THE FUNCTIONAL ROLE OF THE CLOSED CLASS VOCABULARY IN CHILDREN'S LANGUAGE PROCESSING

by

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ABSTRACT

This thesis explores two issues related to the contrast between the closed class vocabulary (members of the minor lexical categories) and the open class vocbulary (members of the major lexical categories). The first of these concerns the hypothesis that the closed class vocabulary plays a major role in preschool age children's sentence processing. The second, related, issue is whether children's performance on closed class words in metalinguistic and repetition tasks is the result of the same mechanisms that are responsible for adults' perfomance in letter detection tasks during reading. Establishing this connection is important in creating a more parsimonious account that relates both types of behavior to the closed/open class processing contrast that has been the focus of a number of recent psycholinguistic investigations. These studies have suggested that the open and closed class vocabularies play distinct computational roles in adult language processing.

The first set of studies presented here is a series of word judgment experiments and a modified sentence repetition experiment. The results of these experiments indicate that children's metalinguistic errors on closed class words cannot simply be attributed to the acoustic-phonetic and semantic characteristics of these words, as has been previously claimed. Word judgment errors on abstract open class words can be largely eliminated by means of a simple training procedure which provides the child with an approximation to the adult concept of "word". On the other hand, closed class errors persist in spite of preliminary training. In addition, the results of these studies suggest that closed class errors are not the result of children's misclassification of these words as bound morphemes, and that, in fact, preschoolers' lexical segmentation abilities have been underestimated in the past. It is hypothesized that children's closed class word judgment errors are parallel to adults' errors in word and letter detection tasks, and that both types of errors reflect different relations between conscious attentional processes and the two word classes.

Experiments 4 - 7 employ a nonsense sentence repetition paradigm to examine the hypothesis that closed class elements of sentences serve as aids for syntactic analysis by children. The results indicate that children are able to interpret Jaberwocky-like sequences sententially. Furthermore, the data from these experiments support the claim that children's closed class deletions are the result of processes occurring after the lexical entries for these items have been contacted.

The last section of the thesis presents two experiments with adult subjects that are aimed at investigating the phenomenon of "invisibility" of closed class words in proofreading and letter detection tasks. Experiment 8 employs a letter detection tasks with materials presented in RSVP (Rapid Serial Visual Presentation) mode. The results of this experiment replicate the findings of previous studies using less controlled stimulus presentations, namely, that subjects are less likely to detect target letters in closed class words than in open class words. Furthermore, they generalize the finding to a broad range of closed class words, and, more importantly, they rule out the hypothesis that the effect is simply correlated with frequency of occurrence of forms. Instead, the results suggests that the "invisibility" effects are dependent on vocabulary type.

Experiment 9, a misspelling detection study, lends support to the claim that the "invisibility" effects obtained in Experiment 8 are the result of post-lexical access processes; a claim which is crucial in constructing an account that incorporates children's performance on closed class words during repetition and metalinguistic tasks and adults' performance during reading tasks under the same explanation related to the closed/open class processing contrast.

Thesis Supervisor: Professor Merrill Garrett

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BIOGRAPHICAL NOTE

Carmen Egido was born on June 6, 1958 in Madrid, Spain. After perfecting her English at the American School of Madrid, she came to MIT to become a mathematician. Why anyone for whom formalisms and abstract descriptions appear to be a consuming passion should turn to experimental psycholology remains a profound mystery.

GENERAL INTRODUCTION

An adequate theory of language acquisition must include an explanation of the relationship between vocabulary growth and development of syntactic processing capacities. Once the child has associated a set of lexical items with their meanings, he/she is faced with the task of inducing both their corresponding syntactic categories and the rules of syntax in which they participate. The studies presented here address the general question of whether the child takes advantage of the design inherent in the language to facilitate this task. In particular, these studies explore the role in acquisition of the contrast between major grammatical categories (e.g., N, V, Adj) and minor grammatical categories (e.g., Det, P, Aux).

This vocabulary distinction is currently under active investigation in the field of Psycholinguistics under the label "open" versus "closed" class vocabulary contrast, and is an issue of longstanding interest in studies of language processing. The distinction manifests itself in memory processes (see e.g. Epstein, 1961), language disorders (see e.g. Goodglass, 1976), and language acquisition (see e.g. Brown, 1973). Moreover, a number of recent psycholinguistic investigations have suggested that the two word classes play distinct computational roles in both language comprehension and production (Garrett, 1982; Bradley and Garrett, 1980). So, for example, the results of several lexical decision experiments point toward the existence of two qualitatively different lexical retrieval devices, one of which is strictly devoted to the closed class vocabulary (Bradley, 1978). These latter studies have been motivated by the hypothesis that this vocabulary distinction is tied to the operation of syntactic processing mechanisms.

The closed class elements of a sentence provide a "skeleton" of constituent structure that facilitates the assignment of grammatical categories to open class items (Bradley and Garrett, 1980). The syntactic support that closed class elements provide is strikingly illustrated by nonsense "sentences" in which all open class words have been replaced by nonwords, as in Lewis Carroll's "Jaberwocky" or sentences such as "The vapy koobs desaked the citer molently". A detailed constituent structure can be assigned to such sentences although no information is available about the grammatical category or meaning of the strings occupying the open class slots.

In light of these observations, it is particularaly pertinent to examine the role of the closed class vocabulary in the process of language acquisition since, at least in a trivial sense, the utterances that language learners are faced with are analogous to Jaberwocky sequences. From the point of view of the child, adults' speech is composed of items for which he/she already posesses some sort of representation of meaning or linguistic function intermingled with items for which the child has no semantic or syntactic information. The question is whether the analogy is in fact deeper, that is, whether children use closed class words and morphemes as starting points for syntactic construction. This less trivial analogy depends on the plausibility of the claim that the closed class vocabulary is functional early in the acquisition process. Thus, the question which is addressed in this thesis is whether in fact the closed class vocabulary has special psychological status for young children.

THEORETICAL BACKGROUND

There are a number of a priori reasons that might lead one to believe that that the closed class should play some role in young children's language processing. First, a mechanism that permits the assignment of phrasal analyses to sentences that contain large gaps of lexical information would be of obvious value to the child. The ability to employ this subset of the lexicon would at the very least facilitate the appropriate segmentation of utterances and provide constraints on the category membership of vocabulary items for which the child has no semantic or grammatical information. Secondly, it seems plausible that the closed class vocabulary might be relatively easy to acquire because it is a very small set of words that appear extremely frequently in sentences and that are often even phonetically distinguished.

A division between the open and closed class vocabularies is certainly implicated in a number of aspects of child language development. During the early stages of acquisition the contrast appears as differences in the productive command of the two vocabularies. Thus, the child's first sentence utterances are composed primarily of referential terms, i.e., open class words. Closed class words are, for the most part, omitted from these first utterances. The resulting "telegraphic" speech is universal across languages and has been very widely discussed in the child language literature.

(Brown, 1973).

The division continues to manifest itself even after the child achieves comparable levels of command in production of the two classes of words. For instance, three- and four-year-old children's sentence repetitions continue to be telegraphic although their spontaneous speech no longer is (Brown and Fraser, 1963). Furthermore, children of up to six years of age exhibit differences between the two vocabularies in metalinguistic tasks. They often deny the lexical status of closed class words (Papandropolou and Sinclair, 1974) and fail to segment closed class words from open class ones in spoken sentences (Holden and MacGinitie, 1972). Even during the most advanced stages of language development, when the child is learning to process language via the visual modality, interesting class related differences persist. For instance, beginning readers exhibit large numbers of substitution errors involving closed class items such as prepositions (Liberman, 1973).

However, the delayed appearance of closed class words in the child's speech, as well as the even more protracted differences between open and closed class words, have generally been interpreted as a reflection of poor command of the closed class, and not of its special status. Most accounts attribute the late appearance of these words in the child's vocabulary to their lack of acoustic phonetic salience and informational value. Content words are deemed easier to learn because they are easier to perceive (i.e., they carry stress) and have clear meanings (de Villiers and de Villiers, 1978). Thus, children's omissions of articles, prepositions, auxiliary verbs, and inflections in sentence imitation tasks (Brown and Fraser, 1963) have been seen as parallel to their omissions of non-primary stressed syllables in nonsense syllable imitation studies (Blasdell and Jensen, 1970). An argument in terms of perceptual threshold limitations will obviously not serve as an explanation here, so in effect this view assumes that, in the early stages, the child's limited capacity decoding mechanisms consist of auditory discrimination processes which are tuned to various cues in the physical signal that mark significant features of adult speech. Thus, the child must be sensitive to relative changes in fundamental frequency, duration, or intensity which signal primary stress.

However, there are several reasons for questioning not only this construal of the closed class vocabulary, but the the resulting interpretation of telegraphic speech and other differences that children exhibit for the two vocabulary classes. First, it is not entirely clear that the token utterances of closed class elements that children hear are as acoustically different from those of open class items as they are in spontaneous adult-to-adult speech. Although this question has not been addressed directly in the literature, there is evidence that adult-to-child speech is slow, clearly enunciated, and intonationally exaggerated (Drach, 1969; Newport, 1975; Sachs, Brown, and Salerno, 1972). Given these characteristics, it is quite possible that utterances of these words in "motherese" are of relatively high acoustic quality.

Second, one may argue that a number of characteristic properties of the closed class should in fact serve to facilitate the child's task of acquiring this vocabulary. For instance, the closed class is a very small set of words (roughly 200 in English) whose members have a very high rate of occurrence in the language (virtually all of the first 100 words in the Kucera and Francis (1967) frequency count are closed class words). In addition, closed class words are often phonologically idiosyncratic. For example, the phonemic realization of word-initial th- is the voiced dental fricative [ð] in the closed class, but the voiceless alveolar fricative [θ] in the open class (compare that and thatch). Word-initial wh- is also particularly frequent in the closed class (analogously, qu- is frequent in the closed class vocabularies of Romance languages).

Third, a number of empirical facts also militate against the notion that closed class items are acquired later as a result of initial perceptual limitations or biases. In the first place, this view incorrectly predicts the order of acquisition of elements within the closed class as well as the consequences of cross-linguistic differences in the acoustic phonetic quality of these words. According to this account, the more acoustically salient closed class elements should be acquired first. Thus, syllabic morphemes (free or bound) should exhibit an advantage over nonsyllabic ones. Items such as uncontractible copulas, determiners, and the syllabic allomorphs of the third person past and the plural morphemes should be learned first. Similarly, children learning languages in which closed class elements are as acoustically prominent as open class words (e.g. Spanish, French) should not exhibit differences in their command of the two vocabularies. Neither of these predictions is borne out. The order of acquisition of closed class morphemes does not appear to be governed by acoustic salience (Brown, 1973; de Villiers, 1978), and telegraphic speech appears to be universal across languages (Brown, 1973) regardless of the acoustic characteristics of their closed class elements. Moreover, sentence repetition studies which equate or even reverse the stress characteristics of open and closed class items in test materials (Scholes, 1969; Ehri, 1975; Eilers, 1975) still report numerous function word deletions in their subjects' imitations. These results suggest that children's telegraphic sentence imitations are not analogous to their omissions of unstressed syllables in nonsense repetition tasks. Thus, it seems that stress differences alone do not account for children's performance with the closed class vocabulary.

Fourth, there is some evidence indicating that very young children understand the subtle nuances of meaning that closed class elements introduce into sentences. For example, Slobin and Bever (1982) report that two-year-old Turkish children have command of the case markings of their language. Also, Katz, Baker, and McNamara (1974) showed that 17-month-old children can determine whether a noun is common or proper from the presence or absence of an article. Similarly, an earlier study by Shipley, Smith, and Gleitman (1969) indicated that syntactic comprehension is superior to production in telegraphic speakers. These results demonstrate that the factors of phonetic salience and information content associated with closed class words do not interfere significantly with the child's appreciation of their interpretive force.

There is, however, another class of observations that suggest poor command of closed class items. These are studies of children's metalinguistic abilities, specifically of children's concept of word. The results of such studies, which suggest that young children do not assign lexical status to closed class words and other abstract words, are frequently cited as support for the notion that the semantic properties of closed class items are largely responsible for their delayed appearance into the child's speech. Papandropolou and Sinclair (1974), for instance, claim that children's notion of what constitutes a word is a very restrictive one, including at first only referential lexical items. In this study children were asked to define "word", to provide "wordhood" judgments about certain words, and to give examples of words. Children's responses (e.g. "Car is a word because you can drive it." "Is isn't a word because you can't see it") suggest a failure to distinguish between words and objects, in congruence with Piaget's "nominal realism" findings (Piaget,

1929) and other more recent demonstrations of word-referent confusions in children (Markman, 1976). Papandropolou and Sinclair consider their subjects' errors on closed class items to be simply a subset of the errors on abstract words, a result of children's failure to differentiate between words and things.

However, this explanation will not account for the types of errors that are elicited by production tasks. The omission errors that children make in their telegraphic productions and repetitions are restricted to the closed class vocabulary; they do not compromise abstract open class items. Given the class-specific nature of these errors, it is reasonable to ask whether the set of children's errors in metalinguistic tasks may be decomposable into two types. Some of these errors may indeed stem from an inability to distinguish words from things, but it is also possible that closed class errors elicited in metalinguistic tasks may be related to processes that produce deletions in repetition tasks, which are clearly unrelated to children's word-referent confusions. If this hypothesis is correct, these metalinguistic errors should occur systematically across a wide range of closed class items regardless of degree of semantic content. The study presented in the next section attempts to disentangle these bases for error in children's responses to "abstract" words.

EXPERIMENT 1

METHOD

Subjects

Sixty nine preschool children from day care centers in the Boston area served as subjects for this experiment. Data from five of the children were rejected because they were incomplete or exhibited alternation or perseveration strategies. In addition, four of the children were unable to master a preliminary sentence judgment task and were not used in the experiment. The remaining sixty subjects ranged in age from 3;5 to 5;0 years, with a mean age of 4;2 years. All children were monolingual native speakers of English.

Materials

Ten words of each of the open class categories Noun, Verb, Adjective, and Adverb were chosen for the experiment. All words were high frequency items judged to be well known to the average preschool age child. In the Noun, Verb, and Adjective categories, the ten items were made up of five "abstract" and five "concrete" words, judged as such by five adult speakers.

In addition, ten words were chosen from each of the closed class categories or groups of categories Pronoun, Auxiliary/Modal Verb, Determiner/Quantifier/Adverb, Preposition, and Conjunction/Complementizer/Wh-words.

Categories were grouped on the basis of the distributional properties of their members. In the category preposition, five of the items were judged to have a low degree of semantic content ("abstract") and five were judged to have a higher degree of semantic content ("concrete") by five adult speakers.

The resulting items (shown in Appendix 1) were divided into ten lists, each of which contained one word from each of the open and closed class category sets as well as five nonword items. All lists were scrambled in pseudorandom order.

Procedure

A word judgment task similar to that used by Papandropolou and Sinclair (1974) was employed in this experiment. However, a few important modifications were introduced. In the first place, the children, who were individually tested, played a preliminary sentence judgment "game". This task, modeled after de Villiers and de Villiers (1972), required the children to make grammaticality judgments about simple sentences and rather transparently syntactically anomalous strings. Its purpose was twofold. First, it served to familiarize the children with the two experimenters, one of whom operated hand-held puppets and spoke to the children while the other noted children's responses. Secondly, it aimed to facilitated the child's understanding of the experimental word judgment task which followed by making the child become accustomed to producing simple metalinguistic judgments.

The second modification to the Papandropolou and Sinclair (1974) procedure was an attempt to make the child understand the concept "word". It amounted simply to modeling a few instances of "real" words and "silly" words (nonwords) to the child before requesting his/her own judgments. The "real" word models were limited to concrete and abstract nouns and verbs only. Limiting the form class of the models made it possible to determine whether whatever concept of "word" the children abstracted from the examples was being generalized to include other grammatical categories.

After these examples, the child was asked to make judgments on the items of one of the lists, which were uttered by the experimenter manipulating the puppets. Each utterance of a test item was followed by the question "Is that a word?". Items were often repeated once more to the child after the question if he/she did not respond immediately or if a distracting noise or event had interfered with the presentation of the test item. The entire testing session typically lasted 20-25 minutes.

Data Treatment

Subject's word/nonword judgments were analyzed for errors. All statistical comparisons used Chi Square analysis.

RESULTS AND DISCUSSION

The results of this experiment are summarized in Table 1 below. Error rates for individual items are listed in Appendix 1.

Table 1. Word/nonword judgment errors in Experiment 1

	Category	Errors	Average % Errors	
OPEN CLASS	Noun		2%	5.2%
	concrete	1/30		
	abstract	0/30		
	Verb		10%	
	concrete	0/30		
	abstract	6/30		
	Adjective		3%	
	concrete	1/30		
	abstract	1/30		
	Adverb	3/54	6%	
CLOSED CLASS	Prepositions		32%	36%
	concrete	6/30		
	abstract	13/30		
	Pronouns	20/59	34%	
	Aux/Modal	27/60	47%	
	Det/Adv/Quant	14/60	23%	
	Conj/Comp (wh-)	24/60	43%	
NONWORDS				4.3%

As can be seen, there is an overwhelming effect of vocabulary type. Children made many more errors on closed class items (36%) than on open class items (5.2%). On the other hand, differences between "concrete" and "abstract" items were not statistically significant in either class. For the open class categories $\chi^2(1)=2.92$, $p>.05$, and for the closed class, i.e., prepositions, $\chi^2(1)=3.77$, $p>.05$. Analyzing each category individually shows an effect of abstractness for verbs ($\chi^2(1)=6.67$, $p<.01$). However, the 6 errors on "abstract" verbs were concentrated on only two of the items, so it is difficult to interpret this difference. Furthermore, there are no differences between nouns and verbs (the modeled categories) and adjectives and adverbs, which implies that the children generalized the concept of "word" to include all open class grammatical categories.

The characteristics of some the responses provided by the children in this study are also worth mentioning. At times, children spontaneously provided corrections for nonwords and for incorrectly classified words. Typically, the child would repeat (correctly) the test item in a questioning tone and would then say "That's not a word. It's supposed to be _______." He/she would then provide a phonetically similar open class word as a correction. Some examples of corrections made in the course of the experiment are pat for at, buzz for was, fish for this, oven for of, olive for all, and cup for up. Such corrections were only supplied for closed class items and for a few nonwords. In addition, we might note that no open class item which was correctly repeated by the child was misclassified as a nonword.

These results suggest that the errors that children make on closed class words in metalinguistic tasks cannot simply be accounted for by appealing to the reduced informational value of these words. It is possible to eliminate children's "word"/"thing" confusions to a large extent, whereas errors specific to the closed class vocabulary are more persistent. Thus, closed class errors and errors on abstract open class items appear to be of a different nature.

A possible account for this difference is that children may not assign independent lexical status to closed class words because they misclassify them as bound morphemes or fail to segment them correctly in spoken utterances. In fact a study by Holden and MacGinitie (1972) in which kindergarteners repeated sentences while tapping a separate poker chip for each word, suggests that children often fail to identify word boundaries before or after closed class words. However, this explanation and these results seem unlikely given the following observations. In the first place, children isolate nouns from determiners, verbs from auxiliaries, etc., in their early spontaneous productions and imitations, which suggests that they must be able to segment closed class elements in speech. Furthermore, children productively introduce independent lexical material between closed class words and their associated open class words. Thus, children insert adjectives between determiners and nouns, pronouns, noun phrases, and adverbs between auxiliaries and main verbs, and a host of different items and constituents between prepositions and nouns. In addition, the Holden and MacGinitie results may be artifactual in the sense that the tapping task employed in their study may induce children to segment utterances on the basis of their rythmic structure. Some examples of the segmentation errors produced by the children in the study lend support to this idea. For instance, the authors report that the segmentation /The book/ was in/ the desk/ was produced by numerous subjects. Similarly, children often grouped the not with its corresponding noun but with a preceding item, as in "Houses were built/ by the/ men".

Thus, it is likely that children's actual segmentation abilities have been underestimanted. It is necessary, therefore, to examine children's treatment of bound morphemes in a word judgment task and to reevaluate children's conceptions of word boundaries in spoken sentences. Any argument against the possibility that children may be misinterpreting the lexical status of closed class words would be seriously undermined if it turned out that word judgments for bound forms resembled those for free closed class forms, or if children do indeed fail to segment speech into conventional units. The following two experiments were designed to examine these possibilities.

EXPERIMENT 2

METHOD

Subjects

Twenty two preschool age children from day care centers in the Boston area participated in this study. Data from two children were excluded from final analysis because they exhibited alternation strategies. The remaining twenty children ranged in age from 3;4 to 4;8 years, with a mean age of 4;5 years. All children were monolingual native speakers of English, and had not served as subjects for Experiment 1.

Materials

The item list used in this experiment included two words from each of the open class categories, Noun, Verb, and Adjective, two words from each of the closed class categories Determiner, Preposition, and Auxiliary Verb, as well as the only two syllabic inflections which are both pronounceable in isolation and likely to be familiar to children, *-ing* and *-er*. These items are displayed in Appendix 2. In addition, six nonword fillers were included in the list. The items were presented in pseudorandom order.

Procedure

The testing procedure was the same as that used in Experiment 1, except that only one experimenter was present, and the testing sessions were tape recorded for later scoring.

Data Treatment

As in Experiment 1, subject's word/nonword judgments were analyzed for errors. Statistical comparisons were made on the basis of Chi Square analyses.

RESULTS AND DISCUSSION

The results of this experiment are summarized in Table 2 below. Error rates for individual items are listed in Appendix 2. Corrective responses of the type found in the previous experiment also occurred for a number of closed class items in this experiment.

TABLE 2. Word/nonword judgment errors in Experiment 2

	Category	Errors	Average % Errors	
OPEN CLASS	Noun	1/40	2.5%	5.8%
	Verb	4/40	10%	
	Adjective	2/40	5%	
CLOSED CLASS	Determiner	9/40	23%	29.3%
	Auxiliary	14/40	35%	
	Preposition	12/40	30%	
BOUND MORPHEMES	-ing/-er	3/40		7.5%
NONWORDS		22/240		9.2%

As in the previous experiment, there is a significant difference in error rates for open versus closed class words. Children made more incorrect judgments for closed class words than for open class words ($\chi^2(1)=22.6$, $p<.001$). On the other hand, there are no differences between error rates for inflections versus open class words ($\chi^2(1)=.04$, $p>.8$). There are also no significant differences between error rates for inflections versus nonwords ($\chi^2(1)=.12$, $p>.7$). These results suggest that children are not treating bound and free morphemes equivalently. Therefore, these data support the idea that the open and closed class differences found in Experiment 1 are not simply a result of children's misclassification of free closed class morphemes as bound forms.

However, this result conflicts with the Holden and MacGinitie (1972) study described above. To investigate the possible reasons for this conflict, the following experiment was designed to assess children's ability to segment words in spoken sentences. The sentence repetition task employed by Holden and MacGinitie was modified in order to eliminate the rythmic nature of the task and thus reduce children's tendency to base their segmentations on the prosodic structure of the utterances.

EXPERIMENT 3

METHOD

Subjects

Twenty eight preschool age children from day care centers in the Boston area participated in this experiment. Data from eight children were dropped from analysis because they were incomplete. The remaining twenty children ranged in age from 4;7 to 5;5 years, with a mean age of 5;2 years. All children were monolingual native speakers of English.

Materials

Seventeen sentences were constructed for use in this experiment. They contained mono- and dissyllabic words and a large variety of closed/open class word boundaries. The sentences were divided into two sets, each of which formed part of a simple story. Appendix 3 lists the complete set of sentence materials used in this experiment.

Procedure

This study employed a modified sentence repetition task in which children were asked to provide repetitions of every other word in a sentence in alternation with the experimenter, who repeated the complement set of words. Children were tested individually in sessions which proceeded as follows: The child two toy frogs and was told that these frogs "often say things together". The experimenter then demonstrated the frogs repeating utterances in alternation with each other. The technique was modeled for the child with three different sentences which were constructed so as to demonstratee that the lexical segmentation required by the task is not based on syllabic structure or on properties of referents of phrases in sentences. The modeled sentences were "We like to talk together", "The yellow pencil is on the table", and "There are stars in the sky".

After modeling these sentences, the experimenter asked the child to act out the role of Frog #2 by repeating every other word of the test sentences in alternation with the experimenter, who took on the role of Frog #1 and started each sentence repetition by providing the first word. The child was asked to switch roles (Frogs) with the experimenter after the first set of sentences. Each test sentence was started 50% of the time by a child and 50% of the time by the experimenter.

The test sentences were embedded in two stories and were picked out for the child by the experimenter saying "The frogs want to say ___" followed by a test sentence. The child was asked to repeat the sentence as a whole until he/she produced a correct rendition. The experimenter then started the alternating repetitions by saying to the child "Alright, let's see how the two frogs say that together" and providing the first word of the sentence (or encouraging the child to do so). Whenever necessary, the child was prompted to provide the next word by means of encouraging gestures or by repeating the current word.

To reduce memory demands on the child, the test sentences were presented together with drawings which represented the objects and/or actions mentioned in the sentences. These drawings remained in the child's view until the alternating repetition was completed. In cases of prolonged hesitation, the experimenter repeated the whole sentence again for the child and prompted him/her to continue the alternating game.

RESULTS AND DISCUSSION

Sentences on which children committed segmentation errors are shown in Table 3. Errors are noted under the relevant word boundaries. For purposes of comparison, Table 4 displays the eight sentences for which Holden and MacGinitie (1972) provide data.

TABLE 3. Segmentation errors in Experiment 3

SET I

1. This /little boy/ lives in that house.
   1/9
2. Bill washes him/self.
   5/10
3. Bill and Mary wanted /to be/ friends.
   4/11
4. They both rode the bus /to school/.
   1/10
5. Don't /take off/ your jackets.
   3/10
6. We will go to /the zoo/.
   1/10
7. The lions live in /the cage/. (1/10 -> /the zoo/)
   1/10
8. We saw monkeys /and giraffes/.
   1/10

SET II

1. My mother is baking a /chocolate cake/.
   4/11
2. That piece looks bigger than /this one/.
   2/10
3. Do you want /some milk/?
   1/12
4. We /want to/ go /to [the movies]/. (4/10 - "wanna")
   1/14 1/6
5. /Put on/ your new mittens.
   2/10

TABLE 4. Data sample from Holden and MacGinitie (1972).

1. /The book/ /is in/ /the desk/.

2. You /have [to/ go] home.
12/33 5/33

3. Snow <u>is</u> cold.
4/27

4. /Is snow/ cold?
6/27

5. /Bill [is/ drinking] soda.
4/51 23/51

6. /Is Bill/ drinking soda?
33/51

7. Houses were built /by [the/ men].
2/27 12/27

8. /The dog/ wanted bones.
34/51

9. /The dog/ wanted /to eat/.
7/24 10/24

The results obtained in this study contrast in several ways with those obtained by Holden and MacGinitie (1972). In comparison with the subjects in the Holden and MacGinitie study, the children in this study committed relatively few segmentation errors. For each of the eight sentences for which Holden and MacGinitie provide data, an average of 49% of their subjects compounded a closed class word with an open class one. On the other hand, for the ten sentences in this experiment where such compounding occurred, the average proportion of children who failed to segment two words was only 18%. Secondly, no child in this study combined a closed class word with a preceding open class item, across a phrasal boundary, except in the cliticization of want to to wanna. This result also contrasts with Holden's and MacGinitie's report and suggests that the rythmic structure of the utterances had less of an influence on children's performance in this case. Furthermore, subjects in this study compounded the with its corresponding noun much less frequently than those in the Holden and MacGinitie study. Such compounding occurred most frequently on the last two words of the sentences, possibly reflecting several children's tendency to want to complete the repetitions themselves. Children also clearly distinguished bound and free closed class elements. No child in the study isolated an inflection from its stem.

Thus, the results of this experiment suggest that Holden and MacGinitie may have underestimated their subjects' segmentation abilities, perhaps as a result of the nature of their experimental task. It appears that children are able to segment utterances into conventional lexical units, and that they are aware of the lexical status of closed class words.

PARALLELISMS BETWEEN CHILD AND ADULT PERFORMANCE

The first word judgment study presented above replicates and extends the finding that children often deny that closed class items are words. However, the results of this study differ significantly from previous ones in that they suggest that children's errors on closed class words cannot simply be attributed to their semantic characteristics. Word judgment errors on abstract open class words were largely eliminated by means of a simple training procedure which provided the child with an approximation to the adult concept of "word". On the other hand, closed class errors persisted in spite of such preliminary training. Experiment 2, the second word judgment experiment presented in this thesis, indicates that these errors on closed class words are also not the result of children's misclassification of these words as bound morphemes. In this study children exhibited very different response patterns for free versus bound closed class morphemes. These results suggest that children assign independent lexical status to closed class words, and thus, stand in opposition to the outcome of previous studies addressing the question of children's lexical segmentation abilities (e.g. Holden and MacGinitie, 1972). However, the results the segmentation study, Experiment 3, indicate that preschooler's segmentation abilities are more developed than has been previously acknowledged, and that the Holden and

MacGinitie (1972) data are artifactual and simply reflect a tendency for the child to segment utterances on the basis of their rythmic structure.

We are still left with an unresolved question, however. If, as argued above, the phonological and semantic properties of the closed class vocabulary do not pose a great obstacle for comprehension, then the character of children's spontaneous productions, repetitions, and performance on metalinguistic tasks cannot be attributed to a lack of requisite knowledge. What accounts then for the asymmetry between the open and closed class vocabularies in children's performance? Some recent investigations of adult language processing which we will now consider provide clues about the answer to this question.

In the first place, there is evidence indicating that there are important differences in the processing of the two vocabularies in a number of domains of adult language behavior. Garrett (1980, 1981), for instance, reports that the two kinds of vocabulary items behave differently in spontaneous speech errors. Open class elements typically engage in exchange errors while closed class elments occur most frequently in shift error patterns. Garrett proposes a "levels of processing" model of speech production in which the two types of lexical items become available at different levels of sentential representation and are recruited by separate mechanisms.

With respect to comprehension, we may add the evidence for qualitative differences in open and closed class word recognition reported by Bradley (1978). In a series of lexical decision tasks she found that while open class recognition is sensitive to frequency of usage of forms, closed class recognition is not. Furthermore, she showed that the interference produced in a nonword classification task by real words embedded as the initial portions of nonwords (Taft and Forster, 1976) arises only if the embedded words are open class forms. Thus, the closed class vocabulary seems to be recognized in some way that does not generate interference from partial analyses created by the left-to-right pass through the graphemic representation of a word. In addition, Bradley (1978) also reports evidence for a hemispheric asymmetry in the recognition of the two vocabularies. Based on these outcomes, Bradley postulates the existence of two independent word retrieval devices, one of which is strictly devoted to closed class recognition.

There is also some evidence that suggests that adults also show an asymmetry in the control of the two vocabulary classes in tests involving reading of normally presented text. The evidence, in part anecdotal, indicates that closed class forms are less available for conscious report than open class forms. The "proof reader's error" constitutes a clear example of this phenomenon. Detection of repeated words in written text is substantially more difficult when the repetition involves a closed class word than when it involves an open class word. Related to this "invisibility" phenomenon is the fact that in marking occurrences of a given letter while skimming over text, subjects are much more likely to miss those tokens of the letter occurring in closed class forms than those occurring in open class forms (Corcoran, 1966; Healy, 1977). Similarly, report rate for closed class items is significantly lower than that for open class items at fast RSVP (Rapid Serial Visual Presentation) rates (Garrett and Cutler, 1976).

In light of these observations, we may return to the question of young children's performance with open and closed class words. The arguments and findings summarized above suggest that children treat closed class words differently from open class words in both production and metalinguistic tasks. Children make errors on closed class words which are not the result of the semantic or phonological characteristics of these words nor of a misclassification of their lexical status. Moreover, the fact that children showed uniform levels of performance across all open class categories in the word judgment experiment mentioned above even though only members of two categories were employed in the training procedure implies that the open class vocabulary is treated as a whole, in a different manner than the closed class vocabulary. These facts about children's performance appear to be analogous to those regarding adults' language processing performance in that we find a clear division between the open class vocabulary and the closed class vocabulary in both cases. If we accept the thesis that adults possess two distinct lexical retrieval systems, their developmental course is a candidate for explanations of the facts regarding children's errors in production and metalinguistic tasks.

The analogy between the two cases becomes particularly plausible upon comparing adults' "invisibility" errors with several aspects of children's performance in the studies presented here. First, like adults' errors on closed class words, children's errors occured only occasionally; every child correctly classified at least 40% of the test closed class words presented to him/her. Also like adults, children show different levels of performance with the closed class on different tasks (eg. word judgment versus alternating repetition) and in different domains of language behavior (production vs. comprehension). Furthermore, the nature of children's spontaneous corrective responses to misclassified closed class words in the first two studies presented also strengthens the analogy. At times during the word judgment experiments described above, children failed to recognize misclassified closed class words even after pronouncing them correctly themselves, and provided open class words as corrections. These observations suggest that, like adults, children have difficulty in bringing closed class items to conscious attention. If this hypothesis is correct, it may be possible to account for children's closed class errors in terms of a more exaggerated case of the invisibility phenomenon. If children's and adults' closed class errors are in fact analogous, it is likely that in both cases they are related either to the special processing associated with of closed class words, or to differences in the representations of closed vs. open class words.

However, the connections between adult and child performance need to be more firmly established, and, furthermore, the relation between the "invisibility" phenomenon and language processing mechanisms concerned with the closed class vocabulary needs to be determined and verified. The experiments presented below focus on two issues in particular. First, the question of whether children analyze utterances with missing open class lexical information in the same way that adults analyze Jaberwocky sequences will be explored in detail. Such an exploration will provide clues about what role, if any, the closed class vocabulary plays in children's language processing. Second, the phenomenon of "invisibility" of closed class words in reading tasks will be more closely examined in an attempt to determine the mechanisms underlying this phenomenon and to assess its relationship to the acquisition process.

Taken together, the arguments and results presented in the previous chapters suggest that a processing distinction between the open and closed class vocabularies is already functional in three- and four- year old children. The question which still remains, however, is whether by this age children make use of closed class words to facilitate syntactic analyses of utterances. The existence of a distinction between the two vocabularies is a necessary but not a sufficient condition in order for children´s analysis of utterances with missing lexical information to parallel adults´ analysis of Jaberwocky sequences. In order to investigate this issue, a logical direction to take is to examine the facilitation of recall of strings mediated by the presence of bound and free closed class morphemes. If children make special use of the closed class in constructing phrasal analyses, we should expect to find facilitatory effects for repetition or recall of strings. Thus, this chapter will address this question directly.

The facilitation of recall through the introduction of linguistic structure into nonsense strings is a well established finding in studies of adult memory and learning (Epstein, 1961; Savin and Perchonock, 1965; Forster, 1966; O´Connell, 1970). Robust facilitation effects have been found to be mediated by grammatical morphemes, cannonical word orders, and suprasegmental factors (see O´Connell, 1970, for a review).

With respect to children, elicited imitation tasks have been extensively used by researchers for a variety of purposes. Beginning with Brown and Fraser (1963), sentence imitation tasks have been employed in investigations of children´s telegraphic speech (Brown and Bellugi, 1964; Scholes, 1970, Freedle, Keeney, and Smith, 1970; Ehri, 1975; Eilers, 1975). The major finding of these studies is that children as old as five or six years commonly delete closed class elements from their imitations of sentences under a wide variety of situations.

A few sentence imitation studies have focused on the question of whether syntax facilitates children´s repetitions (Scholes, 1969; Clay, 1971; Jensen and Rohwer, 1965; Weener, 1971; Love and Parker-Robinson, 1972). The rationale behind the use of such tasks in these studies parallels that of some of the adult studies and is related to the assumption that a string must be syntactically analyzed in order to be understood. Repetition tasks provide measures of whether a subject has structured a string since they involve short term memory, and it is well known that people can hold more material in short term memory if they are able to structure it (Miller, 1951; Neisser, 1967; Savin, 1968). The results of these studies have lead many researchers to conclude that children do not develop the ability to employ syntactic cues until they are quite old. Estimates from various studies range from about six years to nine years of age. However, in what follows I will argue that there are strong reasons to doubt the validity of this claim, and that, unfortunately, previous studies are rather uninformative with respect to the question at hand.

In the first place, there seems to be no consensus in these studies as to what constitutes syntactic cues. The syntactic variables included in these experiments vary considerably across studies although they are all placed under the blanket labels "syntax" or "syntactic cues". Some studies even confound several variables within single experiments. At times in these studies, syntactic structure is provided in stimulus materials by the presence of grammatical morphemes and word order, at times by word order and suprasegmental features, and at times it is even confounded with factors of semantic coherence. This lack of consistency makes for great difficulty in interpreting the results at best. Hence, it is not surprising that we find such variability in the estimates of the age at which "syntax" begins to make a difference.

More serious, however, are problems of scoring and analysis that make these studies unsatisfactory. For the most part, children's responses (imitations) have been scored in an all-or-nothing fashion, that is, researchers have required that responses be perfect repetitions with respect to words repeated or even with respect to ordering of repeated strings. Anything less than perfect is usually considered incorrect without further qualifications. Even when finer scoring methods have been used, equal weight has been given to the imitations of open and closed class elements. These methodologies are particularly ill-chosen in light of the findings of earlier sentence imitation studies which indicate differential response rates for the two vocabularies. These scoring methods may have the unfortunate side effect of obscuring performances recorded for three- and four-year-olds since children in this younger age group are especially prone to omit closed class words from their sentence repetitions. Although the estimates of the age at which syntax begins to facilitate children's repetitions vary wildly across the various studies, the results are in general agreement in that they indicate that syntactic variables only begin to play a role after about age six. However, given that the scoring procedures may be penalizing the younger age group more heavily, it seems essential to examine omission rates for open and closed class words independently.

Researchers' failure to recognize this problem seems to be associated with an assumption that underlies the use of imitation tasks in language development studies and that has at times been taken too seriously. The assumption is that the correctness of children's repetitions reflects their knowledge of linguistic features present in the model sentences. However, this assumption cannot be take to the letter if there is a lag in production with respect to comprehension (Bloom, 1974; Ingram,1974; Shipley, Smith, and Gleitman, 1969). To take an extreme example, a 12-month old's repetitions of words (or, rather the lack of them) cannot be taken as a reliable index of his/her knowledge. Such a child may have an impressive repertoire of words that he/she comprehends and responds to consistently, and yet he/she may be unable to produce many of them. Until we understand the mechanisms that govern production/comprehension lags we cannot draw but the most general conclusions based on children's repetitions. Nevertheless, we can minimally determine whether a child is interpreting a given string as a sentence from the order and completeness of his/her repetition. A string that does not have a sentential interpretation for the child will interfere with with storage processes that intervene between comprehension and reproduction of the string.

The work of a single researcher in this area, Robert Scholes, stands out among the rest because it escapes some of the objections enumerated above. Scholes (1969) carefully controls the influence of suprasegmental variables, and Scholes (1970) examines repetitions of closed class words separately from those of open class words. However, there is a further objection that applies to his studies as well as to most of the others mentioned above. The fact that these studies use sentence materials that contain real English words creates an additional complication. Even if consistency is maintained over syntactic factors under study, it is difficult to control semantic variables in sentence materials that contain real words. Scholes' (1970) materials, for instance, are composed of sentences with highly associated constituents, such as, "My cat liked his milk". The open class elements of a scrambled version of such sentences are still easily restructurable into a meaningful sequence. Given this fact, either of two artifactual consequences are possible. In the first case, children may focus on the open class items, the restructurable ones, and delete relatively more closed class elements in their repetitions of scrambled materials. In the second case, the outcome is in the opposite direction, that is, the very fact that these materials are quite sentence-like in spite of being scrambled may make all of their "constituents" easier to store. Thus, any interactions between syntactic structure and form class may be obscured.

A purer test of the effects of syntactic variables on children's imitations can be achieved by using nonsense sentence materials, i.e., Jaberwocky-like sequences, as was done in the original adult memory studies. Surprisingly, studies using nonsense strings are almost nonexistent in the child literature concerning the effects of syntax on recall, although the use of nonsense syllables has been commonplace in work on children's learning of phonological and morphological rules (Menyuk, 1968; Berko, 1958; Ervin, 1964; Ainsfeld and Gordon, 1968) as well as in studies of concept and word acquisition (Vygotsky, 1962; Bruner, Olver, and Greenfield, 1966; Carey, 1978).

Motivated by these observations, the following nonsense sentence repetition experiment was carried out using three- to five-year old subjects. The aim of this experiment was to determine precisely whether or not preschoolers make use of closed class words to infer sentential interpretations for utterances which lack open class lexical information.

EXPERIMENT 4

METHOD

Subjects

Twenty two preschool children from day care centers in the Boston area served as subjects in this experiment. Data from six children were excluded from final analyses because they were grossly incomplete. The remaining sixteen children ranged in age from 3;4 to 5;1 years with a mean age of 4;4 years. All children were native speakers of American English.

Materials

Sixteen three-syllable-long nonsense sequences were constructed by using sixteen triplets of nonsense monosyllables. Two thirds of the nonsense syllables were used in Noun positions (i.e., as Subject or Object of the sentence) and one third in Verb positions. The syllables were constructed with the following constraints in mind. First, all syllables were strong (i.e. minimally CVC), pronounceable, English-like sequences. Noun syllables ended in sibilants ([s], [z], [š], [č], or [ǰ]), and Verb syllables ended in dentals ([d] or [t]), so that plural or past tense morphemes added to these would be syllabic and therefore equated in phonetic prominence with free closed class morphemes used in the nonsense sentences.

Four sets of sixteen nonsense sentences of the following form were generated using the sixteen triplets: 1) grammatical sentences with free closed class words (two 'prenominal' determiners), 2) grammatical sentences without free closed class words, 3) ungrammatical sentences with free closed class words (scrambled version of Condition 1), and 4) ungrammatical sentences without free closed class words (scrambled version of Conditiion 2). All four types contained verb and noun inflectional morphemes. Thus, the strings in the two conditions without closed class words were two syllables shorter than those in the conditions with closed class words. This design therefore puts the hypothesis to a most stringent test, since the memory load associated with the sequences in the second and the fourth conditions should be smaller than that associated with those in the conditions containing closed class words. The bias introduced by this difference is in the direction opposite to the hypothesis. If closed class words serve as an aid for syntactic analysis, a facilitation effect may be obtained in the first condition in spite of the increased memory load.

Example 1 below provides an illustrative sample of the nonsense sequences employed in the four conditions, and Appendix 4 lists all the materials used in the experiment.

<u>Example 1:</u>

1. The motches klided my gurses.
2. Motches klided gurses.
3. Klided the my motches gurses.
4. Klided motches gurses.

Procedure

The experiment was introduced to the children in the form of a game. The subjects, who were tested individually, were shown two stuffed animals which had the numbers "1" and "2" sewn on them. The child was told that animal Number 2 always repeats whatever animal Number 1 says, and that Number 1 is always trying to trick Number 2 by speaking a strange language. The experimenter then demonstrated the two animals playing the game, and then requested that the child join the game by acting out the role of Number 2, the repeating animal. Most children understood the "game" easily and were eager to play.

The children were then given a series of three practice utterances to repeat, after which the test sequences were presented. The experimenter read each sequence once in as much a list-like fashion as possible, in order to avoid intonational confounds. The child was immediately prompted to repeat the sequence by means of a gesture of encouragement. Between trials the child was told to repeat the sentences right away and to beware of Number 1's tricks. If a child failed to attempt repetition of a test sequence, the experimenter repeated the rules of the "game" to the child and encouraged him/her to not get tricked by animal Number 1 again. Failed items were skipped over and reintroduced at the end of the item set. Each child was tested on sixteen nonsense sequences, four from each condition, so that no child heard the same nonsense triplet more than once. Order of presentation of test sequences was rotated across subjects to control for practice effects. The testing sessions typically lasted thirty minutes and were tape recorded in their entirety.

Data Treatment

The tape recorded repetitions were scored for successful repetitions of the nonsense syllables and of the free closed class words independently. The main criterion for success was whether the child had repeated the syllables in question correctly, regardless of ordering changes or additions. Non-parametric analyses were performed on the data to establish significance of differences.

RESULTS AND DISCUSSION

Table 5 below summarizes the effects of the presence of closed class words and grammatical structure on the number of repetitions of nonsense syllables and closed class words.

TABLE 5. Total number of nonsense syllable and closed class word deletions in Experiment 4

	Grammatical Sequences	Ungrammatical Sequences
Closed class words present	Nonsense Syllables: 19 (9.9%)	Nonsense syllables: 65 (33%)
	Closed Class Words: 52 (41.4%)	Closed Class Words: 32 (25%)
Closed class words absent	Nonsense Syllables: 43 (22.3%)	Nonsense Syllables: 46 (24.5%)

A Friedman two-way analysis of variance on ranks revealed a significant effect of string type on total number of repetitions of nonsense syllables ($\chi^2(3) = 29.7$, $p<.001$). Individual two-tailed Wilcoxon matched-pairs signed-ranks test comparisons of all types against the ungrammatical condition without closed class words locate the effects in two conditions. Grammatical sequences with closed class words yielded significantly higher scores (T=4.5, N=14, $p<.01$) Ungrammatical sequences with closed class words yielded significantly lower scores (T=7.5, N=13, $p<.01$). There was no difference between the grammatical and ungrammatical conditions without free closed class words (T=21.5, N=10, N.S.).

Analysis of closed class word repetitions in the grammatical and ungrammatical conditions with closed class words confirms the significance of an effect in the opposite direction. A Wilcoxon Matched-pairs signed-ranks test on subject totals shows that children's repetitions of grammatical sequences were more often telegraphic than their repetitions of ungrammatical sequences (T=3, N=14, $p<.01$).

The data was also recast by age groups (young vs. old) and a difference for closed class word repetitions emerged. Younger subjects deleted closed class words from grammatical sentences significantly more often than the older subjects ($\chi^2(1)=7.2$, $p<.01$). There was no significant age difference in repetitions of nonsense syllables from grammatical sentences with closed class words.

Apart from deletion errors, the distribution of metathesis errors and of insertion errors was also examined, though there were too few of these to warrant significant effects. Approximately twice as many metathesis errors occurred in the ungrammatical sequences without function words than in any of the other conditions, but this difference was not reliable. Similarly, there was a nonsignificant tendency to insert real words in the ungrammatical condition with closed class words (or, looked at in another way, perhaps a tendency to replace nonsense syllables and reorder them). The effect of both of these trends was to grammaticize the ungrammatical sequences.

A number of conclusions may be drawn from these results. First, the presence of function words made the repetitions of the items occupying open class slots significantly easier even when these sequences were two syllables longer than the grammatical sequences without closed class items. The facilitation effect becomes even more substantial when compared with effects on ungrammatical items of comparable length (ungrammatical condition with closed class words). The presence of closed class items in ungrammatical sequences proved an obstacle for repetitions, presumably because in such sequences their only contribution is added memory load. Secondly, the age analysis indicates that young children benefit equally from the presence of closed class words even though this age group is more likely to delete these items in their repetitions, as shown by the closed class analysis. These analyses confirm the idea that young subjects' performance has been obscured in previous studies by inappropriate scoring procedures. Thus, it seems that children are using closed class items as an aid for constructing sentential analyses of strings.

However, a number of issues need to be explored before finally concluding that the closed class vocabulary plays a special role in three- and four-year-old children's language processing. First, a further control experiment is required in order to determine whether in fact it is the presence of closed class words per se that facilitates repetitions, or whether it is merely the presence of real English words. Thus, Experiment 5 will compare childrens' nonsense sentence repetitions of strings containing open class words and strings containing closed class words.

A second issue that needs to be dealt with is related to the lack of differences between the two conditions without closed class words in Experiment 4, an unexpected result. It seems that grammaticality introduced by cannonical ordering of inflected nonsense syllables did not have a facilitatory effect on childrens' repetitions. It thus appears that the presence of bound closed class morphemes yields no benefit to the child. This issue will be investigated further in Experiments 6 and 7.

EXPERIMENT 5

METHOD

Subjects

Twenty four preschool children from day care centers in the Boston area served as subjects in this experiment. Data from four children were excluded from final analyses because they were incomplete. The remaining twenty children ranged in age from 3;8 to 4;11 years with a mean age of 4;7 years. All children were monolingual native speakers of American English, none of whom had served as a subject in Experiment 4.

Materials

The sixteen nonsense monosyllable triplets from experiment 4 were also used in this experiment. Two sets of sixteen nonsense sentences of the following form were generated using the sixteen triplets: 1) grammatical sentences with closed class words (two determiners), 2) grammatical sentences with open class words (two adjectives). The open and closed class words in the two conditions occupied identical (prenominal) positions and were of similar length (all monosyllabic) and frequency. Neutral, or less informationally salient, adjectives were chosen for the second condition in order to match as well as possible the semantic characteristics of the closed class items in the first conditions. All of the sequences in both conditions were syntactically well formed and contained verb and noun inflectional morphemes. Example 2 below shows sample sequences from the two conditions, and Appendix 5 lists all the materials used in the experiment.

Example 2:

1. Some nidges todded the wazzes.
2. Big nidges todded nice wazzes.

Procedure

The testing procedure used in this experiment was the same as that used in experiment 4.

Data Treatment

The tape recorded repetitions were scored for successful repetitions of the nonsense syllables, closed class words, and open class words independently. As in Experiment 4, utterances were judged for correct repetitions of the syllables or words in question, and changes in ordering and additions were disregarded in the scoring.

RESULTS AND DISCUSSION

Table 6 summarizes the effects of the presence of closed class words versus open class words on the number of repetitions of nonsense syllables. Repetition scores for real words are also shown.

TABLE 6. Total number of nonsense syllable, closed class, and open class word deletions in Experiment 5

	Nonsense Syllable Deletions	Closed Class Deletions	Open Class Deletions
Closed class words present	58 (12.1%)	109 (43.0%)	—
Open class words present	201 (41.8%)	—	23 (7.2%)

As can be seen, the two types of sequences gave rise to qualitatively distinct kinds of repetitions. Nonsense syllables were repeated successfully significantly more often in the condition containing closed class items than in the condition containing open class items ($\chi^2(1)=106$, $p<.001$). The reverse was true for real word repetitions, that is, open class items were more often repeated successfully than closed class items ($\chi^2(1)= 10\,9$, $p<.001$). Thus, the presence of closed class words facilitated repetitions of nonsense items occupying open class slots whereas the presence of open class items seemed to interfere. Children focused their repetitions on real open class items and omitted the nonsense syllables altogether in their repetitions of sequences containing open class words. Children also often inserted other real open class items in place of the nonsense syllables.

The high rate of correct repetitions of nonsense syllables in the closed class condition replicates the finding in Experiment 4. The telegraphic nature of the repetitions in this condition also parallels the results of the previous experiment. Most importantly, however, the differences between the two conditions in this experiment establish the fact that the facilitation effect found in Condition 1 of Experiment 4 can be attributed specifically to the presence of closed class items rather than merely to the presence of real English words.

Thus, the results of Experiments 4 and 5 suggest that young children use closed class words to construct sentential analyses of strings, a possibility that was obscured in previous studies. Furthermore, they suggest that children's deletions of these words must be the result of output, post-lexical access processes, since children are obviously making use of closed class elements prior to deleting them.

We now turn to Experiments 6 and 7, which, as mentioned above, are an attempt to examine in further detail the question of what role bound closed class morphemes play in children's sentence processing.

EXPERIMENT 6

METHOD

Subjects

Twenty six preschool children from day care centers in the Boston area served as subjects in this experiment. Data from six children were excluded from final analyses because they were incomplete or exhibited fixed strategies. The remaining twenty children ranged in age from 3;5 to 4;9 years with a mean age of 4;2 years. All children were monolingual native speakers of American English, and none of them had served as a subjects in Experiment 4 or 5.

Materials

Fifteen of the nonsense sequences used in Experiments 4 and 5 were employed in this experiment. Again, two thirds of the nonsense syllables were again used in Noun positions (i.e., as Subject or Object of the sentence) and one third in Verb positions. The syllables followed the same constraints as in Experiment 4.

Five sets of fifteen nonsense sentences of the following form were generated using the fifteen triplets: 1) sentences with free closed class words (two Determiners and an Auxiliary Verb) and with bound inflectional morphemes (two plural endings and one past tense ending, all syllabic), 2)-sentences with free closed class words but without bound inflections, 3) sentences with bound inflections but without free closed class words, 4) short sequences without free closed class words and without bound morphemes (i.e., a nonsense syllable list of length 3), and 5) long sequences without free closed class words and without bound morphemes (i.e., sequences matched in length with those of condition (3) via the addition of three weak (VC) syllables). Examples of test items from each of the five conditions are shown in Example 3 below. The complete set of materials used in this experiment is provided in Appendix 6.

Example 3

1. My frashes had gleeted some slages.
2. My frash had gleet some slage.
3. Frashes gleeted slages.
4. frash gleet slage
5. frashem gleetun slagif

Procedure

The testing procedure used in this experiment was the same as that used in Experiments 4 and 5.

Data Treatment

The tape recorded repetitions were scored for successful repetitions of the nonsense syllables, disregarding changes in ordering and additions in the scoring. Statistical comparisons were based on non-paramentric analyses.

RESULTS AND DISCUSSION

Table 7 summarizes the effects of string type on total numbers of repetitions of nonsense syllables.

TABLE 7. Total number of nonsense syllable deletions in Experiment 6

	Bound morphemes Present	Bound morphemes Absent
Free morphemes Present	21 (11.6%)	17 (9.4%)
Free morphemes Absent	54 (30%)	48 (26.7%)
Extra nonsense Present	---	62 (34%)

A Friedman two-way analysis of variance by ranks displays a significant effect of string type on subjects' total numbers of repetitions of nonsense syllables ($\chi^2(4)=58.3$, $p<.001$). Individual Wilcoxon matched-pairs signed rank comparisons locate facilitation effects in the first two conditions, with no difference between the two ($T=26$, $N=12$, $p>.05$). The differences between conditions (3) and (4) and between (3) and (5) did not reach significance. However, condition (4) gave significantly better scores than condition (5) ($T=13$, $N=14$, $p<.01$).

Once again, the presence of free closed class words facilitated children's repetitions of sentences. On the other hand, equal numbers of bound inflectional morphemes seemed to have no such facilitatory effect on repetitions. This outcome raises the question of whether children treated bound morphemes merely as additional nonsense syllables without recognizing their linguistic role in the sentences. The lack of differences between strings containing bound morphemes and strings containing only nonsense syllables (Conditions 3 and 4) suggests that the presence of bound morphemes did not increase memory load, unlike the inclusion of an equal number of additional nonsense syllables (Condition 5). However, this result is weakened by the lack of differences between strings containing bound morphemes and strings containing additional nonsense syllables (Conditions 3 and 5).

Nevertheless, the claim that children are recognizing bound morphemes and not treating them simply as extra nonsense syllables makes an additional prediction that is readily testable. Specifically, if this claim is true, children should be sensitive to ungrammaticality produced by mismatching free and bound morphemes in sentences, as in "The bif Klided a dotches". Children as young as three years of age enforce appropriate selectional restrictions for high frequency determiners and quantifiers (Gordon, 1982). If children recognize the plural morpheme in the above example as a plural marker we may expect the ungrammaticality to yield some kind of interference in their repetitions of the sentence. Experiment 7 will address this question directly.

EXPERIMENT 7

METHOD

Subjects

Twenty three preschool children from day care centers in the Boston area served as subjects in this experiment. Data from three children were excluded from final analyses because they were incomplete. The remaining twenty children ranged in age from 3;8 to 4;10 years with a mean age of 4;6 years. All children were monolingual native speakers of American English, and none of them had served as a subjects in Experiment 4, 5, or 6.

Materials

The sixteen nonsense syllable triplets used in Experiments 4 and 5 were employed in this experiment. Two sets of sixteen nonsense sentences were constructed using the sixteen nonsense triplets. The first set consisted of grammatical sequences containing free and bound closed class morphemes with proper number agreement. The second set was composed of sequences containing free and bound morphemes ill-matched with respect to number. Eight of the sequences contained ill-matched free and bound closed class morphemes in Noun Phrase position and eight contained ill-matched morphemes in Verb Phrase position. Example 4 shows some sample sequences used in the two conditions, and Appendix 7 lists the complete set of materials used in the experiment.

Example 4

1. Their stinces were pirting more loshes.

2a. *Their stinces were pirting a loshes.

2b. *Their stinces have pirting more loshes.

Procedure

The testing procedure was the same as that used in Experiments 4, 5, and 6.

Data Treatment

The tape recorded repetitions were scored for successful repetitions of nonsense syllables, closed class words, and bound morphemes, disregarding changes in ordering and additions in the scoring.

RESULTS AND DISCUSSION

Table 8 summarizes the effects.

TABLE 8. Total number of nonsense syllable, free morpheme, and bound morpheme deletions in Experiment 7

	Grammatical matches	Ungrammatical matches
Nonsense syllables deleted	47 (9.8%)	139 (28.9%)
Free closed class morphemes deleted	190 (39.6%)	157 (32.3%)
Bound closed class morphemes deleted	102 (21.3%)	130 (27%)

The data from this experiment clearly indicate that ungrammatically matched free and bound morphemes adversely affect storage repetition of the nonsense sequences. Nonsense syllables were more often deleted in the condition containing ill-matched morphemes ($\chi^2(1)=55.2$, $p<.001$). Since children are sensitive to this type of ungrammaticality, they must be recognizing the anomalous morpheme. Deletion scores for free and bound morphemes were also examined for correspondences and, as can be seen from Table 8, the error patterns are not analogous. There were significantly more free morpheme deletions in the grammatical condition ($\chi^2(1)=37$, $p<.001$), and the ill-matched morpheme condition gives an increased number of bound morpheme deletions ($\chi^2(1)=4.14$, $p<.05$). On the other hand, error patterns for bound morphemes and nonsense syllables are also not comparable either. There were significantly more deletions of bound morphemes than of nonsense syllables in the grammatical condition ($\chi^2(1)=23.2$, $p<.001$). This outcome also supports the claim that these items are not simply being treated as extra nonsense syllables, but the question of what role, if any, they play in children's sentence processing is still unanswered.

A possible explanation for why bound morphemes do not seem to play an equivalent role to free closed class morphemes in terms of facilitating syntactic analyses may be related to the fact that bound morphemes are often redundant once the associated (and, in English, preceding) free morpheme is known. So, for instance plural quantifiers immediately signal an upcoming plural morpheme, the determiner "a", on the contrary, eliminates the possibility of an adjacent nominal form carrying the plural marker, and the various auxiliary and modal verbs usually restrict the main verb ending. Thus, it is possible that the child focuses mainly on free morphemes as the most useful elements.

A separate possibility may be that, initially, only closed class elements that have acquired lexical status in the child's lexicon play a role in syntactic analysis, but this should be considered a rather unlikely possibility since most languages of the world make sole use of bound morphemes to signal syntactic relations.

"INVISIBILITY" OF CLOSED CLASS WORDS IN READING TASKS

The results of the previous set of experiments (Experiments 4 - 7) lend support to the hypothesis that closed class elements (at least free morphemes) of sentences play a role in children's syntactic analysis and, therefore, sentence comprehension. It appears that, like adults, children are able to interpret Jaberwocky-like sequences sententially. Thus, contrary to conclusions based on previous studies, closed class elements facilitate repetition of utterances for three- and four-year-old children. In addition, the greater incidence of telegraphic repetitions for grammatical versus ungrammatical sequences carries further implications. This outcome supports the claim that children's closed class word deletions in repetitions result not from input limitations but from output processes occurring at the time of sentence production (Freedle, Keeney, and Smith, 1970). Furthermore, taken in conjunction with the first result (that the presence of closed class items facilitates repetitions of grammatical sequences), this outcome implies that lexical access of these elements must have occurred prior to their being deleted.

Thus, in order to determine the relation between children's performance on closed class words in repetition and metalinguistic tasks and adults' performance in reading tasks, we need minimally to verify whether adults' closed class word errors result from post- lexical access processes. The two experiments presented below concentrate on this question.

Before turning to them, however, it is useful to review some of the background concerning proofreading and letter detection tasks with adults.

The interest in proofreading and letter detection in continuous text arises from theoretical arguments that such tasks provide measures of visual attention to words and features of words during the process of normal reading. As such, they are believed to provide information about the early stages of processing during visual language comprehension. The primary researcher in this area, Alice Healy, has concentrated on questions concerning the nature of the units employed in reading and the way these units are processed.

Based on the work of Corcoran (1966, 1967), Healy has developed a detection task in which subjects are asked to read a passage of text and to mark every occurrence of a target letter. Results indicate that error patterns in performance are contingent on a variety of factors, including syntactic structure of passages (Drewnowski and Healy, 1977; Schindler, 1978), and, in particular, familiarity (frequency) of words containing target letters (Healy, 1976). Healy reports that more errors (i.e., misses) are made on common words such as the, than on less frequent words.

To account for these results, Drewnowski and Healy (1977) have proposed the 'unitization' hypothesis, which states that subjects miss letters on familiar words because they process such words automatically in units larger than the letter, without needing to complete processing at the letter level. The model includes a linguistic hierarchy of processing units such as letters, syllables, words, and phrases, and hypothesizes that once a unit has been identified, the reader proceeds to the next unit at that level without completing processing at lower levels.

The 'redundancy' model (Corcoran, 1966; Schindler, 1978) is an alternative model which hypothesizes that subjects miss the t in the because the surrounding syntactic and semantic context predicts the occurrence of the word so that they need not focus visual attention on it. Early versions of this model were designed to account for effects on high frequency words, but recent modifications of the 'redundancy' model emphasize effects on high frequency closed class words specifically (Haber and Schindler, 1981). The distinction between open and closed class words in this case is motivated by differences in predictability or redundancy in sentence contexts. Since there are approximately only 200 closed class words in English, and these are subdivided into a small number of form classes, the syntactic constraints on these words are much more restrictive than those on open class words. Thus, the model claims that these highly predictable words draw limited visual attention, and subjects therefore fail to notice their component features.

The 'redundancy' and 'unitization' models have not yet been satisfactorily evaluated with respect to each other. None of the relevant studies published thus far clarify whether the differences between open and closed class words are attributable to differences in their familiarity or in their redundancy. There is a serious confound in all of these studies between frequency and word type that arises because at the high extreme of the frequency range, virtually all the words are members of the closed class. A quick examination of the first page of the Kucera and Francis (1967) frequency count reveals that there are almost no open class words among the 100 most frequent words of English (ranging from about 900 tokens per million to about 36,000 per million for the word <u>of</u> and about 70,000 for <u>the</u>).

It is furthermore not clear that the assumption that the "invisibility" phenomenon reflects differences in visual attention devoted to words is altogether warranted. There may be other explanations compatible with the data which place the invisibility effects at a later stage of processing, after lexical access has occurred, rather than during initial perceptual stages. Such explanations become desirable in making a more parsimonious account that incorporates the invisibility effects into the open - closed class distinction hypothesis. Furthermore, the claim that children's closed class deletions in repetitions and errors in metalinguistic tasks are analogous to adults' "invisibility" errors depends on these being post-access effects. The results of the studies presented in the previous section clearly demonstrate that children must be accessing and making use of closed class items even though they delete them in their repetitions. Unfortunately, the available letter detection data do not distinguish these possibilities for adults because the mode of presentation of materials in these experiments is highly uncontrolled. Since subjects scan pages of text at their own pace it is impossible to determine "exposure" durations for target items. Thus, we do not yet know if the "invisibility" phenomenon is a perceptual or report effect.

A resolution of these issues requires further experimentation with more controlled presentation of materials. Furthermore, to establish whether the "invisibility" phenomenon affects closed class words as a class, it is necessary to not only examine effects across a much broader range of closed class target items, but to effectively manipulate word type separately from familiarity and frequency of usage.

Experiments 8 and 9 constitute an investigation of the "invisibility" phenomenon during reading of materials presented in RSVP (Rapid Serial Visual Presentation) mode. RSVP (250 ms. per word) will ensure uniform exposure durations across items and will therefore reduce variability in visual attention devoted to different words. The visual attention hypothesis made by both the 'unitization' and the 'redundancy' models will be thus tested. If the assumption is correct we should expect at least a substantial reduction of the original effects. If, on the other hand, the assumption is invalid, the invisibility effects obtained during reading of continuous text should transfer to the word-by-word case.

The question of whether the effects occur after lexical entries have been contacted will be addressed by comparing results obtained using a misspelling detection task rather than a letter detection task. If the effects reflect mechanisms that apply after lexical access, misspellings in test items will disrupt them, since alterations in the graphemic representations of words will interfere with the contacting of lexical representations. However, if the effects are due to earlier mechanisms as the two models suggest, misspellings that do not radically alter the shape of target items should be subject to the same invisibility phenomenon.

EXPERIMENT 8

METHOD

Subjects

Twenty four students from the Massachusetts Institute of Technology served as paid volunteers for this experiment. Data from four subjects were excluded from final analyses because these subjects were unable to perform the required task. All subjects were native speakers of American English.

Materials

Twenty pairs of open and closed class words containing the letter "e" were selected from the Kucera and Francis (1967) frequency listing. Each open/closed class pair was selected according to the following criteria: 1) The two members of each pair were matched as closely as possible with respect to frequency of occurrence in the English language (based on the Kucera and Francis frequency count). 2) The two items in each pair were matched with respect to length (i.e., number of letters), with no pair exceeding a two letter difference limit. 3) The position of the "e" in the pairs was matched (within two letters). 4) The phonetic realization of "e" was matched in the pairs, as well as the stress characteristics of the pairs. The resulting twenty test pairs ranged in frequency from 2.30 to 3.20 base 10 logarithm units per million (with mean 2.77) for the open class items and from

2.25 to 3.35 base 10 logarithm units per million (with mean 2.76) for the closed class. The items ranged in length from 3 letters to 9 letters. The complete list of test items is displayed in Appendix 8a.

The test pairs were used in two conditions: a structured sentence condition and a scrambled word condition. The materials for the structured sentence condition consisted of forty sentences which formed part of a story. Each of these sentences contained one of the test words approximately in the middle of the sentence. The target item in each sentence was preceeded by at least four words and followed by at least two words that did not contain tokens of the letter "e". Furthermore, an attempt was made to minimize occurrences of the target letter in consecutive words throughout the sentences. The complete set of sentences used in this experiment is listed in Appendix 8b.

The sequences for the scrambled word condition were obtained by randomizing the words in each of the sentences of the structured sentence condition. The complete list of test sequences used in this condition appears in Appendix 8c.

Procedure

The subjects, who were tested individually, were seated before a CRT screen of a TERAK computer. Before each trial, a fixation cross appeared in the center of the display screen. Subjects were instructed to initiate each trial by pressing a foot pedal. Once a trial had been initialized by the subject, the test sentences appeared one word at a time, each word replacing the previous one. The words were centered on the screen and were displayed for 250 msec each (two hundred and forty words per minute).

Subjects were instructed to read the sentences and to press a microswitch with their preferred hand every time a word containing the letter "e" appeared on the screen. They were warned that occasionally they would be stopped after a trial and asked to repeat the test sequence for the experimenter.

Subjects were tested on both conditions with at least five days elapsing between the two sessions. Subjects saw the scrambled word condition first. Thus, any possible repetition effects would tend to reduce errors (missed e´s) on the structured sentence condition and thereby bias results in the direction opposite to the hypothesis.

Data Treatment

Two independent data analyses were performed. The first considered only the error data, i.e. the instances where subjects missed an occurrence of the letter "e" in a target word. Non-parametric statistical analyses were performed on the error data.

The second analysis considered reaction time latencies for detected targets only. Cutoff values (mean reaction time plus or minus two standard deviations) were calculated for each subject over all items and for each item over all subjects. Any data point lying outside both of these limits was replaced by a cuttoff value (item mean plus or minus two standard deviations for that item) to minimize distortions from extreme data points.

Analysis of variance was performed in two ways on the reaction time data in order to account for two sources of variability: analysis of mean reaction times collapsed over items (subject analysis), and analysis of mean reaction times collapsed over subjects (item analysis). The resulting F ratios were combined in a min F´ analysis, following Clark (1973).

RESULTS AND DISCUSSION

The total numbers of missed e´s in each condition are shown in table 9 below, and the mean reaction times for items in the four conditions are shown in Table 10.

TABLE 9. Total numbers of undetected e's in Experiment 8

	Structured sequences	Unstructured sequences
Closed class words	59 (14.8%)	10 (2.5%)
Open class words	15 (3.8%)	13 (3.3%)

TABLE 10. Mean reaction times for Experiment 8 (ms.)

	Structured sequences	Unstructured sequences
Closed class words	483 44.3 (S.D.)	458 26.8 (S.D.)
Open class words	470 27.9 (S.D.)	454 24.2 (S.D.)

A Wilcoxon matched-pairs signed-ranks test comparing errors on closed class words versus open class words in the structured condition confirms that subjects were more likely to miss target letters in closed class items ($T=7.5$, $N=19$, $p<.01$). Subjects were also more likely to miss target letters in closed class items in the structured versus unstructured sequences ($T=0$, $N=16$, $p<.01$). There were no significant differences among the other conditions.

Two-way analyses of variance (with repeated measure on one factor in the subject analysis) of STRUCTURE X WORD CLASS over reaction times revealed that there was no significant difference between subjects' responses to targets contained in closed versus open class words. In the subject analysis, $F(1,19)=3.67$, $p>.05$, and in the item analysis, $F<1$. Reaction times for targets in structured versus unstructured sequences also did not differ, min $F'(1,31)=2.63$, $p>.05$. The effect did reach significance in the item analysis $F(1,19)=10.1$, $p<.01$, but not in the subject analysis, $F(1,19)=3.56$, $p>.05$. There was also, of course, no significant interaction between structure and word class. In both the item and subject analyses, $F<1$.

Thus, the reaction time results do not parallel the error results. This lack of correspondence is not too surprising, however, given the complexity of the paradigm. It is likely that responses for detected targets are governed by many external factors such as priming relations among test items and other words in the sentences, expectations created by semantic contexts, or frequency effects. The possibility of intervening frequency effects was examined using a regression and correlation analysis of the items in the four conditions. No frequency effects were found for either word type in either syntax condition. Correlation coefficients failed to reach significance in all four conditions.

The error data replicates previous "invisibility" findings. As in previous studies using letter detection tasks from continuous text (Healy, 1976), error rates for closed class items are elevated with respect to those for open class items. Furthermore, error patterns in performance on closed class words are sensitive to the syntactic structure of sentences. This second result is in agreement with similar findings reported by Drewnowski and Healy (1977) and by Schindler (1978) for letter detection from continuous text.

The error results from this experiment also extend previous findings in several important ways. First, the results show that the "invisibility" phenomenon generalizes to closed class words within a broad frequency range lower than that previously examined. Second, the data confirm the hypothesis that the "invisibility" effect is closely connected to the closed class as a set and is not dependent on frequency of usage of words. Open class words within a nearly identical frequency range did not yield comparable error rates. Third, the fact that the results of this study replicate those of previous ones which used continuous text presentation begins to suggest that the effect results not from processes related to perceptual or attentional factors but from processes occurring after lexical retrieval of closed class words has been achieved. However, at this point, this claim must be made with some reservations in mind since it depends on a somewhat questionable assumption. We are assuming here that uniform exposure durations for words leads to uniform (or at least reduced variability in) visual attention devoted to them.

Thus, Experiment 9 was designed to examine the question of whether the "invisibility" effects arise after lexical entries have been contacted. The study employs a misspelling detection task with materials presented in RSVP mode. If perceptual or attentional factors are in fact responsible for the effects, then misspellings that do not alter the shape of the target items should be subject to the same "invisibility" effects. If, on the other hand the claim that the effects reflect mechanisms that apply after lexical access is correct, we should expect to find a disrruption of the effects. Alterations in the graphemic representation of words will interfere with lexical retrieval.

EXPERIMENT 9

METHOD

Subjects

Twenty three students from the Massachusetts Institute of Technology served as paid volunteers for this experiment. Data from two subjects were excluded from final analyses because these subjects were unable to perform the required task (see Results section below). Data from one additional subject was also rejected because the proportion of errors exceeded 70%. All subjects were native speakers of American English and had not participated in Experiment 8.

Materials

The materials used in Experiment 8 were modified for use in this experiment by substituting every occurrence of the letter "e" in the sentences (including the target words) by the letter "c". Appendix 9a lists the complete set of materials used in this experiment.

Procedure

The testing procedure used in this experiment was identical to that used in Experiment 8 except that subjects were instructed to press the microswitch whenever they saw a word on the screen that contained a misspelling. The subjects were informed that the only type of misspelling that would appear would be a substitution of the letter "c" for another letter.

Data Treatment

As in Experiment 8, two independent sets of statistical analyses were performed. One set examined only effects of vocabulary type on detection of target misspellings, while the other set concentrated on effects on reaction time latencies.

RESULTS AND DISCUSSION

Total numbers of undetected misspellings in closed versus open class words are displayed in Table 11, and mean reaction times for detection of targets in closed versus open class words are shown in Table 12.

TABLE 11. Total numbers of undetected misspellings in Experiment 9

	Closed class words	Open class words
Undetected misspellings	19 (4.8%)	16 (4.0%)

TABLE 12. Mean reaction times for Experiment 9 (ms.)

	Closed class words	Open class words
Mean reaction time for detections	496 32.9 (S.D.)	478 32.4 (S.D.)

A Wilcoxon matched-pairs signed-ranks test comparing undetected misspellings of closed versus open class words failed to show a significant difference. Error rates for both types of items were both less than 5%, in contrast with the 15% miss rate on closed class items in the previous letter detection experiment.

A one-way analysis of variance over reaction time also gave no difference between reaction times for detection of targets in closed versus open class words, min $F'(1,31)=2.74$, $p>.05$. In the item analysis, $F(1,19)=3.79$, $p>.05$, and in the subject analysis, $F(1,19)=9.97$, $p<.01$.

Thus, it appears that misspellings in closed class items do not exhibit "invisibility" effects. The fact that such misspellings are easily detected by subjects implies that the "invisibility" effects obtained in Experiment 8 cannot be the result of decreased visual attention devoted to these items. Thus, the data is compatible with the claim that these effects reflect mechanisms that operate after lexical entries have been retrieved.

SUMMARY AND CONCLUSIONS

Taken together, the results of Experiments 8 suggest that the failure to detect target letters in words is a phenomenon that involves the closed class vocabulary as a set, independently of frequency of usage factors. Furthermore, the data from experiment 9 lend support to the hypothesis that the effect is the result of processing mechanisms that apply after lexical retrieval. Slight changes in the graphemic representation of words which undoubtedly interfere with the lexical retrieval process also disrupt the "invisibility" effect.

This claim is a necessary condition for the validity of the suggestion made in earlier sections that the mechanisms responsible for children's performance on closed class words during repetition and metalinguistic tasks are analogous to those responsible for adults' performance during reading tasks. It was argued on the basis of the results of Experiments 4-7 that children's selective closed class deletions from sentence repetitions occur after lexical entries for these words have been contacted.

Extreme caution must naturally be applied in making comparisons between child and adult performance, especially across different experimental tasks. However, the parallelisms between the characteristics of children's performance on the nonsense repetition experiments described above and those of adult performance in letter detection tasks are nevertheless compelling.

First of all, both the "invisibility" effects and children's omissions of items in strings seem to be occassional, seemingly random errors that are more or less restricted to the closed class vocabulary as a unified category. Furthermore, both types of performance are extremely sensitive to the syntactic structure of strings and text passages. The "invisibility" errors and the deletion errors are very much attenuated in syntactically anomalous, or scrambled, materials. This improvement in performance over syntactically structured materials suggests that both kinds of errors are byproducts of processes related to the role of the closed class vocabulary in syntactic processing and not merely to the characteristics of lexical access routines peculiar to the closed class.

Thirdly, and relatedly, both effects appear to be the results of processes that apply after lexical entries have been contacted, as discussed above. In the child case, results indicate that subjects obtain a facilitatory benefit from the presence of closed class words which they nevertheless delete from their repetitions. In the adult case, the RSVP mode of presentation does not disrupt "invisibility" effects, and, furthermore, there are differences in performance during letter detection versus misspelling detection tasks, as predicted by this hypothesis.

Given these parallelisms, it seems all the more desirable to assimilate both types of performance under an explanation that relates both to to the role that the closed class vocabulary plays in syntactic processing. Further research is needed, however, in order to specifically delineate the nature of this role and the precise mechanisms involved. Further work is also needed on issues related to the characteristics of the course of development of the open/closed class distinction in children and the nature of the mechanisms responsible for the "invisibility" effects. At present, we can do no more than speculate about the answers to these questions.

With respect to the developmental question, a proposal has recently been put forth by Gleitman and Wanner (1982). They suggest that the closed class is acquired separately from and later than the open class, and, furthermore, that it requires open class parse trees as the basis for its induction. However, the proposal stands on the assumption that the open/closed class distinction is one whose surface reflex is stress/nonstress (at least in English), and that stressed syllables are perceptually more salient to the youngest learners. As discussed in the first section of this thesis, this assumption remains a problematic one.

With respect to the mechanisms responsible for the "invisibility" effects, several general classes of accounts immediately suggest themselves. First, the effects may reflect representational differences for the open and closed class. While there are compelling arguments against the claim that open class are not definitionally represented (e.g., bachelor unmarried man) (Fodor, Garrett, Walker, and Parkes, (1980), this possibility still remains a likely one with respect to the closed class (as well as for certain verbs). On the basis of crosslinguistic evidence about subtle differences in meanings of words (such as whether a word implies directionality of motion or not), Leonard Talmy (1975) has suggested that prepositions (and verbs of motion) decompose into distinct features, and that languages differ with respect to which features are included in the meaning of words. This possibility is an attractive one, especially considering the obvious differences in the semantics of closed versus open class words.

Other possible accounts that focus on differences in the processing of the two vocabularies are also possible. The effects may be related to the interaction of the separate lexical retrieval devices that control the two vocabularies. Still a further possibility is that in the construction of meaning representation for sentences, closed class elements are discarded once they have performed their syntax-building function, and, therefore, become more difficult to recover. However, as of yet, these possibilities remain untested.

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APPENDIX 1a.

NUMBER OF ERRORS ON OPEN CLASS ITEMS IN EXPERIMENT 1

NOUNS

"concrete"		"abstract"	
man	0/6	time	0/6
dog	0/6	story	0/6
sand	0/6	thing	0/6
house	1/6	day	0/6
truck	0/6	idea	0/6

VERBS

"concrete"		"abstract"	
draw	0/6	make	0/6
sit	0/6	come	0/6
sing	0/6	try	0/6
eat	0/6	put	4/6
pull	0/6	want	2/6

ADJECTIVES

"concrete"		"abstract"	
little	0/6	new	0/6
white	0/6	good	0/6
fat	0/6	sweet	0/6
big	0/6	smart	0/6
ugly	1/6	wrong	1/6

ADVERBS

"concrete"		"abstract"	
loudly	1/6	really	2/6
quickly	0/6	nicely	0/6
gently	0/6	badly	0/6
slowly	0/6	sadly	0/6
safely	0/6	warmly	*

* excluded from analysis because children consistently misunderstood this word for "wormly"

APPENDIX 1b
NUMBER OF ERRORS ON CLOSED CLASS ITEMS USED IN EXPERIMENT 1

PRONOUNS

you	0/6	us	0/6
she	0/6	them	2/5
they	4/6	my	4/6
it	2/6	your	4/6
me	2/6	his	2/6

PREPOSITIONS

"concrete"		"abstract"	
in	2/6	of	3/6
up	1/6	at	4/6
near	1/6	with	2/6
under	1/6	from	3/6
out	1/6	about	1/6

AUX/MODAL

is	1/6	does	3/6
was	4/6	did	5/6
have	1/6	must	2/6
had	5/6	should	4/6
do	2/6	could	4/6

DET/ADV/QUANT

this	3/6	all	1/6
these	3/6	both	1/6
any	1/6	there	1/6
many	0/6	more	1/6
only	1/6	very	2/6

CONJ/COMP

or	3/6	than	4/6
if	2/6	as	5/6
since	2/6	who	0/6
when	3/6	what	0/6
until	4/6	why	1/6

APPENDIX 2

NUMBER OF ERRORS ON INDIVIDUAL ITEMS IN EXPERIMENT 2

OPEN CLASS ITEMS

Nouns:

clock	0/20
ghost	1/20

Verbs:

give	3/20
look	1/20

Adjectives:

small	2/20
green	0/20

CLOSED CLASS ITEMS

Determiners:

this	5/20
your	4/20

Auxiliaries:

is	5/20
did	9/20

Prepositions:

of	7/20
in	5/20

BOUND MORPHEMES

-ing	2/20
-er	1/20

APPENDIX 3

SENTENCE MATERIALS FOR EXPERIMENT 3

SET I

1. This little boy lives in that house.
2. Bill washes himself.
3. Bill and Mary wanted to be friends.
4. They both rode the bus to school.
5. Don't take off your jackets.
6. We will go to the zoo.
7. The lions live in the cage.
8. The elephant is eating some peanuts.
9. We saw monkeys and giraffes.

SET II

1. My mother is baking a chocolate cake.
2. That piece looks bigger than this one.
3. The cake is very good.
4. Do you want some milk?
5. Mike is drinking soda.
6. We want to go to the movies.
7. Put on your new mittens.
8. The movie was very funny.

APPENDIX 4

NONSENSE SEQUENCES USED IN EXPERIMENT 4

CONDITION 1: Grammatical sequences with closed class words.

1. The motches klided my gurses.
2. Some nidges todded the wazzes.
3. These poices vilted more nootches.
4. Those dorges woded these flidges.
5. Few glisses jurted the hodges.
6. Your broshes stinted our doatches.
7. The spishes brudded their doozes.
8. Those lorches smitted all vishes.
9. The tridges marded his bloshes.
10. Most razzes ploded my critches.
11. Some bages motted the spooces.
12. The smaces furded those sidges.
13. Their cazes critted your munges.
14. Few strinches teeded the fozzes.
15. My frashes gleeted some slages.
16. Their stinces pirted more loshes.

CONDITION 2: Grammatical sequences without closed class words.

1. Motches klided gurses.
2. Nidges todded wazzes.
3. Poices vilted nootches.
4. Dorges woded flidges.
5. Glisses jurted hodges.
6. Broshes stinted doatches.
7. Spishes brudded doozes.
8. Lorches smitted vishes.
9. Tridges marded bloshes.
10. Razzes ploded critches.
11. Bages motted spooces.
12. Smaces furded sidges.
13. Cazes critted munges.
14. Strinches teeded fozzes.
15. Frashes gleeted slages.
16. Stinces pirted loshes.

APPENDIX 4 (cont.)

NONSENSE SEQUENCES USED IN EXPERIMENT 4

CONDITION 3: Scrambled sequences with closed class words.

1. Klided the my motches gurses.
2. Wazzes nidges the some todded.
3. More these vilted nootches poices.
4. Woded dorges flidges these those.
5. Jurted hodges few glisses the.
6. Our your stinted broshes doatches.
7. Brudded spishes their doozes the.
8. vishes all smitted lorches those.
9. Tridges bloshes his the marded.
10. My ploded most razzes critches.
11. Spooces bages some motted the.
12. The those furded smaces sidges.
13. Critted cazes munges their your.
14. Fozzes the teeded strinches few.
15. Gleeted my some slages frashes.
16. More their loshes stinces pirted.

CONDITION 4: Scrambled sequences without closed class words.

1. Klided motches gurses.
2. Nidges wazzes todded.
3. Poices nootches vilted.
4. Woded flidges dorges.
5. Jurted glisses hodges.
6. Stinted broshes doatches.
7. Brudded spishes doozes.
8. Lorches vishes smitted.
9. Tridges bloshes marded.
10. Ploded razzes critches.
11. Motted bages spooces.
12. Smaces sidges furded.
13. Cazes munges critted.
14. Teeded strinches fozzes.
15. Gleeted frashes slages.
16. Pirted stinces loshes.

APPENDIX 5

NONSENSE SEQUENCES USED IN EXPERIMENT 5

CONDITION 1: Grammatical sequences with closed class words.

1. The motches klided my gurses.
2. Some nidges todded the wazzes.
3. These poices vilted more nootches.
4. Those dorges woded these fldges.
5. Few glisses jurted the hodges.
6. Your broshes stinted our doatches.
7. The spishes brudded their doozes.
8. Those lorches smitted all vishes.
9. The tridges marded his bloshes.
10. Most razzes ploded my critches.
11. Some bages motted the spooces.
12. The smaces furded those sidges.
13. Their cazes critted your munges.
14. Few strinches teeded the fozzes.
15. My frashes gleeted some slages.
16. Their stinces pirted more loshes.

CONDITION 2: Grammatical sequences with open class words.

1. Good motches klided bad gurses.
2. Big nidges todded nice wazzes.
3. Sad poices vilted tall nootches.
4. Quick dorges woded cold fldges.
5. Fast glisses jurted great hodges.
6. Nice broshes stinted quick doatches.
7. Short spishes brudded thin doozes.
8. Fat lorches smitted big vishes.
9. Good tridges marded slow bloshes.
10. Strange razzes ploded nice critches.
11. Hot bages motted large spooces.
12. Sick smaces furded long sidges.
13. Sad cazes critted bad munges.
14. Tall strinches teeded wide fozzes.
15. Low frashes gleeted fat slages.
16. Great stinces pirted fast loshes.

APPENDIX 6

NONSENSE SEQUENCES USED IN EXPERIMENT 6

CONDITION 1: Sequences with free and bound closed class morphemes.

1. The motches had klided my gurses.
2. Some nidges have todded the wazzes.
3. These poices had vilted more nootches.
4. Those dorges have woded these fludges.
5. Few glisses had jurted the hodges.
6. Your broshes have stinted our doatches.
7. The spishes had brudded their doozes.
8. Those lorches have smitted all vishes.
9. The tridges had marded his bloshes.
10. Most razzes have ploded my critches.
11. Some bages had motted the spooces.
12. The smaces have furded those sidges.
13. Their cazes had critted your munges.
14. Few strinches have teeded the fozzes.
15. My frashes had gleeted some slages.
16. Their stinces have pirted more loshes.

*CONDITION 2: Sequences with free closed class morphemes only.

1. The motch had klibe my gurse.
2. Some nidg have togg the wazz.
3. These poice had vilt more nootch.
4. Those dorge have wobe these flidge.
5. Few gliss had jurt the hodge.
6. Your brosh have stint our doatch.
7. The spish had brull their dooz.
8. Those lorch have smitt all vish.
9. The tridge had marn his blosh.
10. Most razz have plobe my critch.
11. Some bage had mott the spooce.
12. The smace have furb those sidge.
13. Their caze had critt your munge.
14. Few strinch have teeb the fozz.
15. My frash had gleet some slage.
16. Their stince have pirt more losh.

* [d] endings of "verbal" forms in Conditions 2 and 4 were changed to avoid inflectional interpretations.

APPENDIX 6 (cont.)

NONSENSE SEQUENCES USED IN EXPERIMENT 6

CONDITION 3: Sequences with bound closed class morphemes only.

1. Motches klided gurses.
2. Nidges todded wazzes.
3. Poices vilted nootches.
4. Dorges woded fledges.
5. Glisses jurted hodges.
6. Broshes stinted doatches.
7. Spishes brudded doozes.
8. Lorches smitted vishes.
9. Tridges marded bloshes.
10. Razzes ploded critches.
11. Bages motted spooces.
12. Smaces furded sidges.
13. Cazes critted munges.
14. Strinches teeded fozzes.
15. Frashes gleeted slages.
16. Stinces pirted loshes.

*CONDITION 4: Short sequences with nonsense syllables only.

1. motch klibe gurse
2. nidge togg wazz
3. poice vilt nootch
4. dorge wobe flidge
5. gliss jurt hodge
6. brosh stint doatch
7. spish brull dooz
8. lorch smitt vish
9. tridge marn blosh
10. razz plobe critch
11. bage mott spooce
12. smace furb sidge
13. caze critt munge
14. strinch teeb fozz
15. frash gleet slage
16. stince pirt losh

[d] endings of "verbal" forms in Conditions 2 and 4 were changed to avoid inflectional interpretations.

APPENDIX 6 (cont.)

NONSENSE SEQUENCES USED IN EXPERIMENT 6

CONDITION 5: Long sequences with nonsense syllables only.

1. motchit kliden gursel
2. nidgem toddif wazzick
3. poicef viltim nootchat
4. dorgem wodel flidgem
5. glissup jurtif hodgeb
6. broshix stintip doatchum
7. spishig bruddim doozan
8. lorchep smittof vishun
9. tridgeb mardop bloshel
10. razzet plodeck critchel
11. bagem mottop spoocem
12. smacex furdim sidgen
13. cazep crittal munget
14. strinchup teedif fozzub
15. frashim gleetof slageck
16. stincet pirtop loshil

APPENDIX 7

NONSENSE SEQUENCES USED IN EXPERIMENT 7

CONDITION 1: Sequences with grammatically matched free and bound morphemes

1. The motches are kliding my gurses.
2. Some nidges were todding the wazzes.
3. These poices are vilting more nootches.
4. Those dorges were woding these flidges.
5. Few glisses were jurting the hodges.
6. Your broshes are stinting our doatches.
7. The spishes were brudding their doozes.
8. Those lorches are smitting all vishes.
9. The tridges were marding his bloshes.
10. Most razzes are ploding my critches.
11. Some bages were motting the spooces.
12. The smaces are furding those sidges.
13. Their cazes were critting your munges.
14. Few strinches are teeding the fozzes.
15. My frashes are gleeting some slages.
16. Their stinces were pirting more loshes.

CONDITION 2: Sequences with ill-matched free and bound morphemes.

1. The motches are kliding a gurses.
2. Some nidges were todding that wazzes.
3. These poices are vilting this nootches.
4. Those dorges were woding a flidges.
5. A glisses were jurting the hodges.
6. That broshes are stinting our doatches.
7. A spishes were brudding their doozes.
8. This lorches are smitting all vishes.
9. The tridges have marding his bloshes.
10. Most razzes had ploding my critches.
11. Some bages have motting the spooces.
12. The smaces had furding those sidges.
13. Their cazes have critting your munges.
14. Few strinches had teeding the fozzes.
15. My frashes are gleeting some slages.
16. Their stinces were pirting more loshes.

APPENDIX 8a.

OPEN AND CLOSED CLASS STIMULUS PAIRS USED IN EXPERIMENT 8

OPEN CLASS		CLOSED CLASS	
word	frequency (log units)	word	frequency
effect	2.30	else	2.25
mean	2.30	near	2.30
close	2.37	whose	2.57
change	2.38	quite	2.45
example	2.46	either	2.45
matter	2.49	rather	2.57
let	2.58	yet	2.62
given	2.58	often	2.57
president	2.58	several	2.58
eyes	2.60	ever	2.54
set	2.62	less	2.64
head	2.63	next	2.60
general	2.70	every	2.69
house	2.77	since	2.80
life	2.85	while	2.83
men	2.88	few	2.78
years	2.98	each	2.94
made	3.05	some	3.21
like	3.11	those	2.93
time	3.20	more	3.35
MEAN	2.77		2.76

APPENDIX 8b.

SENTENCE MATERIALS USED IN EXPERIMENT 8

1. It was late and the sun was just starting to set in the horizon behind distant hills.

2. We had been driving for a long time that day and needed a good night's rest.

3. I was somewhat worried as our car was rather low on gas.

4. I kept busy staring at maps while my companion drove.

5. He was driving slowly and cautiously since our car had no lights.

6. I watched anxiously out of my window for some country inn where we might stay for the night.

7. I was starting to strain my eyes from looking continuously into the darkness.

8. It quickly became so dark that I hardly made out anything in the the shadows.

9. I was starting to think that either my companion had taken a wrong turn or that we had bought the wrong map.

10. It also occurred to me that the last woman we had asked for information had possibly given us bad directions.

11. We could continue driving until we found a campground or else turn around and risk running out of gas completely.

12. We both sighed with relief as our car drove over a big hill and came to a small village.

13. We went past a tiny brick house that lay at the edge of town.

14. There was a gigantic barn next to it.

15. The property looked as if it was collapsing from many years of bad neglect.

16. My friend said that it was quite spooky looking but that it would be a peaceful spot for sleeping.

17. For a moment we could not make up our minds whether to stay and camp by the barn.

18. Finally I decided that what I would most like was a soft warm bed so we drove on towards town.

19. As we drove around a corner our car almost ran down several shabby

looking old bums.

20. My friend was forced to think quickly and to rapidly change positions on the road.

21. I heard the car brush noisily against a few bushy plants as our car our car swerved to avoid disaster.

22. I was thrown toward the side of the car and I hit my head against a hard object.

23. We heard shouting and saw angry old men cursing loudly at us.

24. In the rearview mirror we saw to our horror that each man was carrying a shot gun.

25. There was also a big mean dog chasing our automobile.

26. I decided that I would quickly report this ugly incident to the local police.

27. I didn't think that anyone should walk around carrying those sorts of dangerous weapons.

28. I was naturally in much more of a hurry now to find a safe place to sleep.

29. We were both as anxious as ever to land in a civilized place.

30. However stepping on the gas and downshifting had no effect at all on our speed.

31. Just then we saw what I thought was a general food and supply store.

32. A man was about to close his shop for the night.

33. As we were parking our old car near his shop the man ran over to talk to us.

34. He introduced himself to us as president of a local trade union.

35. He told us about a grand hotel in town and said that his own family often took a room there for guests.

36. We explained that we were actually looking for a less formal and expensive place.

37. We said that a little inn would be good for example as long as it was close to town.

38. Finally he told us that the only other hotel in town was run by people from a small religious group.

39. It didn't much matter to us who owned the place so we asked him for directions.

40. Fortunately we found the place easily.

41. As we parked our car a fat man whose hair was very long looked out of a window and greeted us.

42. He opened the door for us and let us in to show us a room.

43. It didn't look much like an inn room to us yet it had all the standard furnishings.

44. The rug was the strangest color I have laid eyes on in all my life and wall paint didn't match.

45. The man pointed to a large bay window and said that every room in the place had a view.

APPENDIX 8c

SCRAMBLED SENTENCE MATERIALS USED IN EXPERIMENT 8

1. behind sun it and the in starting just hills horizon set was distant the late was to

2. been had rest day that a hoping time driving for to good long we and were night's get a we

3. as somewhat on I worried gas our was rather car low was

4. drove my kept I staring by companion while busy maps myself

5. slowly he our and driving lights since car no was cautiously had

6. I where might window my out inn for some anxiously night the stay country watched of for we

7. into was starting looking to from eyes my strain the continuously darkness I

8. shadows it became out that in hardly I made dark so anything the quickly

9. wrong think companion to my that either had a starting the or we turn map bought that had I was wrong taken

10. directions also me woman asked had information it to that bad we possibly for us given last the occurred

11. completely could we a out found until or campground of else gas turn and driving risk around continue we running

12. drove we village with as relief drove a over hill and small big to a came a both we sighed

13. edge a town tiny lay at house brick past went of that the we the

14. it gigantic to barn was next a there

15. looked if it the property bad from of collapsing as years many was neglect

16. sleeping said my it would that quite but looking was it be spooky that spot peaceful friend a for

17. moment a not for we house up minds land whether camp our make on the could to and stay the

18. towards we that I would town on I soft like so finally warm most decided what was bed a drove I

19. people looking corner a we almost shabby ran bums old several

car around drove our

20. my them the was to quickly on road <u>change</u> rapidly think forced friend and

21. disaster I the to car against avoid a <u>few</u> brush plants noisily car our bushy heard as swerved

22. a object hit car the and my the against of thrown toward <u>head</u> was I side hard

23. heard saw at loudly angry us cursing <u>men</u> old shouting and we

24. we to rearview horror that saw mirror our that man <u>each</u> gun shot in a carrying the

25. automobile big a was also <u>mean</u> chasing dog there

26. police that I local quickly this <u>report</u> to would ugly I incident decided the

27. that weapons think sorts walk I arround carrying <u>those</u> of didn't anyone dngerous

28. find hurry I to much <u>more</u> in a now find safe to naturally of a sleep was

29. place both as land a in <u>ever</u> to anxious were as civilized we

30. speed gas however on no the and our had <u>effect</u> all at stepping downshifting on

31. store just we what food and thought <u>general</u> I supply saw then

32. night man a to about <u>close</u> for shop the his was

33. were us talk parking car man his <u>near</u> old ran shop our to the over as we to

34. trade he us local to of <u>president</u> a introduced union as himself

35. guests told town a in grand there and he about his said own room a <u>often</u> for took family hotel as that

36. place that explained we formal looking a for a <u>less</u> actually were expensive we

37. close said that we inn good to be for as <u>example</u> long it town was to little as a would

38. told that the us he hotel group other only run town in a was <u>people</u> small from the religious

39. it for who <u>matter</u> us much didn't owned him we so it to asked

directions

40. easily found place the fortunately we

41. us we greeted fat a car hair out <u>whose</u> was long of a and window man our parked looked very as

42. the to he show in to us <u>let</u> and room door for opened us a

43. like didn't furnishings and it all it us much look <u>yet</u> standard had inn to room the

44. the was the walls and on the I have all in my on match <u>life</u> paint color strangest rug laid the eyes didn't

45. view man place window a to had bay said and that <u>every</u> in a room the pointed large the

APPENDIX 8d.

TOTAL NUMBERS OF ERRORS AND MEAN REACTION TIMES FOR INDIVIDUAL OPEN CLASS ITEMS USED IN EXPERIMENT 8

	SRUCTURED CONDITION		UNSTRUCTURED CONDITION	
Item	errors	mean RT	errors	mean RT
effect	0	444	1	413
mean	0	499	1	459
close	1	478	0	478
change	1	469	0	475
example	0	463	0	439
matter	1	509	0	467
let	2	474	0	441
given	2	489	0	455
president	1	497	0	454
eyes	2	412	0	418
set	1	494	0	447
head	0	407	1	455
general	0	469	0	453
house	1	470	1	415
life	0	456	2	493
men	0	444	2	462
years	0	471	2	481
made	0	456	1	414
like	3	495	0	473
time	0	500	2	481

TOTAL ERRORS 15 MEAN 470 — TOTAL ERRORS 13 MEAN 454

% ERRORS 3.8 S.D. 27.9 — % ERRORS 3.3 S.D. 24.2

APPENDIX 8d. (cont.)

TOTAL NUMBERS OF ERRORS AND MEAN REACTION TIMES FOR INDIVIDUAL CLOSED CLASS ITEMS USED IN EXPERIMENT 8

	STRUCTURED CONDITION		UNSTRUCTURED CONDITION	
Word	errors	mean RT	errors	mean RT
else	4	431	2	430
near	1	481	1	479
whose	4	480	0	459
quite	2	445	0	451
either	1	424	1	421
rather	4	499	0	468
yet	0	502	0	500
often	4	511	0	459
several	2	459	1	417
ever	3	438	0	430
less	1	451	0	473
next	3	490	0	477
every	3	494	0	465
since	9	573	1	480
while	3	512	0	474
few	3	434	1	429
each	2	492	2	461
some	2	434	0	411
those	6	568	1	505
more	3	541	0	463

STRUCTURED				UNSTRUCTURED			
TOTAL ERRORS	59	MEAN	483	TOTAL ERRORS	10	MEAN	458
% ERRORS	14.7	S.D.	44.3	% ERRORS	2.5	S.D.	26.8

APPENDIX 9a.

SENTENCE MATERIALS USED IN EXPERIMENT 9

1. It was late and the sun was just starting to set in the horizon behind distant hills.

2. We had been driving for a long time that day and needed a good night's rest.

3. I was somewhat worried as our car was rather low on gas.

4. I kept busy staring at maps while my companion drove.

5. He was driving slowly and cautiously since our car had no lights.

6. I watched anxiously out of my window for some country inn where we might stay for the night.

7. I was starting to strain my eyes from looking continuously into the darkness.

8. It quickly became so dark that I hardly made out anything in the the shadows.

9. I was starting to think that either my companion had taken a wrong turn or that we had bought the wrong map.

10. It also occurred to me that the last woman we had asked for information had possibly given us bad directions.

11. We could continue driving until we found a campground or else turn around and risk running out of gas completely.

12. We both sighed with relief as our car drove over a big hill and came to a small village.

13. We went past a tiny brick house that lay at the edge of town.

14. There was a gigantic barn next to it.

15. The property looked as if it was collapsing from many years of bad neglect.

16. My friend said that it was quite spooky looking but that it would be a peaceful spot for sleeping.

17. For a moment we could not make up our minds whether to stay and cam by the barn.

18. Finally I decided that what I would most like was a soft warm bed so we drove on towards town.

19. As we drove around a corner our car almost ran down several shabby

looking old bums.

20. My fricnd was forccd to think quickly and to rapidly changc positions on thc road.

21. I hcard thc car brush noisily against a fcw bushy plants as our car our car swcrvcd to avoid disastcr.

22. I was thrown toward thc sidc of thc car and I hit my hcad against a hard objcct.

23. Wc hcard shouting and saw angry old mcn cursing loudly at us.

24. In thc rcarvicw mirror wc saw to our horror that cach man was carrying a shot gun.

25. Thcrc was also a big mcan dog chasing our automobilc.

26. I dccidcd that I would quickly rcport this ugly incidcnt to thc local policc.

27. I didn't think that anyonc should walk around carrying thosc sorts of dangcrous wcapons.

28. I was naturally in much morc of a hurry now to find a safc placc to slccp.

29. Wc wcrc both as anxious as cvcr to land in a civilizcd placc.

30. Howcvcr stcpping on thc gas and downshifting had no cffcct at all on our spccd.

31. Just thcn wc saw what I thought was a gcncral food and supply storc.

32. A man was about to closc his shop for thc night.

33. As wc wcrc parking our old car ncar his shop thc man ran ovcr to talk to us.

34. Hc introduccd himsclf to us as prcsidcnt of a local tradc union.

35. Hc told us about a grand hotcl in town and said that his own family oftcn took a room thcrc for gucsts.

36. Wc cxplaincd that wc wcrc actually looking for a lcss formal and cxpcnsivc placc.

37. Wc said that a littlc inn would bc good for cxamplc as long as it was closc to town.

38. Finally hc told us that thc only othcr hotcl in town was run by pcoplc from a small rcligious group.

39. It didn't much mattcr to us who owncd thc placc so wc askcd him for dircctions.

40. Fortunatcly wc found thc placc casily.

41. As wc parkcd our car a fat man whosc hair was vcry long lookcd out of a window and grcctcd us.

42. Hc opcncd thc door for us and lct us in to show us a room.

43. It didn't look much likc an inn room to us yct it had all thc standard furnishings.

44. Thc rug was thc strangcst color I havc laid cycs on in all my lifc and wall paint didn't match.

45. Thc man pointcd to a largc bay window and said that cvcry room in thc placc had a vicw.

APPENDIX 9b.

TOTAL NUMBERS OF ERRORS AND MEAN REACTION TIMES FOR ITEMS USED IN EXPERIMENT 9

OPEN CLASS item	errors	mean RT	CLOSED CLASS item	errors	mean RT
effect	3	536	else	2	517
mean	0	451	near	1	504
close	0	462	whose	0	521
change	1	499	quite	0	456
example	0	487	either	1	498
matter	2	525	rather	1	496
let	0	476	yet	0	515
given	2	524	often	2	516
president	1	495	several	0	504
eyes	1	461	ever	0	513
set	0	406	less	1	453
head	0	435	next	3	521
general	0	460	every	1	479
house	1	483	since	1	480
life	1	500	while	1	468
men	0	478	few	0	431
years	1	477	each	2	576
made	1	442	some	0	454
like	2	507	those	3	518
time	0	467	more	0	505
TOTAL ERRORS	16	MEAN 478	TOTAL ERRORS	19	MN 496
% ERRORS	4	S.D. 32.4	% ERRORS	4.8	SD 32.9