PHONOLOGICAL SIMILARITY EFFECTS IN CANTONESE WORD RECOGNITION

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ABSTRACT

Two lexical decision experiments in Cantonese are described in which the recognition of spoken target words as a function of phonological similarity to a preceding prime is investigated. Phonological similarity in first syllables produced inhibition, while similarity in second syllables led to facilitation. Differences between syllables in tonal and segmental structure had generally similar effects.

INTRODUCTION

The vocabulary of a language contains hundreds of thousands of words, all made up of a very small number of building blocks: phonemes. The phonemic inventory of a language is reckoned not in the hundreds or thousands of items but in the tens (Maddieson [1] lists phoneme inventory ranges from 11 to 141, with a median of 28-29). Thus most words have close phonological neighbours - other words whose sound pattern is only minimally different. The process of spoken-word recognition involves distinguishing a heard word from other words it might possibly be, and recent research in this area has supported the proposal that recognition involves a process of active competition between phonologically similar words (see McQueen, Cutler, Briscoe and Norris [2] for a review). Thus recognition is clearly affected by the presence of phonologically similar words in the vocabulary. However, whether spoken-word recognition can be affected by prior processing of phonologically similar words is as yet uncertain.

Only few studies have examined the recognition of spoken words as a function of immediate prior auditory presentation of another word similar in sound; from these differing, in part apparently incompatible, results have emerged (in fact, cross-modal studies have also produced conflicting results, but this large literature is beyond the scope of the present report). For example, Slowiaczek and Hamburger [3], using a word repetition task in English, found that overlap of initial phoneme between prime and target (e.g. *smoke-still*) facilitated response latency, but overlap of three phonemes (*stiff-still*) inhibited it. Radeau, Morais and Dewier [4], also using word repetition, but in French, found only inhibition effects regardless of amount of overlap. They found similar interference also with the lexical decision task. Emmorey [5] used lexical decision in English and found facilitation for certain pairs sharing the final syllable (e.g. *tango-cargo*). Zhou [6] (to our knowledge the only study of this kind in a Chinese language) presented listeners with pairs of bisyllabic Mandarin words, and found (like [5]) facilitation if the pairs shared the final syllable, but (similarly to [3] and [4]) inhibition if they shared the first syllable.

Mandarin is a tone language, with a four-tone system; its phonological inventory is small and there is very extensive homophony. We here report two experiments, in many respects similar to Zhou's, examining spoken-word recognition in Cantonese as a function of phonological similarity between the response target and a preceding word. Cantonese is also a tone language, but has a much more complex tonal inventory (a nine-tone system, of which three "glottalised" tones occur only on certain syllable types), as well as a more varied phonological structure than Mandarin.

EXPERIMENT 1

Materials

96 pairs of bisyllables were constructed; each pair comprised prime plus target (response item). Half of the 96 targets were nonwords. Of the 48 real-word targets, one quarter had a phonologically and semantically unrelated prime (a baseline control condition; e.g. the words for *scarf-tomato*). A further quarter had a semantically but not phonologically related prime (e.g. *piano-guitar*; a further control to ensure that conditions for inter-word effects had been met). The remaining 24 items had a phonologically related (but semantically unrelated) prime; prime and target shared initial syllables but differed in second syllables. In 12 items, the second syllable differed in tone (e.g. *ji6liu4* "treatment" - *ji6liu5* "feed"); in 12, it differed in rime (e.g. *to4fa1* "peach flower" - *to4fool* "butcher"). In all cases the overlapping syllables were morphologically different.

Subjects and Procedure

32 students at the Chinese University of Hong Kong were tested individually in the experiment; all were native speakers of Cantonese with no reported hearing impairment. 16 subjects in the priming group were instructed to listen to the pairs of bisyllables and to decide, as quickly as possible, whether or not the second was a real word of Cantonese, and to signify their response by pressing one of two response keys (labelled YES and NO) in front of them. For the remaining 16 subjects the targets occurred without preceding primes and subjects were instructed to make a lexical decision for each word. The stimuli, which had been spoken by a female native speaker of Cantonese and digitised (at a sampling rate of 22 kHz), were presented over Sound MD-802A headphones at a comfortable listening level. Prime-target ISI was 400 ms. Stimulus presentation and response timing were controlled by a Macintosh IIsi computer.

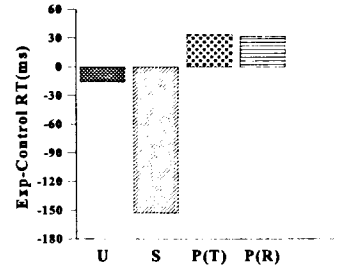

Figure 1. Mean differences between experimental (priming) and control (no-priming) group RT (measured from word offset) for the four prime conditions of Experiment 1. U: Unrelated prime; S: Semantically related prime; P[T]: Phonologically related prime (tone difference in second syllable); P[R]: Phonologically related prime (rime difference in second syllable).

Results and Discussion

Each missing data point was replaced by the mean response time (RT) for the same subject in the same condition. Analyses of variance across subjects and items revealed significant differences between the four conditions and an interaction of the condition factor with the priming/no-priming group factor; this interaction was examined via *t*-tests (again across subjects and items separately) comparing groups in each condition. Figure 1 shows the between-group differences. In the unrelated-prime condition, the groups differed by just 16 ms, a statistically insignificant difference ($t1$ and $t2 < 1$). Thus there are no inter-group differences *per se*. With semantically related primes, there was a highly significant facilitation for the priming group ($t1$ [15] = 3.62, $p < 0.003$; $t2$ [22] = 3.16, $p < 0.005$). Thus the experiment is sufficiently sensitive to exhibit priming where this occurs. However, neither phonologically related-prime condition showed facilitation effects; in contrast, in both groups there was, rather, inhibition, i.e.

RTs were slower than in the baseline condition, although this effect did not reach significance in either condition.

Thus recognition of a spoken Cantonese word is not facilitated, and may indeed be inhibited, by having just heard another word beginning in the same way. Alterations of rime and of tone between prime and target have exactly parallel effects. The pattern of findings parallels reported results from English and French, when the overlap encompasses several phonemes, and data from Mandarin. It is an effect which is consistent with competition-based models of spoken-word recognition (see [2]) in which simultaneously activated words may inhibit one another's recognition.

EXPERIMENT 2

Materials, Subjects and Procedure

The materials were constructed exactly as in Experiment 1, except that in the 24 phonologically related pairs the difference between prime and target occurred in the first rather than the second syllable. Again, the difference involved tone in 12 pairs (e.g. *to4wa6* "picture" versus *to2wa6* "dialect") and rime in the other 12 pairs (*si6yip6* "career" versus *sue6yip6* "leaf"); the second syllables of prime and target were always phonologically identical and morphologically different. 32 subjects from the same population participated in the experiment; none had taken part in Experiment 1. The procedure was as in Experiment 1.

Results and Discussion

The data were analysed as for Experiment 1; Figure 2 shows the between-group differences for each condition. Again there was a significant main effect of condition and a significant interaction between conditions and groups in the analysis of variance; again, the between-group difference in the unrelated-prime condition (6 ms) was not significant (both $t1$ and $t2 < 1$), but there was a significant facilitation effect in the semantically related-prime condition ($t1$ [15] = 3.27, $p < 0.005$; $t2$ [22] = 4.52, $p < 0.001$). For the two phonologically related conditions, the results of Experiment 2 differed from those of Experiment 1; there was facilitation instead of the inhibition observed previously. When the first syllable differed in rime, the difference between groups was significant ($t1$ [15] = 3.12, $p < 0.007$; $t2$ [22] = 3.67, $p < 0.001$). For the condition in which the first syllable differed in tone, the difference between groups was only half as large, and did not reach our criterion of significance ($t1$ [15] = 1.12; $t2$ [22] = 1.47).

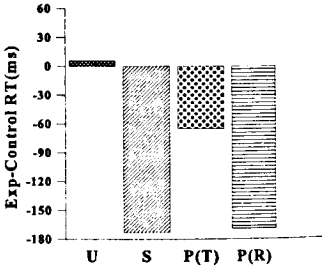

Figure 2. Mean differences between experimental (priming) and control (no-priming) group RT (measured from word offset) for the four prime conditions of Experiment 2. U: Unrelated prime; S: Semantically related prime; P[T]: Phonologically related prime (tone difference in first syllable); P[R]: Phonologically related prime (rime difference in first syllable).

Thus recognition of a spoken Cantonese word appears to be facilitated by having just heard another word ending in the same way. Again, the results from Cantonese parallel those from English [5] and Mandarin [6]. Again, alterations of rime and of tone between prime and target appear to pattern similarly, although when the first syllable differed in tone less robust facilitation was observed than when the first syllable differed in rime.

GENERAL DISCUSSION

Our two experiments on phonological similarity in spoken-word recognition in Cantonese motivate two general conclusions. Firstly, effects of phonological overlap between two bisyllabic words differ as a function of whether the overlap is located in the words' first or second syllable. Secondly, differences between syllables in tonal and in segmental structure have in broad outline similar effects.

Apparent contradictions between previous studies may therefore reflect differences between the types of phonological overlap manipulated. In English [3] and French [4], inhibition occurs when successively presented words overlap in the first few phonemes; the same result occurs with an initial syllable overlap in Mandarin [6] and, as the present study shows, in Cantonese. In this respect there may be little cross-linguistic difference. The findings so far do not allow us to decide whether the overlap must involve integral syllables or merely any word-initial portion. We suggest that the latter is the simpler option. Certainly it is fully compatible with our preferred explanation of the inhibition effect, namely that competition between simultaneously activated word candidates inhibits recognition of a target word.

Facilitation effects of phonological overlap in word-final position have also now been observed in more than one language: English [5], Mandarin [6] and, in the present study, Cantonese. In none of these experiments was this facilitatory effect due to morphological priming (recall that, like Zhou, we exploited the unique properties of Chinese languages to use prime/target overlaps which were syllabic but not morphological); however, it would be interesting to examine whether it might have its origin in a processing strategy designed to exploit the overwhelming tendency across languages for affixes to occur predominantly in suffix position [7].

In Zhou's experiments, and in the studies in European languages, the non-overlapping portions of the prime and target pairs were completely different; in our experiments they differed only in tone or in rime. The similarity between the present results and those from other languages thus suggests that either a tonal or a segmental difference is sufficient fully to distinguish between words, i.e. that tone functions analogously to segmental structure in spoken-word recognition. The parallel effects of the tone and rime difference manipulations (inhibition in Experiment 1, facilitation in Experiment 2) further support this conclusion.

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