal-to-noise conditions. The following discussion will address the results as related to each of these hypotheses.

Text Type:

The results indicated a significant difference in the number errors observed between the text type narrative and the text types restaurant review (representative of the text type description) and recipe (representative of text type procedural). This supports the initial research hypothesis which stated that the number of errors a listener makes when repeating a narrative will be less than the number of errors made when repeating a restaurant review or a recipe. Recall that the rationale for employing these three text types (i.e., narrative, description, and procedural) was based on the experimental literature which has described different text types as possessing different types of organizational structures which yield different degrees of predictability. The resultant outcome of these differences is that text structures with higher predictability are able to effect more top-down processsing than text types which are less predictable. The importance and relevance of this to the current study is as follows: When a speech signal is degraded by

noise, bottom-up processing yields a poorer product than when a speech signal is heard in the absence of background noise. In the context of a first-pass/second-pass approach to processsing it could be said that on the first pass, processing fails to achieve comprehension in an automatic fashion and as a consequence more effortful top-down processes are recruited to facilitate comprehension in the second-pass. Top-down processes facilitate the generation of a coherent message more when a text has a high degree of predictability than when it has less structral organization. In the former case, the listener can fall back on using a macrostructure a macrostructure which prescribes a constrained set of possibilites, whereas in the latter case, the macrostructure prescribes a much wider range of choices. It is for these reasons that in the present experiment, we see subjects better able to perceive narratives than descriptions (i.e., restaurant reviews) in noise.

Familiarity and Text Type:

Significant differences were found between the text type narrative and the text type recipe at all three S:N conditions. The differences between the text type recipe and the text type restaurant review are minimal at 0 and -12 dB S:N, with performance being poorer at -6dB for the text type recipe. It was thought at the outset that performance on recipes would be more similar to narratives than to descriptions because recipes are by their very nature procedural; that is performing one set of actions in a recipe is very closely tied to the actions that precede and follow it, and because the possible events within a recipe are constrained relative to a description, it was thought that at the outset that performance on recipes would be more similar to narratives than decriptions. A measure of familiarity with each of the text types was included as part of the protocol of this experiment. This measure was made at the outset because it was thought that familiarity might play a role in an individual's performance because only subjects familiar with the recipe schema would be expected to use it to advantage. After the recipe data were found to be more similar to descriptions than narratives, suggesting that

the participants were not using the inherent predictable structure of recipes, the error data were regrouped based on subject's familiarity ratings. The analysis revealed that in fact those subjects who had knowledge and familiarity with recipes made fewer errors at -6 and -12 dB S:N. This result suggests that individuals who are familiar with recipes have probably developed a schema for them and as a consequence demonstrate a similar error rate to that found for narratives. In contrast, those individuals who did not rate themselves as very familiar with recipes demonstrate error rates similar to those found for restaurant reviews because for them recipes are not a logical series of steps, but more like the collection of statements found in a description. This result suggests that familiarity with a text type improves an individual's ability to communicate in a noisy situation.

Error Type and Text Type:

The results indicated no significant difference in the number of exchange, addition, and substitution errors between each of the text types in each of the S:N conditions A significant difference in the number of deletion errors between each of the text types was found. Therefore, except for the error type deletion, text type did not influence frequency of error type. Across all three S:N conditions, the number of deletion errors is fewest for the text type narrative. One could speculate that a text type with a highly predictable format facilitates the reception of the speech signal such that less information is lost or alternatively, such that more of the missing information is provided by top-down processing. Also, the number of deletions increased as S:N ratio decreased. This is not surprising. One would expect deletions to increases because as S:N decreases the signal becomes degraded and portions of the text become inaudible.

The error type exchange was rare and its occurrence did not vary with text type or S:N ratio. These results would appear to suggest that the act/process of exchanging words within a

sentence (i.e., metathesis) or shifting a word from one location to another is a phenomenon that is present in speech and its frequency is not related to listening conditions.

Addition errors were more common then exchange errors and did vary with S:N ratio but not with text type. This might be indicative of a need to impose coherency on a text that becomes less perceptible as listening conditions deteriorate.

The number of substitution errors also increased as S:N ratio decreased. These increases occured at a steeper rate then they did for addition errors, especially from -6 to -12dB. The increase in substitution errors is possibly a reflection of the fact that as listening conditions deteriorate the speech signal becomes degraded and information is lost. It was observed that individuals compensate for this missing information in a variety of ways. Some of these response patterns are described below:

(1) the gist (i.e., semantic content) is repeated. For example:

Target: the apples should come just to the rim of the dish and no higher
Response: the apples should come just to the height of the dish and no higher
Auditory: total mismatch
Syntactic: total match
Semantic: total match

(2) a syntactic substitution is given. For example:

Target: her ceasar salad is loaded with bacon bits
Response: her ceasar salad is loaded with calories
Auditory: total mismatch
Syntactic: total match
Semantic: total mismatch

(3) an auditory substitution is given. For example:

Target:	dense and moist and not too sticky sweet		
Response:	dance in the mist with not too sticky feet		
Auditory:	Partial match	partial match	partial match
Syntactic:	total mismatch	total mismatch	total mismatch
Semantic:	total mismatch	total mismatch	total mismatch

These responses are not particularly surprising. The listeners were trying to hear and understand what was being said. At the same time they are attempting to "Repeat back as much and as best" they could. When all else failed they repeated phonetic information, even when the response was not particularly coherent with respect to the text topic. It is also not surprising that the number of substitution response errors increased dramatically as S:N decreased from -6 to -12dB S:N. What these substitution errors are composed of is of interest here. That is, what language element is being substituted for what? For example, does a word substitue for a word, a word for a phrase, or a phrase for a sentence? How semantically , syntactically, or auditorily similar is the response relative to the target? Although the former question was not addressed in this study the latter was and will be elaborated upon in the following sections.

Preservation of Auditory Information:

As S:N ratio decreased the overall number of errors increased, including responses that failed to match the target or matched it only partially. This is consistent with the fact that as listening conditions become poorer, the clarity of the perceptual cues available in the speeech signal is reduced. As a consequence, the listener will hear and repeat back a greater number of misperceptions as the S:N ratio decreases.

When only substitution errors are considered, the number of partial auditory matches to the target are slightly greater than the number of total mismatches to the target. By definition, exchange errors always match the target auditorily, whereas addition and deletion errors never match the target auditorily, even partially. Therefore when all four types of errors are considered the number of total auditory mismatches exceeds the number of partial matches.

Preservation of Syntactic Information:

Degree of Syntactic Match & Partial Auditory Match

Considering substitution errors that partially match the target auditorily (by definition addition and deletion errors would not match the target even partially), in very few cases was syntactic information not preserved and in most cases it totally matched the target. The high percentage of responses in which syntactic information was preserved could be attributed to the limited possibilities dictated by the syntactic constraints of a language. That is, in English, although the possible syntactic constructions are theoretically infinite, the actual occurrence of structural forms is rather predictable. This can be likened to the observation that the vocabulary people tend to use is fairly restricted when compared to their receptive vocabulary or the total number of dictionary entries in a language. Furthermore, when a signal is perceptually degraded it is likely that listeners will attempt to reconstruct it as a syntactically correct utterance. Finally, it is reasonable that, while auditory misperceptions may lead to word level errors, it is less likely that such misperceptions would result in errors in word class selection or other gross syntactic errors. For example a listener might hear 'pot' instead of 'pond' but both are appropriate endings for the sentence "The little girl put her feet in the _____".

Degree of Syntactic Match & Total Auditory Mismatch

Considering substitution errors alone when there is a total failure to match the target auditorily,

a similar pattern of results is seen and a similar explanation may be made as was the case for errors that partially matched the target auditorily. When addition errors, which by definition totally mismatch the target auditorily, syntactically, and semantically, are also considered then the preservation of syntactic information, of course, looks much worse.

A more detailed investigation of the patterns of syntactic breakdown that occur as S:N ratio decreases is needed to gain a better understanding of the processes that are engaged in poor listening conditions to effect comprehension. Such a study would involve the sub-categorization of syntactic errors and a documentation of their changes as S:N ratios changes.

Preservation of Semantic Information:

Degree of Semantic Match: Partial Auditory Match & Total Auditory Mismatch

Considering substitution errors that partially match or completely mismatch the target auditorily, total semantic mismatches significantly out-numbered partial and total semantic matches. Based on these results alone, however, it is not possible to comment on the potential loss of semantic information. To fully interpret the data, it is necessary to further examine in what way these responses are semantic mismatches. It may be the case that although one word may have been substituted for another, the substituted word does not detract from the overall meaning of the text. For example:

(1) Target: then dress himself in Arab robes
Response: and dress himself in Arab robes

or for example:

(2) Target: try the sauteed shrimp and crab on noodles
Response: try the satay shrimp and crab on noodles.

In the first example the substitution of 'and' for 'then' does not detract from the idea that the main character of the story is dressing in a particular style of clothing, and in the second example although the substitution of 'satay' for 'sauteed' changes how the shrimp is prepared it does not change the overall notion that an entree containing seafood served over noodles is a good choice. These examples illustrate that a coding of 'semantic mismatch' is not necessarily a reflection of a loss of all relevant meaning. That is, the gist may be preserved and understanding of the text as a whole may not be significantly impaired.

Degree of Semantic Match & Partial Auditory Match

Considering substitution errors that partially match the auditory target, total semantic matches out-numbered partial semantic matches at 0dB S:N and this relationship reversed as S:N ratio decreased. The following explanantion has some intuitive appeal: As listening conditions are degraded and perceptual errors increase, the number of total semantic matches is likely to decrease. These events occur because it becomes increaingly difficult to retrieve the exact words, through the help of surounding context, however, it is possible to guess which word belongs.

When substitution errors that partially match the target are examined it is found that the percentage of responses in which semantic information is preserved decreases most dramatically as S:N ratio decreases from -6 to -12dB S:N. Based on these findings it could be said that it is not until -12dB S:N that the signal becomes so degraded that context can no longer offer a means by which to preserve semantic information.

Degree of Semantic Match & Total Auditory Mismatch

When error responses were complete auditory mismatches, the number of total and partial

semantic matches were similar in all three S:N conditions. This finding is also intuitively appealing for the following reasons: Since the accompanying perceptual information is incorrect, the probability of giving a response that contains the right target word or semantically appropriate word are equally probable, because in order to make an appropriate guess, the listener is operating on the basis of context. Sometimes such guesses yield a correct target word; and other times such guesses yield a semantically similar word.

The Preservation of Syntax in Relation to Semantics:

When the response only partially matched or failed to match the target auditorily, semantic information was preserved wherever syntactic information was preserved. Only in a very few instances was semantic information preserved without preservation of syntax. These results support the idea that more perceptual precision is required to achieve a semantic match than is required to achieve a syntactic match. That is, to hear a specific word in the presence of background noise is a more difficult task than 'hearing ' the word class to which a particular lexical item belongs. (Where 'hearing' refers to an individual perceiving enough of the acoustic signal to surmise, at minimum, the appropriate word class if not the appropriate lexical item.) For these reasons, it could be said that in the presence of background noise, semantic constructions are weaker and more difficult to preserve than syntax.

When the response partially matched the target auditorily it was observed that the greatest changes occured as S:N ratio decreased from -6 to -12dB. This is likely a consequence of a loss of both syntactic and semantic contextual cues. At higher noise levels, errors are no longer restricted to lexical items or short phrases, but interfere with the perception of significant amounts of the speech signal to such a degree that the construction of a context is not possible.

Overall, it has become evident that if only the number of errors based on auditory mismatches

were counted and used as a means by which to assess the listening abilities of an individual in noise, we would fail to appreciate the robustness of semantic and syntactic information.

Future Directions

The current investigation has shown that highly organized macrostructures facilitate listening to text in noise better than less organized macrostructures. In the process of studying this, it has become evident that there is a need to examine the relationship between working memory and an individual's ability to understand speech in noise. If a relationship can be found, then further insight into the relationship of bottom-up and top-down processing will be gained.

The current study has also shown that auditory errors alone are not an accurate reflection of an individual's ability to understand text in noise. In the process of uncovering this, other questions have surfaced: What is the exact nature of the syntactic and semantic information that is being deleted and substituted?, To what extent does the listener paraphrase or rephrase the incoming information?, and To what degree is this reformulation syntactically and semantically accurate?, And also, what is the relationship between the semantic information that is lost and the extent to which comprehension is affected as listening conditions become poorer?

It is the hope of this researcher that this study serves as a starting point for further investigation into the understanding of speech in noise and for the development of materials and procedures which accurately assess, and therefore reflect, an individual's ability to understand speech in everyday listening situations.

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APPENDIX A

Pure-Tone Thresholds, Babble Thresholds (BT), and Age of Individual Subjects

Subject	Right Ear							Left							Age
	.25	.5	1	2	3	4	BT	.25	.5	1	2	3	4	BT	
MM	10	10	15	0	5	10	0	5	0	5	10	0	5	0	25
FH	0	0	0	5	0	0	0	5	0	0	0	0	10	0	26
DD	0	0	5	0	0	0	0	10	10	10	5	0	10	0	29
SK	0	0	0	0	5	5	0	0	0	0	0	5	5	0	26
TE	0 0	0	0	5	0	0	0	0	0	0	5	0	0	0	23
SM	0	0	5	0	0	0	0	5	5	0	0	0	0	0	29
JG	5	5	0	5	5	20	0	5	10	5	5	15	15	5	27
SW	0	0	5	0	0	0	0	10	5	0	0	0	0	0	29
SP	0	0	0	0	0	0	0	0	5	0	5	10	5	0	29
CK	5	10	10	0	0	5	0	5	5	5	5	5	5	0	28
MS	10	5	5	0	5	0	0	10	0	0	0	0	0	0	27
NT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22

NB: All threshold values are expressed in dBHL

APPENDIX B

Text for the narrative "Scaredy Cat"

1: when I was small
2: the most frightening place in the world for me was the basement in my ownhome
3: there were so many places in the basement
4: where a bogey man could hide
5: I believed him to be waiting and watching from the cool dark corners of the room
6: just longing to catch me alone
7: typical of an old-fashioned cellar, the basement had a low ceiling
8: a bulb hanging at the end of the room was the only lighting
9: shadows from haunted old furniture played games with my mind
10: making my imagination run wild
11: a door to the right of the main room led to a small dim laundry room and workshop
12: one day my eldest sister asked me to run downstairs and fetch some clean dish towels
13: as she was busy cleaning the kitchen
14: "well I'm kinda busy right now", I replied
15: as I sat at the table, twiddling my thumbs
16: "oh come on, don't be so lazy"
17: "unless of course you're afraid of the bogey man," she said gleefully
18: to avoid weeks of harassment from my younger sisters
19: I hurriedly assured her
20: that I would be happy to get the towels
21: and bounced down the stairs to the basement
22: the gloomy quiet atmosphere seemed to close in on me
23: as I cautiously stepped into the room
24: my footsteps echoed loudly along with my heart
25: as I walked slowly across the floor
26: the laundry door room whined protestingly
27: a warning of my presence to all who lurked in the shadows
28: the shelves of the clean laundry remained hidden by a black curtain
29: taking a deep breath
30: I drew the curtain to one side
31: and a pair of evil green eyes stared malevolently
32: from within the deep dark recesses of the cupboard
33: a coronary arrest threatened to overtake me
34: as the cat shot over my shoulder and through the open window like a bullet
35: I crawled upstairs, a nervous wreck
36: and told my sister of my fright

("Scaredy Cat" continued)

37: swearing emphatically that I would never ever go downstairs alone again
38: she was extremely sympathetic
39: "oh," she said
40: "but you've forgotten the tea towels"
41: Hmmph, sympathetic indeed

Text for the narrative "Taxi"

1: it's seven a.m. in Denville
2: and the taxi company has just called a second time
3: to say they can't find my house
4: once again I spell out directions even a blind cabbie could follow
5: only two hours remain until my flight leaves
6: and it's an hour-and-a-half trip to the airport
7: outside the torrential rains are threatening to sweep my little house
8: off the mountain slope on which it teeters
9: a place so far north in denville
10: that city buses lurch past only three times a day
11: the telephone rings again
12: terribly sorry, begins the dispatcher
13: then I realize what's happened
14: flooded with calls the company's maximizing profits by handling only in-city runs
15: I'd heard this happens when the weather gets bad
16: desperately I shout into the phone
17: that I have a plane to catch
18: and I'll meet the taxi a few hundred metres away on a bridge over the Clifton River
19: standing over the roaring gale-swelled river
20: horizontal-driven rain drenching my overcoat
21: I gaze up and down the street
22: No taxi
23: finally, struggling with my umbrella and suitcase
24: I begin to hitchhike
25: a pickup truck goes by
26: driver and passenger staring at the well-dressed business person
27: walking backward in the downpour
28: from the other direction a white car approaches, passes
29: and then jams on its brakes
30: a man throws the door open
31: gesturing for me to get in
32: shaking with cold and anger I get inside
33: in the most humble manner the man identifies himself as the dispatcher
34: with whom I've spoken three times this morning
35: to get me to my plane
36: he's abandoned his post
37: and raced from the company in his personal car
38: he apologizes profusely
39: but does not explain why a taxi couldn't pick me up

("Taxi" continued)

40: except to say they are very, very busy this morning
41: delivering me to the airport bus
42: he refuses the money I press into his hand
43: and with more apologies implores me to patronize his company in the future
44: later settling back into my seat as the plane takes off
45: I open the newspaper
46: On the second page my eyes wander to a headline
47: Taxi strike begins this morning in Denville

Text for the narrative "Jewel Thief"

1: when a trickster named Jim Moran
2: learned that the crown prince of Saudi Arabia was in hollywood for a long visit
3: he decided to pose as the prince one night
4: and see what it was like to be treated as royalty
5: he would wait until the prince was out of town
6: then dress himself in Arab robes
7: and have dinner in a fancy restaurant
8: that was only part of his plan
9: he hired three actors to help him
10: one to pose as his Arab dinner companion
11: the other two as his servants
12: he arranged with a costume company to rent the robes and other clothing they would need
13: then he bought a big batch of glass jewels and a large amethyst
14: an inexpensive gemstone that looks more valuable than it is
15: he stored his so-called precious jewels in a large leather pouch
16: when Moran heard that the prince had left Hollywood for a few days
17: he called an expensive restaurant
18: and reserved a table for that night
19: he also rented a chauffeur driven limosine
20: when they arrived at the restaurant
21: the two servants went inside to make certain
22: that the table was suitable for the prince and his friend
23: after they seated them
24: they stood nearby
25: their table was at the end of the dance floor
26: whenever the dance band played
27: the dancers jostled one another
28: to get a good look at the royal party
29: at one point Moran sent one of his servants
30: to ask the band leader to play this is the life
31: a song that was one of his favorites
32: after the band played the song
33: the prince smiled at the band leader
34: and nodded his approval
35: then he pulled out his pouch of jewels and emptied it onto the tablecloth in front of him
36: as everyone in the restaurant watched
37: he selected the amethyst
38: and then sent it to the band leader as a sign of his appreciation
39: soon after dinner the prince decided to leave

("Jewel Thief" continued)

40: his party started across the dance floor toward the door
41: suddenly the prince's jewel pouch opened
42: and the glass jewels fell to the floor spilling in all directions
43: the servants started to pick them up
44: but the prince said, "leave them"
45: and swept from the room without looking back
46: as the Arabs were seating themselves in the limosine
47: everyone in the restaurant was on hands and knees
48: scrambling for the jewels the prince had left behind

Text for the restaurant review "Siggy's Place"

1: the glass trophy case in the entranceway of Siggy's place
2: is a reflection of one man's work
3: chef-owner Siggy Biewald is a familiar face
4: at international culinary salons across europe
5: and the hardware he's collected from them is impressive
6: the case bulges with medals, plaques
7: and various certificates proclaiming his excellence in competition
8: a guest book overflows with rave reviews from grateful customers
9: although the daily fare at Siggy's is not the stuff of international salons
10: this is good homecooking for a reasonable dollar
11: there are three reasons to keep Siggy's in mind
12: one, the sunday brunch; the best in town for a sunday meal
13: two, his special menu featuring german dishes
14: and three, in the buffalo business Siggy is a groundbreaker
15: during the summer season when your house overflows with out of towners
16: and you're frantic to find a novel dining experience for them
17: buffalo might be the answer
18: the appetizer of choice is smoked goose breast
19: which is lightly smoked so the strong goosy flavor still comes through
20: the amount of choice in this restaurant is staggering
21: apart from buffalo and german dishes the regular menu includes
22: pork tenderloin, rib-eye beef
23: and skewered beef with papaya and pineapple
24: lamb chops and even a pheasant dish
25: if you're a red meat fan
26: you'll enjoy Siggy's special buffalo menu
27: buffalo chili, buffalo steak with mushrooms, buffalo stew
28: buffalo short ribs, or buffalo bratwurst with sauerkraut
29: there's an item you won't find on many menus
30: the buffalo cheeseburgers are okay
31: but I'd be hard pressed to tell them apart from beef
32: the buffalo stroganoff
33: which Siggy makes with less sour cream and more dill pickle than some cooks would like
34: is a comfortable dish for a big appetite
35: with all of this the menu promises fresh vegetables
36: and sometimes they are
37: other times you get squishy frozen carrots
38: avoid if you can the shrimp crepes
39: which are a soggy effort involving some canned shrimp and some strange gray bits

(Siggy's Place continued)

40: that are in fact oysters in less than good eating condition
41: for dessert ask about the black forest torte
42: if it's fresh it's wonderful
43: the wine list is short
44: the service is good
45: dinner for two is about thirty-five dollars, complete

Text for the restaurant review "Ninth Street Cafe"

1: this is a comfortable hole in the wall near the university
2: dim, warm, and almost always full
3: it's become a favorite spot for students
4: with its reasonable prices, pretty good cooking
5: and a menu that's as varied as the choice of music
6: classical is interspersed with jazz and rock-n-roll
7: the regular menu runs to three pages
8: and daily specials are chalked on an overhead blackboard
9: if you're looking for a light meal perhaps a top notch sandwich
10: you're in the right place
11: give this kitchen a couple slices of bread or a burger bun
12: and they're off and running
13: The burgers are made of coarse juicy beef with sprouts, cheese, avocado slices
14: and other good extras dribbling out the side
15: this cafe makes an upscale version of a clubhouse
16: a sandwich which is dipped in egg and fried
17: it's definitely a knife and fork affair
18: as well there is a house special sandwich
19: ham, cheese, tomatoes, mushrooms, onions served open faced
20: this one is a plate licker
21: the soups, which ought to be first rate in a place like this, are ordinary
22: one special had recently been a can of creamed corn
23: which was made smooth
24: and served not quite hot
25: the french onion soup
26: a dark consomme with cubes of bread
27: and lots of fresh onions under a thick layer of baked cheese
28: is a much better deal
29: there's a ceasar salad
30: there's always a ceasar salad
31: but this one involves big juicy ribs of romaine lettuce
32: a rich dressing
33: and a healthy sprinkling of freshly grated parmesan on top
34: it's a better deal than the strips of darkening avocado
35: on either side of defrosted soggy shrimps
36: bathed in a bland cream and celery dressing
37: pasta is available in great variety
38: and you're invited to match any pasta with any six or seven sauces

(Ninth Street Cafe continued)

39: the lasagna is made with fresh spinach and carrots
40: which sounds bizarre but tastes just fine
41: this bistro also offers a selection of heavier meals
42: including peppered steak
43: beef stroganoff
44: veal in cream
45: and various species of fish and fowl
46: for dessert have the homemade ice cream
47: the cheesecake 's dry
48: the cafe has an adequate wine list
49: and champagne is available by the glass
50: if you're more thirsty than hungry
51: there's a lounge upstairs

Text for the restaurant review "Mrs. T's"

1: There's a small restaurant on seventh avenue
2: with a large rock in the middle of the room
3: and a free form fireplace that burns real wood on cold evenings
4: Welcome to Mrs. T's
5: a cafe where well fed customers dawdle happily over their coffee
6: while the refills keep coming
7: the chef in this kitchen actually cooks
8: as opposed to those who merely defrost
9: the food is plain here but good
10: for openers there're garlic laced chicken wings
11: smoked salmon with capers
12: and jumbo garlic shrimp
13: with the smoked salmon leading the pack
14: and the garlic wings running a close second
15: the shrimp are just ordinary
16: among the main courses the chicken kiev is large,golden, a little dry outside
17: some would call it extra crispy
18: its a question of semantics
19: but full of parsley and melted butter
20: which spurts nicely when you slice into it
21: the vegetables are likely to be peas with a scoop of mashed potatoes on the side
22: if you like seafood
23: try the sauteed shrimp and crab on noodles
24: its a well put together plate
25: with lots of mushrooms and a gentle white wine sauce that goes well with the seafood
26: the big plus in this restaurant is the homemade corned beef
27: which is rosy and lean and just spicy enough
28: Mrs T's pride and joy
29: made weekly in discrete quantities in this very kitchen
30: and it's good
31: following in the time honored tradition of this city's finest corned beef sources
32: take note of the house special sandwich
33: it starts with rye bread
34: and builds into a great wad of thin-sliced wonderful beef
35: it's a terrific mouthful
36: if you like your beef uncorned
37: there's beef stroganoff
38: or the roast beef dinner

("Mrs. T's continued)

39: the corned beef also shows up in one of several omelettes
40: but the sandwich is its big moment
41: other big moments here include
42: the honestly homemade pumpkin pie with whipped cream
43: and the classic european cheese cake
44: dense and moist and not too sticky sweet
45: the chocolate cheesecake is a certified diet buster
46: but Mrs. T ain't perfect
47: her ceasar salad is loaded with bacon bits
48: and the dressing doesn't quite make it
49: if you're lusting after the definitive ceasar
50: this won't be it
51: lunch and sunday brunch are both on Mrs. T's schedule
52: and the restaurant is closed on monday evening
53: there's a short wine list
54: service is friendly and efficient
55: in spite of the fact that one waitress seems to handle it all

Text for the recipe "Apple Tart"

1: This recipe makes six to eight servings
2: and requires the following nine ingredients
3: fourteen tablespoons of sweet butter
4: a two third cup of granulatd sugar
5: seven tablespoons of dark brown sugar
6: six large red delicious apples
7: one short crust pastry
8: a quarter teaspoon of nutmeg
9: a quarter teaspoon of cinnamon
10: one tablespoon of water
11: sweetened whipped cream
12: and now for the method
13: preheat the oven to four-hundred-and-fifty degrees
14: the ideal dish for making this tart is a metal dish
15: ten inches in diameter and about two inches deep
16: in the dish put twelve tablespoons of the butter
17: one-third cup of the white sugar
18: and half the dark brown sugar
19: blend thoroughly with your fingers
20: and then pat this mixture around the sides and bottom of the dish
21: next peel and core the apples
22: slice them an eigth to a quarter inch in thickness
23: arrange them in an overlapping symmetrical petal-like fashion
24: over the butter and sugar base
25: when you're finished
26: the apples should come just to the rim of the dish and no higher
27: melt the remaining two tablespoons of butter
28: and add the nutmeg, cinnamon, and remaining brown sugar
29: stir this mixture
30: then sprinkle it over the apples
31: then roll out the pastry into a circle about one-eighth inch in thickness
32: cut it to fit as precisely as possible over the apples
33: fit the pastry over the apples
34: making sure it doesn't overlap the rim of the dish
35: also cut a small slit in the center of the pastry to allow steam to escape
36: bake the tart for thirty minutes
37: or until the pastry is lightly browned
38: afterthirty minutes remove the dish from the oven

("Apple Tart" continued)

39: and increase the oven heat to five-hundred-and-fifty degrees
40: make a round of foil to fit over the dish
41: to prevent the pastry from burning
42: bake, covered, for forty-five minutes to an hour
43: until the liquid that forms around the apples has changed from a runny yellow
44: to a dark, oozing sticky amber
45: this can be noted by carefully tilting the pan
46: and looking under the crust
47: it's important to note that oven thermostats in homes vary
48: and it may be necesssary to adjust the oven heat
49: if the tart starts to burn
50: on the other hand the oven must be hot enough to thicken the filling
51: when the tart's done
52: place a serving plate over the top of the dish
53: then quickly invert the tart
54: The apples should appear dark in color
55: finally melt the remaining sugar with the water in a thick bottomed saucepan
56: when the sugar is melted and is dark amber
57: remove it from the heat
58: using a pastry brush
59: and working as quickly as you can
60: paint a thin layer of caramel over the surface of the apples
61: let the dish cool
62: serve warm with sweetened whipped cream

Text for the recipe "Chocolate Cake"

1: This recipe makes twelve to sixteen servings
2: and requires the following nine ingredients
3: Four cups of sifted all purpose flour
4: One and a half cups of butter
5: Half pound of semi-sweet chocolate
6: One third cup of warm water
7: Half a teaspoon of salt
8: Two cups of heavy cream
9: One-pound of the finest quality sweet chocolate
10: Confectioner's sugar
11: Chocolate curls
12: To make the cake layers
13: Place the flour in the bowl
14: Using a pastry blender, two knives, or your fingertips
15: Work the butter into the flour as though making pastry
16: Until the mixture resembles coarse oatmeal
17: Don't allow the butter to become oil
18: Melt the semi-sweet chocolate very slowly over hot water in a double boiler
19: Then beat in the water and salt until the mixture is smooth
20: Fold the chocolate mixture into the flour and butter mixture
21: Divide the dough into three parts
22: Wrap each part in waxed paper
23: and chill twenty minutes or until firm in the refrigerator
24: Between sheets of waxed paper, roll each third of the dough into a rectangle
25: about eight by twelve inches
26: Peel off the top paper
27: and fold the rectangle of dough into threes
28: peeling the bottom waxed paper off as you go
29: Now wrap in fresh waxed paper and chill about twenty-minutes
30: Repeat this procedure of rolling between waxed paper

("Chocolate Cake" continued)

31: folding and chilling twice more
32: for a total of three times
33: Wrap each third of the dough in waxed paper and chill until very firm
34: This takes about two hours
35: Preheat the oven to three-hundred and twenty-five degrees
36: After removing the dough from the fridge
37: Between sheets of waxed paper, roll out each third of the dough into a circle
38: and remove the top sheet of waxed paper
39: Cut a nine-to-ten inch circle with a sharp knife
40: Leaving a round of waxed paper beneath the layer
41: Place the circle, waxed paper side down, on an ungreased baking sheet
42: Bake thirty minutes or until done
43: Cool on the sheet
44: Repeat with the other two thirds of the dough
45: When the layers are completely cold
46: Place the cream in a chilled bowl buried in ice
47: Melt the fine quality chocolate very slowly over hot water in a double boiler
48: and when its melted, fold it into the cream
49: which has been whipped until stiff
50: Spread the chocolate cream filling between the round layers
51: It will be quite thick
52: Sprinkle the top with confectioner's sugar
53: and garnish with the chocolate curls
54: Chill well
55: The cake should be removed from the refrigerator
56: at least one hour before it is to be served
57: Use a sharp serrated knife for cutting

Text for the recipe "Poached Trout"

1: This recipe makes about eight servings
2: and requires the following nine ingredients
3: Two, three pound trout
4: Two eggs, separated
5: Half a cup of all purpose flour
6: Quarter teaspoon of nutmeg
7: Salt
8: Three tablespoons of melted butter
9: Half a cup of milk
10: One cup of heavy cream
11: Four cups of boiling salted water
12: In preparing this dish, it's important that all ingredients be quite cold
13: before they're put together
14: When purchasing the fish
15: have the trout deboned and filleted by someone in the fish department
16: The bones and skin will be needed for a stock, so be sure to get them
17: Keep the fish, bones, and skin refrigerated until ready to use.
18: There should be about one-and-a-half pounds of fish fillets
19: Combine the egg yolks, flour, half of the nutmeg
20: and the salt in a saucepan, and stir rapidly with a whisk
21: while stirring, add the melted butter
22: Bring the milk just to a boil
23: and beat it into the egg and flour mixture
24: Continue stirring and cooking rapidly
25: until the mixture pulls away from the sides of the saucepan
26: Let the mixture cool
27: This mixture is called a panade
28: Cover and refrigerate until quite cold
29: or put the mixture in the freezer
30: but don't allow it to freeze
31: Next place each fish fillet on a flat surface

("Poached Trout" continued)

32: and proceed to trim away and discard the tiny fishline down the center of each
33: Cut the remainder of the fillets into two-inch lengths
34: and add a few at a time to the container of an electric blender, and blend
35: Continue blending stirring down with a rubber spatula
36: Until all the fish is blended well
37: As the fish is blended, transfer it to the bowl of an electric mixer.
38: Season the fish with salt and the remaining nutmeg
39: and beat well with the electric mixer on medium speed
40: Continue beating while adding the panade a little at a time
41: When this is well blended, add the egg whites a little at a time
42: Beat the cream in gradually
43: Butter a large deep pan
44: about seventeen by twelve by two and a quarter inches
45: Using two large dessert spoons dipped into hot water
46: Shape the fish morsels into oval rounded shapes
47: They should resemble large duck eggs.
48: As they are shaped arrange them neatly on the buttered pan
49: Dip the spoons into hot water between shapings
50: Butter a large length of wax paper
51: and place it buttered side down over the oval shaped fish morsels
52: Pour the hot salted water on top of the wax paper
53: Letting the water flow outward into the pan
54: Bring to a boil on top of the stove and simmer five to ten minutes
55: Drain and serve with a hot mushroom sauce

APPENDIX C

Readability, word, and syllable counts for each text

	Readability[1]	#words	#syllables
Narratives			
Scaredy Cat	70	351	502
Jewel Thief	72	401	553
Getting a Taxi	67	371	545
Restaurant Reviews			
Siggy's Place	63	377	573
Mrs. T.'s	70	416	586
Ninth Street Cafe	69	373	533
Recipes			
Apple Tart	71	398	569
Chocolate Cake	72	375	529
Poached Trout	76	416	570

[1] A Flesch readability score of 60 to 70 is interpreted as a standard reading score for seventh to eighth graders.

APPENDIX D

Examples of boundary decisions:

Example 1:

Experimenter:	line 1: The prince smiled at the band leader
	line 2: and nodded his approval
Pilot subject:	line 1: The prince smiled at the band leader and nodded his approval
Decision:	use two lines as per the experimenter

Example 2:

Experimenter:	line 1: Stir this mixture
	line 2: then sprinkle it over the apples
Pilot subject:	line 1: Stir this mixture then sprinkle it over the apples
Decision:	use two lines as per the experimenter

Example 3:

Experimenter:	line 1: This is a comfortable hole in the wall near the university dim, warm, and almost always full
Pilot subject:	line 1: This is a comfortable hole in the wall near the university
	line 2: dim, warm, and almost always full
Decision:	use two lines as per the pilot subject

Example 4:

Experimenter:	line 1: There's a small restaurant on seventh avenue with a large rock in the middle of the room
Pilot subject:	line1: There's a small restaurant on seventh avenue
	line2: with a large rock in the middle of the room
Decision:	use two lines as per the pilot subject

Example 5:

Experimenter:	Line 1: A place so far north of Denville that city buses lurch past only three times a day
Pilot subject:	line 1: A place so far north of Denville
	line 2: that city buses lurch past only three times a day
Decision	use two lines as per the pilot subject

APPENDIX E

A Distribution of the Words (from 1 to 19) per Line Across Texts.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
TEXT																			
Narrative																			
Taxi	-	1	1	4	5	7	7	4	4	5	4	2	2	-	-	-	1	-	-
Scaredy	-	-	2	4	1	5	7	4	5	2	1	4	1	-	-	1	3	-	1
Jewel	-	-	1	3	3	8	8	5	6	4	3	2	2	1	1	1	-	-	1
Restaurant Review																			
Siggy	-	-	1	2	5	4	6	9	5	4	3	3	1	1	-	1	-	-	-
Mrs. T	-	-	2	6	10	4	11	8	2	2	4	1	2	1	-	2	-	-	-
Ninth	-	1	4	4	5	4	11	4	6	4	2	3	2	-	1	-	-	-	-
Recipe																			
Tart	-	-	3	4	9	12	7	-	9	6	3	1	2	4	-	1	-	-	-
Cake	-	1	2	1	8	13	6	5	6	6	2	2	-	4	1	-	-	-	-
Trout	1	-	1	5	6	8	5	5	5	3	5	5	-	2	2	2	-	-	-

APPENDIX F

Listening Instructions

During this task you will be listening to a passage in background noise. The noise is somewhat like that encountered at a cafeteria or cocktail party.

The passage will be presented in a line by line fashion.
Both the noise and the passage will be presented to your right ear.

After each line is presented please repeat back aloud as accurately as possible what you have just heard. It is important to **listen closely to the words in each of the lines** of the passage, so that you can **repeat them back** to me **as accurately as possible** Each line will be presented only once.

If **AT ANY TIME** you feel you repeated something back incorrectly or feel that you forgot to include some information in a previous statement, I want you to tell me what information you want to change or add.

Also should you be unsure of what you heard, feel free to say whatever possible answers come to mind . For example if the sentence "Suddenly the fans rushed the stage" is presented and you repeat back "The fans ran up to the stage" and then immediately think that what you really heard was "The fans rushed the stage", and then realize that what you really heard was "Suddenly the fans rushed the stage", then give me all three responses, or more if they occur to you.

This listening and repeating task is **not under any time limits**. Take the time you need to repeat back what you hear. And take the ti me to consider any changes you may want to make to the answers you have given: Additions, corrections, whatever..

When you have finished repeating back what you have heard and have made the changes you want to what you have just said, or changes to what you have previously said press the button to indicate that you are ready to go onto the next item.

Finally,it is **important to listen to and understand the passage itself** as you will be asked to answer some questions after the entire passage has been presented.

The responses you make are being tape-recorded for analysis.

APPENDIX G

Questions for the Narrative: Taxi

1. The narrator's house
    a. has been swept off a mountain slope
    b. teeters on a mountain slope
    c. has good bus service
    d. is close to the airport

2. The taxi company in this story is
    a. trying to maximize profits
    b. servicing its customers as best it could
    c. poorly run
    d. doing its best to cope with the rainy weather

3. The taxi driver
    a. is a regular full time driver
    b. is also the owner of the taxi company
    c. is also a dispatcher
    d. is a casual part-time driver

4. The narrator decides to hitchhike because
    a. there's lots of traffic
    b. she's given up on the taxi company
    c. its legal
    d. she's getting wet and cold

5. At the start of the story the narrator is
    a. anxious
    b. sleeping
    c. in a good mood
    d. crying

6. Which of the following vehicles drives by the narrator?
    a. a dump truck
    b. a van
    c. a motorcycle
    d. a pickup truck

7. The taxi driver
    a. makes a lot of money from this drive
    b. charges only half the fare
    c. refuses money for his service
    d. receives a large tip for his service

8. The taxi driver
    a. wants the narrator to make her plane
    b. has had a hard time finding the narrator's house
    c. has risked his life to get the narrator to the airport
    d. is just learning the city

9. When the story begins it's
    a. eleven in the morning
    b. seven in the morning
    c. noon
    d. seven in the evening

10. The narrator waits for a taxi outside on a bridge because
    a. she thinks its the only way she will get a taxi
    b. she is tired of waiting inside
    c. she thinks her house is too hard to find
    d. she can wait for a bus at the same time

Questions for the Narrative: Jewel Prank

1. The jewels were stored in
    a. a safe
    b. a pouch
    c. a purse
    d. a case

2. At the end of the story the restaurant customers
    a. were excited
    b. were upset
    c. were tired
    d. were satisfied

3. When the band played "This is the Life"
    a. Jim Moran was feeling like he was in a dream
    b. Jim Moran was feeling like a drink
    c. Jim Moran was feeling like dancing
    d. Jim Moran was feeling like royalty

4. Jim Moran showed his approval to the band leader
    a. by nodding his head
    b. by clapping his hands
    c. by shaking his hand
    d. by raising his eyebrows

5. In this story the main character
    a. waited until the timing was right to go to a fancy restaurant
    b. wasted no time in making reservations at a fancy restaurant
    c. bought expensive jewels
    d. enjoyed eating at fancy restaurants

6. Upon arriving at the restaurant who entered the restaurant first?
    a. Jim Moran
    b. The band leader
    c. one actor
    d. two servants

7. Jim Moran left the restaurant after
    a. finding a fly in his soup
    b. eating his dinner
    c. the real prince entered the restaurant
    d. spilling his drink

8. In this story, Jim Moran
    a. liked to be generous
    b. liked to hurt people
    c. liked to lie
    d. liked to have fun

9. Jim Moran was
    a. a mobster
    b. an actor
    c. a trickster
    e. a prince

10. The band leader
    a. could not become rich by selling the gemstone he was given
    b. could make lots of money with the gemstone he was given
    c. could become famous by selling the gemstone he was given
    d. was a friend of Jim Moran's

Questions for the Narrative: Scaredy Cat

1. The basement in this story is typically old fashioned because
    a. it has a high ceiling
    b. it has a low ceiling
    c. it has poor sealant
    d. it has no lighting

2. The sister of the narrator
    a. is understanding
    b. is sympathetic
    c. is also scared of the bogey man
    d. is a typical sister

3. The narrator goes down into the basement
    a. because she cares what other people think
    b. because she knows she is being silly
    c. because she hates her sisters
    d. because nobody else will

4. When the narrator goes into the laundry room what happens?
    a. the bogey man jumps out at hert
    b. a monster with green eyes attacks her
    c. a cat jumps out at her
    d. her sister jumps out at her

5. Our imaginations
    a. are strange things
    b. are very creative
    c. are what make us human
    d. are fun to have

6. The narrator goes into the basement to get
    a. bath towels
    b. flour
    c. dish soap
    d. dish towels

7. When returning upstairs the narrator
    a. runs
    b. trips
    c. skips
    d. crawls
8. At the end of the story
    a. the narrator has overcome her fears
    b. still believes in the bogey man
    c. realizes there's no such thing as a bogey man
    d. is glad her sister forced her to confront her fears

9. According to the narrator, her basement is a frightening place because
    a. the bogey man hides there
    b. its hard to see in the dark
    c. nobody likes it
    d. scarey creatures hide there

10. The narrator doesn't want to go down to the basement when her sister asks because
    a. she is too busy
    b. she is lazy
    c. she has other things to do
    d. she is afraid of the bogey man

Questions for the Restaurant Review: Ninth Street Cafe

1. This restaurant is the place to eat
    a. nachos
    b. light meals
    c. dessert
    d. french cuisine

2. The dessert menu at this bistro is
    a. extensive
    b. limited
    c. for chocolate lovers
    d. for cheesecake lovers

3. The ceasar salad at this restaurant
    a. is like any other ceasar salad
    b. is worth ordering if you like salads
    c. is terrible
    d. is not a traditional ceasar salad

4. The lasagna is made with
    a. fresh cottage cheese
    b. fresh ground beef
    c. fresh carrots and spinach
    d. fresh pasta

5. This restaurant has
    a. an extensive menu
    b. a special kid's menu
    c. a different menu every night of the week
    d. all of the above

6. Which of the following was a soup special at this restaurant?
    a. canned cream of mushroom
    b. canned cream of corn
    c. canned cream of asparagus
    d. canned cream of celery

7. The best choice for dessert is
    a. the cheese cake
    b. the chocolate cake
    c. the berries and cream
    d. the homemade ice cream

8. If you're craving pasta
    a. order the spaghetti with garlic
    b. avoid the pasta menu here
    c. there's a limited choice here
    d. you're likely to find something to satisfy your tastebuds

9. This restaurant is near
    a. a university
    b. a subway station
    c. a mall
    d. a college

10. The burgers in this restaurant
    a. are tasty
    b. are ordinary
    c. are just like those you get at McDonald's
    d. are made with tofu

Questions for the Restaurant Review of Mrs. T's Cafe

1. Which of the following is an "Opener" at Mrs. T's?
    a. chicken kiev
    b. shrimp and crab on noodles
    c. smoked salmon with capers
    d. potato skins

2. The efficiency of the restaurant's one waitress is
    a. revolutionary
    b. comforting
    c. terrible
    d. amazing

3.The best corned beef dish on the menu is
    a. the omelette
    b. the sandwich
    c. the pie
    d. the salad

4. The house special sandwich is described as
    a. typical deli food
    b. too much for one person
    c. larger than life
    d. a big moment

5. Mrs T's is the kind of place where
    a. you get a good meal for your dollar
    b. you never feel rushed to leave
    c. you eat and run
    d. everything is microwaved

6. The pride and joy of Mrs. T's
    a. are her children
    b. is the roast beef
    c. is the shrimp and crab on noodles
    d. is the corned beef

7. The restaurant is closed on
    a. Sundays
    b. Sunday nights
    c. Monday nights
    d. Mondays

8. The pumpkin pie served at Mrs. T's is made
    a. from scratch
    b. from a box mix
    c. at a local bakery
    d. only in October

9. In the middle of Mrs. T's there's a
    a. coal stove
    b. rock
    c. table
    d. crock pot

10. The vegetable side dish at Mrs. T's is
    a. predictable
    b. always a surprise
    c. never the same
    d. not something typically made at home

Questions for the Restaurant Review of Siggy's Place

1.The Sunday brunch at Siggy's
   a. features a buffet
   b. is a good meal to take your mother to
   c. is the best deal in town
   d. starts at eleven in the morning

2. When is the best time to order the black forest torte?
   a. Soon after it's been baked
   b. When it's listed as the dessert special
   c. In the evenings
   d. When it's served with fresh whipped cream

3. This restaurant will appeal to
   a. fish eaters
   b. meat eaters
   c. vegetarians
   d. everyone

4. At Siggy's restaurant
   a. the desserts are the best in town
   b. the vegetables are always fresh
   c. the cheeseburgers are outstanding
   d. the choice of foods is staggering

5. Many of Siggy's customers
   a. have experienced indigestion
   b. have come from Europe
   c. think highly of his cooking
   d. are chefs

6. This restaurant specializes in
   a. beef dishes
   b. buffalo dishes
   c. seafood dishes
   d. pork dishes

7. The food at Siggy's is
    a. good
    b. terrible
    c. honest
    d. excellent

8. Siggy's shrimp crepes are
    a. made with the freshest of ingredients
    b. a demonstration of his expertise
    c. a poor reflection of his abilities
    d. a typical example of Siggy's fine cooking

9. At the front of Siggy's restaurant is a glass case which displays
    a. the menu
    b. a guest book
    c. medals
    d. pictures of Siggy with famous chefs

10. According to this restaurant review, Siggy's restaurant
    a. is reasonably priced
    b. will put a dent in your wallet
    c. is known for its blue plate specials
    d. is typical of eateries

Questions for the Recipe: Apple Tart

1. Which of the following does not happen to the apples?
    a. they are peeled and cored
    b. they are arranged in a petal-like fashion
    c. they are sliced
    d. they are boiled

2. The apple tart is meant to be eaten
    a. immediately after it comes out of the oven
    b. with ice cream
    c. five minutes after it comes out of the oven
    d. when it's not too hot and not too cold

3. In this recipe, the instructions provided are
    a. typical of european recipes
    b. described with a fair degree of precision
    c. nonsensical
    d. outlined in a very loose fashion

4. A round of foil is fitted over the dish to
    a. speed up the cooking time
    b. prevent the pastry from burning
    c. prevent the apples from spilling out
    d. prevent the apples from bubbling

5. This recipe describes a
    a. main course
    b. soup
    c. dessert
    d. appetizer

6. After the pastry is rolled out it is put
    a. on the bottom of the metal dish
    b. over the apples in the metal dish
    c. on the bottom of the dish and on top of the apples
    d. in the freezer

7. Which of the following is painted in a thin layer over the apples?
    a. caramel
    b. whipped cream
    c. butter
    d. cinnamon

8. According to the instructions, the tart may burn
    a. because thermostats frequently breakdown
    b. because thermostats are poorly designed
    c. because ovens are often too hot
    d. because not all ovens have an accurate thermostat

9. Nutmeg, cinnamon, & brown sugar are sprinkled over the
    a. pastry to prevent it from burning
    b. pastry to prevent it from turning brown
    c. apples to provide them with flavor
    d. apples to provide them with calories

10. This recipe calls for
    a. one apple
    b. three apples
    c. six apples
    d. twelve apples

Questions for the Recipe: Chocolate Cake

1. The chocolate mixture is folded into
    a. the warm water
    b. the cream and salt mixture
    c. the flour and butter mixture
    d. the bowl

2. A sharp serrated knife is recommended for cutting
    a. because the cake has several layers
    b. because the cake is jelled
    c. because cream filling is thick and stiff
    d. because the cake is frozen

3. The number of layers this cake has is
    a. two
    b. three
    c. four
    d. five

4. Each of the cake layers is baked
    a. with a round of waxed paper underneath them
    b. with a round of tinfoil underneath them
    c. with a round of tinfoil on top of them
    d. with a round of waxed paper on top of them

5. At the beginning of this recipe the butter is combined with the flour
    a. to make a dough
    b. to keep the butter from turning to oil
    c. to make oatmeal
    d. to make a batter

6. The dough is
    a. rolled between two sheets of wax paper
    b. kneaded
    c. left to rise
    d. placed in the freezer four times

7. The top of the cake is decorated with
    a. almond slivers
    b. chocolate slivers
    c. chocolate curls
    d. almond sauce

8. The cake is baked on an ungreased cookie sheet because
    a. the cake is made with cooking oil
    b. the bottom of the cake is meant to be crunchy
    c. the the recipe calls for a teflon coated cake pan
    d. the cake is baked with a round of waxed paper beneath it

9. This recipe
    a. uses one dozen eggs
    b. requires nine ingredients
    c. serves two people
    d. requires two ovens

10. Which of the following techniques is used in this recipe to make dough rolling easier?
    a. Flouring the rolling pin prior to rolling out the dough
    b. Flouring the dough prior to rolling it out
    c. Chilling the rolling pin prior to rolling out the dough
    d. Rolling the dough between sheets of waxed paper

Questions for the recipe: Poached Trout

1. In the preparationof this dish all ingredients need to be
    a. boned
    b. cold
    c. at room temperature
    d. fresh

2. A hot mushroom sauce
    a. turns this dish from a cold appetizer to a hot entree
    b. goes well with this dish
    c. allows the subtle flavors of the fish to fully develop
    d. none of the above

3. T o make this recipe, you would require
    a. A vast array of herbs
    b. A well equipped kitchen
    c. A good knowledge of fish habits
    d. A wok

4. The fish balls are shaped using
    a. an ice cream scoop
    b. a melon baller
    c. two large spoons
    d. your hands

5. This recipe recommends that you
    a. catch the fish yourself
    b. have an expert prepare the fish
    c. wash the fish thoroughly
    d. soak the fish in lemon juice

6. The egg, flour, butter mixture is called a
    a. panade
    b. dough
    c. canard
    d. banger

7. This recipe involves
    a. gravy
    b. salted water
    c. cranberry sauce
    d. lemon juice

8. Which of the following statements best describes this recipe?
    a. "This is your basic fish recipe"
    b. "This dish is a favorite among French Canadians"
    c. "This dish is always served in French restaurants"
    d. "This recipe requires time"

9. This recipe calls for the following amount of nutmeg
    a. one tablespoon
    b. quarter teaspoon
    c. half cup
    d. a pinch

10. When the panade pulls away from the side of the saucepan
    a. It's time to move onto the next step
    b. Something has gone wrong with the recipe
    c. The cooking heat is too high
    d. It's ready for freezing

APPENDIX H

Familiarity Questionaire

Subject code:_____ Session:_____ Date:

Text Type:_____

Text Exemplar:_____

S/N:_____

Familiarity Rating

1. I never encounter {Stories Recipes RestReviews}
2. I occasionally encounter {Stories Recipes RestReviews}
3. I frequently encounter {Stories Recipes RestReviews}

APPENDIX I

Examples of target messages, responses and coding

1. Examples of Deletion

Target: Flooded with calls the company's maximizing profits by handling only in city runs

Response: Flooded with calls the company's maximizing profits

Coding: Deletion

Auditory: no match

Semantic: no match

Syntactic: no match

2. Examples of Addition

Target: "terriby sorry", begins the dispatcher

Response: "I'm terribly sorry", begins the dispatcher

Coding: Addition

Auditory: no match

Semantic: no match

Syntactic: no match

3. Examples of Substitution

Target: and a freeform fireplace that burns real wood on cold evenings

Response: and a free form fireplace that makes it real hot

Coding: Substitution

Auditory: no match

Semantic: no match

Syntactic: no match

Target: to say they can't find my house

Response: to say they can't find my place

Coding: Substitution

Auditory: no match

Semantic: total match

Syntactic: total match

Target: unless of course you're afraid of the bogey man she said gleefully

Response: unless of course you're afraid of the bogeyman she said gruffily

Coding: Substitution

Auditory: partial match

Semantic: no match

Syntactic: total match

Target: the gloomy quiet atmosphere seemed to close in on me

Response: the gloomy dark air started closing in on me

Coding: Substitution

Auditory: partial match

Semantic: partial match

Syntactic: total match

4. Examples of Exchange

Target: and various certificates proclaiming his excellence in competition

Response: and certificates proclaiming his excellence in various competitions

Coding: Exchange

Auditory: no match

Semantic: no match

Syntacti: no match

Target: then he bought a big batch of glass jewels and a large amathst

Response: then he bought a big batch of large glass jewels and an amethyst

Coding: Exchange

Auditory: no match

Semantic: no match

Syntactic: no match

5. Examples of Multiple Codings

Target: Terribly sorry begins the dispatcher

Response: I'm terribly sorry rings the dispatcher

Coding: Addition

Auditory: no match

Semantic: no match

Syntactic: no match

Coding: Substitution

Auditory: partial match

Semantic: no match

Syntactic: total match

Target: well I'm kinda busy right now I replied

Response: well I kinda visited

Coding: Deletion

Auditory: no match

Semantic: no match

Syntactic: no match

Coding: Substitution

Auditory: partial match

Semantic: no match

Syntactic: no match

Coding: Substitution

Auditory: no match

Semantic: no match

Syntactic: no match