Priming effects between words having homographic but non-homophonic characters were more inhibitory, compared with effects between words having homographic-homophonic characters. Words having orthographically different homophonic morphemes did not prime each other throughout the experiments. The results were discussed in terms of how lexical representations incorporate morphological structure and how morphological, orthographic, and phonological information interacts in constraining semantic activation of constituent morphemes and compound words.

INTRODUCTION

Most Chinese words are compound words, composed of two or more constituent morphemes. According to the Institute of Language Teaching and Research (1986), compound words are over 70% of all words used in Chinese. A crucial issue in the study of lexical processing of Chinese is therefore how compound words are represented in the mental lexicon and how their lexical knowledge is accessed in visual or spoken word recognition. In recent years, there have been several studies of the role of morphological structure in lexical representation and processing of Chinese compound words (Taft & Zhu, 1995; Zhang & Peng, 1992; Zhou & Marslen-Wilson, 1994, 1995), and many studies of phonological and orthographic activation in reading Chinese single-character words (Chen, Cheung, & Flores d'Arcais, 1995; Leck, Weekes, & Chen, 1995; Perfetti & Zhang, 1991, 1995; Zhou, 1997; Zhou & Marslen-Wilson, 1999b in press a, b). Few studies, however, have tried to combine the two lines of approaches and to investigate how morphological, orthographic, phonological, and semantic information interacts in lexical processing of compound words. The main purpose of this research was therefore to fill in this gap. Specifically, we examined how lexical processing in reading Chinese compound words is constrained by morphological processing of their constituent morphemes and to what extent orthographic and phonological properties of constituent morphemes interact with morphemic processing and semantic activation of whole words.

In investigating lexical representation and morphological processing, it is essential to distinguish different types of morphological process, in particular between inflectional, derivational, and compounding procedures. Although the linguistic boundaries between these different types of word-formation process are sometimes blurred (Bybee, 1985), there are nonetheless potentially significant differences in the mental representation and processing of each type of complex word. The term ''morphological processing'' is being used here specifically in relation to the processing (and representation) of compound words and, perhaps more importantly, to the form and semantic processing of their constituent morphemes.

Further studies are needed to examine whether the arguments and the generic representation model proposed below for compound words can be applied to other types of

their constituent morphemes sharing some of their features, depending on semantic compositionality (transparency) of compound words (Zwitserlood, 1994).

The modified model can easily incorporate orthographic representations (Zhou & Marslen-Wilson, 1999c). It can be envisaged that there are orthographic representations for constituent morphemes that connect directly to their phonological and semantic representations, as well as to semantic representations of compound words containing these morphemes. Figure 1 illustrates prototypical orthographic (O), phonological (P), and semantic (S) representations and connections between them fosed

level, compound words may share many semantic features with constituent morphemes. The degree of overlap reflects the semantic transparency of compound words. Representations at different levels are excitatorily connected, so that activation spreads bidirectionally between them.

Clearly, the schematic model illustrated in Fig. 1

inf[illegible]mation abou[illegible] [illegible]urrence of these syllables, see Zhou & Ma[illegible]en-Wilson, [illegible] [illegible]t access from orthography to semantics co[illegible] play at mos[illegible] [illegible]. One problem with this strong phonological vie[illegible] however, is [illegible] [illegible]e supporting experimental evidence, which is [illegible]ainly based [illegible] [illegible]parison of the relative time course of ph[illegible]ological and [illegible] [illegible]vation in reading characters, proves to be di[illegible]ult to repli[illegible] [illegible] for example, Chen & Shu, 1997; Zhou & Ma[illegible]len-Wilson, [illegible]n pre[illegible]a, b).

[illegible]ou and Ma[illegible]len [illegible]son ([illegible] press a, b) promoted an interactive view ac[illegible]ding to whi[illegible]h a[illegible] to s[illegible]antics in reading Chinese is constrained by [illegible]oth orthogr[illegible]ph[illegible] a[illegible]ogy operating in interaction with each ot[illegible]. Both dir[illegible]ct [illegible] from orthography to semantics and m[illegible]ation throu[illegible]h [illegible] activation and the interaction between th[illegible]wo routes p[illegible]ay [illegible] [illegible]ultiple constraint-satisfaction process of ac[illegible]sing seman[illegible]ics [illegible]eading. Based on evidence from studies us[illegible] different [illegible]xpe[illegible] [illegible]aradigms tapping directly into semantic ac[illegible]ation, inclu[illegible]ng [illegible]ategorisation (Chen et al., 1995; Leck et al., 19[illegible]; Sakuma, S[illegible]san[illegible] [illegible]umi, & Masaki, 1998; Wydell, Patterson, & H[illegible]phreys, 199[illegible]), [illegible]udgment (Xu, Pollatsek, & Potter, 1999; Z[illegible]u, Pollatsek, & [illegible]len-[illegible]ilson, 1999), and phonologically mediated se[illegible]antic priming (Zh[illegible] 1997[illegible] Zhou & Marslen-Wilson, in press b), Zhou [illegible] his colleag[illegible]s [illegible]her a[illegible]gued that it is orthography, rather than [illegible]nology, that [illegible]lay[illegible] relat[illegible]vely more important role in determining [illegible]antic activati[illegible] in[illegible]eading Chinese.

[illegible]n this study, [illegible]e in[illegible]estigate[illegible] whether this interactive view applies to [illegible]ual recognitio[illegible] of [illegible]wo-cha[illegible]acter, two-syllable compound words. We [illegible]d masked and v[illegible]sual-vis[illegible]al priming lexical decision tasks and manipulated systemati[illegible]ally th[illegible] morphological, orthographic, and phonological relations bet[illegible]een p[illegible]imes and targets. The stimulus onset asyJ1009ca of their constituent morphemes. Although theoretically the initial morpheme of the third type of prime (e.g.,

完整 wan[2] zheng[3], *intact*).

There were at least two reasons for predicting a facilitatory priming effect between words sharing initial morphemes. Firstly, repeated access to morphemes shared between primes and targets, i.e., their orthographic and phonological forms and morphemic meaning, should facilitate the form and semantic activation of the targets. Secondly, primes and targets as wholes were semantically related as well, in the same way as words sharing no common morphemes (e.g., 医生 yi[1] sheng[1], *doctor*; and 护士 hu[4] shi[4], *nurse*). For words having homographic and homophonic morphemes (e.g., 华侨 hua(2) qiao(2), *overseas Chinese* and 华贵 hua(2) gui(4), *luxurious*), one would normally predict an inhibitory effect between them in visual-visual priming. The visual input of the critical character in a prime should activate two different morphemic meanings, one corresponding to the morpheme in the prime and one corresponding to the morpheme in the target. There should be competition between the activation of these morphemic meanings, with the one used in the prime taking the upper hand. When the target is presented, the critical morphemic meaning used in the prime is initially activated further. It takes time for the morphemic meaning used in the target to overcome this competition and to activate semantics of the whole word (Laudanna, Bedecker, & Caramazza, 1989, 1992; Zhou & Marslen-Wilson, 1995). On the other hand, it was not clear what kind of effects we would ex1001625905Tm[(d)]T4955Tm26T(sp)23(o)46

] xiang[2], *glide*; and 华贵 hua[2] gui[4], *luxurious*) depends crucially on whether phonological mediation is the predominant route for accessing

Marslen-Wilson, in press a, b), pre-activating a constituent syllable of the target may have no signi cant in uence on lexical processing of the target.

Method

Design and Materials

Forty compound words were selected as targets, completed with the four types syllables or characters in the ﬁller primes and targets had been used in the critical primes and targets. Twenty prime-target practice pairs, which had the same compositions as formal test items, were also selected.

A Latin square design was used to assign critical primes and their targets to four counter-balanced test versions. In each version, there were ten primes from each of the four priming conditions for the critical word targets, and ten primes for each of the four priming conditions for the critical nonword targets. The same 108 ﬁller prime-target pairs were used in the four test versions. A single pseactidit00110022018Tm[(p)23omr

× 5.4 cm in size and the prime was slightly smaller.

The presentation of stimuli to subjects and the recording of reaction times and response errors were controlled by the experimental software DMASTR, developed by K n and Jonathan Forster. In visual priming, an eye ﬁxation signal (" ") was ﬁrst presented at the centre of the screen for 300 ms, followed by a 300 ms blank interval. A prime was then presented either for 57 ms or for 200 ms, depending on the SOA, followed immediately by presente

target

accurately as possible, by pressing ''yes'' and ''no'' buttons on the response boxes in front of them, whether each target was a real word or not. The dominant hand was used for the ''yes'' keys. Each subject saw first a list of 20 prime-target practice items. There was a break after practice and a break in the middle of the main test session. The first three pairs after each break were always fillers. The complete test session for each subject was less than 20 minutes.

Subjects

A total of 137 native speakers of Mandarin Chinese were tested, 52 in masked priming, 45 in visual-visual priming with SOA of 57 ms, and 40 in visual-visual priming with SOA of 200 ms. Each test version had roughly equal number of subjects. Subjects in masked priming and in visual-visual priming with SOA of 200 ms were either students or visiting scholars at universities in London while subjects in visual-visual priming with SOA of 57 ms were undergraduate students at Beijing Normal University. They all were paid for their participation.

Results

Three words in masked priming, four words in visual-visual priming with SOA of 57 ms, and two words in visual-visual priming with SOA of 200 ms were deleted from analyses because over 50% of responses to these items in one or more test versions were incorrect. Mean reaction times, based on correct responses and without trimming, and percentages of response error were then computed for each subject and each item. Table 2 reports mean reaction times and error percentages to critical word targets in both masked and visual-visual priming.[2] Priming effects for word targets, as assessed against control baselines, are also plotted in Fig. 2. Analyses of variance were performed on reaction times and error rates in overall analyses with sub-experiment as a between-subject factor and prime type as a within-subject factor having four levels (MORPH, CHAR, HOM, and CON). Only items included in all sub-experiments were entered into item tests. Separate analyses were also conducted for different priming conditions.

There was a significant main effect of sub-experiment in the analyses of reaction time [$F_1(2,134) = 3.82$, $P < .05$, $F_2(2,70) = 26.74$, $P < .001$], indicating that subjects in different sub-experiments were not equally fast. More importantly, the main effect of prime type was highly significant

[2] No significant differences between priming conditions in the nonword design were found in this and the following experiments. To save space, we do not report the nonword data in this paper.

TABLE 2
Mean Reaction Times (ms) and Error Percentages in Experiment 1

	MORPH	*CHAR*	*HOM*	*CON*
Masked	563 (5.1)	583 (9.1)	611 (10.1)	609 (8.1)
SOA 57 ms	575 (5.8)	595 (7.6)	628 (9.3)	618 (6.2)
SOA 200 ms	606 (3.7)	648 (7.1)	637 (6.8)	644 (7.1)

[$F_1(3,402) = 42.038$, $P < .001$, $F_2(3,105) = 16.63$, $P < .001$]. Post hoc Newman–Keuls tests showed that the mean reaction times for MORPH primes (580 ms) and CHAR primes (608 ms) were all significantly shorter ($P < .01$ or .05) than the times for HOM primes (625 ms) and CON primes (623 ms). Moreover, while the 28 ms difference between MORPH primes and CHAR primes was significant ($P < .01$), the 2 ms difference between HOM and CON primes was not ($P > .1$), indicating that words having orthographically different homophonic morphemes did not prime each other. The interaction between prime type and sub-experiment was

FIG. 2. Priming effects (ms) in Experiment 1.

of HOM primes and targets were activated when the primes were presented.[4] However, this phonological activation by itself had little effect on the activation of morphemic semantic representations of the initial morphemes. The projection of visual input of the initial morphemes of targets onto the already activated morphemic phonological representations does not contribute much to the semantic activation of these initial morphemes and of the whole targets.

EXPERIMENT 2

Experiment 2 was essentially a replication of Experiment 1, but with the critical morphemes now at the second constituent position of both primes and targets. The purpose of this experiment was to collect converging evidence concerning morphological, orthographic and phonological processing of compound words. The empirical question was whether the pattern of priming effects in Experiment 1 was retained when the activation of critical morphemes in primes and target was more constrained by the processing of the initial morphemes of compound words.

In auditory-auditory priming, such a change of constituent position of critical morphemes in primes and targets resulted in different patterns of priming effects for words having homophonic morphemes (Chen & Cutler, 1997; Zhou & Marslen-Wilson, 1995). Facilitatory priming 3Tm[(e)23(m)23 between the first and second constituents. We therefore expect to observe a similar pattern of priming effects as in Experiment 1.

Method

Design and Materials

The experimental design was very similar to the one illustrated in Table 1, except that the critical morphemes were at the second constituent position. A target word (e.g., 简易 jian[3] yi[4], *simple*, *unsophisticated*, in which 易 means ''easy' with SOA of 57 ms, and 44 in visual-visual priming with SOA of 200 ms. They were native speakers of Mandarin Chinese and were paid for their participation. Each test version of each sub-experiment had roughly equal numbers of subjects.

Results

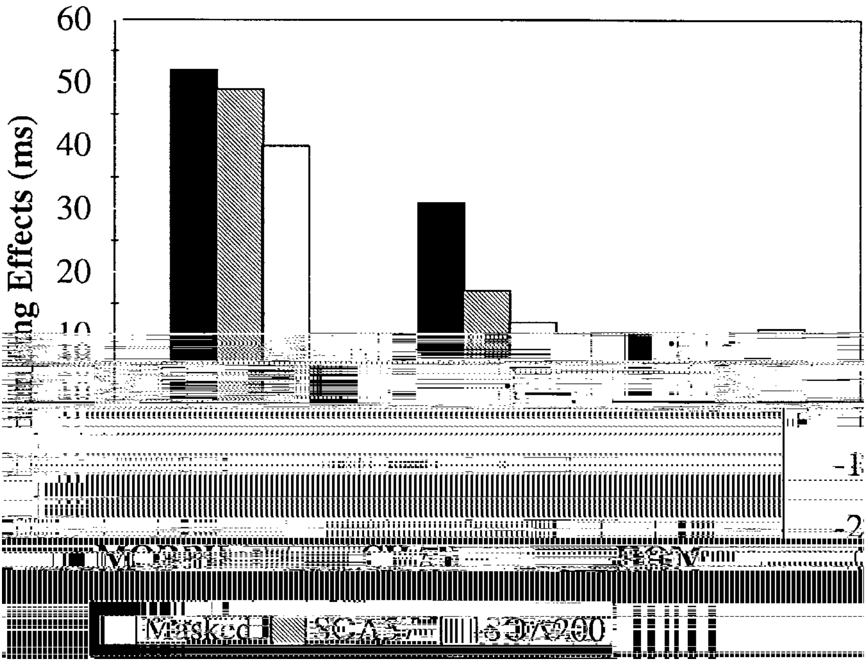
In each sub-experiment, one target was deleted from the analyses because over half of subjects in one or more test versions made incorrect responses. One subject in masked priming was also excluded due to his high response error rate (over 30%). The mean reaction times and error percentages are reported in Table 3. Figure 3 also reports the priming effects for MORPH, CHAR and HOM primes, as assessed against their control primes.

Overall analyses were conducted, with prime type as a within-subject factor and sub-experiment as a between-subject factor. The main effect of prime type was highly signi cant [$F_1(3,426) = 62.81$, $P < .001$, $F_2(3,114) = 15.77$, $P < .001$]. Post hoc Newman–Keuls tests showed that the mean reaction time to target words was signi cantly shorter for MORPH primes (548 ms) than for CHAR primes (575 ms), HOM primes (589 ms), and control primes (594 ms) ($P < .01$). The mean reaction time for CHAR primes was also signi cantly shorter than the time for HOM primes ($P < .05$). In contrast, the difference between HOM primes and control primes was not signi cant ($P > .1$). The interaction between prime type and sub-experiment was signi cance by subjects [$F_1(6,426) = 2.71$, $P < .05$], although not by items, $F_2 < 1$.

Separate analyses were conducted respectively for MORPH, CHAR, and HOM priming effects, as assessed against control primes. For MORPH primes, the priming effect was highly signi cant [$F_1(142) = 156.77$, $P < .001$, $F_2(1,38) = 43.31$, $P < .001$]. Moreover, the interaction between priming effect and sub-experiment was not signi cant [$F_1(2,142) = 1.80$, $P > .1$, $F_2 < 1$], indicating that the morphological priming effect was essentially the same across three sub-experiments. The same pattern

TABLE 3
Mean Reaction Times (ms) and Error Percentages in Experiment 2

	MORPH	*CHAR*	*HOM*	*CON*
Masked	536 (3.4)	557 (5.1)	582 (5.0)	588 (6.7)
SOA 57 ms	554 (3.4)	586 (6.0)	604 (6.0)	603 (6.5)
SOA 200 ms	553 (0.7)	581 (4.7)	582 (4.2)	593 (5.1)

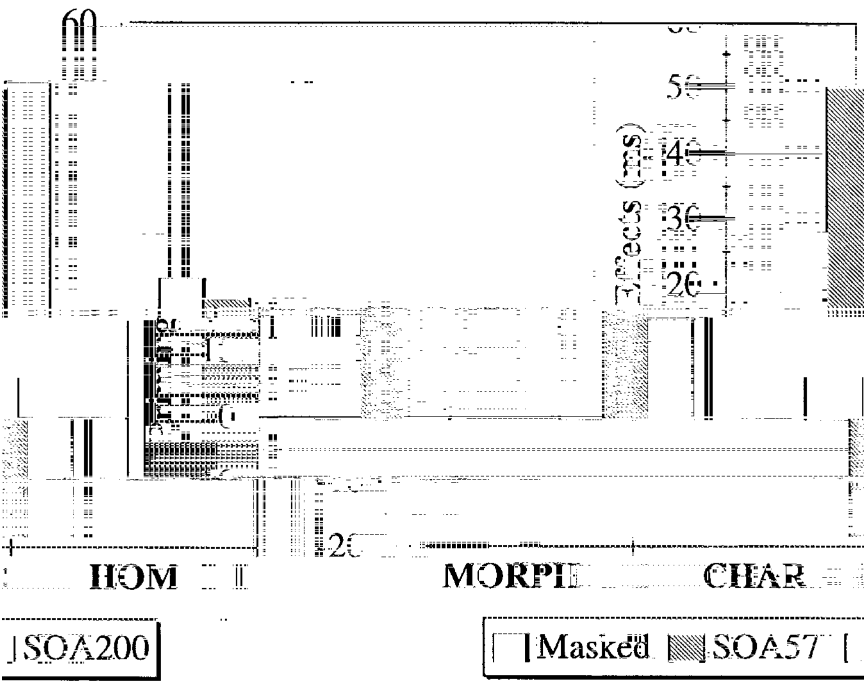


was observed for CHAR primes. Here the priming effect was significant [$F_1(1,142) = 27.07$, $P < .001$, $F_2(1,38) = 4.30$, $P < .05$], but the interaction between priming effect and sub-experiment was not [$F_1(2,142) = 2.05$, $P > .1$, $F_2(2,76) = 1.21$, $P < .1$]. No significant priming effect was found for HOM primes [$F_1(1,142) = 2.82$, $.05 < P < .1$, $F_2 < 1$], nor any interaction with sub-experiment ($F_1 < 1$, $F_2 < 2$).

In the analyses of error rates, the main effect of prime type was significant [$F_1(3,426) = 7.463$, $P < .001$, $F_2(3,114) = 4.99$, $P < .01$]. Post hoc tests showed this effect wawa

subjects [$F_1(6,399) = 2.283$, $P < .05$], and by items [$F_2(6,216) = 2.32$, $P < .05$].

Separate analyses were conducted for priming effects for MORPH, CHAR,



was smaller in masked priming than in visual-visual priming (see Fig. 4). For CHAR primes, the priming effect was significant [$F_1(1,133) = 15.23$, $P < .001$, $F_2(1,36) = 9.07$, $P < .001$], but not the interaction between priming effect and sub-experiment ($F_1 < 1$, $F_2 < 1$). No significant priming effect was found for HOM primes ($F_1 < 1$, $F_2 < 1$). The interaction between this effect and sub-experiment was not significant either, [$F_1(2,133) = 1.04$, $P > .1$, $F_2(2,72) = 1.30$, $P > .1$].

The analyses of error rates found a signi phemes may compete with each other in the time course of activation. It follows that if a character corresponding to a morpheme in the prime does not have a corresponding competitive morpheme in the target, there should be no competition between alternative morphemic semantic conclude that phonological information of constituent morphemes interacts with orthographic information in constraining semantic activation of morphemes and compound words.

Method

Design and materials

There were two sets of critical target words. In Experiment 4A, all the targets were two-character monomorphemic words, such as 沙发 (sha[1] fa[1], *sofa*). Each target was preceded by a compound word (CHAR prime, 沙滩 sha[1] tan[1], *sandy beach*) which had the same initial character as the target. The same target was also preceded by a word (HOM prime, 杀害

Experiments 4A and 4B were run concurrently as a single experiment. The procedures of creating test versions, preparing stimuli, and testing subjects were the same as Experiment 1. Because the patterns of priming effects in masked priming and in visual-visual priming with SOA of 57 ms were essentially the same in Experiments 1, 2, and 3, we did not test subjects for visual-visual priming with the SOA of 57 ms in this and the following Experiment 5.

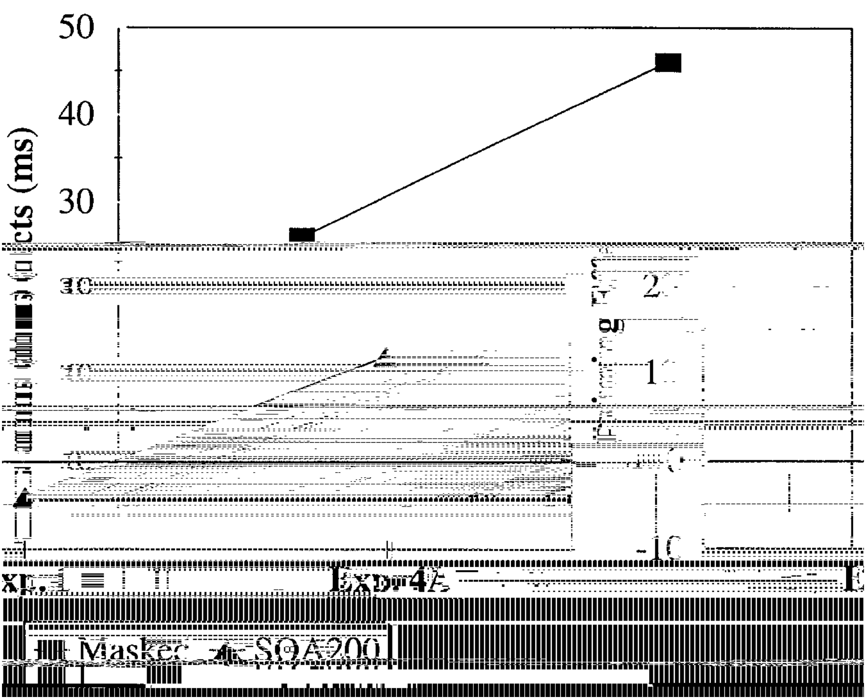
Subjects

Sixty-three subjects in London were tested, 30 in visual priming and 33 in masked priming. Many of them had participated in Experiment 1. However, there was an interval of at least three months between the two experiments. Another 71 subjects were tested in Beijing in a replication of this experiment, with 36 in masked priming and 35 in visual-visual priming. These subjects were undergraduate students at Beijing Normal University and were not tested in the previous experiments.

Results

Because essentially the same patterns of priming effects were found for subjects in London and in Beijing, the analyses reported here were based only on the London data.[6] Mean reaction times and error percentages are reported in Table 5. Separate analyses were conducted for monomorphe-mic targets and phonologically altered (non-homophonic homographic18971

between words sharing homophonic characters, were larger than the effects for compound targets in Experiment 1: the effects for monomorphemic targets increased by 15 ms in masked priming and by 20 ms in visual-visual priming (see Fig. 5). We discuss the implications of these findin



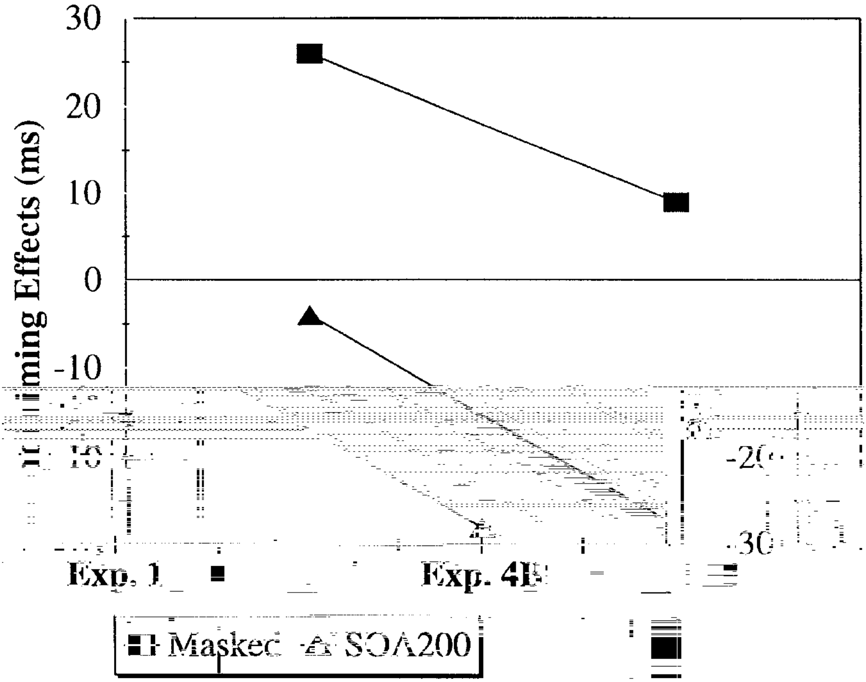


FIG. 6. Priming effects (ms) for CHAR primes in Experiments 1 and 4B.

influences on semantic activation of constituent morphemes and compound words.[7] In the General Discussion we discuss how the model sketched in Fig. 1 handles these findings.

EXPERIMENT 5

The purpose of this experiment was to examine whether the apparent morphological priming effects between words having common morphemes

[7] Because the mean reaction times in Experiment 4B were about 50 ms longer than the times in Experiment 1, one might argue that the more inhibitory effects for targets having non-homophonic homographic characters than for targets having homophonic-homographic characters were not due to the interaction between orthographic and phonological information carried by the homographic characters, but due to the slower reaction times themselves. More phonological information was allowed to come into play when responses were slowed down. It should be noted, however, that the null priming effects between words having orthographically different homophonic morphemes did not change according to the speed of responses (see Tables 1 and 5). Moreover, representing priming effects in terms of the proportion of mean reaction times in control conditions does not change the general pattern of the comparison between experiments.

in Experiments 1, 2, and 3 could be reduced to ‘‘pure’’ semantic priming. As discussed earlier, morphologically related words (e.g., 医院 yi[1] yuan[4], *hospital*; 医生 yi[1] sheng[1], *doctor*) are mostly semantically related as well, like words that are not morphologically related (e.g., 护士 hu[4] shi[4], *nurse*; 医生 yi(1) sheng[1], *doctor*). The previous experiments

MORPH primes and 7.8 for SEM primes. The average word frequencies were 18 and 28 per million respectively for the two types of primes. The mean frequency of control primes was 23 per million.

To prevent subjects from using response strategies based on orthographic

Overall analyses were conducted for reaction times and error rates with prime type as a within-subject factor and sub-experiment as a between-subject factor In the analyses of reaction times, the main effect of prime type was highly signi cant [$F_1(2,118) = 47.41$, $P < .001$, [$F_2(2,84) = 27.85$, $P < .001$], indicating that targets were responded to faster when they were preceded by MORPH and SEM primes than by unrelated control primes. Post hoc Newman-Keuls tests showed that the mean reaction times to targets were signi cantly shorter ($P < .01$) for morphological primes (533 ms) than for semantic prime (557 ms) or control primes (582 ms). The difference between semantic and control primes was also signi cant ($P < .01$). The interaction between prime type and sub-experiment was signi cant by subjects [$F_1(2,118) = 4.32$, $P < .05$, although not by items [$F_2(1,84) = 1.09$, $P > .1$].

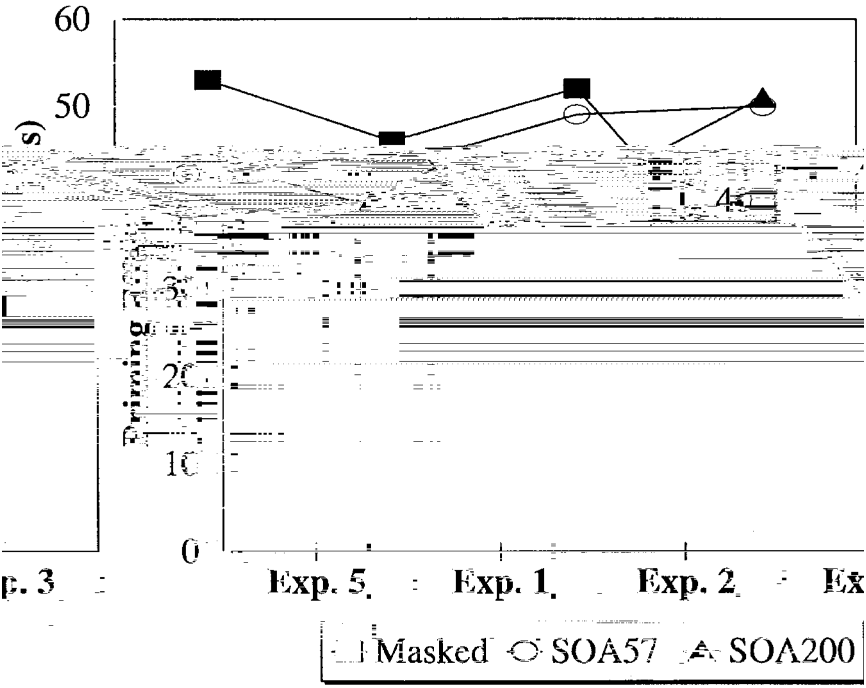
Planned tests were conducted to compare morphological and semantic priming effects. In masked priming, the 36 ms difference between MORPH primes and SEM primes was signi cant [$t_1(28) = 5.99$, $P < .001$, $t_2(42) = 3.30$, $P < .01$]. Moreover, the 17 ms semantic priming effect, as assessed against control primes, was also signi cant [$t_1(28) = 2.23$, $P < .05$, $t_2(42) = 2.65$, $P < .05$]. In visual-visual priming, the difference between MORPH primes and SEM primes (12 ms) was in the same between SEM primes and targets led to larger priming effects for MORPH primes. The larger priming effect in masked priming was likely due to the larger contribution from orthographic and spatial overlap between primes and targets.

GENERAL DISCUSSION

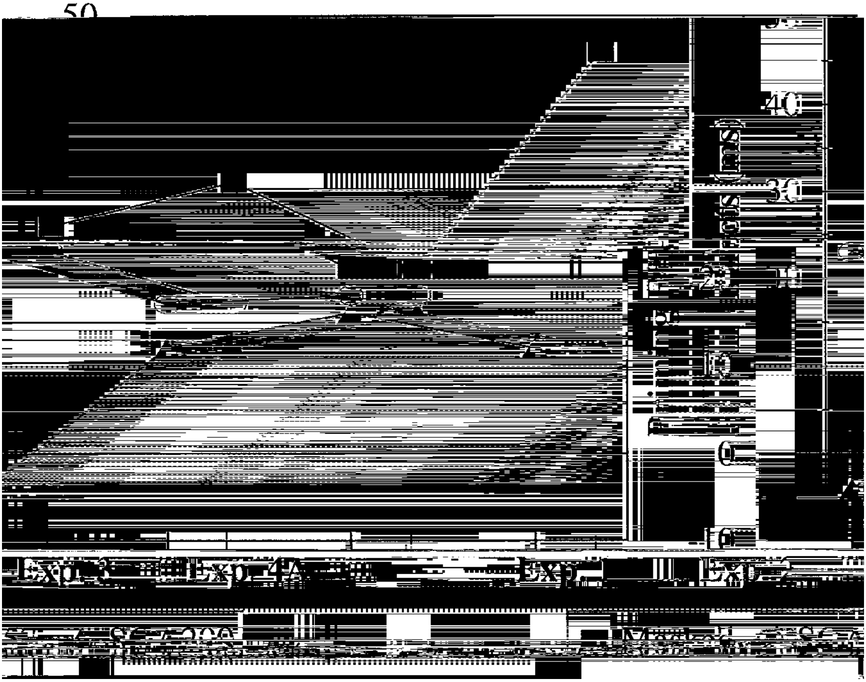
The main purpose of this study was to investigate the interaction between morphological, orthographic, and phonological information in reading Chinese compound words. Results from the five sets of experiments can be summarised as follows. For words having common morphemes, significant priming effects were consistently found in masked and visual-visual priming (Experiments 1, 2, 3, and 5). The effects, however, were reduced in masked priming when the shared morphemes did not occupy the same spatial position (Experiment 3). The morphological priming effects were in general much stronger than the effects between words sharing homographic-homophonic characters or having homophonic morphemes. These effects were also larger than effects between semantically related words not sharing morphemes, although the advantage was reduced in visual-visual priming with a relatively long SOA (Experiment 5). Consistent priming effects were found for words having homographic-homophonic characters (Experiments 1, 2, 3, and 4A), although such words tended to inhibit each other in visual-visual priming with a long SOA when the critical characters were the initial morphemes of both primes and targets (Experiment 1). When the shared homographic characters were not homophones (Experiment 4B), the priming effects between words having these characters as initial morphemes were shifted (Figure 6), with a significant inhibitory effect in masked priming. Throughout the priming tasks and the SOAs between primes and targets, no significant priming effects were found for words having visually different homophonic morphemes (Experiments 1, 2, 3, and 4A).

Morphological priming and morphological structure in the lexicon

Clearly, the priming effects between words sharing morphemes cannot be reduced to just semantic or form-based priming. Instead, they point to a morphological dimension of lexical processing and representation. The prototypical model sketched in Fig. 1 captures this morphological dimension by dynamic *interactions* between form and semantic processing. It is assumed that the orthographic and phonological representations of compound words are composed of the forms of their constituent morphemes. The boundaries of the orthographic and phonological forms of constituent morphemes are clearly marked, partly due to the



Experiments 1 and 2 and with the effects for the same words in visual-visual priming in Experiment 3. The contribution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40
30
Exp. 3
Exp. 4A

second constituent position, however, the competition is weaker, due to the contextual constraint from the processing of the initial morphemes. The processing of the initial morphemes activates the semantic representations of whole words. This semantic activation serves as contextual constraint in interpreting the ambiguous second character and there is less competition between the critical morphemes in these words and the semantic activation of the alternative morphemes. The negative priming effects between words having initial homographic-homophonic morphemes (Experiment 1) can be accommodated by the assumption that the visual input of the initial characters of targets are initially used to support further semantic activation of the critical morphemes in primes. Only when the second constituent of the target enters into semantic processing does the semantic representation of the initial critical character in the target become activated, due to interaction with semantic activation of the whole words.[9]

This semantic account of character priming is supported further by the comparison of priming effects between Experiments 1 and 4A (Figure 5). Because the critical characters do not represent alternative morphemes in monomorphemic words, competition between semantic interpretations of initial homographic morphemes is minimised. Consequently, the processing of monomorphemic targets is more likely to be facilitated by character primes than the processing of compound targets.

Phonology in reading Chinese compound words

In neither masked nor visual-visual priming did we observe significant priming effects between words having homophonic but non-homographic morphemes. This result suggests either that phonological information about constituent morphemes is not activated or that morphemic phonological activation by itself has no significant influence on semantic activation of morphemes and whole words.

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There is evidence that the phonological properties of single-character words or morphemes are automatically activated in reading Chinese (e.g., Perfetti & Zhang, 1995, Zhou, 1997; Zhou & Marslen-Wilson, in press a). There is also evidence that phonological properties of constituent morphemes of compound words are activated, subject to task demands (see Footnote 4). Data from other studies support the proposition of automatic phonological activation of constituent morphemes in reading compound words. Zhou and Marslen-Wilson (1999) found that pseudo-homophones created from compound words by replacing one constituent with orthographically dissimilar homophonic characters were more difficult to reject in lexical decision than matched control nonwords (see also Sakuma et al., 1988 for a similar finding for Japanese kanji constrained both by direct computation from orthography and by phonological mediation. These two routes to semantics operate in interaction with direct access plays a dominant role (Zhou, 1997; Zhou & Marslen-Wilson, in press a, b). The morphemic semantic competition between homographic but not homophonic morphemes is stronger than the competition between homographic-homophonic morphemes. The former types of homographic morphemes compete not only at the semantic level, but also at the phonological level. This phonological competition, acting in conjunction with direct visual access to morphemic semantics, intensifies semantic competition, leading to more negative priming. Another way to account for the phonological effect is to assume that the lexical decision task is sensitive to phonological activation as well as to semantic activation. If semantic activation leads the lexical decision mechanisms to make positive responses but the activation in the phonological syste

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