

Position Effect of Character-Forming Components in Component Priming Paradigm (Post-print)

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Abstract

Character-forming components in Chinese characters occupy diverse positions and serve various functions. Experiment 1 employed a component priming paradigm to investigate the functions of character-forming components at different positions in Chinese character recognition. The prime stimuli were character-forming components occupying three positions (main semantic component position, secondary semantic component position, and phonetic component position), while the target stimuli were Chinese characters containing these position-specific character-forming components; participants were required to perform lexical decisions on the target characters. Experiment 2 combined the component priming paradigm with a visual search paradigm to explore the functions of character-forming components at different positions. The results indicated: (1) The priming effect was stronger when character-forming components occupied the phonetic component position than when they occupied the semantic component position. (2) The priming effect of character-forming components serving as semantic components occurred only when they were in the main semantic component position. (3) Priming by character-forming components in the phonetic component position not only facilitated the recognition of characters containing phonetic position components, but also facilitated the recognition of characters containing main semantic position components, yet inhibited the recognition of characters containing secondary semantic position components. (4) When the primed component was in the secondary semantic component position, it did not affect the recognition of characters containing the relevant component. The overall study demonstrates that component position effects encompass not only the influence of component position on Chinese character recognition, but also the influence of component positional frequency on Chinese character recognition.

Full Text

Location Effect of Chinese Wordable Components in the Component Priming Paradigm

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Abstract

Wordable components in Chinese characters appear in various positions and serve different functions. Experiment 1 employed a component priming paradigm to examine the functions of wordable components in different positions during Chinese character recognition. The priming stimuli were wordable components in three positions (primary semantic radical position, secondary semantic radical position, and phonetic radical position), while the target stimuli were Chinese characters containing these components in the three positions. Participants were required to perform lexical decision tasks on the target characters. Experiment 2 combined the component priming paradigm with a visual search paradigm to further investigate the functions of wordable components in different positions. The results indicated that: (1) The priming effect of wordable components in the phonetic radical position was stronger than that in the semantic radical position. (2) The priming effect of wordable components serving as semantic radicals only emerged when they were in the primary semantic radical position. (3) Priming with wordable components in the phonetic radical position not only facilitated the recognition of characters containing phonetic radical position components, but also facilitated the recognition of characters containing primary semantic radical position components, while inhibiting the recognition of characters containing secondary semantic radical position components. (4) When the priming component was in the secondary semantic radical position, it had no effect on the recognition of characters containing the relevant components. Overall, the study demonstrates that the component location effect encompasses not only the influence of component position on Chinese character recognition, but also the influence of component positional frequency on Chinese character recognition.

Keywords: semantic radical; phonetic radical; wordable components; component priming; location effect

Classification Number: B842

Chinese characters can be structurally classified as simple characters or compound characters. Simple characters are composed solely of strokes without any

radical distinction. Compound characters consist of two or more components and include two types: one type displays character meaning through its constituent elements, such as “男” (composed of “田” and “力,” representing labor in the fields) or “鸣” (composed of “口” and “鸟,” representing bird calls). These are called associative compounds. The other type combines two components, where one component represents the character’s meaning and the other represents its pronunciation. For example, “睁” (composed of “目” and “争,” meaning to open one’s eyes), “根” (referring to plant roots, composed of “木” and “艮” (gèn)), and “经” (referring to longitude and latitude, composed of “糸” and “逕” (jīng)). These are called phonograms. According to the Modern Chinese Dictionary, phonograms account for 81% of the 7,000 commonly used Chinese characters (Li & Kang, 1993). Phonograms consist of semantic radicals (expressing meaning) and phonetic radicals (expressing pronunciation). Semantic radicals, also known as meaning radicals, form radicals, or semantic components, are components semantically related to the phonogram; phonetic radicals, also known as phonetic components, indicate the pronunciation of the phonogram. In phonograms, some components can only serve as semantic radicals, such as “讠” and “冫,” which are non-wordable components (or non-wordable semantic radicals). Other components can function as either semantic or phonetic radicals, such as “立,” “虫,” and “目.” These components are themselves simple characters and can be termed “(wordable) components.” Research on Chinese character cognition should not only focus on the properties of whole characters but also on the properties and positions of their constituent components.

As crucial elements of phonograms, components have attracted considerable attention from psycholinguists regarding their role in cognitive processing. In Chinese character cognition, components serve as basic processing units and sub-lexical elements of characters, possessing both representation and processing capabilities (Liu, Shu, & Xuan, 2002; Peng & Wang, 1997; Zhang & Sheng, 1999; Zhang & Feng, 1992; Zhou, Peng, Zheng, Su, & Wang, 2013). Phonogram cognition can rely on semantic radical cues, which can either facilitate or interfere with processing (Chen & Zhang, 2008; Chen & Zhang, 2012; Fang & Zhang, 2009; Williams, 2013; Zhang & Chen, 2005; Zhang, Fang, & Chen, 2006; Zhang & Peng, 1993; Zhang, Peng, & Zhang, 1991; Zhang, Wang, & Chen, 2014; Zhang, Zhang, & Peng, 1990), as well as phonetic radical cues (Zhang & Shu, 1989; Zhang & Jiang, 2008). She and Zhang (1997) employed a priming paradigm to investigate the roles of semantic radical cues and phonetic radical cues in the phonogram mental lexicon, finding that semantic radical cues exerted a stronger effect than phonetic radical cues, and that both types of cues had greater influence on low-frequency characters than on high-frequency characters.

Chinese character components possess two attributes: function and position. Regarding position, Chinese character components exhibit positional determinism, with components in different positions providing different information and playing different roles in character recognition (Han, 1994, 1996, 1998; Zhou & Zeng, 2003). Some studies have found that in Chinese character recognition, the

right component plays a more significant role than the left component, with the frequency and positional legality of left components constrained by right components, whereas right components face no such constraints (Feng, 1998a). Taft, Zhu, and Peng (1999) argued that characters with high-frequency components on the right side are recognized faster than those with low-frequency components on the right. In pseudocharacter recognition, the right component also proves more important than the left component (Peng & Li, 1995). For European and American students, right and bottom components exert stronger effects than left and top components (Feng, Lu, & Xu, 2005). However, contradictory evidence also exists. Luo et al. (2010) found that participants had the greatest difficulty distinguishing bottom components and responded fastest to left components. Hsiao (2011) discovered an interaction between cue location (left/right) and semantic radical combinability: when cues appeared on the left, characters with semantic radicals combining with fewer characters were processed faster and more accurately in semantic judgment tasks, whereas characters with semantic radicals combining with more characters were processed slower and less accurately. In the study by Yin, Wang, and Zhang (2011), Experiment 2 revealed that priming stimuli sharing the same left or right components with target characters could facilitate character naming in a masked priming paradigm, with responses to target characters sharing right components with priming characters significantly faster than those sharing left components, demonstrating a unique positional effect in single-character naming: the priming effect for right components was significantly greater than that for left components.

Zhang, Wang, and Yin (2014) found that in the visual processing of Chinese characters, readers' attentional processing advantages for component spatial positions are modulated by phonetic radical position. For left-semantic right-phonetic characters, participants attended more to the right side of the character; for right-semantic left-phonetic characters, participants attended more to the left side. This indicates that in Chinese readers' orthographic awareness, there exists a component position-function association of "left side explains meaning, right side explains pronunciation." In accessing the phonology and semantics of phonograms, phonetic radicals possess greater attentional resource advantages compared to semantic radicals, with this advantage being more pronounced in phonological retrieval: phonetic radicals can activate whole-character pronunciation relatively independently without relying on semantic radical information, whereas phonetic radicals require cooperation from semantic radicals to extract whole-character semantics.

Most existing component research has focused on the perspective of semantic radicals accessing whole-character semantics and phonetic radicals accessing whole-character phonology, and has largely proceeded from the structure of phonograms. Only a few studies have examined component position (Ding, Peng, & Marcus, 2004; Feng et al., 2005; Peng, Guo, & Perry, 2006; Yin et al., 2011) or associated the roles of semantic and phonetic radicals from a component position perspective (Zhang et al., 2014). Wu, Mo, Tsang, and Chen (2012) employed multiple paradigms to investigate the role and temporal course

of position-general and position-specific components in Chinese character cognition, finding that both types of components affect Chinese character processing, but that the effects of position-specific components emerge earlier and last longer. Position-general components refer to Chinese character components that appear in diverse positions, occurring not only in semantic radical positions but also in phonetic radical positions. For example, “米” serves as a semantic radical in “粉” but as a phonetic radical in “咪.” However, this study did not further examine how position-general components in different positions affect Chinese character cognition. Feng (1998b) found that component positional frequency influences lexical decision. Theoretically, every wordable component can appear in different positions within Chinese characters, but the same component exhibits different representational and processing characteristics when appearing in different positions. This is because, under the premise of positional legality, components have different positional frequencies. Nevertheless, previous research has not distinguished between the effects of component position and component positional frequency, nor has it investigated the cognitive effects of wordable components in different positions of Chinese characters.

Li (1996a) analyzed and found that among 72 high-frequency semantic radicals, 53 could also serve as phonetic radicals, with 35 of these high-frequency semantic radicals having a character formation quantity exceeding 3 when serving as phonetic radicals. Although the primary function of these components is to serve as semantic radicals, they function as phonetic radicals in a minority of characters. Some components also exhibit primary and secondary distinctions when in semantic radical positions. For example, “口” primarily appears on the left side of characters when serving as a semantic radical, as in “听” ; however, it appears at the bottom of characters in other cases, as in “吾.” Therefore, relative to the concept of “position-general components,” the authors propose the concept of “poly-position components.” While the concept of “position-general components” only considers the multi-position nature of components, “poly-position components” are classified according to both the spatial position of components in Chinese characters and their frequency. Based on the frequency of occurrence of components in different positions within Chinese characters, component positions can be distinguished as primary semantic radical position, secondary semantic radical position, and phonetic radical position. For example, the component “马” primarily appears in the left half of phonograms, such as in “驰” and “驶.” Thus, the left half can be called the primary semantic radical position for “马” ; however, a small number of “马” components appear in the bottom half of phonograms when serving as semantic radicals, such as in “驾” and “弩.” Therefore, the bottom half can be called the secondary semantic radical position for “马” ; “马” can also serve as a phonetic radical, as in “蚂” and “妈.” Thus, the right half can be called the phonetic radical position for “马.”

Chinese characters generally exhibit the structural characteristic of “meaning on the left, pronunciation on the right.” According to statistics, left-right structured phonograms account for two-thirds of all phonograms, with 90% being left-semantic right-phonetic and 10% being left-phonetic right-semantic. Con-

sidering that characters with different structures have different usage frequencies, after weighting by word frequency, the distribution ratio of left-semantic right-phonetic characters to left-phonetic right-semantic characters in the mental lexicon is approximately 5.5:1 (Hsiao & Shillcock, 2006; Zhang et al., 2014). Therefore, Chinese characters are fundamentally a writing system dominated by left-semantic right-phonetic phonograms. Based on this, it can be argued that the left side of Chinese characters represents the primary semantic radical position for most wordable components, while the right side represents the phonetic radical position for most wordable components. Components such as “女,” “木,” “马,” “石,” “山,” “鸟,” and “虫” are typical poly-position components. Some wordable components undergo slight deformations when appearing in different positions of Chinese characters. For instance, “土” remains as “土” when appearing in the bottom half (secondary semantic radical position, as in “垒”) and the right half (phonetic radical position, as in “吐”), but appears as “” when in the left half (primary semantic radical position). Similarly, “木” appears as “” when in the left half (primary semantic radical position, as in “松”) and as “” when in the bottom half (secondary semantic radical position, as in “柴”). These types of components can also be considered “poly-position components.” Although the number of poly-position components is small and their character formation quantity in secondary semantic radical and phonetic radical positions is low, their importance should not be underestimated because these components themselves are commonly used simple characters, and the characters they form when in secondary semantic radical and phonetic radical positions are also frequently used.

Previous research on the role of semantic radicals in Chinese character cognition has employed whole-character priming paradigms or whole-character semantic decision paradigms, which inevitably introduce “contamination” from whole characters. Although experimental designs can separate the role of semantic radicals to some extent, the effects of semantic radicals and whole characters remain difficult to completely disentangle. To more accurately investigate the role of semantic radicals in Chinese character cognition, Zhang and colleagues created the semantic radical priming paradigm. Using this paradigm enables a purer investigation of the activation processes of semantic and grammatical information of semantic radicals. Zhang and Zhang (2016) utilized the semantic radical priming paradigm and found differences in the semantic and grammatical activation processes between non-wordable and wordable semantic radicals. The semantic activation of non-wordable semantic radicals only emerged in the middle stage of priming, with no grammatical information activation observed; the semantic information of wordable semantic radicals remained activated throughout, and their grammatical information was also activated in the late stage of priming. Zhang and Zhang (2017) continued to use the semantic radical priming paradigm to examine the effects of neighborhood size and category consistency on semantic radical activation under different processing depth tasks. They found that in lexical decision tasks, neighborhood size affected semantic radical activation, with large-neighborhood semantic radicals

being less easily activated and small-neighborhood semantic radicals being more easily activated. In semantic relatedness judgment tasks, category consistency affected semantic radical activation, with high-consistency semantic radicals being more easily activated. By slightly modifying the semantic radical priming paradigm and extending it to phonetic radical priming, the component priming paradigm is created. Employing the component priming paradigm enables a clearer investigation of component location effects in Chinese character cognition—that is, to explore the role of components that can appear in different positions of Chinese characters in character recognition. For instance, does the priming effect of components in phonetic radical positions exceed that of components in semantic radical positions? Can components in primary semantic radical positions prime the recognition of characters containing components in phonetic radical positions? Do components in secondary semantic radical positions facilitate or inhibit the recognition of characters containing components in primary semantic radical positions and phonetic radical positions? Therefore, this study investigates the cognitive effects of wordable components in different positions through the component priming paradigm, matching factors such as character usage frequency (all high-frequency characters) and stroke number. Experiment 1 employs the component priming paradigm to explore component location effects of wordable components, and Experiment 2 combines the component priming paradigm with the visual search paradigm to further investigate component location effects of wordable components.

2.2 Design

A mixed design of 2 (priming type: component priming/control priming) \times 3 (priming component position: primary semantic radical position, secondary semantic radical position, phonetic radical position) \times 3 (target character type: characters containing primary semantic radical position components, characters containing secondary semantic radical position components, characters containing phonetic radical position components). Priming type was a between-subjects variable, with two groups of 30 participants each, while other variables were within-subjects variables. Component priming included the same component in three positions, while the priming stimuli in the control priming condition were all “*** “. The target stimuli for both groups of participants were Chinese characters containing the same component in three different positions.

2.3 Materials

The materials included priming stimuli (components in three different positions) and target stimuli (Chinese characters containing components in three positions). First, 25 common semantic radicals were selected based on the criterion of positional diversity. These semantic radicals could also serve as phonetic radicals, and their positions were not fixed when serving as semantic radicals (i.e., they had multiple semantic radical positions). The nameability of these components when serving as phonetic radicals was matched, and the two semantic

radicals with the lowest phonetic radical nameability were eliminated. Thirty college students who did not participate in the experiment rated the familiarity of the semantic radicals, and radicals with familiarity ratings beyond $M \pm 2.5$ SD were eliminated. Finally, 20 wordable semantic radicals were obtained: 石, 火, 口, 田, 白, 米, 土, 马, 虫, 工, 日, 山, 耳, 贝, 立, 木, 子, 文, 目, 女. Based on the List of Commonly Used Modern Chinese Characters (3,500 commonly used characters), the character formation frequency of these wordable components in different positions of phonograms was calculated. The results indicated that the primary function of the vast majority of poly-position components was to serve as semantic radicals, and their positions were diversified when serving as semantic radicals. The primary position for wordable components serving as semantic radicals was on the left, with frequencies ranging from 25% to 85.3% and an average frequency of 55.42%. The secondary positions for wordable components serving as semantic radicals were bottom, top, right, and middle, with frequencies ranging from 10% to 39.3% and an average frequency of 21.97%. The positions for wordable components serving as phonetic radicals were right, top, bottom, and middle, with frequencies ranging from 3.2% to 57.9% and an average frequency of 22.43%.

Chinese characters were selected from the List of Commonly Used Modern Chinese Characters (3,500 commonly used characters) based on component position, matching three target characters for each priming component in primary semantic radical position, secondary semantic radical position, and phonetic radical position (characters containing primary semantic radical position components, characters containing secondary semantic radical position components, and characters containing phonetic radical position components). For components with multiple phonetic radical positions, the same position was ensured as much as possible during material selection. Ideally, each group would contain 60 characters (three corresponding characters for each component in each position), totaling 180 characters. However, due to limitations in actual Chinese character materials, complete matching could not be achieved for six components (one component was matched with only two characters in the primary semantic radical position, and five components were matched with only two characters in the phonetic radical position). Consequently, the final numbers of characters containing primary semantic radical position components, secondary semantic radical position components, and phonetic radical position components were 59, 60, and 55, respectively, totaling 174 characters.

The word frequency and stroke number of the three groups of characters were matched. The material information is presented in Table 1. Before the experiment, all target characters were printed on paper and given to participants to ensure familiarity with all characters before the experiment began.

Table 1 Information of Target Chinese Characters

Character Type	Example Characters	Average Stroke Number	Average Character Frequency (per million)
Characters containing primary semantic radical position components	岭, 峡, 峭	7.73	352.67
Characters containing secondary semantic radical position components	岗, 崩, 崇	8.67	342.33
Characters containing phonetic radical position components	讠, 仙, 汕	7.67	338.67

Note: Word frequency was selected from the Modern Chinese Frequency Dictionary compiled by Beijing Language Institute (1986 edition).

Statistical analysis indicated no significant differences in average stroke numbers among the three groups of characters, $F(2, 171) = 2.33$, $p > 0.05$, and no significant differences in average character frequency, $F(2, 171) = 2.33$, $p > 0.05$. One hundred seventy-four pseudocharacters were created using Windows' built-in Truetype software as filler stimuli.

2.4 Apparatus and Procedure

The experiment was programmed using E-Prime 2.0 software on an IBM desktop computer. The experimental procedure was as follows: first, a fixation point was presented at the center of the computer screen for 300 ms, followed by either a semantic radical priming stimulus or a control priming stimulus. The priming stimulus was presented for 500 ms to ensure adequate visual processing of the character and to allow the character processing in the brain to be essentially completed (Luo et al., 2010). Subsequently, the target stimulus appeared, and participants were required to make a true/false character judgment: press the

F key for a real character and the J key for a pseudocharacter. For half of the participants, the key assignment followed this rule, while for the other half, the key assignment was reversed. This was followed by a 300 ms blank screen before proceeding to the next trial. The computer automatically recorded participants' reaction times and accuracy, with timing units in milliseconds and an error of ± 1 ms. The experimental flowchart is shown in Figure 1 [Figure 1: see original paper].

Figure 1 Flowchart of Experiment 1

2.5 Results and Analysis

Only responses to real characters were analyzed. For reaction time analysis, error responses and data beyond $M \pm 2.5$ SD were eliminated. Participants' mean reaction times and mean error rates for each character type are presented in Table 2 .

Table 2 Mean Reaction Times (ms) and Mean Error Rates for Lexical Decision of Target Characters

Priming Component Position	Target Character Type	Reaction Time (SD)	Error Rate (SD)
Primary semantic radical position	Characters containing primary semantic radical position components	530 (61)	0.041 (0.061)
	Characters containing secondary semantic radical position components	571 (80)	0.047 (0.050)
	Characters containing phonetic radical position components	560 (63)	0.049 (0.059)
Secondary semantic radical position	Characters containing primary semantic radical position components	569 (78)	0.049 (0.061)

Priming Component Position	Target Character Type	Reaction Time (SD)	Error Rate (SD)
Phonetic radical position	Characters containing secondary semantic radical position components	569 (85)	0.054 (0.056)
	Characters containing phonetic radical position components	571 (83)	0.054 (0.050)
	Characters containing primary semantic radical position components	552 (71)	0.049 (0.059)
	Characters containing secondary semantic radical position components	572 (84)	0.052 (0.061)
Control priming	Characters containing phonetic radical position components	535 (75)	0.049 (0.060)
	Characters containing primary semantic radical position components	577 (69)	0.050 (0.039)
	Characters containing secondary semantic radical position components	580 (59)	0.052 (0.050)
	Characters containing phonetic radical position components	574 (58)	0.049 (0.050)

Note: Numbers in parentheses are standard deviations, the same below.

Separate ANOVAs were conducted on reaction times for the control priming group and the component priming group. Repeated measures ANOVA on the component priming group indicated that the main effect of priming component position type was not significant, $F(1(2, 87) = 0.44, p > 0.05, F(2(2, 51) = 0.32, p > 0.05$. The main effect of target character type was significant, $F(1(2, 174) = 9.62, p < 0.01, p^2 = 0.10, F(2(2, 102) = 4.67, p < 0.01, p^2 = 0.10$. The interaction between priming component position type and target character type was significant in participant analysis, $F(1(4, 174) = 5.78, p < 0.001, p^2 = 0.12$, but not significant in item analysis, $F(2(4, 102) = 1.53, p > 0.05$. Simple effects analysis revealed that when priming components were in primary semantic radical positions, participants' reaction times to characters containing primary semantic radical position components were significantly faster than to characters containing secondary semantic radical position components and phonetic radical position components, $p < 0.01$, but reaction times to characters containing secondary semantic radical position components and phonetic radical position components did not differ significantly, $p > 0.05$. When priming components were in secondary semantic radical positions, no significant differences in reaction times to the three character types were found, $p > 0.05$. When priming components were in phonetic radical positions, reaction times to characters containing phonetic radical position components were significantly faster than to characters containing primary semantic radical position components and secondary semantic radical position components, $p < 0.01$, and reaction times to characters containing primary semantic radical position components were significantly faster than to characters containing secondary semantic radical position components, $p < 0.01$. Repeated measures ANOVA on the control priming group indicated no significant differences in reaction times among the three character types, $F(1(2, 87) = 0.05, p > 0.05, F(2(2, 171) = 0.54, p > 0.05$. Repeated measures ANOVA on error rates indicated that all main effects and interactions in the component priming group were not significant, $ps > 0.05$, and differences in error rates among the three character types in the control priming group were also not significant, $ps > 0.05$.

The net priming amounts for the component priming group compared to the control priming group for each character type are presented in Table 3 .

Table 3 Net Priming Amounts (ms) of the Component Priming Group for Various Target Characters

Target Character Type	Priming Component Position	Net Priming Amount
Characters containing primary semantic radical position components	Primary semantic radical position	-47**

Target Character Type	Priming Component Position	Net Priming Amount
Characters containing secondary semantic radical position components	Primary semantic radical position	-3
Characters containing phonetic radical position components	Primary semantic radical position	-17
Characters containing primary semantic radical position components	Secondary semantic radical position	-8
Characters containing secondary semantic radical position components	Secondary semantic radical position	-11
Characters containing phonetic radical position components	Secondary semantic radical position	-3
Characters containing primary semantic radical position components	Phonetic radical position	-25*
Characters containing secondary semantic radical position components	Phonetic radical position	+8
Characters containing phonetic radical position components	Phonetic radical position	-39*

Note: $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, the same below.*

Independent samples t-tests were conducted comparing reaction times in the nine conditions of the component priming group with those in the three conditions of the control priming group. The results showed that the reaction time in the “primary semantic radical position component priming -recognition of characters containing primary semantic radical position components” condition was significantly faster than in the “control priming -recognition of characters containing primary semantic radical position components” condition, $t_1(58) = 2.76$, $p < 0.01$, $d = 0.72$, $t_2(76) = 3.10$, $p < 0.01$, $d = 0.70$, with a net priming amount of -47 ms. The reaction time in the “phonetic radical position component priming -recognition of characters containing primary semantic radical position components” condition was also significantly faster than in the “control priming

-recognition of characters containing primary semantic radical position components” condition, $t_1(58) = 2.31$, $p < 0.05$, $d = 0.61$, $t_2(77) = 2.58$, $p < 0.05$, $d = 0.58$, with a net priming amount of -25 ms. The reaction time in the “phonetic radical position component priming -recognition of characters containing phonetic radical position components” condition was significantly faster than in the “control priming -recognition of characters containing phonetic radical position components” condition, $t_1(58) = 2.40$, $p < 0.05$, $d = 0.63$, $t_2(73) = 4.01$, $p < 0.05$, $d = 0.93$, with a net priming amount of -39 ms. Components in secondary semantic radical positions showed no priming effects on the recognition of any of the three character types, $ps > 0.05$. In other words, when components were in primary semantic radical positions, they could prime the recognition of characters containing primary semantic radical position components and characters containing phonetic radical position components; when components were in phonetic radical positions, they could prime the recognition of characters containing phonetic radical position components and characters containing primary semantic radical position components; when components were in secondary semantic radical positions, they showed no priming effects on the recognition of any of the three character types. This demonstrates that components in different positions play different roles in Chinese character recognition.

3 Experiment 2: Location Effect of Wordable Components in the Visual Search Paradigm

The visual search paradigm (Visual Search Task) is an experimental paradigm frequently used in recent eye movement research. A visual stimulus matrix is presented on the computer screen, and participants are required to identify target stimuli that differ from other stimulus categories. This paradigm can distinguish between attentional vigilance and attentional disengagement difficulty. If searching for a certain type of stimulus in the matrix is faster than searching for other types of stimuli, it indicates that participants exhibit attentional vigilance for that type of stimulus; if searching for a certain type of stimulus is slower than searching for other types of stimuli, it indicates that participants exhibit attentional disengagement difficulty for that type of stimulus. Research has found that humans generally show attentional vigilance toward negative emotional stimuli (Miltner, Krieschel, Hecht, Trippe & Weiss, 2004). In language cognition, if a certain word or concept is activated, participants will fixate more on stimuli corresponding to that word or concept than on other stimuli (Yan, Wu, Hu, & Bai, 2010). Experiment 2 combined the visual search paradigm with the component priming paradigm. If participants showed longer fixation durations and more fixation points on Chinese characters containing the same component under component priming, it would indicate that participants experienced attentional disengagement difficulty for those characters, suggesting that the priming component affected the processing of characters containing the corresponding component.

3.1 Participants

Fifty-six Han Chinese university students, with a mean age of 20.2 years, including 26 males and 30 females, participated in the experiment. All had normal or corrected-to-normal vision and had not participated in Experiment 1. They were divided into two groups of 28 each with balanced gender ratios.

3.2 Design

A mixed design of 2 (priming type: component priming/control priming) \times 3 (priming component position: primary semantic radical position, secondary semantic radical position, phonetic radical position). Priming type was a between-subjects variable, while priming component position was a within-subjects variable.

3.3 Materials

The materials included priming stimuli (components in three different positions) and target stimuli (square pictures containing four Chinese characters). The semantic radicals (20 total) and Chinese characters were selected using the same criteria as in Experiment 1. The difference was that each semantic radical was matched with four Chinese characters in each of the three priming positions (primary semantic radical position, secondary semantic radical position, phonetic radical position): [characters containing primary semantic radical position components, characters containing secondary semantic radical position components, characters containing phonetic radical position components, and filler characters (half real characters without related components, half pseudocharacters with related components)]. Four Chinese characters were randomly combined to form a square picture. The experiment included 60 square pictures, containing a total of 240 Chinese characters (due to material selection limitations, six characters did not strictly meet the experimental material criteria but were retained to ensure four characters per picture). Among these, 60 were filler characters, including 30 real characters and 30 pseudocharacters.

3.4 Apparatus and Procedure

An Eyelink 1000 eye tracker was used, consisting of two 19-inch computers connected via Ethernet. One computer displayed experimental materials, while the other recorded eye movements. The screen resolution was 1024 \times 768 pixels, and the data sampling rate was 1000 Hz. The eye tracker's tracking resolution threshold was 0.2% of pupil diameter, with eye fixations and movements input to the computer through two miniature infrared cameras mounted on a headpiece. Participants viewed stimuli with both eyes, with data recorded from the right eye for half of the participants and from the left eye for the other half. The distance between the display screen and participants' eyes was approximately 80 cm, and the screen refresh rate was 150 Hz. Material presentation and eye movement recording were controlled by dedicated software.

Before each experimental block, calibration was performed to ensure accurate recording of eye movement trajectories. Each calibration included calibration, validation, and drift correction. During calibration, nine calibration points (white dots) appeared sequentially and randomly at the center or periphery of the screen. When a calibration point appeared randomly, participants were required to fixate on it until it disappeared. After calibration, validation was performed with the same nine calibration points following the same procedure. If validation was successful, drift correction was then conducted, with a calibration point appearing randomly at the center or periphery of the screen for participants to fixate. Only after successful calibration could the formal experiment begin.

First, a fixation point was presented at the center of the computer screen for 300 ms, followed by either a component priming stimulus or a control priming stimulus (***) . The priming stimulus was presented for 300 ms, after which a square picture appeared. Participants were required to judge whether a pseudocharacter was present in the picture: press the F key if no pseudocharacter was present in the square picture, and press the J key if a pseudocharacter was present. For half of the participants, the key assignment followed this rule, while for the other half, the key assignment was reversed. If participants did not respond within 1500 ms, the system automatically proceeded to the next trial and recorded that trial as an error response. The experimental procedure is shown in Figure 2 [Figure 2: see original paper].

Figure 2 Flowchart of Experiment 2

Data from two participants (one from the component priming group and one from the control priming group) with accuracy below 90% were eliminated from the analysis. For reaction time analysis, error responses and data beyond $M \pm 2.5$ SD were eliminated. The results are presented in Table 4 .

Table 4 Mean Reaction Times (ms) and Mean Error Rates for Pseudocharacter Search

Priming Type	Priming Component Position	Reaction Time (SD)	Error Rate (SD)
Component priming	Primary semantic radical position	989 (69)	0.077 (0.031)
	Secondary semantic radical position	990 (65)	0.080 (0.038)
	Phonetic radical position	960 (58)	0.071 (0.035)
Control priming		950 (62)	0.075 (0.041)

ANOVA on reaction times in the component priming group indicated that the main effect of priming component position was not significant, $F(2, 78) = 1.96$,

$p > 0.05$, $F2(2, 171) = 1.05$, $p > 0.05$. ANOVA on error rates in the component priming group also indicated that the main effect of priming component position was not significant, $F1(2, 78) = 2.12$, $p > 0.05$, $F2(2, 171) = 1.73$, $p > 0.05$.

Independent samples t-tests comparing the mean reaction times of the component priming group and the control priming group revealed that the mean reaction time in the component priming group was significantly slower than in the control priming group, $t1(52) = 2.10$, $p < 0.05$, $d = 0.58$, $t2(346) = 2.98$, $p < 0.05$, $d = 0.32$, with a net priming amount of 30 ms, indicating that component priming inhibited pseudocharacter search responses. Independent samples t-tests comparing the mean reaction times of the three priming positions in the priming group with those of the control priming group showed that the mean reaction time for primary semantic radical position priming was significantly slower than the control priming group, $t1(52) = 2.23$, $p < 0.05$, $d = 0.59$, $t2(346) = 4.01$, $p < 0.05$, $d = 0.43$, with a net priming amount of 39 ms; the mean reaction time for phonetic radical position priming was also significantly slower than the control priming group, $t1(52) = 2.45$, $p < 0.05$, $d = 0.63$, $t2(346) = 4.12$, $p < 0.05$, $d = 0.42$, with a net priming amount of 40 ms; the mean reaction time for secondary semantic radical position priming did not differ significantly from the control priming group, $t1(52) = 0.56$, $p > 0.05$, $t2(346) = 0.48$, $p > 0.05$. Independent samples t-tests comparing the mean error rates of the three component position priming conditions with those of the control priming group revealed no significant differences in mean error rates, $ps > 0.05$.

3.5.2 Eye Movement Data Analysis

Data from five participants with unstable eye movement data (head movement after 9-point calibration, deviation from calibration position, or too few fixation points) and accuracy below 90% were eliminated, leaving 51 valid participants (25 in the component priming group and 26 in the control priming group). Eye movement data for the main interest areas [characters containing primary semantic radical position components (denoted as A), characters containing secondary semantic radical position components (denoted as B), and characters containing phonetic radical position components (denoted as C)] are presented in Table 5.

Table 5 Mean Eye Movement Indices for Each Main Interest Area

Priming Type	Priming Component Position	Total Fixation Duration (ms)	Number of Fixations
		A	B
Component priming	Primary semantic radical position	220 (40)	183 (36)
	Secondary semantic radical position	194 (42)	191 (30)

Priming Type	Priming Component Position	Total Fixation Duration (ms)	Number of Fixations
	Phonetic radical position	210 (47)	194 (47)
Control priming		181 (31)	180 (38)

The net priming amounts for various interest area eye movement indices in the component priming group compared to the control priming group are presented in Table 6 .

Table 6 Mean Net Priming Amounts (ms) of Eye Movement Indices for Various Interest Areas in the Component Priming Group

Priming Component Position	Total Fixation Duration (ms)	Number of Fixations
	A	B
Primary semantic radical position	39***	3
Secondary semantic radical position	13	11
Phonetic radical position	29*	14

(1) Analysis of Total Fixation Duration for Various Character Types

A 3 (priming component position: primary semantic radical position, secondary semantic radical position, phonetic radical position) \times 3 (target character type: characters containing primary semantic radical position components, characters containing secondary semantic radical position components, characters containing phonetic radical position components) repeated measures ANOVA was conducted on fixation durations in each interest area for the component priming group. The results indicated that the main effect of priming component position was not significant, $F1(2, 72) = 1.41, p > 0.05, F2(2, 51) = 1.30, p > 0.05$. The main effect of target character type was significant, $F1(2, 144) = 6.48, p < 0.01, p^2 = 0.10, F2(2, 102) = 5.91, p < 0.01, p^2 = 0.10$. The interaction between priming position type and target character type was marginally significant in participant analysis, $F1(4, 144) = 2.41, p = 0.052, p^2 = 0.09$, but not significant in item analysis, $F2(4, 102) = 1.81, p > 0.05$. Simple effects analysis revealed that when the priming component position was primary semantic radical position, the total fixation duration for characters containing primary semantic radical position components was significantly longer than for characters containing secondary semantic radical position components, $p < 0.05$; when the priming component position was phonetic radical position, the total fixation duration for characters containing phonetic radical position components was also

significantly longer than for characters containing secondary position components, $p < 0.05$; when the priming component position was secondary semantic radical position, no significant differences in total fixation duration were found among the three interest areas, $p > 0.05$.

Independent samples t-tests comparing the mean total fixation durations of the component priming group under the nine conditions with those of the control priming group under the three conditions revealed that under primary semantic radical position component priming, the total fixation duration for characters containing primary semantic radical position components was significantly longer than in the control priming condition, $t1(49) = 3.79$, $p < 0.001$, $d = 1.09$, $t2(76) = 3.94$, $p < 0.001$, $d = 0.90$, with a net priming amount of 39 ms. Under phonetic radical position component priming, the total fixation duration for characters containing primary semantic radical position components was significantly longer than in the control priming condition, $t1(49) = 2.58$, $p < 0.05$, $d = 0.73$, $t2(77) = 3.44$, $p < 0.05$, $d = 0.79$, with a net priming amount of 29 ms; the total fixation duration for characters containing phonetic radical position components was also significantly longer than in the control priming condition, $t1(49) = 2.92$, $p < 0.01$, $d = 0.82$, $t2(73) = 3.67$, $p < 0.01$, $d = 0.87$, with a net priming amount of 34 ms. Priming effects in other conditions were not significant, $p > 0.05$.

These results demonstrate that when priming components are in secondary semantic radical positions, they do not affect the recognition of any type of character containing that component. When components are in primary semantic radical positions, they can affect the recognition of characters containing primary semantic radical position components, with participants showing longer fixation durations for such characters, indicating attentional disengagement difficulty. When components are in phonetic radical positions, they affect not only the recognition of characters containing phonetic radical position components but also the recognition of characters containing primary semantic radical position components, with participants showing longer fixation durations for both character types, also indicating attentional disengagement difficulty. When priming components are in secondary semantic radical positions, they have no significant effect on the recognition of any of the three character types.

(2) Analysis of Number of Fixations for Various Character Types

A 3 (priming component position: primary semantic radical position, secondary semantic radical position, phonetic radical position) \times 3 (target character type: characters containing primary semantic radical position components, characters containing secondary semantic radical position components, characters containing phonetic radical position components) repeated measures ANOVA was conducted on the number of fixations for various character types in the component priming group. The results indicated that the main effect of priming component position was not significant, $F1(2, 72) = 0.56$, $p > 0.05$, $F2(2, 51) = 0.48$, $p > 0.05$. The main effect of target character type was significant, $F1(2, 144) = 10.93$, $p < 0.01$, $\eta^2 = 0.13$, $F2(2, 102) = 9.33$, $p < 0.01$, $\eta^2 = 0.10$.

The interaction between priming component position and character type was significant, $F1(4, 144) = 5.34$, $p < 0.001$, $p^2 = 0.23$, $F2(4, 102) = 4.77$, $p < 0.001$, $p^2 = 0.12$. Simple effects analysis revealed that when priming components were in primary semantic radical positions, the number of fixations on characters containing primary semantic radical position components was significantly greater than on characters containing secondary semantic radical position components and phonetic radical position components, $p < 0.01$, and the number of fixations on characters containing phonetic radical position components was also significantly greater than on characters containing secondary semantic radical position components, $p < 0.05$. When priming components were in phonetic radical positions, the number of fixations on both characters containing primary semantic radical position components and secondary semantic radical position components was significantly fewer than on characters containing phonetic radical position components, $p < 0.01$, and the number of fixations on characters containing secondary semantic radical position components was also significantly fewer than on characters containing primary semantic radical position components, $p < 0.05$. When priming components were in secondary semantic radical positions, no significant differences in the number of fixations among the three character types were found, $p > 0.05$. This indicates that components in different positions have different effects on Chinese character recognition.

Independent samples t-tests comparing the mean number of fixations in the nine conditions of the component priming group with those in the three conditions of the control priming group revealed that under primary semantic radical position component priming, the number of fixations on characters containing primary semantic radical position components was significantly greater than in the control priming group, $t1(49) = 2.07$, $p < 0.05$, $d = 0.59$, $t2(76) = 2.86$, $p < 0.05$, $d = 0.65$, with a net priming amount of 0.2 fixations. Under phonetic radical position component priming, the number of fixations on characters containing phonetic radical position components was significantly greater than in the control priming group, $t1(49) = 3.23$, $p < 0.01$, $d = 0.92$, $t2(77) = 4.96$, $p < 0.01$, $d = 1.13$, with a net priming amount of 0.3 fixations; under phonetic radical position component priming, the number of fixations on characters containing secondary semantic radical position components was also significantly fewer than in the control priming group, $t1(49) = -2.11$, $p < 0.05$, $d = 0.60$, $t2(73) = -2.89$, $p < 0.05$, $d = -0.68$, with a net priming amount of -0.2 fixations.

This indicates that when the priming component position is phonetic radical position, a negative priming effect occurs for the number of fixations on characters containing secondary semantic radical position components. Characters containing secondary semantic radical position components receive significantly fewer fixations compared to characters containing primary semantic radical position components and phonetic radical position components, suggesting they receive less attention. When components are in primary semantic radical positions, characters containing primary semantic radical position components receive significantly more fixations; when components are in phonetic radical positions,

characters containing phonetic radical position components receive significantly more fixations, indicating attentional disengagement difficulty in both cases.

Therefore, Experiment 2 demonstrates that when priming components are in primary semantic radical positions, participants show longer fixation durations and more fixation points on characters containing primary semantic radical position components, indicating attentional disengagement difficulty that facilitates the recognition of characters containing primary semantic radical position components. When priming components are in phonetic radical positions, participants show longer fixation durations and more fixation points on characters containing phonetic radical position components, also indicating attentional disengagement difficulty that facilitates the recognition of characters containing phonetic radical position components. Simultaneously, fixation durations for characters containing primary semantic radical position components are also longer, and the number of fixation points for characters containing secondary semantic radical position components is fewer, which facilitates the recognition of characters containing primary semantic radical position components while inhibiting the recognition of characters containing secondary semantic radical position components. When priming components are in secondary semantic radical positions, neither facilitatory nor inhibitory effects are present.

Ding et al. (2004) employed a priming paradigm and found that the same component facilitates the cognition of characters containing components in the same position but inhibits the cognition of characters containing components in different positions. This study only demonstrated that component position effects exist in Chinese character cognition and that such effects can be either facilitatory or inhibitory, but it did not distinguish in detail between the roles of component position and component positional frequency. The present study further confirms the existence of component position effects and also identifies different types of component position effects and component positional frequency effects. Experiment 1 revealed that when priming components were in primary semantic radical positions, they facilitated the recognition of characters containing primary semantic radical position components but could not facilitate the recognition of characters containing components in other positions; when components were in phonetic radical positions, they not only facilitated the recognition of characters containing phonetic radical position components but also facilitated the recognition of characters containing primary semantic radical position components; when components were in secondary semantic radical positions, they could not prime the recognition of any type of character containing that component. Experiment 2 demonstrated that when priming components were in primary semantic radical positions and phonetic radical positions, pseudocharacter search times were longer compared to the control priming group; when priming components were in secondary semantic radical positions, pseudocharacter search times did not differ significantly from the control priming group. This pattern occurs because component priming activates component representations, and when the square picture contains characters with components in the same position as the priming component, participants allocate

more attention, experiencing attentional disengagement difficulty, which consequently slows search times. This inference is also confirmed by eye movement data. Experiment 2 found that when priming components were in primary semantic radical positions and phonetic radical positions, total fixation durations were longer for characters containing primary semantic radical position components and phonetic radical position components; when priming components were in secondary semantic radical positions, fixation durations for different target character types were unaffected.

When priming components were in primary semantic radical positions, the number of fixation points on characters containing primary semantic radical position components was significantly greater; when priming components were in phonetic radical positions, the number of fixation points on characters containing phonetic radical position components was significantly greater, while the number of fixation points on characters containing secondary semantic radical position components was significantly fewer. This indicates that when priming components are in primary semantic radical positions, they facilitate the recognition of characters containing primary semantic radical position components and inhibit the recognition of characters containing secondary semantic radical position components; when priming components are in phonetic radical positions, they facilitate the recognition of characters containing phonetic radical position components and inhibit the recognition of characters containing secondary semantic radical position components. Therefore, the priming effects of component positions are not unidirectional or equivalent: under the premise of positional legality, different component positions indeed lead to different priming effects, and positions with different frequencies produce differences in priming effects. In summary, when wordable components are in phonetic radical positions, their priming effect on Chinese character recognition is greater than when they are in other positions (primary semantic radical position and secondary semantic radical position). For components in semantic radical positions, the magnitude of their priming effect in Chinese character recognition is determined by positional frequency, with components in high-frequency primary semantic radical positions producing greater priming effects. The magnitude of component priming effects, in descending order, is: phonetic radical position components > primary semantic radical position components > secondary semantic radical position components. The main reasons for this pattern are as follows:

- (1) Wordable components in phonetic radical positions more easily capture readers' attention. Although the character formation frequency of wordable components in phonetic radical positions is relatively low, their priming effect is the strongest. Zhang et al. (2014) found that in the visual processing of Chinese characters, readers' attentional processing advantages for component spatial positions are modulated by phonetic radical position. For left-semantic right-phonetic characters, participants attend more to the right side of the character, while for right-semantic left-phonetic characters, participants attend more to the left side. This demonstrates

that the priming effect of wordable components in phonetic radical positions is stronger than that of components in semantic radical positions.

Chinese characters are primarily a writing system with left-semantic right-phonetic structure. The attentional advantage for phonetic radicals does not conform to people's left-to-right reading habits. If following left-to-right reading habits, semantic radical positions on the left side of characters should have the greatest priming advantage. However, this study found that whether semantic radicals are in primary or secondary semantic radical positions, their priming effects are not as strong as those of phonetic radicals. The main reasons are threefold: First, phonetic radicals have greater visual dominance than semantic radicals. Generally, stimuli occupying larger areas in the visual field more easily attract individual attention. Although the same component has the same number of strokes when serving as a phonetic radical or semantic radical, the area it occupies in the character differs. Components often occupy larger areas and proportions when serving as phonetic radicals than when serving as semantic radicals. This is because Chinese characters are square-shaped; when a character serves as a semantic radical in another left-right structured character, it often adopts a "narrowed" form, whereas when serving as a phonetic radical, it less frequently adopts a "narrowed" form (Zhang et al., 2014). Second, the influence of orthographic awareness of "semantic radicals explain meaning, phonetic radicals explain pronunciation." Semantic radicals have meaning-indicating functions, but the meaning-indicating function of phonetic radicals cannot be ignored. In fact, phonograms were not created for phonetic representation but for meaning differentiation. Phonetic radicals are the main components of phonograms, and characters sharing the same phonetic radical often have common semantics. For example, "𡗗" means small: small water is "浅," small metal is "钱," small silk is "线," small evil is "残," small shell is "贱," and small paper is "笺." Wang Shengmei of the Song Dynasty first discovered this pattern and proposed the "Right-Wen Theory," summarizing the phenomenon of "sound containing meaning" in phonograms. The core of the "Right-Wen Theory" is the phenomenon of "sound containing meaning" in phonograms (Zhou, 2009). Zhang (2007) found that when left-semantic right-phonetic phonograms served as priming characters, they could activate target characters semantically related to their phonetic radicals, such as "娘" activating "优," "梧" activating "我," "好" activating "儿," and so on. This indicates that phonetic radical activation includes some degree of semantic activation. However, as the name suggests, phonetic radicals have stronger phonetic-indicating functions. Although wordable components can be pronounced, when they occupy semantic radical positions in whole characters, their phonetic-indicating function is often replaced by their meaning-indicating function, or at least greatly weakened. Lin and Zhang (1999) found that in lexical decision tasks, phonology showed no priming effect for single characters, suggesting that Chinese visual cognition can access semantics directly. However, priming effects existed in single-character naming and in lexical decision for rhyming two-character words, indicating that phonology plays a role in lexical access and that a phonological pathway exists

in Chinese reading. They argued that both the form-to-meaning pathway and the phonological pathway exist in Chinese word cognition. During component priming, since priming duration exceeded 300 ms, both the form and phonology of characters were activated, and participants' true/false character judgments were influenced by character phonology. When priming components had phonological connections with target characters, they were more easily primed. Third, although both semantic and phonetic radicals have meaning-indicating functions, their division of labor differs. Zhang et al. (2014) pointed out that phonetic radicals and semantic radicals in phonograms have different meaning-indicating characteristics: phonetic radicals represent the implicit, specific, and etymological meanings of things, while semantic radicals represent the categorical, general meanings of things, or only indicate related meanings associated with certain things. Implicit, specific, and etymological meanings require more attentional resources to process than categorical, general, and related meanings. For these combined reasons, wordable components in phonetic radical positions produce the strongest priming effects.

- (2) The priming effect of wordable components in phonetic radical positions is bidirectional. Priming components in phonetic radical positions facilitate the recognition of characters containing phonetic radical position components and characters containing primary semantic radical position components but inhibit the recognition of characters containing secondary semantic radical position components. Previous research has shown that right components play a greater role in Chinese character recognition than left components, with the frequency and positional legality of left components constrained by right components, whereas right components face no such constraints. Among left-right structured characters, left-semantic right-phonetic characters predominate. This indicates that phonetic radicals play a stronger and more flexible role in Chinese character recognition. However, previous studies examining component position effects only distinguished between semantic radical positions and phonetic radical positions or left and right component positions, without further dividing semantic radical positions according to their usage frequency. In fact, semantic radicals appear in various positions, and the relationship between semantic radicals in different positions and phonetic radicals also differs. This study demonstrates that in the mental lexicon of native Chinese speakers, phonetic radical cues have positive facilitatory effects on the recognition of characters containing phonetic radical position components and characters containing primary semantic radical position components, but have no effect or reverse inhibitory effects on the recognition of characters containing secondary semantic radical position components. This is because when priming components are phonetic radicals, they more easily serve as independent Chinese character cues visually. When components in target characters occupy phonetic radical positions and primary semantic radical positions, they more readily capture readers' attention based on both usage habits and visual search habits, making them more easily

associated with phonetic radical cues and recognized. When components occupy secondary semantic radical positions, they are difficult to associate with phonetic radical cues based on either usage habits or visual search habits and may even be ignored.

- (3) Component positional frequency effects constitute an indispensable part of component position effects. In this study, when priming components were in primary semantic radical positions, they facilitated the recognition of characters containing primary semantic radical position components but had no significant effect on the recognition of characters containing secondary semantic radical position components. Therefore, the priming effect of semantic radicals only manifests when they are in primary positions rather than secondary positions, reflecting the role of component positional frequency. She and Zhang (1997) argued that in the phonogram mental lexicon, semantic radical cues play a greater role than phonetic radical cues. This is inconsistent with the present study's findings but not necessarily contradictory, as previous research did not distinguish between wordable and non-wordable semantic radicals, nor did it differentiate the positions of semantic radical cues. This study proves that semantic radical cues in primary and secondary positions have different effects on Chinese character recognition, and that the priming effect of semantic radicals on Chinese character recognition mainly manifests in primary positions. That is, for wordable semantic radicals, positional frequency has an important influence on Chinese character recognition, and only when semantic radicals occupy primary positions can they effectively prime whole-character recognition.
- (4) Component positional frequency effects mainly manifest in semantic radicals rather than phonetic radicals. The reasons are twofold: First, wordable components generally form fewer characters when serving as phonetic radicals. Therefore, for phonetic radical priming, position effects dominate in the priming effect, with no or minimal positional frequency effects. This involves the relationship between component position and function. Based on this study's results, it can be argued that for wordable components serving as semantic radicals, position and function are dissociated, with position playing a stronger role than function, since no significant priming effects were found when semantic radicals occupied secondary positions. However, for phonetic radicals, position effects and functional effects should coincide in this study, with function playing the primary role. Nevertheless, this does not negate the existence of phonetic radical position effects. Second, during material selection, the sameness of phonetic radical positions for each component was ensured as much as possible, except for a few characters, without employing materials with structures inconsistent with the "left-semantic right-phonetic" structure, such as "right-semantic left-phonetic" or "top-phonetic bottom-semantic" structures. Therefore, further research on phonetic radical position effects is necessary.

In summary, the differences in priming effects when components occupy phonetic radical positions versus different semantic radical positions demonstrate that component position affects Chinese character recognition, while the differences in priming effects when semantic radicals occupy primary versus secondary positions reveal the influence of component positional frequency on Chinese character recognition. Therefore, in Chinese character recognition, component location effects actually encompass the dual effects of component position and component positional frequency. This is a novel finding of this study. The results also have implications for Chinese character learning and teaching: instruction should combine character learning with knowledge of Chinese character structure and component positions, emphasizing the roles of phonetic radicals and semantic radicals in primary positions in Chinese character learning. After children have mastered a certain number of characters, greater emphasis should be placed on recognizing semantic radicals in secondary positions, enabling children to acquire more comprehensive orthographic knowledge of Chinese characters and making character learning more efficient.

- (1) The priming effect of wordable components in phonetic radical positions is stronger than that of components in semantic radical positions. The priming effect of wordable components in phonetic radical positions is bidirectional: facilitating the recognition of characters containing phonetic radical position components and characters containing primary semantic radical position components while inhibiting the recognition of characters containing secondary semantic radical position components.
- (2) Semantic radicals in primary and secondary positions have different effects on Chinese character recognition. The priming effect of semantic radicals on Chinese character recognition mainly manifests in primary semantic radical positions.

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Note: Figure translations are in progress. See original paper for figures.

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