883

SEMANTIC INFLUENCES ON PHONETIC IDENTIFICATION AND LEXICAL DECISION

Philip Elliot Rubin

B.A., Brandeis University, 1971
M.A., University of Connecticut, 1974

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

at

The University of Connecticut

1975

SEMANTIC INFLUENCES ON PHONETIC IDENTIFICATION AND LEXICAL DECISION

Philip Elliot Rubin, Ph.D.
The University of Connecticut, 1975

In a phoneme monitoring task it can be shown that a specified phoneme is detected faster when it begins a spoken word than when it begins a spoken nonword. This word advantage can be interpreted as due to a difference in the rate at which descriptions of words and descriptions of nonwords become available as a basis for responding. Morton's Logogen Model provides a convenient framework for viewing this result, particularly the assumption that thresholds determining output are lower for word logogens than for nonword logogens. On this assumption, attributes of a word become available more rapidly than attributes of a nonword. The word advantage for initial phoneme detection, and its account in terms of a Logogen Model, were further explored in the present experiments, with specific reference to: (1) lexical decision and (2) semantic influences on phonetic identification.

Experiment 1 addressed the thesis that the locus of the phoneme detection advantage was to be found in the assumed lower threshold for word logogens. In a lexical decision task words were identified as "words" sooner than nonwords were identified as "nonwords". This result seemed to support the assumption that readout from the logogen occurs faster for words than it does for nonwords. The question of whether or not lexical distinction exerted an obligatory influence on lower-level decisions was examined in Experiment 2. In contrast to phoneme detection it was shown that detection of sex of speaker was not influenced by the word/nonword difference.

As a way of testing the supposed lexical base for the phoneme detection advantage, two experiments were conducted which involved semantically biasing the logogen. In these experiments pairs of items of the following form were presented -- PRECURSOR-RELATED WORD, PRECURSOR-UNRELATED WORD, and PRECURSOR-NONWORD. The procedure of Experiment 3 was similar to that of the first experiment -- subjects were required to decide if the second item in a pair was or was not a word. In this lexical decision task it was found that latencies for related words were less than those for unrelated words, and these in turn were less than those for nonwords. This biasing effect was also evident in a phoneme-monitoring task with the same stimulus set (Experiment 4). The supposition that whatever determines lexical decision also determines initial phoneme detection was supported.

The fifth experiment assessed whether phoneme detection and, hence, lexical decision were reliant upon semantic processes. A procedure was introduced which attempted to manipulate the semantic biasing seen in the previous two experiments. This involved the incidental task of having subjects count the number of syllables in the precursor. The results of this final experiment showed that the difference between related and unrelated words, as seen in Experiments 3 and 4, was no longer evident. In addition, the word apprehension effect demonstrated in Experiment 1 disappeared. These results were suggestive of the notion that lexical decision is semantically based and that differences in phonetic detection latencies derive eventually from this semantic influence. Considered together, these experiments also suggest that semantic/contextual influences are not restricted to the material being processed, but rather they are reflective of the event of which an experimental procedure is a part.

ACKNOWLEDGEMENTS

I want to express my gratitude to Michael Turvey for his intense devotions of time, effort and concern in all aspects of the present research. In addition, I am indebted to him in countless other ways. The next Guinness is on me.
I wish to thank Alvin Liberman for his continued interest, assistance and, further, for the 'sense of wonder' he brings to the enterprise we are all engaged in. Philip Lieberman and Jay Keyser have both been fundamental in sparking and maintaining my interest in language; I thank them for being who they are. I would like to thank Ignatius Mattingly for reading this manuscript and for his constant support and friendship. I am also indebted to the following people: Steven Braddon, Claire Michaels and Terry Halwes -- who assisted me by reading parts of this manuscript; Tim Rand and Peter Van Gelder -- who provided me with valuable technical assistance; Robert Remez -- for his intellectual excitement and for unrelated, but intensely enjoyable, discussions of an evolving megatheory; J. Brown -- for providing a pleasant environment in which to work. The psychologists to whom I owe the greatest intellectual debt are H. Marx, Michael Turvey, Robert Shaw, N. Bernstein and James J. Gibson. I would also like to thank my parents, Rae and Sanford Rubin, for their love and continued interest. And lastly, but most importantly, I'd like to express my love and gratitude to my wife -- Joette Katz Rubin. She thinks she'll keep me.

This research was made possible in part by support from NICHD Grant HD-01994 to Haskins Laboratories and by a grant from the National Science Foundation to the Computer Center at the University of Connecticut.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

INTRODUCTION

It is commonly known that the perception of the sounds of speech is significantly influenced by the contexts in which they occur. In part, this is owing to the nature of the speech code. Research conducted by the Haskins Laboratories group (cf. Liberman, 1970; Liberman, Cooper, Shankweiler and Studdert-Kennedy, 1967) has revealed that the information needed to make decisions about selected portions of the speech signal (e.g. identifying the phoneme /b/ in /bag/) is oftentimes neither discrete nor localized to a specific portion of the signal. In the acoustic stream, speech information is structured in a highly encoded form due, in part, to the mechanical constraints of the production system.

Recent evidence points directly to the influence that contextual or higher-order structure has on making decisions about lower-level aspects of the stimulus pattern. Pisoni and Tash (1974) report that same-different reaction-time judgements to consonants and vowels in pairs of consonant-vowel utterances depend upon the information carried in the entire syllable. If in syllable pairs the portions of the signals <u>not</u> being compared were the same (e.g. if vowels were being compared, then consonants were the same), latency for the same-different judgement was significantly less than when the non-target portions of the syllable were different. A further demonstration of the influence of syllabic context on phonetic identification is that the intelligibility of vowels in a consonant environment is superior to vowels presented in isolation (Shankweiler, Strange and Verbrugge, in press).

As we might suppose, contextual determinants of the perception of speech sounds extend beyond a simple consideration of syllabic structure. For example, Lieberman (1963) and Pollack and Pickett (1963) presented to listeners words excised from sentences and found a subsequent decrement in their recognition. Furthermore, there is evidence that judgements about the rise and fall of final pitch contours in utterances are not so much dependent upon the actual physical description of contours as they are upon whether the total contour is perceived as a question or as a statement (Studdert-Kennedy and Hadding, 1973; Hadding-Koch and Studdert-Kennedy, 1964). In short, the contextual base provided by such factors as syntax, semantics, prosody, etc. plays an important part in the overall speech recognition process. For a more complete discussion of such contextual considerations see Darwin (in press).

Of course, the effect of higher-order structure on recognition of particulars of the information nested within that structure is not limited to problems in speech. Evidence from experiments in visual perception present an analagous situation. Biederman (1972) and his associates (e.g. Biederman, Glass and Stacy, 1973) have shown that the detection and/or identification of an object in a representation of a real world scene is negatively affected if the overall coherency of the scene is disturbed by cutting up the picture and reorganizing its parts, leaving intact the target object and its location. Weisstein and Harris (1974) have shown that the detection of lines of particular orientation is improved when these lines are embedded in pictorial representations of well-formed three-dimensional objects. Reducing the coherency of the context in which these lines are presented results in subsequent decrements in detectability. A further illustration is provided by Reicher (1968) and Wheeler (1970): in a forced-choice test of letter recognition, under conditions of visual masking, subjects recognize a letter more accurately in a word than in a nonword (see also Johnston and McClelland, 1974).

As previously noted, contextual influences in speech recognition have been demonstrated in a variety of different paradigms. In general, however, the problem has not been addressed of how higher-order properties (i.e. lexical, semantic) can influence the processing of lower-level particulars (i.e. acoustic, phonetic, phonological) in word recognition. The present author and his associates (Rubin, Turvey and Van Gelder, 1975) looked at the effect of manipulating lexical membership on the detection of specified phonemes appearing in initial position in spoken consonant-vowel-consonant syllables. A brief description of these experiments and their theoretical interpretation is in order, for they provide the departure point for the present series of experiments.

Rubin, et. al. (1975) employed a phoneme-monitoring task in two experiments. Participants were presented with spoken consonant-vowel-consonant syllables, both words and nonwords, with this distinction determined solely by a difference in final consonant (e.g. /bit/ versus /bip/). Their task was to press a key whenever a syllable began with a particular consonant. The first experiment used sequences of either all words or all nonwords, in which one item in a sequence began with the target consonant. In order to avoid contextual effects due to the use of homogeneous sequences (all words or all nonwords), words and nonwords were randomly intermixed within blocks in the second experiment. In both experiments it was found that consonant targets that began words were detected faster than consonant targets that began nonwords.

Most commonly, accounts of the speech recognition process (cf. Studdert-Kennedy, 1974) have been hierarchically-based, that is, the recognition process has been viewed as a mapping from less to more abstract linguistic levels, e.g. auditory, phonetic, phonological, lexical, syntactic and semantic. While a hierarchy of this sort can allow for conversation between these levels, (for example, higher-order factors may be used in correcting or determining information at the lower end), the basic order of the hierarchy is preserved.

In this view, we can interpret the word advantage effect for phoneme detection by assuming that the various linguistic levels interrelate prior to phonetic identification. On this assumption we are not surprised by lexical and other higher-order influences on phonetic identification. But if we continue to assume that the order of levels of representation in the hierarchy is maintained, and that phonetic detection occurs at a low level, then why should the registration of lower and higher level influences be necessary before a simple response, contingent upon phoneme detection, can be made? Let us put this question aside for a moment and consider one other set of relevant findings.

It has been shown that, in a latency-of-detection task, two-syllable word targets can be detected faster than one-syllable word targets. These, in turn, can be detected faster than individual phonemes (Foss and Swinney, 1973). In addition, there is evidence that certain three-word sentences can be detected faster than single words (McNeill and Lindig, 1973). Observations of this kind have motivated legitimate reservations about the relevance of the detection task to the analysis of perceptual stages. Perhaps we should be dubious about the claim that the word advantage effect for phoneme detection actually reflects perceptual processes. To the contrary, we might wish to entertain the idea that this effect and those reported by Foss and Swinney, McNeill and Lindig and others, are more accurately interpreted as manifestations of processes <u>subsequent</u> to perception.

This point of view is elegantly expressed by Foss and Swinney (1973). In accounting for their results (and the results of an experiment similar to that of McNeill and Lindig, above), they found an explanation in terms of perceptual processes to be implausible: the search for the critical element of perception in speech, they argued, is reduced to absurdity when sentences and multi-syllabic words are shown to be more easily identified than phonemes. For an alternative interpretation, they sought to distinguish between perception and identification and looked at their results as addressing the question of how, subsequent to perception, some "identification units" become accessible to consciousness more readily than others. The differential rate of entry into awareness, they argued, is determined by the size of the linguistic unit. Thus two-syllable words are detected more rapidly than single syllable words because two-syllable words, as larger units, become available to awareness at shorter delays. If the notion of "larger units" is taken literally, however, it is difficult to see how such a conception can explain the facilitatory effect of words over nonwords in the phoneme detection task. In this case the words and nonwords were both monosyllables; there was no "larger unit". Perhaps differences in latencies of availability to consciousness are determined not by "size", but by a metric of familiarity or meaning.

The word advantage effect can be seen as reflecting processes subsequent to perception which extract salient information and bring it to consciousness. A theoretical framework for this point of view can be found in Morton's (1969, 1970) Logogen Model which seeks to account for performance in a variety of word recognition tasks (e.g. the word frequency effect, the word apprehension effect) and in more complex language behavior.

The starting point for the Logogen Model is the assumption that when a response becomes available, the same final unit has operated to produce that output regardless of the source of information that led to the response. The term "logogen" refers to the supposed origin of this response. Each logogen is best described in terms of its output, which can be represented as a collection of sets of attributes of the following kind: visual, acoustic, phonological and semantic. The information of relevance to a logogen is multimodal; further, it is detected in a relatively direct fashion (cf. Morton and Broadbent, 1967). The detection of relevant attributes in the structured energy at the receptors increments a counter which has various thresholds or critical values. When critical values are reached, the logogen sends information to two locations: the Cognitive System and the Response Buffer (see Figure 1). The former is responsible for semantic and syntactic analysis, and is the source of contextually influenced inputs to the logogen; the latter, the Response Buffer, is the only means of entry into the response systems (Morton, 1970). We should remark that, for our purposes, the Response Buffer is analagous to the identification unit of Foss and Swinney (1973).

The output from the logogen to the Cognitive System predates the output from the logogen to the Response Buffer. This follows from the assumption that the critical value for a logogen's semantic output is lower than that for its phonological output. The semantic output goes to the Cognitive System for contextual (and other) elaboration, and the phonological output -- which occurs subsequent to a reciprocal interchange between the Cognitive System and the logogen -- goes to the Response Buffer. We may summarize these comments as follows: the logogen interfaces semantic and phonological information. Threshold or critical values are not constant for all logogens (e.g. it is argued that they may vary inversely with word frequency), moreover they exhibit short-term as well as long-term variation. The threshold of a logogen can be reduced temporarily by the facilitative effect of prior word presentation (Neisser, 1954) and more permanently by morphemic pretraining (Murrell and Morton, 1974).

We can now return to the word advantage effect for phoneme detection. In the Logogen Model it is explained in terms of a differential availability to consciousness of words and nonwords. The lower threshold for outputs from word logogens as compared with nonword logogens[1] will result

---

[1]We are making the assumption that both words and nonwords have logogens (cf. Norman, 1968; Meyer and Schvaneveldt, 1971).

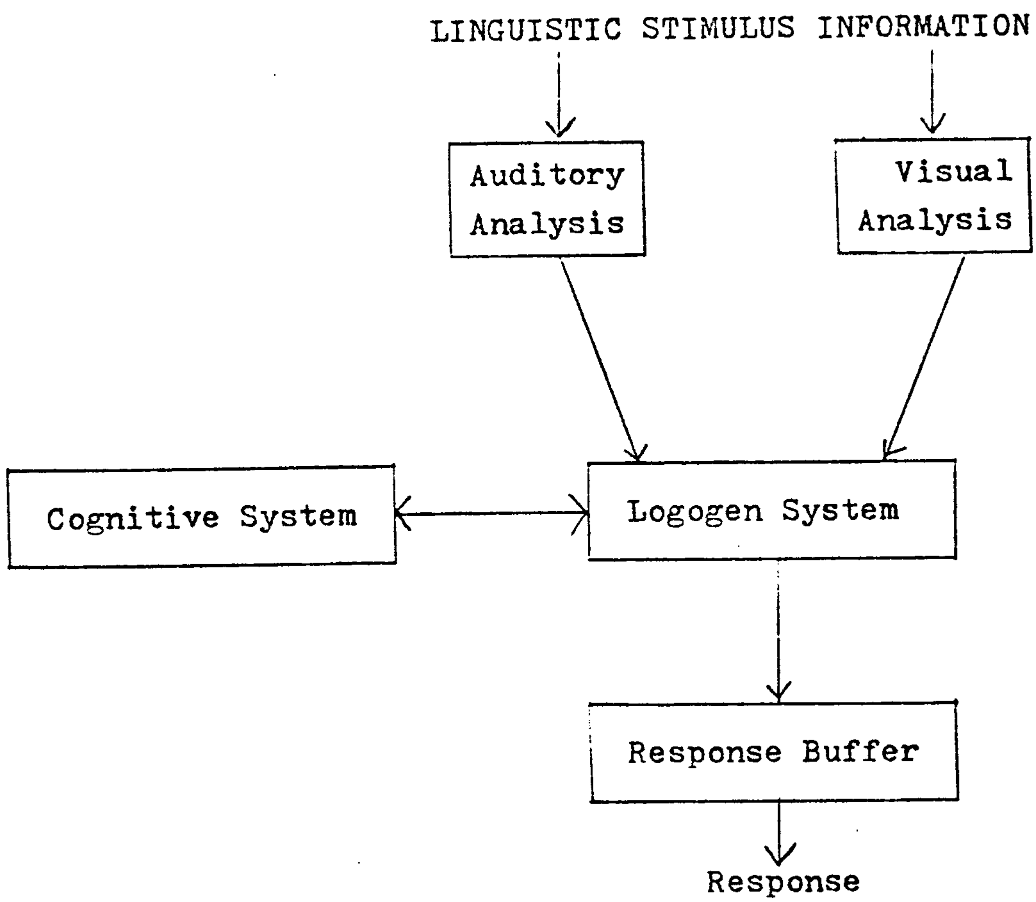

Figure 1. Flow diagram for the Logogen Model (cf. Morton, 1969, 1970).

in differences in the latencies with which sets of attributes of these items (e.g. phonetic, semantic) arrive in the response buffer. Thus, decisions about these attributes can be made sooner for words than for nonwords.

The explanatory framework provided by the Logogen Model can be an extremely powerful device for viewing problems in word recognition and, similarly, problems in other related areas -- for example, higher linguistic processes, memory, etc. It should be pointed out, however, that the language Morton uses to describe this model is metaphorical and that the system is not a rigid and final statement. One notes, for example, that it has undergone constant modification (cf. Morton and Broadbent, 1967; Morton,1964, 1969, 1970). Several aspects of the model are open to a variety of interpretations while still leaving the basic structure and utility of the system unchanged. By way of example, Posner (1972) views logogens in a more general sense as conceptual units that can be activated by many inputs whose physical characteristics can vary. He says, "These concepts serve as a means of storing the general character of past experience."

Along similar lines, the present author feels that integral concepts of the Logogen Theory -- the amodal nature of influences on the logogen, the contribution of the "Cognitive System" -- may be spoken of in another light. The logogen can be considered to be a device differentially sensitive to specifications of information provided by invariant aspects of stimulation (cf. Gibson, 1966). Moreover, logogens are not triggered solely by sensory input; they can be directly addressed by the Cognitive System (e.g. endogenous speech acts). It appears that the logogen may be profitably viewed as an instantiation of a "coalitional" system, one that abstracts particulars from information provided, in an interactive way, from a variety of sources.

In terms of a Logogen Model, the present experiments considered both lexical decision and contextual influences on phonetic and lexical decision, specifically, influences of a semantic nature.

EXPERIMENT 1

The previously demonstrated word advantage for phoneme detection was tentatively explained in terms of a model which assumes that different linguistic units become available to consciousness at different rates. Thus, in Rubin, et. al., it was hypothesized that words become consciously available more rapidly than nonwords and, in consequence, the detection latency of a phoneme in a word is less than that for a phoneme in a nonword.

Evidence exists from studies of visual word recognition that words are more easily or quickly recognized than nonwords. The interpretation of such results, however, remains a controversial point. This word apprehension effect (Neisser, 1967) has been demonstrated in a variety of ways, for example, tachistoscopic letter identification (Woodworth, 1938; Tulving and Gold, 1963), binary classification reaction time (Eichelman, 1970; Henderson, 1974), visual scanning (Krueger, 1970; Novik and Katz, 1971) and naming latencies (Cattel, 1886; Berry, 1971; Forster and Chambers, 1973). Another example is an experiment conducted by Rubenstein, Lewis and Rubenstein (1971), in which subjects were visually presented with words, and pronounceable and unpronounceable nonwords. The task involved deciding whether the item was an English word or a nonsense word. Subjects responded more rapidly to words than they did to nonwords, both pronounceable and unpronounceable.

Experiment 1 involved a somewhat analagous procedure to that of Rubenstein, Lewis and Rubenstein (1971), using spoken items. In the present experiment subjects heard consonant-vowel-consonant items and were instructed to press one of two keys if the item was a word and the other key if it was a nonword. The purpose of this experiment was to determine whether, in speech recognition, lexical decision operated in a similar fashion to phenomena described in the case of visual word recognition. Such a demonstration would provide further support for the model presented by Rubin, et. al., specifically with respect to the proposed differential rate of detection of words and nonwords. As in the cases seen in the visual experiments, it was hypothesized that identification latencies would be shorter for words than for nonwords.

Method

Subjects

The subjects were nine male and nine female undergraduates at the University of Connecticut. The subjects participated to receive experimental credit in introductory psychology.

Apparatus and stimulus materials

Each subject received three blocks of trials, where each block consisted of sixty spoken consonant-vowel-consonant syllables. Within a block there were an equal number of words and nonwords. These were then equally divided into syllables with the phoneme /b/ in initial position, syllables with /s/ in initial position, and items with various other consonants in initial position. In any word/nonword pair, the form of distinction consisted solely of a change in the final consonant (e.g. /bit/ versus /bip/). All items were randomly organized throughout a block and each block contained a different order of items. Table 1 contains selected sample syllables from a test block. Interstimulus intervals were randomly assigned durations of two, three, four or five seconds. The practice block contained eighteen items drawn from the overall stimulus set, organized in a fashion analagous to that of an actual test block. Presentation by block was either to the left ear, right ear or, in the binaural case, to both ears. A subject was presented with one of three ordered block sequences: 1. left, right, binaural; 2. right, binaural, left; 3. binaural, left, right.

The speech was recorded at a normal speaking rate by a male speaker on one channel of an Ampex AG-500 tape recorder. The speech waveform was then digitized and edited using the Haskins Laboratories PCM system (Cooper and Mattingly, 1969). In the case of syllables beginning with the phoneme /s/, onset was standardized by starting sampling 100 msec. before the start of the vowel. The digitized waveform samples were converted to analog signals and, on a Crown 800 tape recorder, were recorded on one track of a test tape. The average duration of a stimulus was 500 msec.; all word/nonword pairs were edited to the same duration. On the second track of the tape a 500 msec., 500 Hz tone appeared, coincident with the onset of each syllable.

Test tapes were presented to subjects via a Sony TC-100 tape recorder. The 500 Hz tone was used to start a timer in a Data General Nova computer which sampled the signal from track two of the presentation tape through an analog-to-digital converter. When a syllable (and its coincident tone) was presented, the real-time clock in the computer was started. The button-push of a subject stopped the clock, thus giving the reaction time of the subject. Reaction times were printed out on a teletype after each block. Reaction times greater than 1500 msec. were defined as errors in the program. The ear of presentation was controlled by feeding the channel-one output of the tape recorder through a mixer which presented the signal to either the left, right, or both speakers of two sets of Superex headphones -- one set for the subject and one set for the experimenter who monitored the experiment. The procedures outlined in this section remained the same for the entire series of experiments in this paper.

Procedure

The subjects were told that they were going to hear three blocks of trials, each block consisting of a long sequence of spoken syllables -- both nonsense words and real words -- with randomized times between stimulus presentations. Examples of test stimuli were then given. The subjects were instructed to attend to all stimuli, and to press one of two keys as rapidly as possible whenever they heard an English word and the other whenever they heard a nonsense word. The keypress procedure consisted of keeping the index finger on a start marker and moving upward and left or upward and right to the appropriate keys. The keys were labelled as "WORD" and "NONWORD". The relation between the word/nonword condition and key was counterbalanced across subjects. Further examples of test stimuli were given and trial runthroughs were conducted to familiarize subjects with the experimental task. The subjects were instructed that their performance was being monitored and that they should continue targeting even if they made an error. They then heard the practice block of eighteen items. Five seconds before each block the word "ready" (recorded on track one of the test tape) was presented, to prepare the subjects for the start of the block. Before the start of each block subjects were informed of the ear of presentation and were again cautioned to wait for the "ready" signal and encouraged to press the appropriate key as fast as possible on hearing the target items. Between each block the subjects were given a two minute rest period. During this period the reaction times of the subject for the previous block were typed out and a partial data analysis was performed by the computer. Upon completion of the final block, reaction times were again typed out and the computer completed a further overall analysis.

Results

Median reaction times for each subject were used in this and all other experiments to negate the effect of extreme

Table 1

Experiment 1: Sample Test Syllables

BAT	TIG	SIP	BIP
BUN	BAP	CAT	SIT
SIG	SAT	BED	BAG
TIN	BEP	SIJ	BET

Table 2

Experiment 1

Means of Subjects' Median Reaction Times in Msec.

		Phoneme in Initial Position			
		/b/		other	
		Word	Nonword	Word	Nonword
Ear of presentation	Left	812	932	931	977
	Right	821	964	918	998
	Binaural	835	943	925	993
	Overall	823	946	925	989

scores common to reaction time procedures. The means of the median reaction times across subjects for all conditions are presented in Table 2. The inflated nature of these scores reflects the timing procedure, in which the start pulse was coincident with the onset of an item. Analysis of the data consisted of a consideration of all stimuli and a separate treatment of those items beginning with the phoneme /b/. The reasons for this separate treatment were (1) the /b/ items represented the controlled set of syllables used in Rubin, et. al. (1975); (2) due to the sampling rate of the PCM system, there was a decrement in intelligibility of particular initial consonants (e.g., /s/, /f/, /v/) which could result in difficulties in making lexical decisions.

A repeated measures analysis of variance was performed on the overall data. The word versus nonword difference was significant, with subjects responding more quickly to words ($\bar{X}$ = 874 msec.); (nonwords -- $\bar{X}$ = 968 msec.), $F(1,17) = 67.02$, $p < .001$. Subjects also responded significantly faster if the item, word or nonword, began with the phoneme /b/ ($\bar{X}$ = 885 msec.) than they did if the item began with other phonemes ($\bar{X}$ = 957 msec.), $F(1,17) = 48.27$, $p < .001$. This stemmed from difficulties in judgement of various non-/b/ items (see above). The only other effect to attain statistical significance was the word/nonword difference by initial phoneme interaction, $F(1,17) = 30.17$, $p < .001$. The effect of ear of presentation -- left, right or binaural -- was not significant, $F(2,34) = 2.93$, $p > .4$. The overall error rate was 9.2%. An analysis of variance for errors in this overall treatment revealed that subjects made significantly more error for nonwords (66%) than they did for words (34%), $F(1,17) = 88$, $p < .001$. The initial phoneme by word/nonword interaction also was statistically significant, $F(1,17) = 43.04$, $p < .001$.

The separate analysis for stimuli beginning with the phoneme /b/ yielded a similar picture to that of the overall analysis (see Table 2). In a repeated measures analysis of variance, the only main effect to attain statistical significance was that of the word/nonword distinction, words ($\bar{X}$ = 823 msec.) being responded to faster than nonwords ($\bar{X}$ = 946 msec.), $F(1,17) = 72.41$, $p < .001$. An analysis of variance of subjects' errors for this condition also reflected the increased facility of subjects in dealing with words as compared with nonwords, $F(1,17) = 127.38$, $p < .001$.

Both considerations of the data clearly demonstrate a superiority for words over nonwords in making judgements about lexicality. As was assumed, overall responding was more rapid when test syllables began with the phoneme /b/ than it was when syllables began with other phonemes. This was due to intelligibility difficulties with /s/ items, which comprised one third of the stimulus set. The decision to extend the analysis of responses to target syllables beyond the stimulus set of Rubin, et. al. represented an attempt to retain the use of the original stimulus set while also exploring the possible generality of the present procedure. Although the results for syllables with /b/ in initial position present a cleaner picture of the advantage accruing to words in such a paradigm, the results with other phonemes as the initial item also serve as support for this notion.

Discussion

As we have remarked, the critical values of logogens reflect linguistic usage: the logogens for more frequent words have lower critical values. Similarly, in the case of words and nonwords, the model would predict a lower critical value, in general, for words than for nonwords. Evidence from naming studies (e.g. Berry, 1971; Forster and Chambers, 1973) provides support for such a notion. Forster and Chambers (1973), for example, showed that in a task involving pronunciation of visually presented words, naming times for words were shorter than for nonwords and, moreover, the naming times for high frequency words were shorter than for low frequency words. These results are consonant with the predictions of the Logogen Model.

Experiment 1 is further evidence for a conception which stresses that rate of accessibility for future processing is dependent upon lexical status. The interpretation proposed by Rubin, et. al. (1975) for the word advantage effect for phoneme detection relied upon words becoming accessible for analysis or decomposition sooner than nonwords. The present experiment provides some support for this notion of a differential rate of accessibility.

EXPERIMENT 2

The principle idea expressed thus far is this: in terms of the Logogen Model, a description of a word becomes available to the Response Buffer sooner than a description of a nonword, and this difference is responsible for differences in phoneme detection latencies (Rubin, et. al., 1975). Suppose now that a subject was requested to monitor for some other characteristic of an utterance, say, the pitch which identifies whether the speaker is male or female. Would we expect to find a similar result, namely, that latency of pitch detection was determined by the lexical status of the utterance.

Intuitively, a phoneme is a more integral component of a speech utterance than the pitch contour. We may say of the phoneme that it is (by virtue of coarticulation) _nested_ in the speech utterance; of the pitch contour it would be perhaps more appropriate to say that it is _carried_ by the utterance. The distinction we draw here parallels Garner's (1970, 1974) distinction between integral and separable dimensions, a distinction which supposedly has implications for information processing.

Consider this distinction from the point of view of the logogen concept. As a detection device, the logogen is sensitive to phonemic attributes for they are integral to lexical identification, but it ought to be indifferent to pitch contour. Thus the word advantage effect found for phoneme detection ought not to be found for pitch detection. We should remark, however, that in vision there is evidence that linguistic variables affect non-linguistic, physical judgements (Eichelman, 1970; Henderson, 1974).

Method

Subjects

The subjects were eleven female and seven male undergraduates at the University of Connecticut. The subjects participated to receive experimental credit in introductory psychology.

Stimulus Materials

Each subject heard three blocks of trials, where a block consisted of eighty spoken consonant-vowel-consonant syllables. Within a block there were an equal number of syllables spoken by a female speaker and a male speaker. There were an equal number of word and nonword syllables. To ensure ease of onset timing, all syllables began with one of four possible, equally occurring, stop consonants (/b/, /p/, /t/ or /d/). The medial vowels follwoing all initial consonants were equally occurring members of the set, /ih/, /ae/, /eh/, /oh/ and /oo/. The form of distinction of any word/nonword pair consisted of a change in the final consonant (e.g. /pit/ versus /pib/). All items, both male and female produced, were randomly organized throughout a block and each block consisted of a different order of items. Interstimulus intervals were a random ordering of two, three, four or five seconds. Table 3 presents a sample partial test sequence. The practice block contained sixteen items drawn from the overall stimulus set, organized in a fashion analagous to that of an actual test block. Block presentation remained the same as outlined in the Methods section of Experiment 1.

Procedure

The general procedure outlined in Experiment 1 also was used in this experiment, with the following exception. After an explanation of the stimulus materials, subjects were instructed to press one of two marked keys whenever they heard any utterance, word or nonword, produced by a female speaker. The other key was to be pressed for a male speaker.

Results

Table 4 shows the means of subjects' median reaction times for all conditions. A repeated measures analysis of variance revealed no significant main effects and no significant interactions. There were slight tendencies for subjects to respond more rapidly in the case of binaural presentation and also in the case of a female as opposed to a male speaker.

Discussion

Examination of the data in Table 4 shows that latencies for decisions on the speaker's sex ranged between 634 and 646 msec., on the average. These data indicate that the decision process had been terminated prior to hearing complete utterances. The subjects seemed to be responding on the basis of gross acoustic differences, most probably on the basis of the differences in fundamental frequencies between the female and male speakers. Other such aspects of the signal may also have been implicated as the basis for responding. It was clear, then, that semantic constraints could not be operating, for in this experiment what differentiated a lexical item from a non-lexical item was the final consonant.

In the initial-phoneme monitoring task (see Rubin, et. al., 1975) targeting for the specified phoneme involves extracting significant linguistic information from the signal. As we have remarked, such a process seems to be dependent upon the relation between the utterance and its constituent elements. In the present experiment, however, the information needed to make a fundamental frequency decision does not seem to relate in similar fashion to the utterance. In Garner's (1970, 1974) terms the lexicality of the utterance and its pitch contour are separable dimensions.

Table 3

Experiment 2: Sample Selection of a Test Sequence*

PIN (M)	TIB (F)	BEP (F)	DOT (M)
BIM (M)	TAT (F)	PEM (M)	BUG (F)
DUP (F)	TAG (F)	BUL (M)	PIB (F)

* F -- female speaker; M -- male speaker

Table 4

Experiment 2
Means of Subjects' Median Reaction Times in Msec.

		Speaker			
		Female		Male	
		Word	Nonword	Word	Nonword
Ear of presentation	Left	634	642	667	656
	Right	645	636	633	649
	Binaural	624	625	637	629
	Overall	635	634	646	644

EXPERIMENT 3

Earlier we remarked upon the relation between the Logogen and Cognitive Systems. In the experiments that follow our attention is focused on this relation, in particular how it might affect lexical decision and, in consequence, phoneme monitoring.

Consider the following task. Suppose that one hears a word and shortly thereafter hears a second word that is or is not semantically associated with the first. And suppose further that one must decide as swiftly as possible whether the second utterance is indeed an English word. Will this lexical decision be affected by the semantic relation between the two successive items? Situations similar, though not identical, to the one described have been examined in vision. From that source the answer to our question appears to be "yes" (Meyer and Schvaneveldt, 1971; Meyer, Schvaneveldt and Ruddy, 1972).

In terms of the Logogen Model we can assume that within the Logogen System, logogens are "spatially" proximate to the degree that they are semantically associated. Consequently, causing one logogen to be "excited" by the occurrence of the appropriate utterance causes the thresholds of other, neighboring logogens to be lowered. A conception of this kind, referred to by Meyer and his colleagues as a "spread of excitation" (Meyer and Schvaneveldt, 1971; Meyer, et. al., 1972), would predict that a word/nonword decision on the second item of a pair would be facilitated by a prefacing semantic associate. An alternative view, however, puts the location of this effect not in the logogen system _per se_, but in its semantic interaction with the Cognitive System. We speak to this second alternative in Experiment 5. For the present, Experiment 3 is directed toward assessing whether a precursor item can affect lexical decision in a listening task. That is to say, it asks whether lexical decisions on spoken words preceded by semantic relatives are different in latency from lexical decisions on spoken words that are not so prefaced.

Method

Subjects

The subjects were seven female and nine male undergraduates at the University of Connecticut. The subjects participated to receive experimental credit in introductory psychology.

Stimulus Materials

Each subject heard two blocks of trials, where each block consisted of 93 word-syllable pairs. The first item in any pair was an English word of one or more syllables (e.g. ANIMAL, PLANT, VEGETABLE, SIZE). The second item in a pair was a consonant-vowel-consonant monosyllable, either a nonsense word or a real word. All monosyllables began with one of the following stop consonants: /b/, /d/, /g/, /k/, /p/ or /t/. These syllables could either be related to the first word in the pair (the precursor), be unrelated to the precursor, but still a real word, or be a nonword. For any precursor, there appeared somewhere in the block three pairs of the following form: PRECURSOR-RELATED WORD, PRECURSOR-UNRELATED WORD, PRECURSOR-NONWORD. Related, unrelated and nonwords connected with a specific precursor differed only in a change in the final consonant (e.g. VEHICLE-BUS, related; VEHICLE-BUT, unrelated; VEHICLE-BUP, nonword). In a block there were seventeen different precursors, with some of these words being used for more than one second-item triad. The structure of a PRECURSOR-RELATED pair was based on category inclusion (VEHICLE-BUS, ANIMAL-CAT, etc.).

A block, then, consisted of a random ordering of 31 PRECURSOR-RELATED WORD pairs, 31 PRECURSOR-UNRELATED WORD pairs and 31 PRECURSOR-NONWORD pairs. Table 5 presents a sample portion of the test sequence. The time occurring between the end of the precursor and the following syllable could be either one, two or three seconds. Between all pairs there occurred a five second period of silence. The duration of monosyllables following the precursor was approximately 350 msec. Due to the lack of significant ear effects in either of the previous experiments, it was decided to restrict all stimulus presentation to the binaural condition. The two blocks, then, consisted of different random orderings of the stimulus pairs. Block order was counterbalanced across subjects. The practice block contained twelve PRECURSOR-SYLLABLE pairs drawn from the overall stimulus set. Timing was controlled by a tone coincident with the onset of the second item in all pairs (see Experiment 1).

Procedure

Subjects were told that they were going to hear pairs of items, with the first item in a pair being an English word and the second item in a pair being a monosyllable -- either a real word or a nonword. Examples of items and pairs of items were then given. Subjects were instructed to listen to all pairs and, as quickly as possible upon hearing the second item in a pair, press one of two keys if the item they heard was either a real word or a nonsense word. The key-press arrangement remained the same as that in Experiment 1. Examples of this procedure were given and the previous instructions were repeated until the subject was completely familiar with the experimental task. Subjects then received a practice block of trials and the two test blocks. Between blocks there was a two minute rest period.

Results

Table 6 presents a summary, for all conditions, of the means of subjects' median reaction times. A repeated measures analysis of variance showed that all effects were significant. The effect of relationship of precursor to following syllable was significant, $F(2,30) = 74.21$, $p < .001$. Across blocks, subjects responded fastest to words related to the precursor ($\bar{X} = 890$ msec.), next fastest to words unrelated to the precursor ($\bar{X} = 1038$ msec.) and slowest to nonwords ($\bar{X} = 1119$ msec.). Scheffe' multiple comparisons revealed that the difference between related words and the other syllable types was significant at the .999 confidence level and that the difference between unrelated words and nonwords was significant at the .95 confidence level. The order of block presentation was significant, $F(1,15) = 25.98$, $p < .001$, with subjects' latencies being longer for the block presented first ($\bar{X} = 1078$ msec.) than for the block presented second ($\bar{X} = 953$ msec.). The interaction of order of block presentation and syllable relation to precursor was also marginally significant, $F(2,30) = 3.76$, $p < .05$.

The results for the first block presented mirrored the overall effect: related words were responded to more rapidly than unrelated words, and unrelated words were responded to more rapidly than nonwords. However, this advantage for related words ($\bar{X} = 951$ msec.) is much clearer than the difference between unrelated words ($\bar{X} = 1121$ msec.) and nonwords ($\bar{X} = 1162$ msec.). In the case of the second block presented, as overall latency decreased there was a clearer stratification of the groups, once again displaying the overall effect, with related words ($\bar{X} = 829$ msec.) being faster than unrelated words ($\bar{X} = 954$ msec.), and nonwords being responded to slowest ($\bar{X} = 1076$ msec.). A consideration of the data reflects the tendency for stratification by relation to precursor to become more apparent as subjects gain experience with the particular task and stimuli.

Table 5

Experiment 3

Sample Portion of a Test Sequence

PRECURSOR	--	SYLLABLE	CONDITION
ANIMAL	--	PIB	NONWORD
WEAPON	--	GUT	UNRELATED
ANIMAL	--	PIG	RELATED
METAL	--	TIN	RELATED
METAL	--	TIP	UNRELATED
WEAPON	--	GUN	RELATED
METAL	--	TIG	NONWORD
ANIMAL	--	PIN	UNRELATED

Table 6

Experiment 3

Means of Subjects' Median Reaction Times in Msec.

		Relation to Precursor		
		Related	Unrelated	Nonword
Presentation Order	First Block	951	1121	1162
	Second Block	829	954	1076
	Overall	890	1038	1119

The overall error rate was 8.6%. In an analysis of variance of these error results the only significant effect was that of syllable relation to the precursor, $F(2,30) = 3.63$, $p < .05$. These results presented a picture analagous to that of the overall analysis -- subjects made the least errors in the case of related words (20%), more errors in the case of unrelated words (36%) and the most errors in the case of nonwords (44%).

Discussion

The result of this experiment is singularly straightforward: lexical decision is biasable by manipulating the associative semantic relation between the precursor and the target item. The word apprehension effect seen in Experiment 1 is still evident in the present experiment. Words, both related and unrelated to the precursor, are identified more rapidly than nonwords. A more significant observation, however, is that the decision that a word is a word takes the least time to make if there is an associative semantic relation between the particular word and the word that precedes it.

The results of the present experiment corroborate those of Meyer and Schvaneveldt (1971) and Meyer, et. al. (1972). It should be pointed out that aside from the difference in mode of presentation, the present experiment differed in one other significant way from those of Meyer. For Meyer, subjects were required to respond overtly to both items in a pair. By way of contrast, subjects in the present experiment were instructed to respond only to the second item of a pair. The expectation was that the precursor would extend its influence in a tacit manner; apparently, such an effect did occur.

In the Meyer experiments the associative semantic relationship was spoken of as facilitatory: the latencies for the lexical decision task were lessened if the pair was semantically related. In the present experiment, however, it is unclear whether the nature of this effect is facilitatory or interfering. A comparison of the results for words in Table 2 and for related words in Table 5 shows that the latencies for related words are no less (and perhaps are even greater) than those for the case of simple lexical decision. The data, however, do not speak directly to this issue, for a direct comparison between these two experiments would call for a within-subjects design. This issue, however, is not central to the concern at hand which is whether or not the lexical decision task can be biased by semantic information. This influence has been demonstrated in the present experiment. The significance of this demonstration to our quest for an understanding of the word advantage effect in phoneme detection will become evident in the next experiment.

EXPERIMENT 4

The fourth experiment pulls together three sets of experimental results and their allied interpretations. First, we recall the finding of Rubin, et. al. (1975) that a specified phoneme can be more rapidly detected when it begins a word than when it begins a nonword. The proposed interpretation of this result focused on the idea that logogen thresholds for words and nonwords differ; the thresholds of the former are lower than those of the latter. In consequence, descriptions of words become available to the Response Buffer, i.e. become identification units (Foss and Swinney, 1973), in less time than descriptions of nonwords. The upshot of all this is that fragmenting a word into its constituent phonemes can begin that much sooner -- hence the advantage of words in initial phoneme detection.

Experiment 1 provided some measure of support for this interpretation: lexical decisions were shown to be faster for spoken words than spoken nonwords. But Experiment 3 revealed that the latency of lexical decision is modifiable. If we are correct in our assumption that phoneme detection differences are tied to differences between the thresholds of word and nonword logogens, and if the lexical decision task reflects this threshold differential, then any modifications in lexical decision should be paralleled by modifications in initial phoneme detection. Experiment 4 tests this assertion.

Method

Subjects

The subjects were eleven female and eleven male undergraduates at the University of Connecticut. Subjects participated to receive experimental credit in introductory psychology.

Stimulus materials

The subjects received two blocks of trials, both blocks consisting of 120 word-syllable pairs. Pairs were created in the manner described in Experiment 3. In the present experiment, however, there were two major differences. First, all precursor words (e.g. ANIMAL, VEHICLE) had at least two different groups of monosyllables associated with them. The difference between these groups was based on a change in initial consonant. For example, in the case of related items, a precursor like VEHICLE might be followed by either BUS or CAR. This technique ensured that subjects would not have absolute knowledge about the initial consonant of a syllable following a precursor. The second major difference was that only those syllables beginning with the phoneme /b/ were considered to be target items. There was a total of 48 pairs of PRECURSOR-SYLLABLE items where the syllable had /b/ as the initial phoneme. These were equally divided into sixteen RELATED pairs, sixteen UNRELATED pairs and sixteen NONWORD pairs. The distinction between a word related to the precursor, a word unrelated to the precursor, and a nonword was based on a change in the final consonant. Table 7 presents a sample test sequence. On track two of the test tape, coincident with the onset of the phoneme /b/ in a SYLLABLE item, appeared the timer start tone. In all other ways the stimulus materials resembled those described in Experiment 3.

Procedure

Subject instructions remained the same as outlined in Experiment 3, with the following exception. The subjects were instructed to press a key as fast as possible whenever the second item of a stimulus pair began with the sound /b/, be it word or nonword. Examples and short trials of this procedure were then given. The keypress arrangement consisted of a single telegraph key and an orienting start marker, on which the subject's index finger was placed at all times, except when responding.

Results

A summary of the data for all conditions is presented in Table 8. In a repeated measures analysis of variance the only effect to attain statistical significance was that of syllable relation to the precursor, $F(2,38) = 10.94$, $p < .001$. Subjects targeted for the phoneme /b/ in the initial position of a consonant-vowel-consonant syllable most rapidly when that syllable was related to the preceding word ($\bar{X} = 614$ msec.). They were slower in the case of both words unrelated to the precursor and nonwords, with unrelated words ($\bar{X} = 652$ msec.) being responded to slightly faster than nonwords ($\bar{X} = 660$ msec.). The use of Scheffe' multiple comparisons revealed that the related words were responded to significantly faster than unrelated words and nonwords at the .99 confidence level. The difference between unrelated words and nonwords, however, was not significant.

A separate repeated measures analysis of variance was carried out for each order of block presentation. The overall effect for syllable relation to precursor was significant in the first block, $F(2,38) = 7.84$, $p < .005$. This main effect was also significant in an analysis of the data for the second block presented to subjects, $F(2,38) = 5.74$, $p < .01$. An examination of Table 8 shows that the results for the first block are similar to those for the overall effect, with related words ($\bar{X} = 612$ msec.) being faster than unrelated words ($\bar{X} = 664$ msec.) and nonwords ($\bar{X} = 656$ msec.). The difference in unrelated and nonwords for the first block was small. In the second block, however, as subjects had increased exposure to the stimulus materials, the data seem to reflect the stratification seen in Experiment 3. Related words ($\bar{X} = 615$ msec.) are faster than unrelated words ($\bar{X} = 640$ msec.), which in turn are faster than nonwords ($\bar{X} = 664$ msec.). The difference between related words and unrelated words, and the difference between unrelated words and nonwords were almost equal, in both cases being approximately 25 msec.

Table 7

Experiments 4,5

Sample Portion of a Test Sequence*

PRECURSOR	--	SYLLABLE	CONDITION
VEHICLE	--	<u>BUS</u>	RELATED
ANIMAL	--	PIB	NONWORD
WEAPON	--	GUT	UNRELATED
VEHICLE	--	CAR	RELATED
VEHICLE	--	<u>BUP</u>	NONWORD
METAL	--	TIG	NONWORD
VEHICLE	--	<u>BUT</u>	UNRELATED
ANIMAL	--	PIG	RELATED

*Underlined syllables are target items

Table 8

Experiment 4

Means of Subjects' Median Reaction Times in Msec.

		Relation to Precursor		
		Related	Unrelated	Nonword
Presentation Order	First Block	612	664	656
	Second Block	615	640	664
	Overall	614	652	660

An analysis of variance of error data once again presented an analagous picture to that of the analysis of the reaction time data. The overall error rate was 6.5%. The only significant effect was that of syllable type, $F(2,38) = 6.76$, $p < .005$. Fewer errors were made for related words (20%) than for unrelated words (32%). The most errors were made in the case of nonwords (48%).

Discussion

To begin with, the results of this experiment replicate the observation that a specified phoneme is detected faster when it begins a word than when it begins a nonword. Secondly, and for our present purposes more importantly, a manipulation which we have shown to affect lexical decision (Experiment 3) is shown here to affect phoneme detection in very much the same way.

Initial phoneme detection was most rapid when the word carrying the target phoneme semantically related to its precursor; yet, the overall latency for initial phoneme detection in unrelated word pairs was only slightly better than that for nonwords. With increased exposure to the stimulus materials, as witnessed in the final block of presentation, the pattern of latencies did tend to relate more closely to that of the previous experiment; that is, targets in related words were responded to faster than those in unrelated words, and these in turn were responded to faster than targets in nonwords.

In sum, Experiment 4 provides confirmation for our belief that the word advantage for phoneme detection is (in somewhat jaded jargon) a <u>spin-off</u> of lexical decision.

EXPERIMENT 5

Let us return now to the explanation of the biasing effect demonstrated in Experiments 3 and 4. In its most simplistic form the problem to be explained is this: How is a word logogen affected by the preceding occurrence of a word to which it is semantically associated? It is evident that in the language of the Logogen Model the nature of the effect of one word upon another must be in terms of a modulation of logogen threshold. In the "spread of excitation" conception described above, a change in threshold of one logogen induces a similar, if less pronounced, change in its topological neighbors. An interpretation of this kind, which suggests a relatively direct effect of logogens upon each other, essentially rules out any involvement of the Cognitive System. It is perhaps for this reason that Meyer and Schvaneveldt (1971) could conclude that the biasing effect in lexical decision was not owing to semantic factors.

Nevertheless, as we understand Morton's (1969, 1970) description of the Logogen Model, it seems that the biasing effect ought to have its locus in the Cognitive System. It is this system which mediates contextual effects, and the biasing phenomenon may be regarded as a limiting instantiation of such effects. In short, in this latter view, the effect of one logogen upon another is relatively indirect.

How might we, therefore, adjudicate between the two views? Suppose that on hearing the first member of a pair of successively presented words one had to determine how many syllables it was composed of. In free recall experiments (e.g. Hyde and Jenkins, 1969, 1973) performing a task such as this on lists of to-be-remembered words significantly impairs subsequent recall. The interpretation was that the incidental task inhibited a full semantic registration of the presented words.

In the present context, let us take this to mean that in order to perform an incidental task such as syllable counting one does not have to exploit the Cognitive System to its fullest. We do not wish to identify what this means precisely, we only wish to hypotehsize that such a curtailment occurs. Now consider the syllable counting task from the point of view of the Logogen System. In order for a description that is appropriate to the response of syllable counting to be entered into the response buffer, the appropriate logogen must be sufficiently activated, which means, of course, that it can induce a threshold change in its neighbors. In short, any interpretation of the biasing effect which places the locus of the effect in the Logogen System ought to predict that biasing of lexical decision will still occur when the response to the first member of a pair is syllable counting. The fifth experiment tests this prediction.

Method

Subjects

The subjects were nine male and three female undergraduates at the University of Connecticut. Subjects received three dollars for one experimental session.

Stimulus Materials

The stimulus materials for this experiment differed from those of Experiment 4 only in terms of timing of stimulus presentation. Syllables making up a pair were separated by two second intervals. The time between any two pairs of items in a block was three seconds. This change in timing was made to ensure that subjects would not have difficulty with the response task discussed below.

Procedure

As in the previous experiment, subjects were told that they were going to hear pairs of items and the nature of these items was explained to them. In the present experiment subjects, upon hearing the first item in a pair, were additionally required to make a judgement about the number of syllables in this word, precisely, whether it contained one syllable or more than one syllable. Subjects received a scoring sheet on which they were to check the appropriate number of syllables (e.g. ____/____ one more). The rest of the procedure remained the same as that of Experiment 4, including the phoneme monitoring task on the second item in a pair.

Results

Table 9 contains a summary of the means of the subjects' median reaction times for all conditions. A repeated measures analysis of variance revealed that statistical significance was reached in the case of both the syllable effect (related/unrelated/nonword), $F(2,22) = 6.23$, $p < .01$, and the order of block presentation, $F(1,11) = 10.84$, $p < .01$. The overall means show that subjects responded with similar latencies to related words ($\bar{X} = 536$ msec.) and nonwords ($\bar{X} = 538$ msec.), while the latency to unrelated words was longer ($\bar{X} = 568$ msec.). A Scheffe' multiple comparison showed no significant difference between the effect of unrelated items and the combined effect of related words and nonwords. The significant effect of block presentation order reflected an overall decreased latency across all conditions with increased exposure to the stimulus materials. The syllable by block interaction was not significant, $F(2,22) = 2.43$, $p > .2$. There was a tendency for the subjects to show less difference between groups with increased exposure to the stimulus materials.

An examination of the reaction times presented in Table 9 shows that the difference of unrelated items from the other

Table 9

Experiment 5

Means of Subjects' Median Reaction Times in Msec.

		Relation to Precursor		
		Related	Unrelated	Nonword
Presentation Order	First Block	557	607	560
	Second Block	515	529	515
	Overall	536	568	538

groups is less apparent in the second block of presentation. Separate repeated measures analyses of variance were conducted for these blocks of presentation. There was a significant effect of syllable relation to precursor for the first block presented to subjects, $F(2,22) = 6.36$, $p < .025$. A Scheffe' multiple comparison test revealed that, at the .99 confidence level, the latency for unrelated items ($\bar{X} = 607$ msec.) was significantly greater than those for the combined effect of related words ($\bar{X} = 557$ msec.) and nonwords ($\bar{X} = 560$ msec.). The analysis of variance for the second block presented (see Table 9) revealed no significant differences, $F(2,22) = 1.07$, $p > .25$. The difference between groups in the overall analysis was due, in the main, to the effect of the unrelated words in the first block of stimulus presentation.

The overall error rate was 4.5%. The data base in this case was not sufficient for a further analysis.

Discussion

We have shown in Experiments 3 and 4, respectively, that when a word is preceded by a semantic associate, both lexical decision and initial phoneme detection are faster in comparison to the case in which the preceding word is a nonassociate. In Experiment 5 we modified the biasing technique: the number of syllables in the first word of the pair had to be counted. This modification not only eliminated the initial-phoneme detection difference for the related/unrelated word-pair contrast, but also eliminated the detection difference in the word/nonword contrast.

On our interpretation of the Logogen Model we had thought that the syllable-counting manipulation might eliminate the biasing effect, i.e., the related/unrelated word-pair difference. It is not so apparent, however, why the word/nonword difference should be similarly affected. One possibility is that lexical distinctions are, in the final analysis, truly semantic distinctions. Although this proposition is only speculative, it would provide an explanation for the loss of the word apprehension effect.

CONCLUSION

The phenomenon that motivated the present research was that initial consonants could be detected more rapidly when they began spoken words than when they began spoken nonwords (Rubin, Turvey and Van Gelder, 1975). This phenomenon could be seen as expressive of the dynamics of a perceptual hierarchy. Preference, however, was given to the following, alternative point of view. It is possible that such latency-of-detection tasks do not speak directly to perceptual stages, rather they are indicative of processes of identification subsequent to perception. In this view, latencies of detection derive from operations that carry identification units into awareness at different rates (Foss and Swinney, 1973). The Logogen Model (Morton, 1969, 1970) provides a useful way of accounting for this differential rate of accessibility to consciousness. Central to this model is the assumption that semantic output becomes available for response (i.e. becomes an identification unit) sooner than lower-level forms of information, such as a phonological description. The present series of experiments focused on (1) lexical decision and (2) semantic influences on phonetic identification and lexical decision, both in terms of the Logogen Model. Let us now summarize our results in terms of these classes of interpretation.

Experiment 1 replicates a phenomenon most often demonstrated in vision -- the word apprehension effect. Subjects, upon hearing an item, classified words as "words" faster than they classified nonwords as "nonwords". Consistent with a Logogen Model, this result falls into line with the interpretation of the phoneme monitoring result of Rubin, et. al. (1975). That is, the basis for the word advantage in initial phoneme detection is exploitative of the advantage seen in lexical decision -- words enter awareness more rapidly than nonwords. We should ask, however, whether it is the case that the advantage afforded by lexical/semantic information is determinate in all considerations?

Experiment 2 undertook to examine the question of whether lexical/semantic structure must operate in an obligatory fashion on all low-level decisions. In this speaker-sex judgement procedure it was expected that the word advantage would carry through to the lower-level decision about the signal's fundamental frequency. The ease with which subjects made this decision, however, removed the influence of the lexical/semantic structure: subjects responded before the end of syllables and, thus, before the items were marked as words or nonwords. In order for higher-order factors to be influential, their structure over time must be apparent to the subject, even if only at a tacit level. Thus, it would be expected that in the phoneme-monitoring task the advantage for lexicality would be lost with slowed articulation, multisyllabic items, or artificially increased times of presentation. In these cases the phonetic decision could be made prior to receiving the overall structure. For example, it is intuitively clear that if a subject must target for an initial consonant (e.g. /b/) in a multi-syllabic word (e.g. BAPTIST, BALUSTRADE) spoken at a moderate rate, this process would occur before the end of a word is reached.

These considerations suggest that the process of word recognition involves a form of parallel processing (cf. Novik, 1974; Henderson, 1974). Where subjects are required to make phonetic decisions, both semantic and phonetic representations are being determined in parallel. In terms of the Logogen Model, the output for response will depend on which critical value has been reached first. In general, it appears that semantic descriptions have a lower threshold for output and, in that sense, can be said to have primary influence. Thus, in the case of targeting for a phoneme in a word, semantic factors will override phonetic and other 'lower-level' decisions unless the 'lower-level' information is available as output before the semantic influence can be registered. We have argued that an effect of the latter kind can be seen to be operating in Experiment 2.

The word advantage effect, in terms of the Logogen Model, is due to pigeon-holing (Broadbent, 1971) -- a difference in criterion for response -- as a function of linguistic usage. (We recall the hypothesis that high frequency words have lower thresholds than low frequency words.) Experiments 3, 4 and 5 attempt to show that effects due to this lexically-based difference are biasable, precisely, through semantic manipulations. Indeed, a bias of this kind is predicted by the Logogen Model (Morton, 1970): the Cognitive System modulates logogen thresholds.

The maleability of logogen thresholds is the topic of a recent paper by Murrell and Morton (1974) in which they argue that the threshold of a logogen can be biased by recognition and production, and in which they proceed to demonstrate that a biasing of logogen criteria can occur through morphemic pretraining. In a similar vein Experiments 3 and 4 of the present paper sought to tacitly bias the logogen system through a semantic prestimulus influence. The procedure was quite straightforward. The subject listened to two items in succession. The items were either both words or the first was a word and the second was a nonword. Where both items were words, the first was or was not a semantic associate of the second. Lexical decisions on the second item were faster for words than for nonwords, but, significantly, lexical decisions to words preceded by semantic relatives were faster than those to words which were not. When subjects were asked to target for the presence of a specified initial phoneme in the second member of a pair, essentially the same pattern of results was manifest.

How might we interpret these effects? Consider the view which suggests that a change in logogen threshold is 'spread' to other logogens in close proximity. Here, reference need not be made to the contribution of the Cognitive System, for the transmission of the biasing effect is in the nature of a relatively direct connection between logogens. When a subject is participating in a situation that involves hearing successive pairs of related items it would be expect that, due to this direct "spread of excitation", activating one logogen would also activate its neighbors. On this view, it must be the case that experience with a particular item, and hence logogen, will affect related logogens, regardless of how the subject treats this item. Such a view can be seen as consonant with the results of Experiments 3 and 4, where the influence of a preceding associative word modulates lexical decision and, consequently, initial phoneme detection. The output from the logogen of the first item will influence related logogens and result in differences in latencies based upon whether there is proximity between the logogens, i.e. whether the two items are semantically related. But in Experiment 5 we have shown that, dependent upon the nature of the task, this need not be the case. Thus, when subjects are required to count the number of syllables in the first item, there are no latency differences manifest in the responses to the second.

What provides the basis for the distinction between the results of Experiments 3 and 4 where semantic-biasing occurs and those of Experiment 5, where not only was there no semantic-biasing, but, in addition, there was no word/nonword distinction? Our interpretation is that the Cognitive System provides the basis for semantic/contextual influence: thus, if this system is not fully addressed, which we claim is the case in the fifth experiment, then information of a semantic/contextual nature cannot come to bear. One speculative conclusion arising from this interpretation is that semantic information is the important determinant of lexical decision.

A contextualist position proposed by Jenkins (1974) has emphasized the necessity for considering the <u>event</u> within which an experimental procedure is embedded. This contextualist position provides another perspective for viewing the results of the final series of experiments. We note that the fifth experiment altered the procedure of the third and fourth experiments only slightly, yet resulted in the elimination of the word apprehension effect. It must be pointed out, however, that this procedure involved making the event which the subject related to substantially different from that of Experiments 3 and 4. Let us explain: in the fifth experiment the subject consciously had to deal with aspects of the overall situation in a non-semantic manner (i.e. counting syllables), resulting, we may suppose, in a non-semantic frame of reference. Thus, the event structure of this experiment was different in kind from that of the experiments which preceded it; in those the event was characterized by tacit semantic influences. In terms of a Logogen Model, the context provided by this event structure is in the domain of the Cognitive System and represents those influences passed from this system to the logogen. Following Jenkins (1974), it can be seen that contextual considerations speak directly to the nature of events. An examination of aspects of a particular situation has to be viewed within the framework of its event structure.

At the outset we provided examples of how contextual factors in both vision (e.g. Biederman, 1972; Weisstein and Harris, 1974) and speech recognition (Lieberman, 1963; Pisoni and Tash, 1974) can extend their influence in a variety of ways. The experiments in this paper have focused on the problems of word recognition and phonetic identification. An understanding of such processes was proposed to be based upon the contribution of semantic information. Context refers to the effect of higher-order factors on lower-level aspects of stimulation. Semantic influences speak to similar concerns, as has been demonstrated in this study. It is possible that context and semantics are not separable, rather they are instantiations of the same way of representing and dealing with information. This isomorphism derives from a consideration of what remains invariant across both descriptions: information must be viewed in terms of the event in which it is nested. We may want to consider that what is meant by both context and semantics is the frame provided by the structure of an event.

BIBLIOGRAPHY

Berry, C., Advanced frequency information and verbal response times. Psychonomic Science, 1971, 23, 151-152.

Biederman, I., Perceiving real-world scenes. Science, 1972, 177, 77-79.

Biederman, I., Glass, A. L. & Stacy, E. W., Jr., Searching for objects in real-world scenes. Journal of Experimental Psychology, 1973, 97, 22-27.

Broadbent, D. E., Decision and stress. New York: Academic Press, 1971.

Cattell, J. M., The time taken up by cerebral operations III. Mind, 1886, 11, 377-392.

Cooper, F. S. & Mattingly, I. G., A computer controlled PCM system for the investigation of dichotic perception. Journal of the Acoustical Society of America, 1969, 46, 115(A).

Darwin, C. J., The perception of speech. In E. C. Carterette & M. P. Friedman (Eds.), Handbook of perception, Vol. 7. New York: Academic Press, in press.

Eichelman, W. H., Familiarity effects in a simultaneous matching task. Journal of Experimental Psychology, 1970, 86, 275-282.

Forster, K. I. & Chambers, S. A., Lexical access and naming time. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 627-635.

Foss, D. J. & Swinney, D. A., On the psychological reality of the phoneme: Perception, identification, and consciousness. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 246-257.

Garner, W. R., The stimulus in information processing. American Psychologist, 1970, 25, 350-358.

Garner, W. R., The processing of information and structure. Potomac, Md.: Lawrence Erlbaum Associates, 1974.

Gibson, J. J., The senses considered as a perceptual system. Boston: Houghton Mifflin, 1966.

Hadding-Koch, K. & Studdert-Kennedy, M., An experimental study of some intonation contours. Phonetica, 1964, 11, 175-185.

Henderson, L., A word superiority effect without orthographic assistance. Quarterly Journal of Experimental Psychology, 1974, 26, 301-311.

Hyde, T. S. & Jenkins, J. J., Differential effects of incidental tasks on the organization of recall of a list of highly associated words. Journal of Experimental Psychology, 1969, 82, 472-481.

Hyde, T. S. & Jenkins, J. J., Recall for words as a function of semantic, graphic and syntactic orienting tasks. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 471-480.

Jenkins, J. J., Remember that old theory of memory? Well, forget it! American Psychologist, November 1974, 785-795.

Johnston, J. C. & McClelland, J. L., Perception of letters in words: Seek not and ye shall find. Science, 1974, 184, 1192-1194.

Krueger, L. E., Search time in a redundant visual display. Journal of Experimental Psychology, 1970, 83, 391-399.

Liberman, A. M., The grammars of speech and language. Cognitive Psychology, 1970, 1, 301-323.

Liberman, A. M., Cooper, F. S., Shankweiler, D. P. & Studdert-Kennedy, M., Perception of the speech code. Psychological Review, 1967, 74, 431-461.

Lieberman, P., Some effects of semantic and grammatical context on the production and perception of speech. Language and Speech, 1963, 6, 172-179.

McNeill, D. E. & Lindig, K., The perceptual reality of phonemes, syllables, words and sentences. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 419-430.

Meyer, D. E. & Schvaneveldt, R. W., Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. Journal of Experimental Psychology, 1971, 90, 227-234.

Meyer, D. E., Schvaneveldt, R. W. & Ruddy, M. G., Activation of lexical memory. Paper presented at the meeting of the Psychonomic Society, St. Louis, November 1972.

Morton, J., A preliminary functional model for language behavior. International Audiology, 1964, 3, 216-225.

Morton, J., The interaction of information in word recognition. Psychological Review, 1969, 76, 165-178.

Morton, J., A functional model for memory. In D. A. Norman (Ed.), Models of human memory. New York: Academic Press, 1970.

Morton, J. & Broadbent, D. E., Passive versus active recognition models, or is your homunculus really necessary? In W. Wathen-Dunn (Ed.), Models for the perception of speech and visual form. Cambridge, Mass.: M.I.T. Press, 1967.

Murrell, G. A. & Morton, J., Word recognition and morphemic structure. Journal of Experimental Psychology, 1974, 102, 963-968.

Neisser, U., An experimental distinction between perceptual process and verbal response. Journal of Experimental Psychology, 1954, 47, 399-402.

Neisser, U., Cognitive psychology. New York: Appleton-Century-Crofts, 1967.

Norman, D., Toward a theory of memory and attention. Psychological Review, 1968, 75, 522-536.

Novik, N., Parallel processing in a word-nonword classification task. Journal of Experimental Psychology, 1974, 102, 1015-1020.

Novik, N. & Katz, L., High speed visual scanning of words and nonwords. Journal of Experimental Psychology, 1971, 91, 350-353.

Pisoni, D. B. & Tash, J., Reaction times to comparisons within and across phonetic categories. Perception and Psychophysics, 1974, 15, 285-290.

Pollack, I. & Pickett, J. M., The intelligibility of excerpts from conversation. Language and Speech, 1963, 6, 165-172.

Posner, M. I. & Warren, R. E., Traces, concepts, and conscious constructions. In A. W. Melton & E. Martin (Eds.), Coding processes in human memory. Washington, D. C.: V. H. Winston & Sons, 1972.

Reicher, G. M., Perceptual recognition as a function of meaningfulness of stimulus materials. Technical Report No. 7, 1968, The University of Michigan, Human Performance Center.

Rubenstein, H., Lewis, S. S. & Rubenstein, M. A., Evidence for phonemic recoding in visual word recognition. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 645-657.

Rubin, P. Turvey, M. T. & Van Gelder, P., Initial phonemes are detected faster in spoken words than in spoken nonwords. Haskins Laboratories Status Report on Speech Research, SR-44, 1975, in press.

Shankweiler, D. P., Strange, W. & Verbrugge, R., Speech and the problem of perceptual constancy. In R. Shaw & J. Bransford (Eds.), Perceiving, acting, and comprehending: Toward an ecological psychology. Potomac, Md.: Erlbaum Associates, in press.

Studdert-Kennedy, M., Speech perception. Haskins Laboratories Status Report on Speech Research, SR-39/40, 1974, 1-52.

Studdert-Kennedy, M. & Hadding, K., Auditory and linguistic processes in the perception of intonation contours. Language and Speech, 1973, 16, 293-313.

Tulving, E. & Gold, C., Stimulus information and contextual information as determinants of tachistoscopic recognition of words. Journal of Experimental Psychology, 1963, 66, 319-327.

Weisstein, N. & Harris, C. S., Visual detection of line segments: An object-superiority effect. Science, 1974, 186, 752-754.

Wheeler, D. D., Processes in word recognition. Cognitive Psychology, 1970, 1, 59-85.

Woodworth, R. S., Experimental psychology. New York: Holt, 1938.