THE INFLUENCE OF SUBCATEGORICAL MISMATCHES ON LEXICAL ACCESS

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Abstract. When the noise portion of an [s] or [?] is combined with vocalic formant transitions appropriate to the other fricative, the resulting consonantal percept is almost always that of the noise. Whalen (1982) has shown that the mismatch of transitions nonetheless slows the identification of that fricative. This result was extended to a lexical decision paradigm to answer two questions: Does the inappropriate transition slow down access of a word, or is the delay limited to tasks involving specifically phonetic judgments? Second, what could such a delay tell us about how the lexicon is searched? The stimuli were 48 English words and 48 phonotactically legal nonwords, each containing either [s] or [?]. Two versions of each stimulus occurred, one with the original vocalic portion, and one in which the vocalic formant transitions were inappropriate to the fricative. In a speeded lexical decision task, word judgments were slower when the transitions were inappropriate. A nonsignificant delay occurred in nonwords (as in a similar experiment by Streeter & Nigro, 1979). The implications for the logogen and cohort theories of lexical access are discussed. Lexical access is shown to be sensitive to fine phonetic detail.

INTRODUCTION

The noise portion of the alveolar and palatal voiceless fricatives in English is a powerful enough cue for place of articulation to override any place information in the vocalic formant transitions of accompanying vowels. Thus, if the vocalic segment from [sa] is excised and combined with the noise portion from [sa], the resulting percept is the syllable [sa]: The transitions seem to be ignored. Such an artificial mismatch, in which a cue is put in a new environment where its value is not sufficient to produce the appropriate percept, will be called a subcategorical phonetic mismatch; the cue that is overridden will be called a mismatched cue. The present experiment will determine whether such mismatched transitions affect decision time within a lexical decision task. The results will help us decide whether listeners make phonetic decisions based on isolated time slices of the acoustic stream, or rather integrate all the information they receive.

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Earlier experiments (Martin & Bunnell, 1982; Whalen, 1982) have shown that subcategorical mismatches, while not changing the phonetic percept, slow phonetic identification. When the transitions of fricative-vowel syllables are mismatched, phonetic identification of both the fricative and the vowel is slowed. Whalen (1982) argued that listeners attempt to integrate all cues available, even if the result of that attempt is not noticeable in the final phonetic judgment. Since those experiments elicited phonetic judgments, it is possible that the effect is limited to such rather unnatural tasks. The lexical decision task is more natural.

Subcategorical mismatches have been examined previously in a lexical decision task. Mismatched transitions into a medial stop resulted in slower times in a speeded lexical decision task (Streeter & Nigro, 1979). The effect only appeared for word judgments, but not for nonword judgments. Streeter and Nigro interpret this result in terms of an exhaustive lexical search, in which the physical nature of the nonword stimulus has no effect. There are other interpretations possible (one of which is given below in the Discussion section), and the effect itself needs replication. The present study uses the same lexical decision paradigm, and extends it.

One drawback to the Streeter and Nigro study was that the mismatched cue always preceded the overriding cue. Thus their results cannot distinguish between two inherently plausible explanations. One account would say that the subjects were slowed because they made a phonetic decision as the closure transitions were perceived and had to reverse that decision when the opening transitions were perceived. This account can be called "disposing," since each cue is dealt with in strict temporal order (cf. Whalen, 1982). The other account would assume that the subjects tried to integrate the information of each set of transitions and were slowed by the mismatch in its own right. This account can be called "integrating," since every cue over a (yet to be determined) time frame is examined in conjunction with the other cues. Only when the overriding cue comes first do these two accounts differ. The disposing account would then say that the mismatched cues should simply be ignored and thus not slow phonetic identification. The integrating account would say that the mismatched cues provide phonetic information, but if that information is to be overridden, the integration will take extra time no matter where the mismatch occurs. The present study will examine this question directly, by having the mismatched cue preceding the overriding cue in some cases, and following in others.

The phonetic experiments of Whalen (1982) have shown that mismatched cues that follow the overriding cue do slow judgments. This provided evidence against disposing theories (cf. Blumstein & Stevens, 1960; Cole & Scott, 1974; Klatt, 1979; Stevens, 1975). In a disposing theory, every time-slice of the acoustic stream is examined, without regard for context, for its phonetic contribution. Once this information is extracted, that time-slice is not considered further. The alternative, "integrating," theory (cf. Liberman, 1979; Liberman & Studdert-Kennedy, 1978; and Repp, 1982) was better able to account for the data of Whalen (1982). This account assumes that listeners deal with all phonetic information over a fairly large stretch of time, taking the overall acoustic context into account. Thus the mismatched cues that followed the overriding cues were just as disruptive as ones that preceded.
While the evidence from the phonetic experiments supported the integrat-
ing account, that account would lead us to expect mismatched cues in both
words and nonwords to slow lexical decision. However, as already noted,
Streeter and Nigro (1979) did not find an effect of mismatches in nonwords.
If their finding is replicated, we would have to conclude either that the
mismatch effect is limited to the strange combination of successful lexical
access on the one hand and purely phonetic judgments on the other, or that
the lack of an effect with the nonwords is an artifact of the lexical decision
methodology. Finally, if we find no interaction between cue appropriateness
and cue position, then the integrating account of speech perception will be
further supported.

EXPERIMENTAL PROCEDURE

Materials

The test stimuli were 48 monosyllabic English words and 48 phonotactically
possible, monosyllabic nonwords (see Appendix). Each contained either [s]
or [z], in either initial or final position. All were chosen to be of
relatively low frequency (less than 50 occurrences in the Kučera and Francis,
1967, corpus). For each word or nonword, there was another word or nonword
that differed from it only in containing the other fricative. This matching
made it possible to change only the transitions, leaving the vowel quality in
the friction the same. Thus, for example, "soak" was matched with "shoak," "mess"
with "mesh," and "sipe" with "shipe." The mean duration of test items
was 569 msec. Words were slightly longer overall than nonwords (575 vs. 564
msec).

To avoid having fricatives in every word, two filler items were con-
structed for each test item. The fillers were all monosyllabic words or
phonologically legal nonwords. The words were matched with the test words for
frequency, and the distribution of phonemes in the nonwords approximated that
of English words. The mean duration of filler items was 525 msec. Again,
words were slightly longer than nonwords (532 vs. 518 msec).

A male native speaker of English recorded three tokens of each of the
test and filler items. The stimuli were read in randomized order during a
single recording session. Materials were low-pass filtered at 10 kHz and
digitized at a sampling rate of 20 kHz. One token of each item was chosen for
the experiment. Filler items were chosen for naturalness and clarity. Test
items were chosen so that the friction and vocalic segment of the two
corresponding items (such as "soak" and "shoak") were of equal duration. In
this way, the two versions of each item (matched or mismatched transitions)
were of equal duration.

Once the tokens had been selected, friction of each test item was
combined with its corresponding vocalic segment. The resulting stimuli fell
into four categories of interest: 1) The stimulus was a word containing
vocalic formant transitions that matched the fricative percept generated by
the noise ("appropriate transitions"); 2) The stimulus was a word, but the
transitions were inappropriate; 3) The stimulus was a nonword, and the
transitions were appropriate; and 4) The stimulus was a nonword, and the
transitions were inappropriate. Note that every test item occurred with both
appropriate and inappropriate transitions, and that, since friction always overrode transitions, both the matched and the mismatched versions of, for example, "soak" were identified as "soak."

The stimuli also varied systematically along other lines. There was an equal number of items with initial fricatives and items with final fricatives. This was varied to test the effect of mismatched cue position. In addition, there was an equal number of items whose lexical status changed from word to nonword or vice versa with the change of fricative (e.g., "soak," a word, and "shook," a nonword) and items whose status remained the same with either fricative (e.g., the words "mess" and "mesh," and the nonwords "froose" and "froosh"). Thus in half the test items, the change from [s] to [ʃ] would change the correct answer, and in half it would not.

Subjects

Two groups of subjects were tested, expert and naive. The expert listeners were 18 researchers at Haskins Laboratories, all of whom were phonetically trained and/or had extensive experience in phonetic research. Two were left-handed. The naive subjects were 18 volunteers, all native speakers of English, who were paid for their participation. One was left-handed.

Apparatus

Subjects were seated in a quiet room and heard the stimuli over Telephonics TDH-39 headphones. They responded by pressing one of two buttons on a panel in front of them. The "yes" response was on the left and the "no" response on the right. During the test, if the answer was correct and within the stated time limit (longer than 100 msec and shorter than two seconds), a small light on the control box in front of them lit up. Their response time, answer, and the correctness of that answer went into a computer file after each trial.

Procedure

The subjects' task was to judge whether each item was an English word or not. They were told to hit the "yes" button if the item was a word and "no" if it was not. Examples of words and nonwords were given to the subjects. They were then instructed to judge the status of the item as quickly as possible. Subjects were told to expect a few mistakes, both because they could misperceive items and because they could press a button by accident. They were instructed to slow down if they made too many of the latter mistakes. It was explained that these were careful pronunciations, so that "toas" and "bline" were to be taken as nonwords, even if these pronunciations might occur instead of "toast" and "blind." Any word that was known only as a slang word was to be counted as a nonword. The feedback light was explained.

There were two conditions for the experiment. In the first, the subject heard all test items, half with appropriate transitions, half with inappropriate. Since there were two versions of each test item, only one could be presented to a subject in a standard lexical decision task (which requires each item to occur only once, in order to avoid priming effects). This forced
the first analysis of the transition effect to be cross subject. In the second condition, the subject heard every test item again, but in its other version. The second condition thus resembled a lexical decision test in which each item has been primed by a repetition. The combination of the two conditions, while having the complication of speeded decisions on second presentation (cf. Dannenbring & Briand, 1982; Scarborough, Cortese, & Scarborough, 1977), allows the transition effect to be examined within subjects.

Two random sequences containing all the test and filler items were made. One version (with appropriate or inappropriate transitions) of each test item occurred in one sequence, with the other version occurring in the other. The assignment of subjects to one sequence or the other for the first condition was counterbalanced within groups.

A practice block, containing twenty words and twenty nonwords that did not occur in the test, was run to familiarize the subjects with the equipment and the task. After it was determined that no questions remained, the two test blocks of the first condition were run. A thirty second pause occurred between blocks. Each block contained 144 trials, plus four "warm-up" stimuli at the beginning (which were not tallied in the results). After a short break, the two blocks of the second condition were run.

The stimuli were recorded on one channel of an audiotape while, on the other channel, a timing tone was recorded simultaneously with the onset of the stimulus. The inter-stimulus interval was three and a half seconds.

**RESULTS**

The results of the two conditions (first presentation of the test items vs. second presentation) and the two conditions together were analyzed similarly. An analysis of variance was performed on the mean reaction time with the following factors: Expert vs. naive subjects ("group"); vocalic formant transitions were appropriate to the fricative or not ("appropriate transitions"); word vs. nonword; and initial vs. final fricatives. A separate analysis was done for each condition, then a combined analysis with the added factor of condition.

**Results for Condition 1**

Only correct responses within the specified time limits (longer than 100 msec, shorter than 2 sec) were included in the analysis of the results. This gave an overall error rate of 8.6%. The rate was 10.7% for words and 6.4% for nonwords. One item effect showed up strongly in the errors: The word "deuce/douce" accounted for one out of seven errors on words. Errors occurred at approximately the same rate in the two versions of each word (8.7% for the original versions, 8.4% for the mismatched versions).

As can be seen from Figure 1, inappropriate transitions slowed lexical decision, $F(1,34) = 6.04, p < .02$. Subjects were 18 msec faster in their decisions when the transition was appropriate (means of 932 and 950 msec, respectively). It is also evident that nonwords took longer than words, $F(1,34) = 6.41, p < .02$. While inappropriate transitions delayed response for both words and nonwords, the effect was larger with the words, $F(1,34) = 4.16,$
p < .05. A separate analysis of variance of just the nonwords shows that the transition effect did not reach significance, $F(1,34) = 0.84$, n.s.

![Figure 1. Lexical decision times for the first presentation of each item (Condition 1).](image)

When the results were analyzed by item rather than subject, the transition effect did not reach significance, $F(1,92) = 2.17$, n.s. Since transition was a between-subject factor for the item analysis, and since the effect was of small magnitude, this outcome is not too surprising. However, it does mean that the results for the first presentation of an item alone do not allow us to conclude that the transition effect will hold for any word or nonword of English.

Items with initial fricatives (overriding cue preceding) took longer to identify than those with final fricatives (overriding cue following), $F(1,34) = 33.05$, $p < .001$ for the subject analysis, $F(1,92) = 6.06$, $p < .025$ for the item analysis. This occurred despite the greater average duration of the fricative-final items (563 msec for the final fricative items vs. 555 msec). This factor is not of great interest in itself. These groups necessarily contained different items. Thus the effect simply indicates that some items were reliably identified faster than others. However, there are many possible causes for such item effects, and we do not have the evidence for distinguishing among them. For present purposes, the initial/final factor is of interest.
only if it interacts with the appropriateness of transition factor, and this it did not do: The delay caused by inappropriate transitions was the same whether the friction came before the transitions or after: \( F(1,34) = 1.56, \) n.s., for the subject analysis, \( F(1,92) = 1.37, \) n.s., for the item analysis. Thus the effect was the same whether the overriding cue came first or not.

The experts were significantly faster than the naive subjects, \( F(1,34) = 10.21, \) \( p < .01. \) The means were 886 and 996 msec, respectively. One interaction involving this factor was significant. The inappropriate transitions slowed reaction times for both words and nonwords for both groups, but the difference for the word responses of the naive subjects was much larger than their nonword responses or the experts' response to either words or nonwords, \( F(1,34) = 6.73, \) \( p < .02. \) This could be a proportional effect due to the greater magnitude of their reaction times, since the transition effect was not significant for the nonwords for either group.

Results for Condition 2

The overall error rate for Condition 2 was 6.7%. The rate was 7.6% for words and 5.9% for nonwords. Errors occurred at roughly the same rate in the two versions of each word (7.2% for the original versions, 6.3% for the mismatched versions).

The results for this condition, as can be seen from Figure 2, are quite similar to those of the first condition. The effect of the appropriateness of

![Figure 2. Lexical decision times for the second presentation of each item (Condition 2).](image-url)
the transition was again significant, \( F(1,34) = 5.64, p < .05 \). Subjects were 14 msec faster in their decision when the transitions were appropriate. In the analysis by item, the transition effect again failed to reach significance, \( F(1,92) = 2.28, \text{n.s.} \), so that it still cannot, on these data, be reliably generalized to other items.

Decisions about words remained faster than about nonwords, \( F(1,34) = 5.23, p < .05 \). On average, subjects were 25 msec faster in their decision when the stimulus was a word (means of 908 msec vs. 933). In the analysis by item, this difference was not significant, \( F(1,92) = 3.87, \text{n.s.} \). Together, the analyses indicate that the word/nonword effect disappeared on the second presentation of these items (min \( F'(1,112) = 2.22, \text{n.s.} \); cf. Clark, 1973). This occurred despite the larger difference in overall response time in comparison to the first condition (18 msec for Condition 1, 25 msec for Condition 2).

The interaction of word/nonword and appropriateness of transition did not reach significance, \( F(1,34) = 3.28, \text{n.s.} \), for the subject analysis, \( F(1,92) = 1.38, \text{n.s.} \), for the item analysis. However, since the first condition did have such an interaction, a separate analysis by subject of the nonword judgments was made. It showed that the transition effect was again not present for these subjects in the nonword judgments, \( F(1,34) = 0.25, \text{n.s.} \).

Items with initial fricatives were still identified more slowly than those with final fricatives, \( F(1,34) = 31.16, p < .001 \) for the subject analysis, \( F(1,92) = 8.87, p < .05 \) for the item analysis. The interaction of position of the fricative and appropriateness of transition was also not significant, \( F(1,34) = 0.34, \text{n.s.} \), for the subject analysis, \( F(1,92) = 0.05, \text{n.s.} \), for the item analysis. On second presentation of an item, then, inappropriate transitions again slowed the judgment whether they preceded or followed the friction.

The experts were again significantly faster than the naive subjects, \( F(1,34) = 5.98, p < .02 \). The means were 872 and 970 msec, respectively. No interactions with this factor were significant. Thus the effects of interest seem to be independent of linguistic sophistication.

Results for Conditions 1 and 2 Combined

When the results for first and second presentation of an item are considered together, the effect of the appropriateness of the transition was significant for the subject analysis, \( F(1,34) = 15.26, p < .001 \). The transition effect did not reach significance in the item analysis, \( F(1,92) = 3.81, p = .054 \), but the min \( F' \) did (min \( F'(1,17) = 6.2, p < .025 \)). Decisions were 17 msec faster when the transition was appropriate (means of 922 msec for the appropriate and 939 for the inappropriate transitions). Since each subject's data now contain responses to both versions of each test item, inter-subject variability is much reduced for the subject analysis. In the item analysis, each subject gave a response to each version of the item, so that the subject variability is much reduced there as well. The lack of an interaction between condition (i.e., first presentation vs. second presentation of each item) and appropriateness of transition, \( F(1,34) = 0.08, \text{n.s.} \), for the subject analysis, \( F(1,92) = 0.36, \text{n.s.} \), for the item analysis,
indicates that the slowing effect of inappropriate transitions is the same for initial access of a word and for the second access.

Across the two conditions, the word/nonword factor interacted with the appropriateness of transition in the subject analysis, $F(1,34) = 6.68$, $p < .02$. The item analysis showed no interaction, $F(1,92) = 0.62$, n.s. While the decisions were slower to both words and nonwords when the transitions were inappropriate, the effect was much larger with words (28 msec vs. 8 msec). A separate analysis on just the nonwords showed that the delay with nonwords was again not significant in the subject analysis, $F(1,34) = 1.10$, n.s. The item analysis alone shows a significant transition effect for the nonwords, $F(1,92) = 4.46$, $p < .05$, but the two analyses together are not significant, min $F'(1,5) = 0.88$, n.s.

Decisions about words remained faster than about nonwords, $F(1,34) = 7.10$, $p < .025$ for the subject analysis, $F(1,92) = 5.59$, $p < .025$ for the item analysis. On average, subjects were 21 msec faster in their decision when the stimulus was a word (means of 920 msec vs. 941).

The initial/final factor was still extremely significant, $F(1,34) = 68.09$, $p < .001$ for the subject analysis, $F(1,92) = 24.31$, $p < .001$ for the item analysis. The items with initial fricatives took longer to decide upon (951 msec) than those with final fricatives (910 msec). However, in these combined results, there was still no interaction between initial vs. final fricative and the appropriateness of transition, $F(1,34) = 2.63$, n.s., for the subject analysis, $F(1,92) = 0.62$, n.s., for the item analysis.

The effect of hearing the item for the second time was one of shortening the decision time by an average of 20 msec, $F(1,34) = 4.70$, $p < .05$ for the subject analysis, $F(1,92) = 76.76$, $p < .001$ for the item analysis. This factor did not interact with either the word/nonword or the appropriateness of transitions factor, together or singly (the $F$ value was less than 1 in most cases). That the speeding effect of repetition was present in the nonwords as well as the words is confirmed in the separate analysis of the nonword results. Responses to the second presentation of a nonword were, on average, 18 msec faster than to the first, $F(1,34) = 4.19$, $p < .05$ for the subject analysis, $F(1,92) = 42.90$, $p < .001$ for the item analysis.

The experts were significantly faster than the naive subjects, $F(1,34) = 8.25$, $p < .01$. The means were 879 and 983 msec, respectively. This factor was involved in three interactions. One involved only the location of the fricative (initial or final), which is not relevant to the present discussion except in its lack of an interaction with the transition factor. The two remaining interactions involved three and four other factors; no natural explanation for the interactions was apparent.

**DISCUSSION AND CONCLUSION**

The delay caused by inappropriate transition previously found in phonetic identification was found again in a more natural paradigm. A mismatch of fricative and transitions caused a delay in lexical access on both the first presentation and the second. Even when subjects are not paying attention specifically to the segmental phonetic structure of an item, a subcategorical
phonetic mismatch slows the judgment. The effect failed to hold up in the nonword decisions. Since this result was obtained previously (Streeter & Nigro, 1979), it is not unexpected. However, the explanation given by those authors is not appealing. An alternative, that the lexical decision process itself is responsible for the disappearance of the effect, will be discussed below.

In the previous paragraph and in the discussion below, there is a benign ambiguity about the origin of the mismatch effect: We have assumed that mismatches slow phonetic analysis, but it is possible that the slower times simply reflect the subjects' lessened confidence in their judgments. In either event, the implications for the integration vs. disposal issue are equivalent. Experiments could be devised to choose between these alternatives, but the present study does not do so. The remainder of the discussion will argue the first interpretation only, although arguments for the second could be constructed with equal ease.

The lack of an interaction between the position of the transitions (whether the fricative was initial or final) and the appropriateness of transitions shows that listeners were attending to the mismatched transitions whether the overriding cue came before or after them. If the noise cue of fricative-initial stimuli were dealt with and disposed, then the place information of the transitions would not cause a delay even if it conflicted with the place information of the noise. Listeners do not "dispose" of each piece of the phonetic stream as it comes, but rather integrate over a larger stretch. The present stimuli do not help us decide just how large a stretch this integration covers.

Other considerations can be mentioned here (cf. Whalen, 1982). If each slice of the signal were treated as a cue to one or more phones independent of the rest of the signal, the phonetic construct would get out of hand. Each slice would give information about one particular phone, but there are often ten or more 25-msec slices in one fricative noise. Even if each slice is sufficient to identify the fricative, the phonetic construct does not have ten fricatives for each noise. In addition, some parts of the signal have a separate significance in isolation that would be misleading if each time slice were considered alone. For example, the transitions of the vocalic segment, if presented in isolation, give rise to a stop percept (cf. Whalen, 1982). There must be some way of telling that, with no silent closure, the transitions are not to be taken as constituting a stop. That is, the signal must be integrated over a larger piece of the signal. Thus, even a disposing account must make some use of integration.

Results similar to those obtained in this study were interpreted by Streeter and Nigro (1979) to support the notion that the mismatched cues are not dealt with in the construction of the phonetic percept, but rather are carried along in a "degraded" representation. Their claim relies on lack of a delaying effect of mismatches in nonwords. They assumed that the construction of the phonetic representation of an item's two versions would take the same amount of time but that the representation of the mismatched version would not be as well-constructed as that of the matched version. This difference was equated with the difference between a stimulus presented with and without added noise. The lack of an effect of mismatched cues in the nonwords would
thus depend on there not being any entry in the lexicon to match, so that the quality of the stimulus would not affect the decision time. While no studies of lexical decision have used both auditory presentation and added noise, there have been visual analogs. Stanners, Jastrzembski, and Westbrook (1975), for example, found that a random dot pattern partially obscuring the words and nonwords slowed reaction times for both categories and in fact more so for the nonwords. Streeter and Nigro predict the opposite for auditory presentation. If they are wrong and nonwords in noise are classified as nonwords more slowly than those without added noise, then their proposal would be less than convincing. It seems more plausible that something in the nonword decision itself is responsible for the reduction in the mismatched cue effect.

One possible explanation attributes the reduced effect to an added step in the nonword decision. The extra time spent on nonword decisions may reflect phonetic reanalysis, in which even matched cues are treated as suspect: When a string is found to lack an entry in the lexicon, it may be rechecked for previously undetected phonetic ambiguities that might make it a word. If the original analysis is retained, the nonword decision is then made, but the process will have reduced the difference in response time between items with matched and mismatched transitions. If this account is correct, the delays found here and in Streeter and Nigro (1979) are inherent in the phonetic analysis; their disappearance in the nonwords is an artifact of the lexical decision methodology.

Some support for the added-step interpretation of the nonword data is contained in the data from the second condition. Previous results of repeated presentation are relevant here. Scarborough et al. (1977) demonstrated that repetition of items decreases reaction times even after a lag of 31 items. More importantly, they found that the effect of repetition on a well-known factor in lexical decision times (in this case, frequency of occurrence) varied across experiments. In some cases, the frequency effect disappeared, while in others it persisted.

With the present experiment, the effect of inappropriate transitions was the same on the first presentation as on the second. If anything, we might have expected the transitory effect to weaken when the words were being heard for the second time, since the criterial levels for recognition would presumably be lowered. That did not happen. Thus the effect found seems to occur in both the initial access of a lexical item and on the second. The second presentation of words reduced the time required to respond to them, as would be expected (Forbach, Stanners, & Hochhaus, 1974). But repetition was equally effective in reducing the time required to judge nonwords (cf. Dannembring & Briand, 1982). We would perhaps expect that all times would be reduced by practice, but that words, since they prime themselves (Scarborough et al., 1977), should show greater effects than nonwords. This was not the case. Streeter and Nigro (1979) and others assume that nonwords do not have an entry in the lexicon. An item without an entry in at least a temporary lexicon could not be self-priming. Any time gained in the nonword decisions, then, would be due to a faster search. This could be accomplished either through familiarity with the task or by searching a subset of the lexicon. Even if a subset of the lexicon is searched on the second presentation, the words should still have an added advantage from the priming. The evidence leads us to say that nonwords have lexical representations, at least within a test session.
Lexical decision judgments, then, are affected by subcategorical mismatches that do not result in overt ambiguities. Since most theories of lexical access are vague about the properties of the phonetic input, they can accommodate almost any result from experiments of the present sort. I will briefly discuss the treatment of the present results in two of them, the logogen theory (Morton, 1969, 1979) and the cohort theory (Marslen-Wilson, Note 1; Marslen-Wilson & Welsh, 1978).

The logogen theory assumes that words (or morphemes) are collections of phonetic, semantic, and other properties with an associated threshold. If that threshold is met, that word is accessed. Priming is a temporary lowering of the threshold, while greater frequency within the language lowers the threshold permanently. Logogens are completely passive.

The cohort theory asserts that words are organized by their initial sounds into groups or "cohorts." Once the initial sounds (probably a half syllable) are identified, all words in that cohort become candidates. These candidates are eliminated by further incoming data until only one word remains, or until none remains. Cohorts, then, are partially active.

One common feature of these two theories is a distinction between phonetic analysis and lexical access. Neither theory has much to say about the phonetic analysis, except that, if it occurs, it does so either before input to the logogens, or in step with cohort activity. The mismatches introduced into the present stimuli could have affected either process. If the phonetic analysis was slowed, the decision would be slowed for both words and nonwords. If the search was conducted on a degraded stimulus (as proposed by Streeter & Nigro, 1979), the decision for words would be slowed while that for nonwords might not be (see the discussion above). The two theories of lexical access are compatible with either interpretation.

The logogen theory is more easily made compatible with the delay in the phonetic analysis. In that event, the activation of logogens would be delayed until the phonetic analysis was completed, so the theory would not need to be modified to take account of these results. If the degraded stimulus version were correct, then a degraded stimulus would add less to the correct logogen's activation. Then the threshold must be lowered over time or the activation increased for the word decision to be initiated.

The cohort theory is also compatible with both versions. The two versions look much more similar to each other with this theory. In both versions, early mismatches would slow the cohort's self-activation. If the selection of a cohort is delayed a few milliseconds because of a mismatched cue, then the final output of that cohort will be delayed. Later mismatches, occurring after the cohorts are active, would either be available to the cohort later, or would be more slowly utilized by the cohort. Since the lexical lookup stage in the cohort theory is interleaved with the phonetic decisions, the choice between the two explanations is of limited interest.

The two main theories of lexical access are thus unaffected by the choice between assigning the effect of the mismatched cues to the phonetic analysis or to the use of a degraded analysis in the search of the lexicon.
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Note that both the logogen theory and the cohort theory are disposing. The logogen theory is obviously disposing, since each time-slice adds a certain amount to the relevant logogens' activation. Conflicting information would not lower that activation, but simply add to another logogen's activation. Thus the logogen theory has the same problem of explaining why it is that the transition cues for fricatives are not also treated as cues for stops. The cohort theory behaves similarly.

The proposal that nonword judgments require phonetic reanalysis would allow the cohort model to explain something it has had trouble explaining before, namely, the consistent finding that nonword decisions take longer than word decisions. When all words in a cohort are contradicted by the phonetic input, the nonword decision should be possible, thus giving faster reaction times for nonwords. If the cancellation of a cohort instead called for a phonetic reanalysis and check that the proper cohorts had been active, another step would be introduced and the effect would be explained. Shorter nonword decisions could be expected for items that eliminate all possibilities very early in the word. Since the present items were monosyllabic, they do not provide the best evidence for the cohort theory.

The phonetic reinterpretation proposal gives us an alternative proposal for another set of results as well. Phoneme monitoring has been shown to be speeded when the phoneme-bearing stimulus is a word as compared with a phonetically similar nonword (Rubin, Turvey, & Van Gelder, 1976). If subconscious lexical access is taking place, then subconscious failure of lexical access must be taking place as well. The theory proposed by Rubin et al. is that the phonological representation available to the words makes the phonemic judgment easier. It could also be that a phonetic reanalysis occurred with the nonwords (even though lexical status was not explicitly at issue), thus slowing the (equally well-supported) phoneme response.

The current results demonstrate that even in the paradigm of judging lexical status, subjects are sensitive to subcategorical phonetic mismatches. Since this effect occurs whether the mismatched cue precedes the overriding cue or follows it, we can conclude that listeners are attempting to attribute the proper value to every cue they receive, even if it seems redundant.

REFERENCE NOTE


REFERENCES


Rubin, P., Turvey, M. T., & Van Gelder, P. Initial phonemes are detected faster in spoken words than in spoken non-words. Perception & Psychophysics, 1976, 19, 394-398.


Appendix—Stimuli for Lexical Decision Task

Numbers in parentheses are the frequencies from Kučera and Francis (1967).

<table>
<thead>
<tr>
<th>Initial s/ʃ</th>
<th>Final s/ʃ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>word</strong></td>
<td><strong>nonword</strong></td>
</tr>
<tr>
<td>s/ʃ</td>
<td></td>
</tr>
<tr>
<td>change</td>
<td>1. soak (7)</td>
</tr>
<tr>
<td></td>
<td>2. sap (1)</td>
</tr>
<tr>
<td></td>
<td>3. soup (16)</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>word/</td>
<td>4. soap (22)</td>
</tr>
<tr>
<td>nonword</td>
<td>5. soy (1)</td>
</tr>
<tr>
<td>status</td>
<td>6. silk (12)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>1. shade (28)</td>
</tr>
<tr>
<td></td>
<td>2. shaft (11)</td>
</tr>
<tr>
<td></td>
<td>3. shout (9)</td>
</tr>
<tr>
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<td>4. shut (46)</td>
</tr>
<tr>
<td></td>
<td>5. shove (2)</td>
</tr>
<tr>
<td></td>
<td>6. chef (9)</td>
</tr>
<tr>
<td>s/ʃ</td>
<td>1. shoot (27)</td>
</tr>
<tr>
<td>change</td>
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<td></td>
</tr>
<tr>
<td>caused</td>
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</tr>
<tr>
<td>no</td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>change</td>
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</tr>
<tr>
<td>in</td>
<td></td>
</tr>
<tr>
<td>word/</td>
<td></td>
</tr>
<tr>
<td>status</td>
<td></td>
</tr>
<tr>
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<td>3. sack (8)</td>
</tr>
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<td></td>
<td>4. self (40)</td>
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<tr>
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<td>5. shelf (12)</td>
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<td>6. sock (4)</td>
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<td>7. shock (31)</td>
</tr>
<tr>
<td></td>
<td>8. sake (41)</td>
</tr>
<tr>
<td></td>
<td>9. shake (17)</td>
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