

# Lexical Knowledge and Word Recognition: Children's Reading of Function Words

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The paper presents a series of experiments on children's recognition of function words such as connectives and prepositions. The questions address: Is there a developmental difference in the recognition of content and function words? How available are words from the two word classes in reading? Is the difference in lexical availability of content and function words a matter of grammatical class or of meaningfulness? To what extent does the context affect the recognition of function words? Two lexical decision experiments are reported in which the availability of connectives and prepositions has been compared to that of content words. A third experiment involved a semantic categorization task, in which the subjects had to decide whether content and function words were words referring to the concept of time or not, and in which function words were decided upon much more slowly. The fourth was a probe latency experiment in which the subjects had to decide whether a given word—a connective, a preposition, a verb, or a noun—had been part of a sentence previously presented. Finally, the fifth was an experiment on word recognition in context. The results showed a lower availability of function words as compared to content words. A second finding was that this lower availability may be, at least in part, more a matter of meaningfulness than of grammatical class, function words being characterized in general by less semantic content. A third conclusion was that context facilitates recognition of function words only at a higher age.

Words unknown or unfamiliar to the reader present more difficulties than familiar words. A child's reading behavior offers an obvious and dramatic demonstration of this fact; if we ask a child already somewhat advanced in the reading acquisition process—say, a second or third grade pupil—to read a text containing unfamiliar or for him totally unknown words, we will undoubtedly notice some changes. He may stop, slow down the reading rate, start reading syllable-by-syllable or letter-by-letter, or misread the word by substituting it with a similar word, orthographically or phonetically related to it. Obvious as this statement can sound, reading skill is directly related to the lexical knowledge of the child.

A better knowledge of the developmental course of this lexical competence and of its relation to the word recognition process is of interest for a better understanding

of the acquisition of reading and for possible explanations of sources of certain reading difficulties in children. If lexical knowledge is an obvious and important variable in word recognition in reading, it is important to have more specific information on the availability of word classes in the child's internal lexicon, because this availability directly relates to the ease of the reading process.

In this paper I will report a few experiments on children's recognition and understanding of printed words: the experiments have compared the recognition of function words with the recognition of content words. This distinction is rather straightforward. Grammarians, linguists, and psycholinguists distinguish content and function words, sometimes called open or closed class words, or substantial and grammatical words. Open class words are the main lexical categories—such as nouns, verbs, and adjectives—which bear a clear semantic meaning. Closed class words are syntactic operators with grammatical categories such as determiners, prepositions, and conjunctions. Words belonging to this class are not very numerous. In English, in Dutch, and in Italian, for example, they are of the order of few hundreds words, as compared to the enormous size of the open class.

Function words are characterized by several syntactic, lexical, and semantic properties which make them rather different from content words. Most of these words have a poor semantic content, do not bear reference, have a clear relational function in the sentence, and are hardly used in isolation. Even for the educated adult speaker, some of these words are often difficult to define. Agrammatic patients often show particular difficulties in reading function words ("Small words are the worst" and "One of them horrid words again", Marshall and Newcombe, 1966).

### **Studies on content and function words.**

Until recently very few psycholinguistic studies of the mental lexicon and on reading have paid attention to function words. Most studies on lexical access and on word recognition typically use as experimental stimuli nouns, which are easier to constrain and control for the design of a proper experiment. Properties such as word frequency, word length, word contour, imagery value, number of associations, etc., can with some care, at least to some extent, be controlled for with nouns. To carry out similar operations with connectives or prepositions would often mean to be left with only one or two stimulus words for an experiment or with none at all.

Behavioral evidence on differences in processing content and function words in normal subjects is scarce, and not unequivocal. Function words presented in isolation in lists are more difficult to learn than content words. However, they are learned more easily when they are embedded in sentence contexts which emphasize their role of relational words in the sentence (Glanzer, 1962). Recording of eye fixations during reading of connected text have revealed that function words attract gaze much less frequently than content words (Carpenter and Just, 1977). In reading passages of prose it is more difficult to recognize spelling errors in function than in content words (Haber and Schindler, 1981). Interesting enough, this difference

holds for the same word in two contexts which selectively determine the use of the item as a function word or as a content word, such as the word *have* in the function of auxiliary or in the possessive sense (Abramovici, 1983).

Clinical or experimental work with aphasic and dyslexic patients, on the other hand, has often revealed interesting differences in the performance with open and closed class words. The evidence available in this area, once more, is by no means univocal. While agrammatics often display difficulties with function words, there are also cases of relative correspondence in the ease of processing words from either class. For example, Goodglass, Gleason, and Hyde (1971) did not find any impairment in a Broca aphasic's comprehension of directional prepositions in sentence context.

Vocabulary type seems to have an effect on the word retrieval process both in production and in comprehension (Garrett, 1982). In language production the first, most obvious, source of evidence in this direction comes from language acquisition data. Children's telegraphic speech (Brown and Bellugi, 1964) is characterized by selective omission of closed class words. Another source of evidence is the differential loss of vocabulary in aphasics: there is some indication that agrammatic patients preserve more open class items, while Wernicke are more likely to preserve words from the closed class. A third interesting type of evidence comes from analysis of spontaneous errors in linguistics production: errors consisting in the exchange of position are normally limited to open class vocabulary, while errors consisting of shifts of single elements, instead, are typical of closed class vocabulary (Garrett, 1982). All this and other evidence has been taken (for example by Garrett, 1980, 1982) as basis for the hypothesis of two distinct computational routes for the access to content and to function words. In language production closed class vocabulary would be recruited at the point in which the surface form of the sentence is being constructed, while open class vocabulary within the propositional structure underlying a sentence are being created.

Language comprehension data yield a similar picture. For example, a series of recent studies with lexical decision tasks has provided some evidence of different behavior of function and of content words. One such effect is the differential sensitivity of content and function words to frequency. In lexical decision tasks, word frequency is highly correlated with speed of decision: in fact, it is probably the best predictor of lexical decision latency. This effect, however, seems to hold only for open class word and not for closed class words (Bradley, 1978). This result is still controversial, for it could not be replicated (Gordon and Caramazza, 1982), but other effects speaking for a different computational route for open and closed class words are at hand. For example, in lexical decision tasks with non-words obtained by adding a morpheme or a suffix to an open class word (e.g., *worderty*) or to a closed class word (e.g., *sucherty*), interference effects on decision times were obtained only with open class but not with closed class words (Bradley and Garrett, 1980). Again, the evidence available speaks in favor of the existence of two functionally

distinct computational routes for the access to function and to content words. Items of the two classes would be accessed through two different retrieval processes. Since closed class vocabulary items would have a special role in the procedures for assigning phrasal analyses to sentences, they would have a distinct retrieval route.

At any rate, whether the same or two different computational procedures have to be postulated for the processing of words belonging to the two classes, it remains an important question for any psychological theory of reading to try to assess in the first place whether there are systematic differences in the developmental course of word recognition for content and function words. The present work presents some evidence on the differential availability of lexical knowledge about content and function words in children and about the use of this knowledge in reading.

### **Meaningfulness and word recognition.**

While content words tend to be rich in meaning, function words are usually void of semantic content. This variable of semantic richness or "meaningfulness" is often confounded with grammatical class.

A distinction is often made between syntactic and lexical use of function words such as prepositions. The first serves mainly a grammatical function within the sentence, while the second would carry a semantic content on its own. The same lexical unit may take different semantic contents when used in two different senses. For example, the verb *have* in the possessive and in the auxiliary use displays two different amounts of meaningfulness. The possessive sense has a specific meaning, while the auxiliary use only serves a grammatical function. Similarly, the preposition *by* has, among others, an agentive and a spatial use, and the second is intuitively "richer" in meaning than the first.

These differences also result in the performance with the same lexical unit in the two different uses. The same item seems processed differently whether it is used as a content or as a function unit (Abramovici, 1983). Another example is given by the performance of P.W., a dyslexic patient studied by Morton and Patterson (1980) who seemed capable of understanding the semantic content of function words, but not their syntactic value.

In the present author's opinion is not easy to represent the distinction as a true dichotomy. I prefer to think of a continuum with various degrees of semantic richness, and with corresponding differences in the speaker's internal lexicon. In the present work I will use the notion of "semantic richness" in a very intuitive sense, simply to indicate the presence of different amounts of semantic content in a word.

In early attempts to "measure" meaning, meaningfulness of a word was by some authors (e.g., Noble, 1952) simply defined in terms of the numbers of associations elicited by the word. More recently, semantic richness turned out an important variable in lexical decision tasks. Whaley (1978) examined the contribution of a large number of variables to the performance scores on several words in a lexical decision task, and in a factor analysis of the intercorrelations between these variables

obtained an important (13% variance) factor of "semantic richness" with high loadings of meaningfulness, concreteness, imagery and age of acquisition. Another factor analytic study on 51 variables on 125 words yielded a similar factor of "imagery and meaning" with similar variables (Rubin, 1980). Thus meaningfulness seems an important variable in lexical access, which, however, has not often been taken into appropriate consideration.

Function words are semantically much poorer than content words, but within each of the two broad classes there exist large differences in semantic richness. Since many senses of the function words present a very low degree of meaningfulness, and since at any rate function words are characterized by a lower meaningfulness than the majority of content words, it may be reasonable to ask whether the processing differences between function words and content words which has been found in different experiments (e.g., Flores d'Arcais, 1981) might be related to meaningfulness rather than, or in addition to, grammatical class. This question has been addressed in the present study.

### **The role of context in word recognition.**

Another question investigated in the present paper is the extent to which context affects children's recognition of function words. Comparing children's comprehension of complex sentences (Flores d'Arcais, 1978a) with their understanding of connectives in isolation (Flores d'Arcais, 1978b, 1981), it can be concluded that children might understand function words such as connectives when embedded in sentences, but would not yet fully comprehend the same words in isolation. An obvious implication of this conclusion is that the children would supply their lack of specific lexical knowledge by using the context and, perhaps even to a larger extent, their pragmatic knowledge of the world. This conclusion is consistent with the finding in word recognition experiments that contextual effects are larger for words which are more difficult to recognize in isolation (Stanovich and West, 1979, 1981). In the present study I have tried to determine whether function words, which were assumed to be less available than content words, would be affected by context and therefore become more easily recognizable.

Until recently a widely held belief about the effects and use of context in reading was that good readers are more effective in reading also because they make a much more efficient use of context (e.g., Smith, 1971). However, recent research has shown that poor readers use the context more than good readers (e.g., Perfetti, Goldman, and Hogeboom, 1979; Stanovich, West, and Freeman, 1981). This evidence has been convincingly interpreted on the argument that the skilled reader requires less context simply because he is good at recognizing words anyhow. The process of reading words in the good reader is highly automatized and rapid, precluding a large influence of context. Poor readers, on the other hand, would rely more on context to compensate for the lacking skill in word recognition. We can evaluate this explanation in terms of easy and difficult words rather than good and

poor readers. What would be the differential use of context in recognizing words for which the children are good and poor readers, namely content and function word respectively? If the explanation is true, then we should find a larger use of context for function words than for content words. This prediction has been tested in the last experiment reported in the present chapter.

### **The problem.**

The extent to which written word recognition of function words depends on the semantic-lexical competence available to the child at a given age is an important question for knowledge of the reading process, to which this paper intends to give a contribution.

The questions to which the present study tries to give an answer are the following. First, is there a developmental difference in word recognition for content and function words? Second, how available are words from the two word classes in the reading process? Third, to what extent does such a difference, if present, depend on word class or rather on differences in meaningfulness? Finally, to what extent does the context affect the recognition of function words in children?

The experiments reported explore with different techniques children's reading of function words. The first two are lexical decision experiments, the third a semantic categorization study, the fourth a probe latency experiment, and the fifth an experiment on word recognition in context. The first and the third experiment have been reported elsewhere (Flores d'Arcais, 1981) and will only be summarized here.

### **Experiment 1—Lexical decision with connectives.**

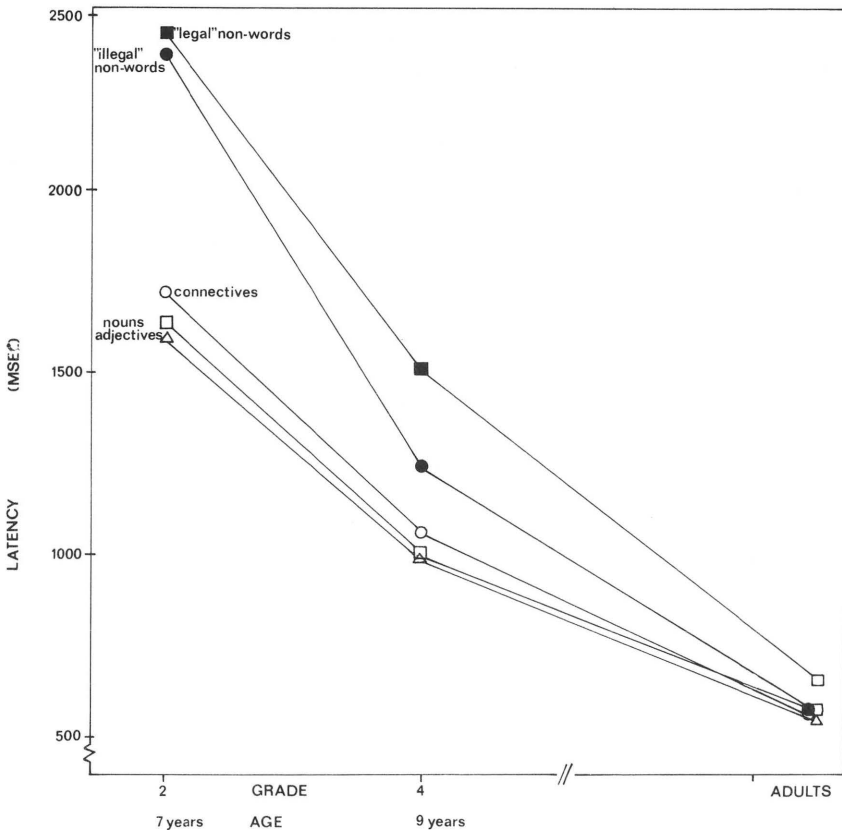
My previous work with connectives (Flores d'Arcais, 1978 a, b; 1981) has shown that the lexical knowledge about connectives develops much more slowly than one would predict on the basis of the results of experiments on the comprehension of complex sentences which include connectives. Most connectives which in context appeared to be appropriately interpreted, seemed not yet considered as meaningful word units when presented in isolation. To test this discrepancy, I used a lexical decision task, which consists of deciding whether a string of letters presented visually is, or is not, a word of the language. Of course, this means that the subjects have to be literate, and this poses obvious problems for experiments with children. Rather good results have been obtained, however, with children as young as seven years (Schvaneveldt, Ackermann, and Semlear, 1977). The dependent variables in a lexical decision task can be the number of errors and/or the latencies for the correct decisions—this latter index being almost universally the one used in studies with this procedure. Both variables can be taken as indicators of processing complexity, or about the strength with which a word has been acquired. If a child makes an error in the decision or takes very long to take the appropriate decision about a word, we may assume that he still does not know the word or does not know it well.

**Method, material and subjects.** The subjects were presented a display with written strings of letters. They were 19 children of second and 23 of fourth grade, approximately 7 and 9 years respectively, and 20 adults. The stimulus words were 8 nouns, 8 adjectives, and 8 connectives, 16 legal non-words and 8 illegal non-words. The 8 connectives were chosen among the most frequent 20 connectives in Dutch (Uit den Bogaard, 1973). The nouns and adjectives were matched to the connectives in frequency, length, number of syllables, and word contour.

**Results.** The average latencies for correct responses are reported in Figure 1. An analysis of variance on the latencies showed a significant overall effect for age and for class of words. For the children, the connectives are somewhat slower than the nouns and adjectives, which in turn require approximately the same decision times within each age level. The adults show no difference.

**Discussion.** If speed in making the lexical decision can be taken as an indication of the availability of the words in the mental lexicon, then it can be easily concluded that the connectives are less readily available to the child than content words.

Figure 1. Experiment 1—Average lexical decision latencies (msec) for nouns, adjectives, connectives, and for non-words.



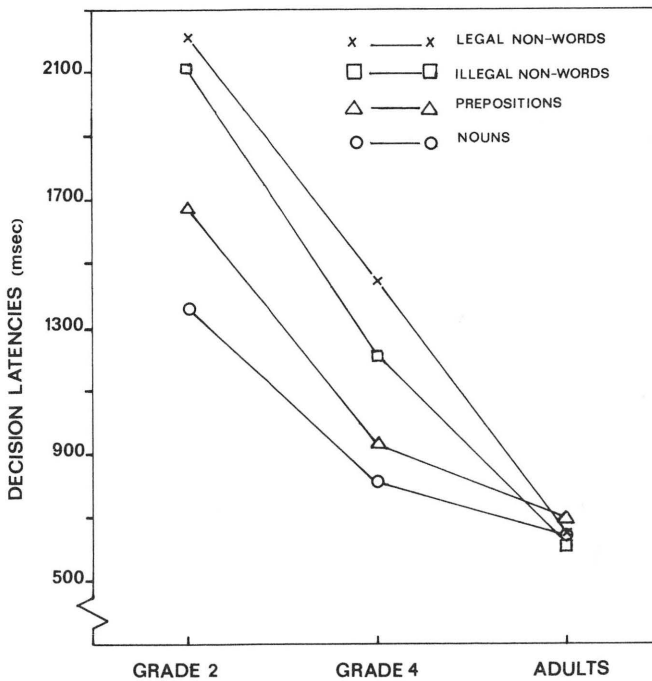
### Experiment 2—Lexical decisions with prepositions.

The first experiment showed a clear difference in the speed of lexical access of connectives as compared to nouns and adjectives. In the present experiment another class of function words was considered, namely prepositions. Children start using temporal and locative prepositions rather early in language development, earlier than connectives. It was therefore of interest to see to what extent the earlier acquisitional history could affect the efficiency of the lexical access.

This experiment was essentially the same as Experiment 1. Eight Dutch prepositions were presented together with 8 nouns, 8 legal non-words, and 8 illegal non-words. The subjects were 14 children of grade 2 and 15 of grade 4, with approximate ages 7 and 9, and 15 adults. The procedure was identical to that of Experiment 1.

**Results.** The results, average latencies for correct responses, are reported in Figure 2. An analysis of variance carried out on these latencies showed a significant effect of age and of word class. The latencies in deciding that prepositions are words of Dutch were slower than the lexical decisions for the matched nouns for the children but not for the adults.

Figure 2. Experiment 2—Average lexical decision latencies (msec) for prepositions, nouns, and for non-words.



**Discussion.** The results obtained are consistent with those of the previous experiment: like connectives, prepositions are more difficult to access than nouns. The words used are normally correctly understood when functioning in an appropriate sentence, as it became evident through a small experiment using an “acting out” technique with toys, and as is known from comprehension of few spatial prepositions in children (Clark, 1973). In isolation, unlike nouns and like connectives, prepositions are difficult to access as determined by a lexical decision task.

### **Experiment 3—Semantic categorization: Words of time**

The task of lexical decision requires the recovery of the lexical entry in the mental lexicon: one cannot decide that a letter string is a word or not if he has not been able to retrieve the appropriate lexical unit. The task is, however, rather abstract in character, for it does not specifically require the subject to consciously activate the meaning of the word. Access to the latter is obviously the most important feature of the process of word recognition in normal reading. It was therefore of interest to assess lexical access of function and content words with a technique which would specifically require the full availability of the meaning of the words. The procedure used in this experiment is of this type: a semantic category decision task, namely to decide whether a word belongs to a given lexical domain or not. In the experiment function and content words were presented with the task for the subject to decide whether they belong to the semantic-lexical domain of words of time.

**Method, subjects and procedure.** Sixty words were used, namely 25 words of time, and 35 from other lexical domains. The 25 words of time were of the following classes: a) 11 nouns: 3 of time measuring instruments (such as ‘clock’) and 8 of duration (e.g., ‘year’); b) 2 adjectives; c) 6 adverbs; d) 6 connectives. Of the 35 words of other categories, 25 were matched approximately to the experimental words in class, frequency (Uit den Bogaard, 1973; de Jong, 1979), length and word contour (11 nouns, 2 adjectives, 6 adverbs, and 6 connectives), the remaining 10 were 5 nouns, 1 adjective, 2 connectives, and 2 adverbs. The words were presented one at a time on a display. The subject had to decide whether the word was a word about time or not. The subjects were 20 children each of grades 2, 4, and 6, and 20 adults.

**Results.** The proportion of errors on the 25 experimental words (deciding that one of those 25 words of time was not in this category) for the children and the median latency data (based on correct responses only) are presented in Figures 3 and 4. Error data and latencies show the same trend. The results of both sets of data (the proportion of errors having been transformed in arc sin) gave a significant effect for age and for category of words. The following results are particularly worth noticing: a) the decision latencies decrease regularly from grade 2 to grade 6, but still decrease further from the 6 grade to adulthood; b) the relative difficulty of the categories of words remains constant throughout the age levels.

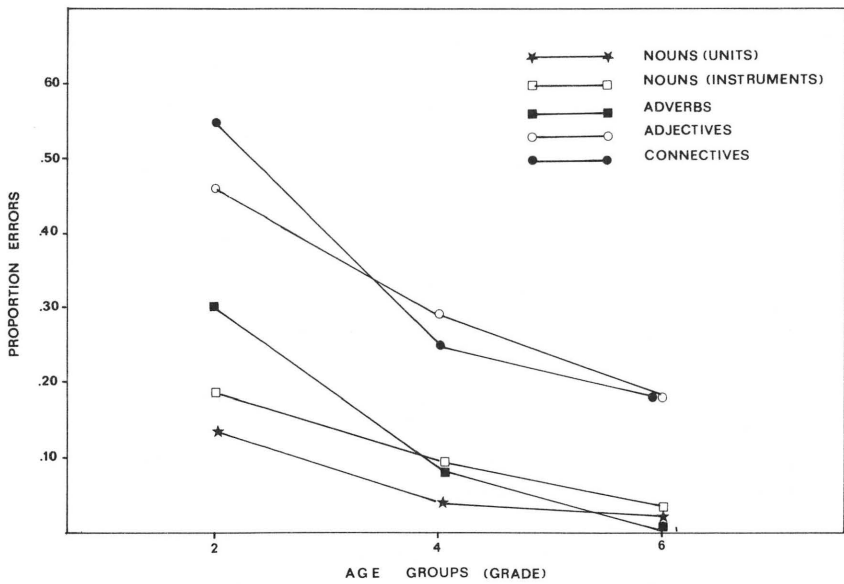
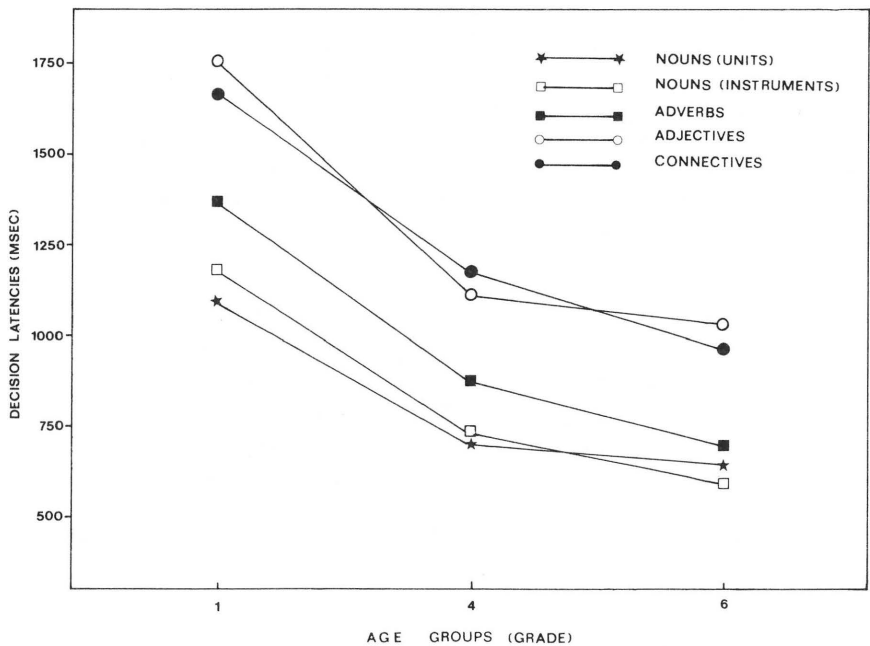


Figure 3. Experiment 3—Categorization of words of time. Proportion of semantic categorization decision errors for different word classes.

Figure 4. Experiment 3—Categorization of words of time. Average semantic decision latencies (msec) for different word classes.



**Discussion.** If the few words used can be taken as a good sample of the words of the different classes within the domain of the words of time—and this was not the case for the adjectives—then there is an order in the difficulty of access of the different words. Nouns are all the easiest, followed by adverbs, and the connectives by far the most difficult.

An interesting result was the relative ease of adverbs as compared to connectives. This difference in the ease of the semantic decision can be explained as due to the different semantic status of the time adverbs as compared to time connectives. Connectives are relational words; adverbs possess their own meaning. Both *now* and *while* are deictic terms, refer to the “present time”—the time in which the speaker and the hearer are communicating. However, *now* indicates a point in time: it is the time T1 in which the speaker and the addressee are, *while* indicates a time which is contemporary or parallel to the time T1. *Yesterday* is the day before the day T1, *before* is the time or action which takes place prior to another time or another action. Children’s lexical knowledge seems to reflect these differences.

The developmental data obtained showed another interesting fact, namely the high consistency of the relative differences of latencies for the words used across the age levels. The most difficult words for the children are also the most difficult ones for the adults, although of course the overall performance of the latter is much better.

#### **Experiment 4—Memory for content and for function words: A probe latency study.**

This experiment investigated children’s short term availability of content and function words after sentence presentation. Short term recall or recognition of words which were part of a sentence has been widely used as an indication of processing difficulty or processing capacity. For example, it is well known (Jarvella, 1970; Caplan, 1972; etc.) that words from the last clause of a sentence are recalled rather well immediately after the end of the clause, while words from previous clauses are remembered more poorly; evidence of this type has been taken as support for the “clausal hypothesis” of sentence segmentation, which holds that a sentence is kept in working memory clause-by-clause, and that once a clausal unit has been understood, working memory is cleared of surface material and the semantic information is sent to long-term memory.

Material from sentences structurally more complex is remembered at the end of the sentence less well than material from structurally simple sentences. For example, latencies in deciding whether a word was present or not in a previously given sentence were shorter when the target word was in a main than when it was in a subordinate clause (Kornfeld, 1973).

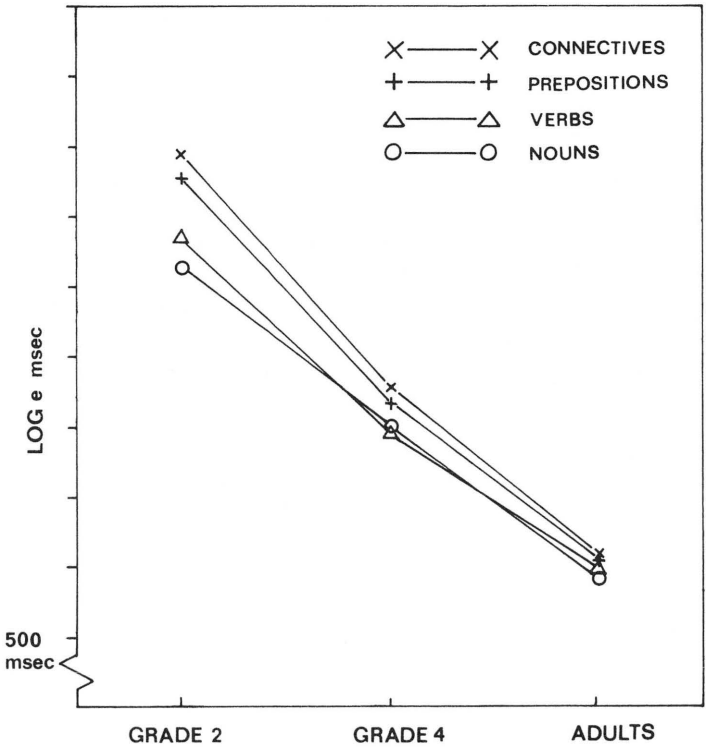
Whether lexical availability of an individual word has an effect on recall or recognition after sentence end has, to my knowledge, not been investigated. The hypothesis tested in the present experiment was that words which are less available

in the child's mental lexicon would be recalled and recognized less well after sentence presentation because these words would not be processed at the same level of the rest of the sentence. It is known from memory research carried out within the level of processing framework of Craik and Lockhart (1972), namely, that processing at a shallow level impairs memory performance (Craik and Tulving, 1975). The technique used in this study was a probe recall task, with the latency of the response being taken. The technique consists in presenting a written sentence, followed by a word which was, or not, part of the sentence presented. The task of the subject was to decide as fast as possible whether the word had been presented in the sentence. The critical words were either content or function words, and so were the distractors.

**Material, method and subjects.** The subjects were 16 children of grade 2 and 18 of grade 4 (the respective mean age being approximately 7.6 and 10 years) and a control group of 12 adults. They were run individually and paid for their cooperation.

The experimental material consisted of 24 sentences, with the critical words being 6 connectives, 6 prepositions, 6 nouns, and 6 verbs, approximately matched for fre-

Figure 5. Experiment 4—Memory for content and function words. Average latencies (msec) in deciding whether a word was in a sentence or not.



quency and length. For every experimental sentence half of the subjects received as the probe a function word (a connective or a preposition) the other half a content word (noun or verb). 16 filler sentences were used, the probe being a distractor (and the required response being therefore a "No"). The probability of the target was therefore .60, that of the distractor .40.

The sentence was presented one word at the time in succession from left to right, and remained visible on the display until the last word of the sentence had been presented. Half a second after an "end-of-sentence" signal the sentence disappeared from the display and a test word was displayed. The test word was either one of the words of the sentence previously presented or a distractor. The subject had simply to answer as fast as possible whether the word had been in the sentence or not, by pressing one of two response keys. A comprehension question followed some of the sentences, with probability of .40, to ensure that the subjects had read the sentences for comprehension.

**Results.** Figure 5 gives the latencies for the correct responses. The analysis of variance showed a significant effect of age and type of word. At both age levels the children performed significantly better with content than with function words. This difference tends to diminish with age.

The experimental words were rated by 4 judges for their "semantic richness", defined rather informally as the "amount of semantic content carried by a word in absence of contextual information" and through a series of examples. Not surprisingly, the ratings of content words were much higher than those of function words. Within the set of function words the ratings showed a large variability, with words such as *before* being rated higher in meaningfulness than words such as *although*. If we compare the average meaningfulness ratings of the 12 function words with the proportions of recall and with the average latencies in the present probe recall task, we find that the less meaningful words have elicited more errors and longer latencies. The correlation of meaningfulness and probe response times was  $-.75$ , an indication of a strong tendency to respond more slowly to less meaningful words. This holds much less for content words ( $r = -.31$ ). Unfortunately, it is very difficult to match content and function words in meaningfulness, especially if one tries to match the words for frequency. Such an attempt, moreover, has not been a guiding principle in the selection of the material in the present experiment, as the decision to carry out the analysis here described was taken only after the experiment was over.

**Discussion.** The data of the experiment have shown that content words are more available immediately after sentence presentation than are function words. Not all surface aspects of the sentence are therefore available equally well: there is a selective difference which favors content words over function words. If we look more closely at the function words used, we find that words with a richer semantic content are recalled better than syntactic function words. The data, in other words, reveal a role of both grammatical class and of semantic richness in word recall.

### Experiment 5—Word recognition in context.

The experiments reported so far have shown that in the mental lexicon of the child function words are less available than content words, and that short term availability of the latter ones immediately after sentence presentation is better than availability of function words. Both in isolation and in sentence, then, function words—and words that are less meaningful—are somewhat disfavored in children's reading behavior.

As briefly discussed in the introduction, sentence context has been found to affect differentially the recognition of easy and of difficult words (Stanovich and West, 1981). To what extent does an appropriate sentential context affect the ease of recognition of content and function words in children? To this question I addressed the present experiment. The subjects were presented with written sentences in which a word was "masked". At the end of the sentence a contextually appropriate or an inappropriate word was presented on the display and the subject's task was simply to read it as quickly as possible.

**Material, method, and subjects.** The material consisted of 32 sentences of different length. Those containing connectives were two- clause sentences, those containing prepositions could be one or two clause sentences. The target words were 4 connectives, 4 prepositions, 4 nouns, and 4 verbs. The target nouns and verbs were approximately matched in length, frequency, and word contour to the target connectives and prepositions.

The sentences were selected on the basis of ratings of about hundred sentences: a group of 6 judges rated on a 5 point scale the appropriateness of the words in the context sentences. The 16 experimental sentences were selected on the basis of high—and uniform across judges—appropriateness scores. A set of control material consisted of 16 complete sentences and the same target words bearing no relation to the sentence. Experimental and control sentences were presented in a completely random order, with some constraints to avoid presentation of the same target words within a block of 6 sentences.

The sentences were displayed by a PDP 11/20 one word at the time on a display. The words were presented from left to right at a rate of 200 msec per word and remained visible until the end of the trial. The target word was substituted by a "word" composed by a series of Xs—its length always being the same.

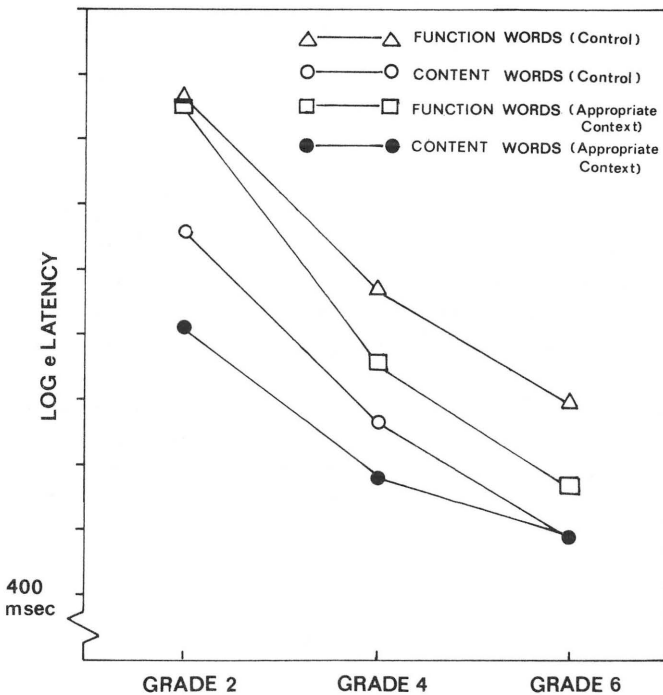
The subjects were 16, 14, and 17 children, respectively, from grades 2, 4, and 6. The subjects first read the sentence by pressing the key and obtaining in this way the succession of words on the display. They were instructed to "read" as fast as possible and to go on when the "masked" word was shown. At the end of the sentence a word was displayed next to a bar which was present during the reading phase. The subject had to read the word as fast as possible, and the latencies between onset of the word on the display and the onset of the subject's verbal response was measured through a voice operated relay and recorded by the computer. The children were re-

quested to be sure to have "ready" the whole word before starting uttering it, and received several trials of exercise, in which they were discouraged to start uttering syllables or half words or non verbal expressions which could stop the voice operated relay.

**Results.** Figure 6 shows the average latencies (for the correct naming only, the data associated with errors in reading having been discarded) for the function and for the content words with the context and without appropriate context (the control condition). The results can be summarized as follows: (a) Content words are named faster than function words: there is a clear difference in the latency of recognition of content and function words. (b) The context affects recognition of content words at a lower age and function words more at a higher age.

The latencies have been submitted to an analysis of variance with class of words, context, and age as factors. All three factors turned out to have a significant effect on speed of recognition. The interactions between age and context, and between age and class of words were both significant, and so was the interaction between age, class of words, and context.

Figure 6. Experiment 5—Word recognition in context. Average naming latencies (msec) for content and function words.



As in the previous experiment, ratings of meaningfulness have been obtained by 6 judges for the experimental words, and again the content words scored by and large higher meaningfulness ratings than function words. In an attempt to examine the effect of meaningfulness on the speed of word naming, the words of the two classes, function and content class, were given a score of 1 when above the median average rating, while a score of 0 was attributed to the words below the median rating in meaningfulness. An analysis of variance was run on the data so dichotomized, with age, content, type of class, and meaningfulness as factors in a 3 x 2 x 2 x 2 design. Meaningfulness showed some effect, but did not reach significance ( $p = .11$ ). However, the interactions of meaningfulness with class of words and with age were both significant, and so was the age by word class by meaningfulness interaction. These results, together with the single comparisons among group means performed on the basis of the results of the analysis of variance indicate that meaningfulness had affected children's performance with function words, while it did not much affect the performance with content words.

These results have to be taken with a word of caution, for the ratings have been obtained after the experiments, and the distributions of the ratings were far from satisfactory. Also, the experimental words have not been selected on the basis of meaningfulness and the words of the two classes have not been matched on this variable. However, within these limits, it seems possible to conclude that the poorer performance with function words can, at least to some extent, be related to meaningfulness and not only to grammatical class.

**Discussion.** The first important result of this experiment was the fact that at all age levels content words are named better than function words. The difference in the ease of recognition between the two classes of words decreases with age, as is shown by the significant interaction between age and word class, but is still present at the age of about 12-13 years. Content words seem more "available" for recognition than function words. A second conclusion is that this difference might be not so much a matter of grammatical class as of meaningfulness. A third intriguing finding was the differential effect of context at the different age levels for function and for content words. A prime sentence affects differentially the speed of word naming depending on age, and on word class. It seems that recognition of function words is facilitated more by context in older children than in young ones. This result can be interpreted as follows. Context can improve word recognition when the words are already somewhat available. This is the case of content words for small children, while when function words are presented there is only space for facilitation at an older age.

## General discussion.

The experiments discussed in this paper have offered some interesting information about the lexical availability and use of function words in children's reading. Connectives and prepositions take longer (and elicit more errors) in a lexical decision task than content words such as nouns or adjectives. Connectives turn out poorly also in a semantic categorization task. These results can be taken as an indication of lower accessibility of these words in the child's internal lexicon.

Even in context function words are less directly available, as revealed by a probe recognition latency experiment and by an experiment on naming of words primed by a sentence context. Short term availability of function words after sentence presentation is worse than it is the case for content words.

Another conclusion of the present study is that the lower availability of function words can, at least in part, be a matter of meaningfulness rather than of word class only. Both grammatical class and meaningfulness turned out to contribute separately to the availability of the words in the reading process. This hypothesis deserves more attention in experiments specifically designed to face this problem. At any rate, the results of the experiments reported in the present study allow the conclusion that the distinction between open and closed class is perhaps less important for a theory on lexical access than it was thought, and that meaningfulness can be an important variable in the process of word recognition.

A third contribution is the finding that context affects differentially word recognition of the two word classes under investigation at different age levels. Younger children seem capable of using contextual cues in recognizing content words, while context does not seem to facilitate function words. These receive facilitation from context only at an older age. This result can be interpreted as indicating that context facilitates word recognition when it is possible to take some advantage of it. Performance with function words at the lower age level studied is still rather poor, and the child can make very little use of the contextual information. This interpretation, if correct, has interesting practical implications for applied research on children's reading, dyslexia, and remedial procedures.

## References

- Abramovici, S. Errors in proofreading: Evidence for syntactic control of letter processing? *Memory and Cognition*, 1983, 11, 258-261.
- Bradley, D. Computational distinction of vocabulary type. Unpublished Ph. D. Dissertation. MIT, Cambridge, Mass., 1978.
- Bradley, D., and Garrett, M. Effects of vocabulary type on word recognition. Occasional paper 12. Center for Cognitive Science. MIT, Cambridge, Mass. 1980.
- Brown, R., and Bellugi, U. Three processes in the child's acquisition of syntax. *Harvard Educational Review*, 1964, 34, 133-151.
- Caplan, D. Clause boundaries and recognition latencies for words in sentences. *Perception and Psychophysics*, 1972, 12, 73-76.
- Carpenter, P.A., and Just, M.A. Reading comprehension as eyes see it. In M.A. Just and P.A. Carpenter (Eds.) *Cognitive processes in comprehension*. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.
- Clark, E.V. Non-linguistic strategies and the acquisition of word meanings. *Cognition*, 1973, 2, 161-182.
- Craik, F.I., and Lockhart, R.S. Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 1972, 11, 671-684.
- Craik, F.I., and Tulving, E. Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, 1975, 104, 268-294.
- Flores d'Arcais, G.B. The acquisition of the subordinating construction in children's language. In R.N. Campbell and P.T. Smith (Eds.), *Recent advances in the psychology of language: Language development and mother-child interaction*. New York: Plenum Press, 1978, a.
- Flores d'Arcais, G.B. Levels of semantic knowledge in children's use of connectives. In A. Sinclair, R. J. Jarvella, and W.J.M. Levelt (Eds.), *The child's conception of language*. Berlin, Heidelberg: Springer Verlag, 1978, b.
- Flores d'Arcais, G.B. The acquisition of meaning of the connectives. In W. Deutsch (Ed.), *The child's construction of language*. London: Academic Press, 1981.
- Garrett, M. Levels of processing in sentence production. In B. Butterworth (Ed.) *Language production*. Vol. 1. London: Academic Press, 1980.
- Garrett, M. Remarks on the relation between production and language comprehension systems. In M.A. Arbib, D. Caplan, and J.C. Marshall (Eds.), *Neural models of language processes*. New York: Academic Press, 1982.
- Glanzer, M. Grammatical category, rote learning and word association analysis. *Journal of Verbal Learning and Verbal Behavior*, 1962, 1, 31-41.
- Goodglass, H., Berko Gleason, J., and Hyde, M.R. Some dimensions of auditory language comprehension in aphasia. *Journal of Speech and Hearing Research*, 1971, 13, 124-135.
- Gordon, B., and Caramazza, A. Lexical decision for open and closed-class items: Failure to replicate differential frequency sensitivity. *Brain and Language*, 1982, 15, 143-160.
- Jong, S. de, *Spreektaal frequenties*. Utrecht: Oosthoek, Scheltema, and Holkema, 1979.
- Haber, R.N., and Schindler, R.M. Errors in proofreading: Evidence of syntactic control of letter processing? *Journal of Experimental Psychology: Human Perception and Performance*, 1981, 7, 573-579.
- Jarvella, R.J. Effects of syntax on running memory span for connected discourse. *Psychonomic Science*, 1970, 19, 235-236.

- Kornfeld, J.R. Clause structure and the perceptual analysis of sentences. *Quarterly Progress Report, Research Laboratory of Electronics*, MIT, 1973, 108, 277-280.
- Marshall, J.C., and Newcombe, F. Syntactic and semantic errors in paralexia. *Neuropsychologia*, 1966, 19, 169-176.
- Morton, J., and Patterson, K. 'Little words—No-'. In M. Coltheart, K. Patterson, and J.C. Marshall (Eds.), *Deep Dyslexia*. London: Routledge and Kegan Paul, 1980.
- Noble, C.E. An analysis of meaning. *Psychological Review*, 1952, 59, 421-430.
- Perfetti, C.A., Goldman, S.R., and Hogeboom, T.W. Reading skill and the identification of words in discourse context. *Memory and Cognition*, 1979, 7, 273-282.
- Rubin, D.C. 51 properties of 125 words: A unit analysis of verbal behavior. *Journal of Verbal Learning and Verbal Behavior*, 1980, 19, 736-755.
- Schvaneveld, R., Ackermann, B.P., and Semlear, T. The effect of semantic context on children's word recognition. *Child Development*, 1977, 48, 612-616.
- Smith, F. *Understanding reading*. New York: Holt, Rinehart and Winston, 1971.
- Stanovich, K.E., and West, R.F. Mechanisms of sentence effects in reading: Automatic activation and conscious attention. *Memory and Cognition*, 1979, 7, 77-85.
- Stanovich, K.E., and West, R.F. Mechanisms of sentence context effects in ongoing word recognition: Test of a two-process theory. *Journal of Experimental Psychology: Human Perception and Performance*, 1981, 7, 658-672.
- Stanovich, K.E., West, R.F., and Freeman, D.J. A longitudinal study of sentence context effects in second-grade children: Test of an interactive-compensatory model. *Journal of Experimental Child Psychology*, 1981, 32, 185-199.
- Uit den Bogaard, P.C. *Wordfrequenties*. Utrecht: Oosthoek, Scheltema and Holkema, 1973.
- Whaley, C.P. Word-Nonword classification time. *Journal of Verbal Learning and Verbal Behavior*, 1978, 17, 143-154.