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The Contribution of Aspirated Feature Information of Initial in Mandarin-Chinese Monosyllable Word Processing

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Abstract: The passage mainly focuses on aspirated feature of stop consonants priming effect in Mandarin-Chinese monosyllable real spoken words. The experiment contrasted 4 prime conditions of "prime-target" pairs: homogeneous (pa1-pa1), aspirated feature (p^ha1-pa1), post-homogeneous (ma1-pa1) and unrelated (lu1-pa1). In the experiment, all tonal information is matched and the aspirated feature of initial in Mandarin-Chinese monosyllable real spoken words is the variant. The latter two pairs are control groups. The data were from ten Mandarin native listeners, then they were calculated and got the mean reaction time (RT), the standard deviation (std) and standard error (std. err). By comparing with the unrelated group, the other three shows that if some segmental information are matched, there will be significant negative priming effect. The first two pairs test whether aspirated feature activate priming effect at word recognition in Mandarin-Chinese monosyllable real spoken words by auditory priming, by comparing the homogeneous (H) group with the aspirated group and post-homogeneous group, the result shows that changing the aspirated feature do have a positive priming effect.

Keywords: word recognition, Mandarin, auditory priming

1. Introduction

Language comprehension refers to the process that human beings are actively creating in brain through auditory or verbal language material, it can be divided into speech comprehension and reading comprehension [1]. Spoken word recognition is an important part of speech comprehension, it involves segmental and suprasegmental information. By extracting features from words, one can recognize them.

There are many segmental factors influence word recognition, which can be roughly divided into consonant factors and vowel factors. In the process of recognizing a Mandarin word in speech comprehension, it is of great importance to extract aspirated feature from Mandarin-Chinese consonant. As a tonal language, four tones also play an essential part of Mandarin-Chinese, the contribution of it at the process of Mandarin spoken words can be tested at the same time.

Previous studies have made some research on segmental and suprasegmental priming effect. Jiang finds out Mandarin-Chinese tone has implicate priming effect while Cantonese-Chinese do not have through the reaction accurate rate and mean reaction time [2]. Sereno and Lee did two priming experiments examined the separate contribution of lexical tone and segmental information in the processing of spoken words in Mandarin Chinese and concluded that segment plays a major role

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while tone plays the secondary one in it and Zhong found the same result by using the evidence of eye movement [3,4]. However, it turns different in some other researches, Li and Wu draw a conclusion that tonal information plays a more important role in Mandarin-Chinese compound words recognition [5]. Li and Wu thought that the different priming ways and the experiment tasks are factors, for example, the result of auditory paradigm may vary from that of visual paradigm [5].

From a traditional Chinese phonology view, Mandarin-Chinese syllable (apart from the tone) consists of a initial and a final (Table 1) [6,7]. The initial is optional and it has twenty consonant phonemes, which can be divided into six natural classes, each includes a minimal pair contrasted by aspirated feature, three of them are stops. Different from most Indio-European languages, here are four tones in mandarin: a Tone1 or 55 in Chao Yuan-ren's five level tone marks, a Tone2(35), aTone3(214) and a Tone4(51) [8]. The paper will focus on aspirated feature and tonal information of this two way contrast language based on priming effect.

Table 1: Traditional Chinese syllable.

Traditional Chinese Syllable				
Initial	Final			Tone
	Medial	Nucleus	Coda	
C	H	V	C	

According to Table1, Onset in the Indio-European typical theory is replaced with initial and medial, rhyme is replaced with nucleus and coda.

This study will focus on aspirated feature priming in stops of Mandarin-Chinese monosyllable words and whether it has or not: if it has, whether it is positive or negative. At the same time in the experiment, divide the data according to the tone, analysis whether tone is a factor in the priming.

2. Methodology

2.1. Participants

There are about ten participants involved in the experiment, which includes five males and five females in sex. All of the participants are Mandarin-Chinese native speakers, aged from 18 to 25 years. Participants will first fill a Edinburgh Handedness Inventory, and they need to get a score greater than 40 to prove they are right-handed [9]. Besides all of the participants will be of normal hearing.

The audio will be recorded by a male Mandarin-Chinese native speaker born and growing up in north China, who cannot speak any dialect of Chinese, even a variant of Mandarin-Chinese. The audio will be recorded in a quiet room with a pair of airpods pro and a MacBook Pro (2019) at the sampling frequency of 44100Hz.

2.2. Corpus Design

In order to get the minimal side effect by other structures of syllable, the corpus will use the minimal Mandarin-Chinese syllable structure with a consonant onset: "C-V" structure, that means the syllable has only two phonemes. Co-articulation will also has some influence between words, so all words in corpus are monosyllable real words.

Here is a preview of corpus design (Table 2).

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Table 2: Preview of corpus design.

	Target	homogeneous	+-aspirated	Post-homogeneous	unrelated
p	pa^T	pa^T	p^ha^T	ma^T	\
p^h	p^ha^T	p^ha^T	pa^T	ma^T	\
t	ta^T	ta^T	t^ha^T	na^T	\
t^h	t^ha^T	t^ha^T	ta^T	na^T	\
k	ka^T	ka^T	k^ha^T	xa^T	\
k^h	k^ha^T	k^ha^T	ka^T	xa^T	\

According to table2, The corpus consists of three groups, each of them is made up of a minimal pair, which is contrasted by aspirated feature. In each group, there is a target with four types of primes, which are homogeneous (ex. pa1-pa1), aspirated (ex. p^ha1-pa1), post-homogeneous (ex. xa1-k^ha1) and unrelated (ex. lu1-pa1). In every group, four tones are distributed equally, each syllable has four different tones (neutral tone is not taken into account). In total, there are 24 target words and 96 primes. In the corpus, every prime-target pair shares the same tone.

This experiment focuses on auditory priming, so in the same group, these four words are not related to each so as to avoid the influence of semantic priming.

Here is part of the corpus (Table 3).

Table 3: Part of the corpus.

	Tone	Target	homogeneous	+-Aspirated	post-homogeneous	unrelated
p<b>	HH(tone1)	pa^{55}<ba1>	pa^{55}<ba1>	p^ha^{55}<pa1>	ma^{55}<ma1>	lu^{55}<lu1>
	LH(tone2)	pa^{35}<ba2>	pa^{35}<ba2>	p^ha^{35}<pa2>	ma^{35}<ma2>	$tɕi^{35}$<ji2>
	LL(tone3)	pa^{214}<ba3>	pa^{214}<ba3>	p^ha^{214}<pa3>	ma^{214}<ma3>	xu^{214}<hu3>
	HL(tone4)	pa^{51}<ba4>	pa^{51}<ba4>	p^ha^{51}<pa4>	ma^{51}<ma4>	$ɕi^{51}$<xi4>
p^h<p>	HH(tone1)	p^ha^{55}<pa1>	p^ha^{55}<pa1>	pa^{55}<ba1>	ma^{55}<ma1>	$tʂi^{55}$<zhi1>
	LH(tone2)	p^ha^{35}<pa2>	p^ha^{35}<pa2>	pa^{35}<ba2>	ma^{35}<ma2>	$tʂ^hu^{35}$<chu2>
	LL(tone3)	p^ha^{214}<pa3>	p^ha^{214}<pa3>	pa^{214}<ba3>	ma^{214}<ma3>	ni^{214}<ni3>
	HL(tone4)	p^ha^{51}<pa4>	p^ha^{51}<pa4>	pa^{51}<ba4>	ma^{51}<ma4>	li^{51}<li4>

According to Table 3, pairs of “homogeneous-target”, “aspirated feature-target” and “post-homogeneous-target” all have the same vowel, while unrelated priming will use the different vowel as well as consonant. In addition, the initials of post-homogeneous priming belong to the same natural class of the target initials. All “priming-target” pairs are from the same row of the corpus, so all pairs have the same tone, which means in this priming experiment, tonal information is matched.

2.3. Procedure

All participants will be tested in a silent room with headphones, there will be a computer screen and a keyboard. Participants will hear the sound of a priming followed by a target word. Every time they will hear a ‘priming-target’ pair and after the target word, they need to judge whether these two words are of the same pronunciation or not as quickly as possible by typing the keyboard (‘B’ for same and ‘X’ for not). The programme will record the reaction time. All the audio files will be packaged in Paradigm Experiment for participants [10].

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3. Results

The reaction times of a male and a female are much larger than the other 8 participants, so they were trimmed before calculating. For the rest eight participants and the four prime conditions, the correct rates are as followed (Table 4).

Table 4: The correct rates of four prime conditions.

Prime condition	A	H	P	UR	Total
Correct rate	97.91%	88.54%	95.83%	100%	95.58%

According to Table4, the order of correct rate is H<P<A<UR, it shows that the more different the segmental information is, the easier it is to judge whether they are the same or not.

For reaction times that are above or below two standard deviations of mean reaction time were trimmed, in total there are 46 trails deleted, accounting for 6.12%. The result of mean reaction time (RT), standard deviations and standard errors are shown in Table5 and Figure1.

Table 5: The statistics of four prime conditions.

Prime condition	A	H	P	UR
RT (mean)	834.72	866.91	874.42	829.38
std	381.34	353.78	359.07	504.10
std.erro	28.19	27.62	26.62	36.39

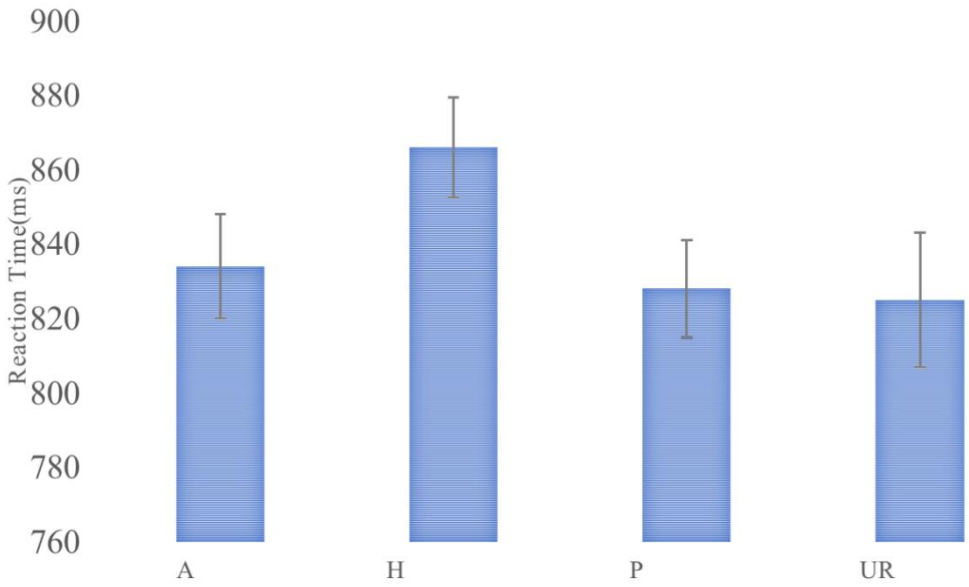

Figure 1: The statistics of four prime conditions.

According to Table5 and Figure1, the mean reaction time of four prime conditions from the slowest to the fastest is Post-homogeneous (P, 874ms) Homogeneous (H, 866ms), Aspirated (A, 835ms) and Unrelated (UR, 829ms). Make unrelated group as the baseline, all other three groups are slower,

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especially the H(38ms) and P(47ms) groups, which means that segmental information has a negative priming effect in Mandarin-Chinese spoken words. When the initials of monosyllable words are changed from aspirated stop to unaspirated or reversed, from the result, the RT will be significantly shortened, while P group here is a controlled variable showing that change the initial to other consonants will not shorten the RT. That means the contracted aspirated feature of the initial will have a significant priming effect when other information is overlapped.

4. Discussions

This experiment focuses on Mandarin-Chinese real spoken words, ignoring the pseudo-word. Aspirated features of pseudo-words may have a different priming effect due to the familiarity and other more factors. Jiang (2019) discovered that the order of tone implicate priming effect mean reaction time between real words and pseudo-words in Mandarin-Chinese is not the same. Besides, the experiment mainly focuses on aspirated feature of stops rather than all types of consonants in Mandarin-Chinese, for one reason is to control variable, but in further study, consonants of other natural classes are ought to be taken into consideration, and the manner information can be extracted and tested whether there is a priming effect or not. Because certain tones do not match a certain consonant in the corpus (only /pha^{214}//ka^{35}/ and /ka^{51}/ in the corpus), these items were deleted before calculating.

5. Conclusion

The paper begins with language comprehension and word recognition, then it talks about the traditional Chinese syllable structure. Th experiment designed four prime conditions and corpus to test the aspirated feature of Mandarin initial word processing. Based on priming effect, the paper calculated the mean reaction time of participants and drew the conclusion that changing the aspirated feature of initial can lead to a positive priming effect.

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