PHONOLOGICAL PRIMING IN CANTONSE SPOKEN-WORD PROCESSING

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An auditory priming experiment with 28 native Cantonese speakers was conducted to examine the effects of phonological overlap between monosyllabic target words and preceding primes. In the experiment, listeners heard a pair of Cantonese monosyllables (prime-target) with 250 milliseconds inter-stimulus interval in between and they were instructed to name aloud the second item (target). Results indicated that facilitation was observed in two conditions: (1) shared rime and tone between primes and targets and (2) shared onset and rime between primes and targets. However, when shared the onset and tone between the monosyllabic prime and target, an inhibition effect was observed. These findings are discussed in terms of the segmental and supra-segmental information of Cantonese.

Key words: phonological information, priming effects, Cantonese, spoken word processing

The role of phonological information played in the temporal course of spoken word processing has attracted several experimental studies during the past ten years (Goldinger, Luce, Pisoni, & Marcario, 1992; Hamburger & Sliwaczek, 1996; Radeau, Morais, & Dewier, 1989; Radeau, Morais, & Segui, 1995; Sliwaczek & Hamburger, 1992; Slowiaczek, McQueen, Soltano, & Lynch, 2000). The results of these phonological priming studies generally suggest that the processing of spoken words would be affected by the phonological overlap between those words and their preceding spoken words. Nonetheless, the extent of facilitation and inhibition is dependent on the different proportions of the phonological overlapping. For example, in their word shadowing experiment, Slowiaczek and Hamburger (1992) found that an inhibition effect was observed when the three initial phonemes were shared between the prime and target words. A recent study by Slowiaczek, McQueen, Soltano, and Lynch (2000) also found a consistent facilitation effect when the primes and targets rhymed. Therefore, the main empirical question in this line of research is how different proportions or positions of the phonological overlapping between the primes and targets influence the course of spoken word processing? Answers for this question can reflect the relationship between the phonotactic structure of a language and its perceptual processing.

In fact, all the relevant studies have been mainly tested in English and several

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other Indo-European languages (e.g., French & Dutch). To the best of my knowledge, this line of research has not been systematically examined in Cantonese Chinese. Cantonese Chinese is a Sino-Tibetan language that differs significantly from English and most Indo-European languages (e.g., in its use of lexical tones, its morphemic monosyllabic property) and it offers at least two unique psycholinguistic properties in its phonological and phonotactic structures (see Li, 1998, for a review). The first one is that Chinese language involves a tonal system to differentiate different lexical items, and different tones often distinguish between different meanings associated with the same syllables. Lexical tone in Chinese is comparable to the stress in English since both of them are one kinds of prosodic feature (Cutler, Dahan, & Donselaar, 1997). However, it may be difficult for English speakers to think of the importance of tonal information in spoken word processing that is parallel to the function of segmental information of a monosyllable.

In addition, the phonotactic structure of Cantonese is simple but distinct (Kao, 1971). Normally, a monosyllable of Cantonese consists of two components: segmental information and supra-segmental features. The segmental information of Cantonese syllables can also be described into two parts: initials and finals. In Cantonese linguistics, initials are generally the onset consonants of the syllable and finals are the rimes. Rimes in Cantonese can be appeared as a single vowel (V), diphthongs (VV), or a combination of vowel+consonant (VC). Also, the tonal information is rested on the portion of rime within the syllabic envelope. From here, one can see that the phonological information and the phonotactic structure of Cantonese are somehow different from English or other Indo-European languages, and then would their priming results in spoken word processing be similar or not? Therefore, it is theoretically interesting to examine which aspects of the phonotactic structure of a language that our perceptual processing system is particularly sensitive to. The present study aims to further investigate this line of research by using Cantonese as a crucial testing case. Due to its salient phonological features, it obviously can further verify the existing findings in this field. Finally, a better understanding to the general picture of spoken language processing can be achieved from the cross-language evidence obtained in the present study (Cutler, 1997).

Recently, Yip, Leung, and Chen (1998) have first explored the phonological priming effects on spoken word processing in Cantonese by a shadowing task. They found that the only reliable facilitation effect was observed in the condition that the onset and the rime were shared by the prime and target words. No other effects were found. Therefore, their findings are generally inconsistent with many priming studies that use English as the materials. After careful investigation, the author found that the phonological relatedness proportion (PRP) of the materials used in their study might be a confounding to affect the results. In their study, 75% of the experimental trials were phonologically related and the remaining 25% were unrelated. Several studies suggested that the PRP is an important factor to influence the priming effects (Goldinger et al., 1992; Hamburger & Slowiaczek, 1996). It is because the PRP would affect the threshold of producing spoken word by the
participants; for example, participants would increase their preparedness to produce a spoken word when they encountered a high PRP materials set, compared with the low PRP materials set. Therefore, the priming results obtained from the study of Yip et al. (1998) would be contaminated by the factor of PRP.

In the present study, the author extends the work of phonological priming of Cantonese spoken word processing along the following lines. First, to make a replication of our previous work, the author followed up the general paradigm used in Yip et al. (1998). So, the results can partially illustrate the precious effects exerted by the factor of PRP. Second, to make a more balanced experimental design, the author added equal numbers of fillers to the entire materials set in order to avoid the confounding of PRP. This amendment of the overall experimental design and materials sets can help to narrow the range of other confounding effects and to highlight the genuine phonological priming effects in Cantonese spoken word processing.

A syllable-shadowing experiment (Bates & Liu, 1996) is designed to address the following questions: Which aspects of the phonotactic structure (onset, rime or tone) of Cantonese is particular sensitive to the perceptual processing? Would the shared rime between primes and targets facilitate participants’ shadowing performance? Does the factor of PRP matter?

**Method**

**Participants:**
Twenty-eight native Cantonese speakers who reported no speech or hearing deficits participated in this experiment. All participants were students at the Chinese University of Hong Kong. They took part in the experiment as a laboratory requirement for credit in an introductory psychology course.

**Materials and Apparatus:**
Forty hundred and twenty existing Cantonese syllables were selected and arranged into sixty pairs. Each pair of stimuli consisted of four different types of prime and a target. For example, each pair of stimuli included a target such as /cho2/, and four types of prime: (a) a phonologically related prime with shared onset and rime (P[O + R] such as /cho1/), (b) a phonologically related prime with shared rime and tone (P[R+T] such as /do2/), (c) a phonologically related prime with shared onset and tone (P[O+T] such as /cho2/), and (d) a phonologically unrelated prime (P[U] such as /gwa1/). In order to manipulate the PRP to 50% in the present study, the number of phonologically unrelated prime was tripled the number of the other three conditions. [A full list of materials can be obtained upon requested]

**Experimental Apparatus:**
All the stimuli were read by a female native Cantonese speaker at a normal speaking rate, and were tape-recorded by a SONY DAT and then digitized into a PowerMac computer. A sampling rate of 22kHz with a 16-bit sound format was used for digitizing. In addition, an effort was also made to have each monosyllable of equal duration.

**Procedure:**
Participants were instructed to hear a 300-millisecond short warning tone, followed by a 500-millisecond pause. And then a pair of monosyllables with a 250-millisecond inter-stimulus-interval (ISI)

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1 For the pronunciation, /ch/ is the onset consonant; /o/ is the vowel; /2/ is the tone of the monosyllable /cho2/ (see Zhang & Zhang, 1987)
was followed with a prime-to-target sequence; and their task was to name aloud the target (i.e. the second syllable) as accurate and quickly as possible.

Each listener received 60 pairs of stimuli in the experiment that include 30 phonologically related primes and 30 phonologically unrelated primes. The order of presentation for the stimuli was pseudorandomly arranged such that no one heard the same syllables twice in the experiment.

All participants did the experiment individually. The presentation of stimuli was controlled by the PsyScope program (Cohen, MacWhinney, Flatt, & Provost, 1993). They heard all the stimuli via two amplified speakers connected to a PowerMac computer. Participants' naming latencies were recorded and calculated (counting from the beginning of the target) by the CMU button-box (Cohen et al., 1993). A unidirectional microphone to register participants' vocal response was connected to the button-box through the box's voice-activated relay. Participants' response accuracy was recorded over a remote-controlled SONY tape-recorder by the experimenter in another partition. Before the actual experiment began, participants were given a practice session in which they heard a set of separate but similar stimuli. The whole experiment lasted for thirty minutes.

**Data analysis:**

Two dependent variables were measured in this experiment. The first one was listeners' response latencies to each target. The latency was counted from the offset of the target word to the participants' vocal response. The second dependent variable was the error rate in each condition.

**Results**

Average naming latencies for correct responses as a function of different types of prime are presented in Table 1. Error rates and missing rates were very rare (on the average 1.85% for each conditions), so the error proportions and missing rates were not analyzed in the present experiment.

A repeated measure ANOVA was conducted on the naming latencies across participants. The results revealed the main effect of types of prime was significant at, $F(3,25) = 9.34$, $p < .05$. These results suggested that different types of primes significantly influence the naming performance of participants. Post hoc analysis (Tukey HSD test) found that these effects were mainly contributed by the differences between the O+R; R+T conditions and the unrelated conditions, $p < .05$. The facilitation effects were observed when the prime and target words shared the onset and rime; as well as shared the rime and tone. The inhibition effect was observed if primes and targets shared the onset and tone, but this result was not statistically significant, $p > .05$.

<table>
<thead>
<tr>
<th>Types of Prime</th>
<th>O+T</th>
<th>O+R</th>
<th>R+T</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>420 (35.2)</td>
<td>386 (26.1)</td>
<td>408 (42)</td>
<td>418 (41.8)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

O—shared onset
R—shared rime
T—shared tone
U—phonologically unrelated
The present set of results was much clearer than our previous work (Yip et al., 1998) and consistent with several established findings. First, the facilitation effect on the O + R condition was consistent with our previous work. That is, shadowing a Cantonese monosyllable appears to be facilitated by having heard another preceding monosyllable which having the same segmental information (32 milliseconds). Treiman (1983; 1986) also suggested that word processing was largely influenced by the whole syllable structure rather than its constituents. Also, this result also illustrated the inferiority of tonal information of spoken word processing in Cantonese, which is in line with the findings observed by Cutler and Chen (1997).

Second, another facilitation effect was found on the R + T condition. Although the priming effect was slightly weak (10 milliseconds), the pattern clearly showed that the naming performance across participants was accelerated. This result is also consistent with the recent findings by Slowiaczek et al. (2000), that the speed of producing a spoken word would be facilitated after hearing a rhymed spoken word before.

In addition, the inhibition effect was observed on the O + T condition though statistically unreliable, the inhibition effect here was very small (~2 milliseconds). Production of inhibition effect on the naming of a target that followed by a onset-shared prime was well-established in the priming studies, such as Goldinger et al., 1992 and Slowiaczek and Hamburger, 1992. Therefore, the inhibition effect of the O + T condition obtained in the present result is generally consistent with these kinds of findings, other than the tone inferiority effects of Cantonese spoken-word processing (Cutler & Chen, 1997).

**Discussion**

Results of the present study clearly suggested that native Cantonese speakers are particularly sensitive more to the segmental information than to the supra-segmental information along the temporal course of Cantonese spoken word processing. Moreover, the entire syllabic envelope, or the whole syllable seems to be a more stable and prominent processing unit in Cantonese. This constant unit is also argued that it cannot be automatically decomposed in the processing stage (Chen & Yip, 2000; Chen, Yip, & Wong, 1998).

From the present study, two points should be followed up in the subsequent research. Firstly, one can also see that the function of rime in Cantonese spoken-word processing is critical. The naming latencies will facilitate when the primes and targets shared the portion of rime while the naming latencies will inhibit when the prime-target pair did not share the element of rime. However, one should be noted that the shared rimes used in the present study are included both vowel and also the combination of “vowel plus final consonant”. Therefore, the rime effects may be caused by the additional phonemic information of the final consonant processed by the participants. Further investigation on this regard is useful to illuminate this speculation.
Secondly, from the comparison of the present results and our previous work, there are some differences. These differences proposed the potential confounding of the factor, PRP, in the spoken word processing in Cantonese. However, this factor is not systematically varied in the present study, so how far this factor influences Cantonese spoken word processing is still unclear. Further research on this aspect is also required in order to get the general pattern of the priming effects.

Lastly, ongoing experiments are being designed to further examine the priming effects of Cantonese spoken-word processing by considering the factor of PRP, lexicality of the prime and also the precious phonemic structure of Cantonese monosyllables.

Reference Note


REFERENCES

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