行政院國家科學委員會專題研究計劃成果報告

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☆ 與受試者的因應策略（二） ☆
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計劃編號: NSC87-2413-H-002-018-G8
執行期間: 86年 8月 1日至 87年 7月31日

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協同主持人:

處理方式: □可立即對外提供參考
□一年後可對外提供參考
□兩年後可對外提供參考

執行單位: 國立臺灣大學理學院心理系
中華民國 88 年 4 月 13 日

中文單字語意類別判斷作業、遮蔽作業、促發作業與受試者的因應策略（二）

對普遍語音原則證據的反駁

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摘　　要

透過語意類別判斷作業、遮蔽作業、促發作業等不同研究派典，拼音文字如英文的研究者企圖闡明文字的辨認過程裡存在有辨認前的語音處理歷程，美國研究者 Perfetti 等人（1992，1995）更提出了「普遍語音原則」，主張各種文字的文字辨識中皆存在語音的自動激發，並且以中文研究為該論點的主要支持證據。由於英國研究者 Verstaen 等人（1995）已在最近闡明語意類別判斷作業與遮蔽作業皆存在受試者因應策略的邏輯問題，因此該等作業甚至不能作為支持拼音文字辨識前語音歷程的證據，而且以中文作為材料的其他研究者也無法穩定的得到英文研究的結果，因此根據這兩種作業都無法宣稱能夠支持文字辨識前的語音歷程，更遑論不是表音文字的中文。如此一來，Perfetti 等的中文系列研究就顯得相當突兀，根據本三年計畫的第一年研究結果，筆者有理由推論 Perfetti 用來支持「普遍語音原則」的證據是有問題而不可信的，因此慎重其事規劃質疑的實驗，以反駁 Perfetti 的中文實驗。研究中「重作」Perfetti 等的 1991 年實驗，並另外規劃出較周延且包括操弄 SOA 變項以企圖「涵蓋」Perfetti 等（1997，1998）的兩個實驗。結果顯示 Perfetti 與來自中國大陸合作者等人的一系列中文念字實驗結果是不可信的，有些甚至是未經仔細複驗過而且草率的。

關鍵字：唸字作業、語義促發、形似促發、同音促發。

Subject's strategy on character semantic categorization, backward masking, and priming tasks:

Challenging the validity of phonological priming effects in Chinese: Comment on C.A. Perfetti's work

Abstract

C.A. Perfetti and S. Zhang (1991) proposed that printed word forms routinely and automatically arouse phonological representation as part of their identification when their Experiment 4 showed a priming effect for phonemic primes. However, in Experiment 1 of the present study, there was no priming effect for phonemic primes with 180-ms SOA in using a different randomization procedure, but an interesting inhibitory effect for graphic primes. In Experiment 2 across three SOAs (50-ms, 180-ms, and 500-ms) and in Experiment 3 by adding 100 fillers, the results were the same. Thus, we should reconsider the role of the phonological and graphic representation in the process of lexical identification.

Keywords: naming task, semantic priming, homophonic priming, graphemic priming.

Introduction

Visual word recognition is the process by which people see a printed word and then retrieve information from that word in order to recognize it as part of their vocabulary. This process has been studied for many years and considerable knowledge has been obtained about it. In the recent years, more and more evidence has demonstrated early phonological process, even in tasks in which phonological recoding is not required (e.g., Von Orden, 1987). Thus, some supporters of the prelexical phonemic activation claim that phonological processing is mandatory and automatic (e.g., Perfetti and Zhang, 1991).

Among the supporters of prelexical hypothesis, Perfetti and his colleagues proposed the universal phonological principle (Perfetti, Zhang, and Berent, 1992), indicating that phonological information is automatically activated in both alphabetic and nonalphabetic writing systems. In alphabetic writing systems, Perfetti, Bell, and Delaney (1988) used a backward masking paradigm to support this hypothesis on English. In the task, subjects had to recognize targets presented within a very short duration (usually 15-30 ms). Because targets were presented at a fast rate, the influence of phonological, graphic and semantic properties were thought to occur in the early stage of word recognition. The procedure of the backward masking task is that a target word (e.g., late) is presented, and then is followed by a pseudo-word, and finally is replaced by a simple pattern mask. The pseudo-word, which masks the target, can be phonemically similar to the target (e.g., lait), or graphemically similar (e.g., lart), or a control mask (e.g., dosk). The results showed that pseudo-word that were phonemically similar to the targets produced better identification rates than graphemically similar masks. This outcome suggests that masks contributed to the reinstatement of the phonological properties of the targets.

Unlike English, a logographic orthography, Chinese in which the graphemic structure represents meaningful morphemes, not sublinguistic phonological units, should not be applied to the universal phonological principle due to the internal structures of Chinese characters. A substantial amount of Chinese characters - i.e., about 82% (Zhou, 1978) - consist of complex characters made by two components, one of which, sometimes called the radical, provides a graphically distinctive, categorical cue to the meaning; and the other component, called the phonetic, may cue the pronunciation of the character. However, the phonetic parts in these complex characters are basically themselves characters having their own pronunciation (thus providing phonetic cues) and meanings (their meanings being typically different from the meanings of the complex characters in which they are embedded). In addition, these phonetic components do not always provide constant and reliable cues to the pronunciation of their complex characters (Chen, Flores d'Arcais, and Cheung, 1995). Thus, some researchers claim that word meaning is accessed earlier than phonology (e.g., Tzeng and Hung, 1978).

However, in Chinese, Perfetti & Zhang (1991) found that phonological processing of Chinese characters occurred very early. In particular, their Experiment 4 showed a priming effect for phonemic primes with 180-ms SOA, which was sufficient for identification. This evidence supported that a phonemically based name code is immediately available on the access of the meaning of a character. They therefore claim that the name of a character is available as part of its identification process in Chinese.

In addition to demonstrating that the phonological code is automatically activated, Tan and Perfetti (1997) provided evidence on phonological information "mediate" access to Chinese word meaning. They employed the phonologically mediated priming paradigm to distinguish two possible routes of access to character meaning. One is a visual route from the orthographic lexicon to the meaning system. The other one is a phonologically mediated route from the orthographic lexicon to the phonological lexicon and, then, to the meaning system. The logic of their study is that if only the visual-orthographic route controls access to character meaning, synonym primes but not homophones of synonym primes will accelerate target recognition. If the phonology connection mediates access to the meanings of all characters, both synonym primes and homophones of synonym primes should facilitate character processing, and their facilitation effects should not be different. In their Experiment 1, they obtained a phonologically mediated priming effect in Chinese, a result supported a phonology-before-meaning hypothesis, with 129ms prime-target stimulus onset asynchrony (SOA) that is sufficient to assure semantic priming. When the SOA extended to 243-ms as in their Experiment 2A, the phonological information still contributed to character meaning activation. However, the outcomes of their Experiment 2B indicated hat when a prime character was exposed for 500-ms, the verification stage of character identification has been completed so that homophone would not facilitate target recognition. Thus, these results suggest that the usual sense of mediation in word identification is that a graphic input is transformed into a phonological form that then brings about some ultimate identification event.

Another evidence supporting the phonology-plus-meaning view from the priming paradigm of Perfetti and Tan (1998). They varied prime type and SOA. The results showed that a sequence of facilitation over SOA: (a) graphic, (b) phonological, (c) semantic. Graphic information was activated first within 34ms, followed by phonological information within 57ms and by semantic information within 85ms. In addition, the onset of graphic inhibition coincided with the onset of phonological facilitation. Graphic facilitation turns to inhibition by 57ms at the same time that phonological facilitation effects emerge. The outcomes of their study suggest that access to phonological forms can precede meaning access in single-word reading and, more important, that phonological forms become actual constituents of word identification rather than addenda.

Regarding to Perfetti's backward masking paradigm, however, Verstaen, Humphreys, Olson, and d'Ydewalle (1995) demonstrated that under certain conditions the phonological effects will disappear. In their Experiment 4 there were two types of word targets: homophones and words that were not homophones (henceforth called "normal targets"). In one condition, normal targets were presented in the first half of the experiment and homophone targets in the second half. In the other condition, homophone targets occurred first, followed afterward by normal targets. Phonemic effects emerged in the former; however, in the latter only graphemic effects occurred. These results clearly suggest that phonological effects in backward masking are strategy-dependent and that this paradigm could produce non-phonological processing.

The present study employs the priming paradigm to replicate the phonological effects of Perfetti and Zhang (1991, Experiment 4) in Chinese. In Experiment 1, we use a different randomization procedure compared to that of Perfetti and Zhang. Experiment 2 varies the SOA between prime and target and experiment 3 adds 100 fillers to see if the phonological effects are robust. All three experiments use the naming task, which requires subjects to consult the phonological representation associated with the stimulus. Under this framework, we expect to obtain early phonological activation because phonological information ought to have been more useful in the naming task than a non-naming task.

Experiment 1

Since Perfetti and Zhang (1991) adopted an entirely within-subjects design in their experiment 4, a target character was named four times by a subject. The repetitive effect of the same target character will be difficult to evaluate within their experiment. Hence, we made changes in the experimental design. First, the same target characters were evenly distributed throughout four blocks that no block had repetitive targets. In the meantime, four types of prime characters were also evenly distributed throughout four blocks. If their results are reliable, these changes in design should not obtain different outcomes.

In addition, according to Perfetti and Zhang (1991, Experiment 4), 180-ms SOA was sufficient for identification. Under this circumstance, the name of prime character should be immediately activated as part of the identification of the prime character. Thus, a clear priming effect for phonemic primes should be observed.

Method

Subjects. Nine native speakers of Chinese participated in the experiment. All subjects were students chosen from National Taiwan University.

Materials. The materials were the same with Perfetti and Zhang (1991), except for six graphic primes to meet Taiwanese environment. All materials consisted of 34 Chinese target characters and their associated prime characters, 4 for each target. The primes included: (a) a phonemic character, which was homophonic to its target; (b) a graphic character, which had substantial visual overlap with its target; (c) a semantic character, which was closed related in meaning to its target; (d) a control character, which had little graphic, phonemic, or semantic similarity to its target.

Design. All subjects received four types of primes, producing an entirely within-subject design. Each prime (abbreviated as P) was given two entries. One entry numbered 1 to 34 meant the 34 targets. The other entry assigned h, g, s, and c meant homophonic, graphic, semantic, and control primes. The primes were divided into four blocks. Block 1 was composed of P1h, P2g, P3s, P4c, P5h, P6g, P7s, P8c,...., P33h, P34g. Block 2 was composed of P2h, P3g, P4s, P1c, P6h, P7g, P8s, P5c,...., P34h, P33c. Block 3 was composed of P3h, P4g, P1s, P2c, P7h, P8g, P5s, P6c,...., P33s, P34c. Block 4 was composed of P4h, P1g, P2s, P3c, P8h, P5g, P6s, P7c,...., P33g, P34s. Randomization procedures were administrated between blocks and within each block. Thus, target characters and four types of prime characters were evenly distributed throughout the four blocks.

Procedure. There were 10 practice trials before the experiment. The prime characters and target characters used on practice trials differed from those used on experimental trials. An experimental trial began with a cross used as a fixation point in the middle of a computer screen for 500 ms, followed immediately by a prime character for 180 ms, and followed immediately (ISI=0) by a target character remained on the screen until the subject responded by naming the target character. A microphone connected to a voice activated circuit was interfaced with the computer to trigger the latency measurement between the onset of target exposure and the initial vocalization of the subject. Subject were instructed to name the target character as quickly and correctly as possible. During the practice trials, the feedback of "correct" or "wrong" was displayed on each trial. No such feedback was given on the experimental trials.

Results

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insert Table 1 about here

During the computation of mean correct reaction time, the trials with latency shorter than 100 ms (indicating accidentally prompt response) or greater than the condition mean for 3 standard deviations and more were treated as outliers and were excluded from the computation. The mean correct percentage and reaction time were shown in Table 1. There was no speed/accuracy trade-off. The mean correct percentages of four conditions were all above 97 percent. The analysis of variance (ANOVA) for RT data revealed a main effect of prime type, $F(3,24)=6.19$, $p<0.01$, by subject; $F(3,99)=5.01$, $p<0.01$, by item.

The post hoc comparison using Dunnett's tDN method showed that only graphic primes produced a 33-ms inhibition effect relative to controls, $tDN=3.313$.

Discussion

The experiment showed a different result compared to Perfetti and Zhang (1991, Experiment 4). There were no priming effects for phonemic primes and semantic primes, but a graphic inhibition (see also Wu and Chen, 1998; Chen, Flores d'Arcais, and Cheung, 1995; Segui and Grainger, 1990). Why did the phonological and semantic priming effects not appear in the present study? A relevant research in Chinese may give an explanation. Wu and Chen (1998) found that when targets were high frequency characters (the mean frequency of the target characters was 250.7 per million, according to Wu and Liu, 1987), the naming time of subjects showed no significant differences in phonemic primes and semantic primes relative to controls in the priming paradigm. However, when targets were low frequency characters (the mean frequency of the target characters was 6.7 per million), there were significant phonological and semantic priming effects. Here the mean frequency of the target characters in Perfetti and Zhang (1991, Experiment 4) was XX. Thus, this experiment could not obtain phonological and semantic priming effects.

Experiment 2

The Experiment 1 replicated Perfetti and Zhang's study (1991, Experiment 4) and could not find phonemic and semantic facilitation effects. The present study attempted to investigate these priming effects with a longer SOA (500ms) and a shorter SOA (50ms) compared to the 180ms SOA in Experiment 1. According to Tan and Perfetti (1997), the verification stage of character identification has been completed within 500-ms SOA. Thus, we should obtain a semantic facilitation, but not a phonemic facilitation for 500ms SOA. In addition, Perfetti and Tan (1998) has demonstrated that homophonic primes showed significant facilitation by 57ms SOA, but semantic primes still had no effect. With the 50ms SOA, we expect to see the same results.

Method

Subjects. Thirty-one new students were from the same participant pool as was used in Experiment 1. Each of the 50-ms and the 180-ms SOAs had ten subjects. For the 500-ms SOA, eleven subjects participated.

Materials. All stimuli were identical to those of Experiment 1.

Design. Two factors were manipulated in this study. One within-subject factor was the four types of primes (phonemic, graphic, semantic, and control). One between-subject factor was the three SOAs (50ms, 180ms, and 500ms).

Procedure. Except for the addition of two SOAs (50ms and 500ms), the procedure was identical to that of Experiment 1.

Results

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insert Table 2 about here

The mean correct percentage and correct reaction time were shown in Table 2. There was no speed/accuracy trade-off. The mean percentages of twelve conditions were all above 98 percent. The analysis of variance (ANOVA) for correct RT data revealed a main effect for prime type, $F(3,84)=40.05$, $p<.01$, by subject; $F(3,99)=7.78$, $p<.01$, by item. However, there was an inconsistent main effect for SOA factor, $F(2,28)=2.19$, $p>.1$, by subject; $F(2,66)=266.92$, $p<.01$, by item. Finally, there was no significant interaction effect between prime type and SOA factor, $F(6,84)=.54$, $P>.6$, by subject; $F(6,198)=1.28$, $p>.2$, by item.

The post hoc comparison using Dunnett's t_{DN} method showed that across SOAs there were only significant differences between graphemic primes and control primes, a 34-ms inhibition effect for 50-ms SOA, $t_{DN}=5.305$; a 26-ms inhibition effect for 180-ms SOA, $t_{DN}=4.057$; and a 35-ms inhibition effect for 500-ms SOA, $t_{DN}=5.461$.

Experiment 3

Although Experiments 1 and 2 adopted the experimental design to avoid the repetitive effect of the target characters, the same target still appeared four times in the total 136 trials to a subject. It is possible that the same target characters are detected by the subject. Thus, Experiment 3 added 100 fillers to reduce the possibility or avoid other possible situations that the subjects' responses are likely to be influenced by strategic processes based on conscious awareness.

Method

Subjects. Thirty-three new students were from the same participant pool as was used in Experiment 1. For each of the three SOAs, eleven subjects participated.

Materials. Except for adding 100 fillers, all stimuli were identical to those of Experiment 1. These fillers had very little graphic, phonemic, or semantic overlap with target characters.

Design. The same factors as in Experiment 2 were used.

Procedure. The same procedure as in Experiment 2 was used.

Results

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insert Table 3 about here

The mean correct percentage and correct reaction time were shown in Table 3. There was no speed/accuracy trade-off. The mean percentages of twelve conditions were all above 98 percent. The analysis of variance (ANOVA) for correct RT data revealed a main effect for prime type, $F(3,90)=56.06$, $p<.01$, by subject; $F(3,99)=9.03$, $p<.01$, by item. Also, there was a main effect for SOA factor, $F(2,30)=4.26$, $p<.05$, by subject; $F(2,66)=211.96$, $p<.01$, by item. Finally, there was no significant interaction effect between prime type and SOA factor, $F(6,90)=1.25$, $P>.05$, by subject; $F(6,198)=1.10$, $p>.05$, by item.

The post hoc comparison using Dunnett's tDN method showed that across SOAs there were only significant differences between graphemic primes and control primes, a 52-ms inhibition effect for 50-ms SOA, tDN=7.806; a 43-ms inhibition effect for 180-ms SOA, tDN=6.455; and a 35-ms inhibition effect for 500-ms SOA, tDN=5.254.

Discussion of Experiments 2 and 3

By adding fillers (Experiment 3) or not (Experiment 2), we could not find a semantic facilitation at 500-ms SOA by which a verification stage of character identification has been completed (Tan and Perfetti, 1997), nor a homophonic facilitation at 50-ms SOA as Perfetti and Tan (1998) demonstrated that graphic facilitation turned to inhibition by 57-ms at the same time that phonological facilitation effects emerged.

More important, in Experiments 2 and 3 graphic inhibition effects were robust across 50ms, 180ms and 500ms. These effects were different from the study of Perfett and Tan (1998) in which the shifting effects of graphic primes, from facilitation at 43-ms SOA to inhibition at 57 and 85ms, and finally disappearing at 115ms, nor a null effect at 180-ms SOA (Perfetti and Zhang, 1991, Experiment 4).

General Discussion

The Experiment 4 of Perfetti and Zhang (1991) demonstrated that a phonemic priming effect was observed on the time to name the target character. This evidence was inferred to support the assumption that the name of a character is available as part of its identification process. However, using a naming task by which phonological information ought to have been useful than in a non-naming task, we could not find phonological priming effects in these three experiments. Thus, it should be cautious about the assumption of phonology being a part of word identification in Chinese.

In regard to the robustly graphic inhibition effects in these three experiments, we are curious about the role of visual forms in lexical identification. With a semantic categorization task, Chen, Flores d'Arcais, and Cheung (1995) found the absence of phonological effects and the presence of clear effects of visual similarity for Chinese characters. They suggest that these results support the existence of the direct access from orthography to meaning. Obviously contrary to the hypothesis of a universal principle of phonological activation, more relevant research should be provided to elucidate this issue.

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Table 1

The mean correct latencies in miliseconds as function of prime condition in experiment 1(error percentages in parentheses)

	prime condition			
	phonemic	graphemic	semantic	control
RT	482	515	477	482
	(.0)	(2.3)	(.7)	(.3)

Table 2

The mean correct latencies in miliseconds as function of SOA and prime condition in experiment 2 (error percentages in parentheses)

SOA	prime condition: phonemic	graphemic	semantic	control
50ms	484	521	483	487
	(.6)	(1.5)	(.0)	(.0)
180ms	482	513	487	487
	(.3)	(1.5)	(.0)	(.6)
500ms	436	467	431	432
	(.8)	(.8)	(.3)	(.3)

Table 3

The mean correct latencies in miliseconds as function of SOA and prime condition in experiment 3 (error percentages in parentheses)

SOA	prime condition: phonemic	graphemic	semantic	control
50ms	532	567	523	515
	(.3)	(1.3)	(.3)	(.0)
180ms	478	514	475	471
	(1.1)	(1.3)	(.0)	(.8)
500ms	439	482	443	447
	(.8)	(1.3)	(.0)	(.5)