Semantic activation of phonetic radicals in Chinese ideophonetic compound processing

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The phonetic radicals embedded in Chinese ideophonetic compounds serve as indicators of the ideophonetic compounds' pronunciations. The mainstream research, therefore, has focused on the *phonological* activation of the phonetic radicals and their contribution to the host ideophonetic compounds' phonological processing. The present study, however, by employing a primed part-of-speech judgment task and manipulating the *phonetic regularity* variable, examined phonetic radicals' *semantic*, instead of phonological, activation as well as the role of *phonetic regularity* in the processing of the host ideophonetic compounds. These results endorsed the presence of the semantic activation of phonetic radicals, refuting the influence of phonetic regularity on their activation. Conversely, they affirm that *phonetic regularity* could modulate the semantic activation of the entire ideophonetic compound.

Keywords: phonetic radical, semantic activation, phonetic regularity, Chinese ideophonetic compound processing

1. Introduction

Research on Chinese ideophonetic compound processing has extensively investigated the phonological activation of sub-lexical phonological units, namely phonetic radicals. It is unclear, however, whether phonetic radicals can be semantically activated. Considering that most phonetic radicals can function as independent characters, possessing their own semantic representations at the lexical level, it adds to the likelihood that these phonetic radicals can be semantically activated at the sub-lexical level. This intriguing issue, however, has been scarcely explored. The present study is dedicated specially to examining this mystery.

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1.1 Introduction to Chinese ideophonetic compounds and phonetic radicals

The Chinese writing system is morpho-syllabic, wherein each Chinese character encompasses both syllabic (phonological) and morphemic (semantic) information. A majority of Chinese characters, approximately 85%, are classified as ideophonetic compound characters (Tan et al. 1995; Ho & Bryant 1997; Ho et al. 1999; Liu et al. 2023). These ideophonetic compounds comprise two functionally distinct components known as semantic radicals and phonetic radicals. As their names imply, semantic radicals provide semantic cues to the ideophonetic compounds, while phonetic radicals bear phonological information associated with the pronunciation of the entire ideophonetic compound. It should also be noted that a majority of phonetic radicals can function independently as self-sufficient characters, such that they have their own meanings and pronunciations at the lexical level (e.g., the phonetic radical 青 of the ideophonetic compound 晴) (Zhou 1980; Liu & Liu 2018; Zhu 2003).

Depending on the extent of similarity in the pronunciations between the whole ideophonetic compounds and their embedded phonetic radicals, ideophonetic compounds are classified as regular, semi-regular (or partially regular), and irregular (Yum et al. 2014; Luo et al. 2018). *Regular* ideophonetic compounds exhibit the same pronunciations (same phonemes and tones) with their phonetic radicals (e.g., ideophonetic compound 蜻, /tɕ^{h}ɪŋ^{1}/, 'dragonfly'; phonetic radical 青, /tɕ^{h}ɪŋ^{1}/, 'green'). *Semi-regular* ideophonetic compounds can be divided into two subtypes. The first subtype includes those in which the ideophonetic compound and its phonetic radicals share identical phonemes but differ in tones (i.e., same phonemes different tones, SPDT) (e.g., ideophonetic compound 請, /tɕ^{h}ɪŋ^{3}/, 'please'; phonetic radical 青, /tɕ^{h}ɪŋ^{1}/, 'green'). The second subtype includes compounds where the ideophonetic compound and its phonetic radical share the same vowels but differ in consonants (i.e., same vowels different consonants, SVDC). An example of this is the ideophonetic compound 橙 (/ʈʂ^{h}ɤŋ^{2}/, 'orange'), where the phonetic radical is 登 (/tɤŋ^{1}/, 'climb') (Rickard Liow et al. 1999). *Irregular* ideophonetic compounds feature no phonological connection to their phonetic radicals (e.g., ideophonetic compound 倩, /tɕ^{h}jɛn4/, 'pretty'; phonetic radical 青, /tɕ^{h}ɪŋ^{1}/, 'green') (Lee et al. 2006; Yum et al. 2014; Zhang et al. 2014; Zhang et al. 2022). On balance, regular ones make up approximately 35–40%, with semi-regular and irregular ones being 30% and 30%–35% respectively (Law et al. 2009). Phonetic regularity of Chinese ideophonetic compound characters, by definition, express the validity of the phonological indications provided by their embedded phonetic radicals (Shu et al. 2000; Lee et al. 2004).

1.2 Uncertainty concerning the semantic activation of phonetic radicals

In the realm of Chinese ideophonetic compound processing studies, the mainstream research concentrates either on the phonological activation of phonetic radicals, or on the semantic activation of semantic radicals. Hardly are there any studies dedicated to the semantic activation of phonetic radicals or the phonological activation of semantic radicals. A tacit belief may be that since phonetic radicals and semantic radicals take on separate roles in making up ideophonetic compounds, there seems to be little significance in examining issues that stand somewhat afar from their regular functions.

However, there does exist a handful of studies that set foot in the semantic, in contrast with phonological, activation of phonetic radicals taking place in the host character's processing. As an example, Zhou & Marslen-Wilson (1999b) observed significant priming effects when the target characters were semantically related with the phonetic radicals embedded in the prime characters, even when the prime and target characters bore no semantic connection at the whole-character level. For instance, the prime character 裱 (/pjɑʊ^3/, 'to paste up') could facilitate the naming responses for the target character 鐘 (/ʈʂʊŋ^1/, 'the watch') via a semantic relatedness with the embedded phonetic radical 中 (/ʈʂʊŋ^1/, 'middle'). This result suggests that phonetic radicals were semantically activated during the ideophonetic compound's recognition process. A similar pattern of effects was found in Lee et al. (2006), which adopted the similar experimental paradigm as Zhou & Marslen-Wilson (1999b), but employed ERPs component N400 as an indicator. Specifically, when compared with the unrelated baseline condition, there was robust facilitative priming effects, showcasing the semantic activation of phonetic radicals. This activation occurred when phonetic radicals (e.g., 風, /fɤŋ^1/, 'the wind') in the prime characters (e.g., 楓, /fɤŋ^1/, 'maple') were semantically related to the target characters (e.g., 雨, /y^3/, 'the rain') at 50 ms SOA. Tsang et al. (2017), by replicating the above-mentioned two studies, also demonstrated that the embedded phonetic radicals could activate their semantic information in the process of character recognition, much resembling the behavior of entire embedding characters (Bi et al. 1998; Perfetti & Tan 1998). For instance, robust facilitative priming effects were observed when the phonetic radicals (e.g., 見, /tɕjɛn^4/, 'to see') in the prime characters (e.g., 硯, /jɛn^4/, 'inkstone') were semantically related to the target characters (e.g., 看, /k^{h}an^4/, 'to look at'). Most noteworthy, Yeh et al. (2017) conducted a Stroop task to investigate the same issue. In the experiment, the participants were required to judge the color of the target characters which consisted of a color-name (e.g., 青, 'green') or colored-object (e.g., 血, 'blood') phonetic radicals. Robust interference effects were observed when the phonetic radicals denoted different colors from the target characters. For instance, the target character 猜 'guess' was printed in *red*, while the phonetic radical 青, which represented the color *green*, denoted a different color from the whole character. It was found that the phonetic radical 青 had slowed down the host character's recognition. Similar effects occurred for the embedding character 恤 'compensate' which was printed in *green*, with its embedded phonetic radical 血 representing the color *red*. All these findings indicate that the priming effects, whether facilitative or inhibitory, offered insights – though not extensively – into the semantic activation of phonetic radicals.

Given the limited research reviewed above, the issue with regard to the semantic activation of the phonetic radical is far from being resolved. More evidence needs to be obtained preferably either from replication studies or from studies that employ innovative experimental designs and tasks. Furthermore, the confirmation of the semantic activation of the phonetic radical may shed new light on the machinery governing Chinese ideophonetic compound processing.

1.3 The present study

The present study aims to further investigate whether phonetic radicals undergo their own semantic activations during a Chinese ideophonetic compound processing. This is to be achieved by employing an innovative semantic priming paradigm. The semantic relatedness between the prime characters and the phonetic radicals of the target characters is manipulated. Participants are required to make a part-of-speech judgment. This experimental design differed from previous studies in three major ways. (1) Previous studies like Zhou & Marslen-Wilson (1999b), Lee et al. (2006) and Tsang et al. (2017) incorporated phonetic radicals in prime characters, while the present study embedded them in target characters. (2) Previous studies utilized either a character naming task (Zhou & Marslen-Wilson 1999b), a character recognition task (Lee et al. 2006), a lexical decision task (Tsang et al. 2017), a semantic categorization task (Tsang et al. 2017), or a Stoop task (Yeh et al. 2017). No known study, however, adopted part-of-speech task. In our opinion, the part-of-speech judgment task, in this context, has gained an advantage over semantic categorization task and the Stroop task in that it stands between character naming task, character recognition task/lexical decision task and the former two tasks in terms of semantic relevance, much like a partial-semantically-relevant task. The point is that, should the partial-semantically-relevant task exhibit the utility to delicately capture the semantic activation of phonetic radicals, there should be a greater likelihood that the semantic activation of phonetic radicals is a reality. In addition, the Stroop task employed in previous study (Yeh et al. 2017) lacked comprehensive coverage of phonetic radicals, as it primarily focused on those with color-related meanings. This limitation prevented the derivation of conclusions broadly applicable to all phonetic radicals. Also, the semantic categorization task in Tsang et al. (2017) required participants to memorize specific categories prior to making judgments. Consequently, the observed priming effects may have resulted from the retrieval of memorized semantic categories rather than the semantic activation of phonetic radicals. To address this issue, we implemented a semantic part-of-speech judgment task, where participants were not required to memorize any information but could directly perform the task. This design ensured that all observed effects were solely attributed to the semantic activation of phonetic radicals. ③ Previous researchers only compared regular and irregular ideophonetic compound characters, while the present experiment took the semi-regular characters into account, aiming to enlarge the richness and breadth of this body of research.

2. Method

The primary objective of this experiment was to investigate the semantic activation of phonetic radicals via a part-of-speech judgment task, which necessitated the accurate retrieval of the meanings and part-of-speeches of whole ideophonetic compound characters to perform accurately. The part-of-speech judgment task has been extensively employed to examine lexical activation in alphabetic languages (e.g., Melinger & Koenig 2007; Momma et al. 2020). It has been suggested that the activation level of part-of-speech features can directly influence lexical processing (Melinger & Koenig 2007). Evidence indicated that participants exhibited slower responses and more errors when asked to describe a target picture if the semantics and part-of-speech of the picture name did not match the semantic category and part-of-speech of the keywords in the prime sentence (Momma et al. 2020). This interference was presumably due to the automatic semantic and part-of-speech activation of the keywords in the sentence prime, which interfered with the retrieval of the target picture's meaning.

In this connection, if the processing of phonetic radicals involves not only phonological but also semantic activation (Zhou & Marslen-Wilson 1999b), we should anticipate similar interference – specifically, inhibitory priming effects – when judging the part-of-speech of whole ideophonetic compound characters that possess different semantics from their phonetic radicals. Furthermore, if inhibitory priming effects indeed occur even in a task with the partial-semantic relevance (as discussed in the previous section), it would indicate that the semantic activation of phonetic radicals exerts a robust influence.

2.1 Participants

A priori sample size calculations were conducted using G*Power 3.1 (Faul et al. 2007). The analysis indicated that 16 participants would be required to detect a medium effect size ($f = 0.25$) (Cohen 1969) with 80% power for a two-way within-subjects ANOVA ($\alpha = .05$, number of groups = 1, number of measurements = 2*4 = 8, non-sphericity correction = 1). These calculations adhered to the guidelines for repeated measures within-subjects ANOVA (*a priori*) provided in the G*Power 3.1 Manual (Buchner et al. 2023) and Brysbaert (2019). To account for possible exclusions, a total of 31 participants were recruited in the experiment who were native Mandarin speakers residing in mainland China (eight male, mean age = 25.10 years, $SD = 2.48$). They were all students from Sichuan International Studies University (SISU), being right-handed and possessing normal or corrected-to-normal vision. The participants were required to finish written informed consents before the formal experiment, and compensation was provided upon completing the experiment.

2.2 Materials and design

This experiment employed a *2 (prime: semantically related vs. unrelated control) × 4 (target ideophonetic compound: regular vs. semi-regular-same phoneme different tone [semi regular-SPDT] vs. semi-regular-same vowel different consonant [semi regular-SVDC] vs. irregular)* design. The two prime types each contained 40 Chinese characters (refer to Table 1 for sample materials and their properties). The semantically related (SR) primes (e.g., 倍, /peɪ⁴/, 'double') bore a semantic relationship to the targets (e.g., 拌, /pan⁴/, 'to stir') solely at the phonetic-radical level (e.g., 半, /pan⁴/, 'half'), with no semantic connection at the whole-character level. Conversely, the unrelated control (UC) primes (e.g., 神, /ʂən²/, 'god') bore no semantic, orthographic, or phonological connection with the targets (e.g., 拌, /pan⁴/, 'to stir') either at the radical or the whole-character levels. The SR and UC primes were matched in the character's structure, number of strokes ($t(39) = -.797$, $p = .430$), part of speech, and mean frequency ($t(39) = .625$, $p = .536$).

As for the target types, regular ideophonetic compounds (e.g., 拌, /pan⁴/, 'to stir') and their embedded phonetic radicals (e.g., 半, /pan⁴/, 'half') possessed the same pronunciations. Concerning the *SPDT* semi-regular ideophonetic compounds, these compounds (e.g., 訪, /fɑŋ3/, 'to visit') had matching phonemes but differed in tones from their phonetic radicals (e.g., 方, /fɑŋ¹/, 'square'). In the case of *SVDC* semi-regular ideophonetic compounds, the compounds (e.g., 吟, /ɪn²/, '*to chant*') shared the same vowels but differed in consonants from their phonetic radicals (e.g., 今, /tɕɪn¹/, 'present'). In contrast, irregular ideophonetic compounds (e.g. 捉, /tʂuɔ¹/, 'to catch') had distinct phonology with their phonetic radicals (e.g. 足, /tsu²/, 'foot') (see Table 1). Moreover, all the embedded phonetic radicals shared no semantic relationship with their host ideophonetic compounds (e.g., the meaning of phonetic radical 今'present' differed significantly with that of the host character 吟 'to chant'). The four types of target characters were matched in terms of the character's number of strokes ($F(3, 27) = .411$, $p = .747$ $\eta^2 = .044$), part of speech, and mean frequency ($F(3, 27) = 1.737$, $p = .183$, $\eta^2 = .162$).

Table 1. Sample materials and their properties in Experiment 1

Primes		Targets		Phonetic radicals embedded in the targets
Semantically related (SR)	Unrelated control (UC)			
倍 /peɪ⁴/-*double*	神 /ʂən²/-*god*	拌 /pan⁴/-*to stir*	Regular Ideophonetic compounds	半 /pan⁴/-*half*
圓 /ɥœn²/-*circle*	困 /kʰuən⁴/-*sleepy*	訪 /fɑŋ³/-*to visit*	Semi-regular Ideophonetic compounds (SPDT)	方 /fɑŋ¹/-*square*
古 /ku³/-*ancient*	小 /ɕjɑʊ³/-*small*	吟 /ɪn²/-*to chant*	Semi-regular Ideophonetic compounds (SVDC)	今 /tɕɪn¹/-*present*
腳 /tɕjɑʊ³/-*foot*	辮 /pjɛn⁴/-*braid*	捉 /tʂuɔ¹/-*to catch*	Irregular Ideophonetic compounds	足 /tsu²/-*foot*

Twenty-five native Chinese speakers who did not participate in the formal experiment rated the semantic relationship between the prime and the phonetic radicals and their embedding target characters on a 7-point *Likert* scale ranging from 1 (not related at all) to 7 (extremely related). The ratings revealed a high level of semantic relatedness (6.021) between the SR primes and the phonetic radicals of the target characters, but much lower levels of semantic relatedness between the SR primes and the embedding target characters (1.281), between the UC primes and the embedded phonetic radicals (1.288), and between the UC primes and the embedding target characters (1.212), respectively. The first type of semantic relatedness (between SR prime and the embedded phonetic radicals in targets) significantly differed from the other three types ($ps = .000$); however, there were no significant differences among the latter three ($ps > .05$).

Overall, forty pairs of primes (SR and UC primes) were matched with 40 target characters, yielding 80 experimental trials (2 types of prime types × 40 target characters = 80 trials). These trials were divided into two blocks of 40 trials each, and all trials were presented in a fully randomized order.

2.3 Procedure

The stimuli were displayed on a 15-inch CRT monitor with a white background color, using E-Prime 2.0 software (Psychology Software Tools, Inc.). The characters were presented in the Song font. The presentation took place in a shielded room, and participants were seated comfortably approximately 60 cm away from the computer. At this viewing distance, each character occupied a visual angle of 1 in both width and height when encircled.

Participants initially pressed "Q" for a 6-trial practice session to familiarize themselves with the procedure, receiving feedback for each response. Upon readiness, they could press "P" to proceed to the formal experiment, comprising 80 randomized trials. Each trial involved a 300-ms eye fixation signal "+", followed by a 300-ms blank interval. A prime was then presented for 300 ms, and overwritten immediately by the corresponding target which remained visible until participants had responded. An 800-ms blank screen followed each trial, with breaks permitted between test sessions. Participants were told to judge whether the target was a verb or not, responding as quickly as possible by pressing the "J" or "F" keys. The "pressing key" configurations were counterbalanced across participants, half with "J" for "VERB" and "F" for "NOT VERB", and the other half vice versa. Accuracy and reaction times were recorded. On average, each participant took about 5 minutes to complete the entire session. This experiment was conducted in the Key Laboratory of Foreign Language Learning and Cognitive Neuroscience in SISU.

3. Results

Data on all 31 participants were included in a statistical analysis. The mean accuracy was 96.53%. The errors and reaction times exceeding 1.5 SD (1.38%) from the mean RT of each condition were deleted from further analyses. The results were displayed in Figure 1.

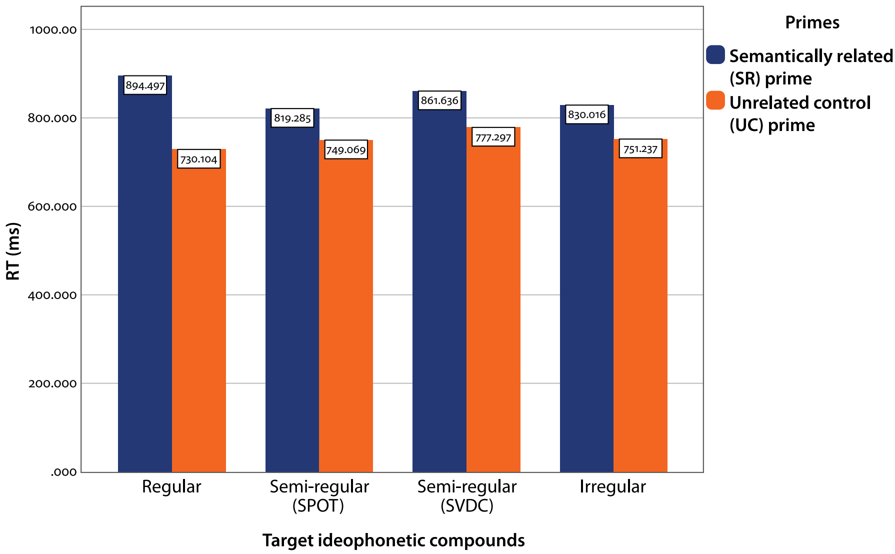

Figure 1. Mean RT (ms) for target judgment

A two-way repeated-measures *ANOVA* was performed to measure the RTs. Results showed that the main effect of the *Semantic Relatedness* was significant ($F(1, 30)=16.289$, $p=.000$, $\eta^2=.353$). The mean RTs to the targets preceded by semantically related primes (851.358 ms) were slower than those following control primes (751.927 ms). The main effect of the *Phonetic Regularity* was not significant ($F(3, 90)=2.256$, $p=.087$, $\eta^2=.070$). The interaction between the *Semantic Relatedness* and the *Phonetic Regularity* was significant, $F(3, 90)=3.098$, $p=.031$, $\eta^2=.094$.

The simple effect analyses revealed that for the four categories of target ideophonetic compounds, significant differences were all observed between the two types of primes. Specifically, the RTs to regular targets preceded by primes semantically related to the targets' phonetic radicals (894.497 ms) were significantly slower than those preceded by control primes (730.104 ms) ($p=.000$). The RTs to semi-regular (SPDT) targets preceded by primes semantically related to the targets' phonetic radicals (819.285 ms) were significantly slower than those preceded by control primes (749.069 ms) ($p=.029$). The RTs to semi-regular (SVDC) targets preceded by primes semantically related to the targets' phonetic radicals (861.636 ms) were significantly slower than those preceded by control primes (777.297 ms) ($p=.021$). The RTs to irregular targets preceded by primes semantically related to the targets' phonetic radicals (830.016 ms) were also significantly faster than those preceded by control primes (751.237 ms) ($p=.024$). In contrast, irrespective of the priming condition, no significant differences were found among the four categories of target words (*ps* > .05). These results revealed significant inhibitory priming effects in all of the four types of target ideophonetic compounds. These indicated that the embedded phonetic radicals were semantically activated during the target ideophonetic compounds' part-of-speech judgment, and these activations occurred regardless of the phonetic regularity of the whole ideophonetic compounds.

Concerning the magnitude of the inhibitory priming effect, further analyses from a one-way ANOVA showed that the RT differences (894.497 ms $_{\text{RT-SR prime}}$ −730.104 ms $_{\text{RT-UC prime}}$ = 164.392 ms) of regular targets were significantly larger than the RT differences of the semi-regular (SPDT) targets (819.285 ms $_{\text{RT-SR prime}}$ −749.069 ms $_{\text{RT-UC prime}}$ = 70.217 ms), semi-regular (SVDC) targets (861.636 ms $_{\text{RT-SR prime}}$ −777.297 ms $_{\text{RT-UC prime}}$ = 84.338 ms), and irregular targets (830.016 ms $_{\text{RT-SR prime}}$ −751.237 ms $_{\text{RT-UC prime}}$ = 78.779 ms), respectively ($p = .027$, $p = .034$, $p = .032$, respectively). In contrast, there were no significant differences between other inhibitory priming effects (*ps* > .05). The mean RT differences were displayed in Figura 2. These results revealed the semantic inhibitory priming effects in regular ideophonetic compound targets, significantly exceeding those observed in the other three types: semi-regular (SPDT), semi-regular (SVDC), and irregular compounds.

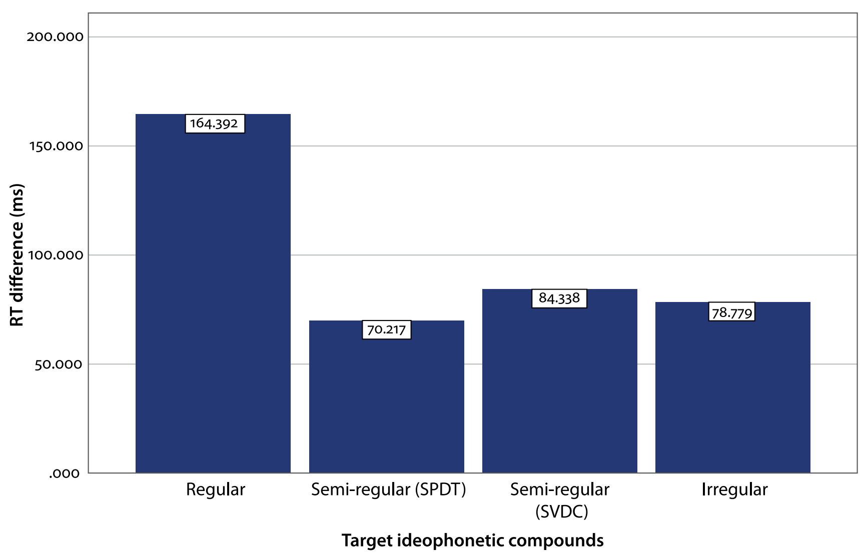

Figure 2. Mean RT differences (ms) for inhibitory priming effects across four types of target ideophonetic compounds

4. Discussion

This experiment sought to explore whether phonetic radicals can activate their semantic meanings in a Chinese ideophonetic compounds' part-of-speech judgment process. The results suggested that the meanings of phonetic radicals could indeed be activated, even if they interfered with the meanings of the entire characters. This observation is consistent with the previous findings supporting the semantic activation of phonetic radicals (Zhou & Marslen-Wilson 1999b; Lee et al. 2006; Tsang et al. 2017; Yeh et al. 2017). It also aligns with the Model of Character Processing (Tsang et al. 2017) which predicts that when an independent radical is embedded within another character, its meaning can be activated even if it bears no direct connection with the meaning of the entire character. The present study adds to the weight of current evidence that endorse the semantic activation of phonetic radicals. The phonetic radical, by definition, takes on the role of providing cues to the pronunciation of the embedding ideophonetic compound, and assumes the function of contributing to the retrieval of its host ideophonetic compound's phonology by activating its own phonological information (Zhang et al. 2009; Hung et al. 2014; Wang et al. 2016). In the present study, phonetic radicals bore nothing semantic in common with the whole ideophonetic compound's meanings, and their semantic activation may inhibit the completion of the ideophonetic compound's part-of-speech judgment. The rationale is that, should the meaning of the phonetic radical be activated, extra cognitive efforts would be taken to get it suppressed. This suppression would lead to an interference or a delay in semantic-oriented processing of the whole ideophonetic compound (like *the part-of-speech judgment*). In this regard, it is seemingly pointless that the phonetic radical has its semantic information activated. However, given the fact that an independent character has triadic interconnections of its phonology, orthography and semantics in human mental lexical representation (Perfetti et al. 2005), there might exist spacious room for semantically activated phonetic radicals to act a role. What exactly this role may be and what possible machinery may underlie this role, is undoubtedly both an intriguing and complex question which calls for more elaborate experimental design and inquiry in the future. Nevertheless, the present study has attained its objective of revealing the phonetic radical's unusual behavior – semantic activation of itself. Meanwhile, the results indicated that *phonetic regularity* of ideophonetic compounds did not modulate the semantic activation of the embedded phonetic radicals. During Chinese ideophonetic compounds' semantic recognition, the semantic meaning of their phonetic radicals was activated, be the embedding ideophonetic compounds regular, semi-regular (SPDT), semi-regular (SVDC), or irregular. A similar pattern of inhibitory effects was observed across the four types of ideophonetic compounds, lending support to this. This aligns with and adds additional evidence to the findings of Zhou & Marslen-Wilson (1999b) and Tsang et al. (2017), who revealed no differential semantic activation of phonetic radicals on the part of regular and irregular prime characters.

However, our findings revealed that the *phonetic regularity* of ideophonetic compounds could indeed modulate the semantic activation of the whole ideophonetic compound. The most pronounced inhibition effect was observed in regular ideophonetic compounds, where the semantic activation of the phonetic radical hindered the semantic processing of the entire character. This indicated that the interference from the phonetic radical's meaning was strongest in regular compounds, challenging the traditional view that phonetic regularity mainly affects the whole character's phonological processing (Rickard Liow et al. 1999; Zhou & Perfetti 2021), and rarely influences the semantic domain. Contrary to this perspective, our findings suggested that phonetic regularity may impact not only phonological but also semantic processing, affecting both the whole ideophonetic compound and its embedded phonetic radical.

The largest magnitude of inhibition observed in regular ideophonetic compounds may be explained from two perspectives. First, regarding the role of phonetic regularity, previous studies have highlighted that during the processing of compound characters, phonetic radicals' phonological and semantic information is automatically activated (Seidenberg 1985; Zhou & Marslen-Wilson 1999a), interacting with the phonological activation of the whole character (Zhou et al. 2003). When the phonetic radical and the whole character share the same pronunciation, *mutual reinforcement* occurs, leading to the enhanced phonological activation of the entire character. Conversely, when their pronunciations differ, *interference* emerges, reducing phonological activation and complicating semantic access (Zhou et al. 2003). Second, Yin and Weekes' (2003) triangle model of Chinese reading proposes two independent pathways for semantic access: (1) a lexical-semantic pathway, where orthographic representations directly map onto semantic representations, and (2) a phonological-mediated pathway, where orthographic representations are processed via phonological activation before accessing semantics. The lexical-semantic pathway enables direct access to semantics through orthographic representations in the mental lexicon (Chen, et al. 1995; Chen & Shu 2001), whereas the phonologically mediated pathway involves a two-step process in which orthographic input first activates phonological representations (e.g., syllables, tones), which subsequently activates the corresponding semantics (Zhou et al. 2003).

In this connection, for regular ideophonetic compounds in the present study, once the phonetic radical's semantic information had been activated, the phonological consistency between the phonetic radical and the whole character might promote robust phonological activation of the whole character. This may well suggest two potential pathways for the semantic access: (1) A direct lexical-semantic pathway, wherein the phonetic radical's orthographic form directly activated the whole character's orthographic representation, followed by its semantic representation. However, since the sublexical (radical-level) and lexical (whole-character-level) semantic information differed, this pathway encountered inhibition, obstructing access to the whole character's meaning. (2) An indirect phonological-mediated pathway, wherein the phonetic radical's semantic activation indirectly enhanced the whole character's phonology, which in turn facilitated their semantic access. However, when semantic access relied heavily on phonological activation, competing semantic representations associated with the same syllable (i.e., phonological overlap between sublexical and lexical levels) must contend for activation, consuming cognitive resources (Zhou et al. 2003). In cases where the phonetic radical and whole character shared the same pronunciation (i.e., in the case of regular ideophonetic compounds), this competition intensified, further inhibiting whole-character semantic retrieval.

In contrast, the phonological interference between the phonetic radical and the whole character was less pronounced in semi-regular (both SPDT and SVDC) and irregular ideophonetic compounds. This could reduce reliance on the indirect phonological-mediated pathway and shifted the focus toward the direct lexical-semantic pathway, where the phonetic radical's orthographic activation directly activated the whole character's orthographic and semantic representations. Despite this shift, the persistent semantic discrepancy between the sublexical and lexical levels continued to inhibit full semantic extraction of the whole character, resulting in the observed inhibition effects.

Another intriguing observation worth noting was the lack of significant differences in inhibition across the other three types of ideophonetic compounds, even in semi-regular (SPDT) compounds where only the tone between the whole compound and the embedded semantic radical differed. This finding suggested that only when the phonetic radical and the whole character shared the exact identical phonological representations could the radical's phonology exert a significant influence on whole-character semantic retrieval. Such results underscored the varying effects of sub-lexical phonetic radicals on the lexical-level semantic processing depending on the degree of phonological regularity, providing new insights into the intricate interaction between phonology and meaning in ideophonetic compound processing.

Overall, our findings underscore that the strongest inhibition in whole-character semantic retrieval occurs in regular ideophonetic compounds, where phonetic radicals' semantic activation aligns with phonological consistency. This alignment creates a unique challenge for semantic processing, especially when sublexical and lexical semantic representations diverge. In semi-regular and irregular compounds, where phonological interference is reduced, the emphasis shifts to direct orthographic access, though semantic inconsistencies still exert a residual inhibitory effect. These results suggest that phonetic regularity may well play a more complex role in both phonological and semantic processing than previously recognized, affecting not only the character as a whole but also its constituent radicals. Importantly, no prior study has addressed the semantic activation of phonetic radicals embedded within semi-regular ideophonetic compounds. This study, therefore, makes a valuable contribution by addressing this gap in the literature.

The present study well attained its objectives; however, several limitations should be acknowledged. First, the materials used in this experiment were constrained both in terms of quantity and the variety of division types. While we ensured that the frequencies of the four types of target characters were controlled, prior research has shown that high-frequency and low-frequency characters exhibit distinct patterns of semantic access (Li & Chen 1997). Future studies should systematically manipulate character frequency to better understand its impact on the semantic activation of phonetic radicals. Second, the part-of-speech judgment task employed in this study only partially engaged with the semantics of the characters. More comprehensive, semantically-rich tasks should be considered in future research to provide finer-grained insights.

5. Conclusion

In Chinese ideophonetic compound processing research, there is a prevalent belief that phonetic radicals can be phonologically activated as they have the potential to contribute to the host ideophonetic compounds' phonology. The present study, however, on top of a couple of previous studies, demonstrates that phonetic radicals can also be *semantically activated*. This finding illuminates current mainstream research which revolves predominantly around phonetic radicals' phonological activation and semantic radicals' semantic activation. This finding opens up a likelihood that phonetic radicals may contribute to the whole ideophonetic compounds' processing not only by phonologically activating themselves but also by semantically activating themselves. What exactly this machinery is undoubtedly necessitates further inquiry.

The present study further elucidates the role of *phonetic regularity* in the semantic activation of phonetic radicals. Consistent with previous research, the findings indicated that phonetic regularity does not directly influence the semantic activation of phonetic radicals themselves. However, it significantly affects the semantic processing of whole characters in regular ideophonetic compounds.

List of abbreviations

SISU	Sichuan International Studies University
SPDT	same phonemes different tones
SR	semantically related
SVDC	same vowels different consonants
UC	unrelated control

Appendix. Primes and targets used in the experiment

Item no.	Semantically related (SR) prime	Unrelated control (UC) prime	Target		Phonetic radicals embedded in the target characters
1	倍	神	拌 /pan^4/		半 /pan^4/
2	雨	肉	楓 /fɤŋ^1/		風 /fɤŋ^1/
3	武	面	蚊 /uən^2/		文 /uən^2/
4	里	豆	钟(鐘) /ʈʂʊŋ^1/		中 /ʈʂʊŋ^1/
5	查	坐	嬸 /ʂən^3/	Regular Ideophonetic compounds	審 /ʂən^3/
6	上	美	吓(嚇) /ɕja^4/		下 /ɕja^4/
7	草	寶	描 /mjaʊ^2/		苗 /mjaʊ^2/
8	樹	班	淋 /lɪn^2/		林 /lɪn^2/
9	尾	員	沫 /mɔ^4/		末 /mɔ^4/
10	民	虫	棺 /kwan^1/		官 /kwan^1/
11	圓	困	訪 /faŋ^3/		方/faŋ^1/
12	爬	述	瞪 /tɤŋ^4/		登 /tɤŋ^1/
13	低	暖	稿 /kaʊ^3/		高/kaʊ^1/
14	危	窄	按 /an^4/	Semi-regular Ideophonetic compounds *(SPDT)*	安/an^1/
15	綠	好	情 /tɕ^{h}ɪŋ^2/		青/tɕ^{h}ɪŋ^1/
16	妻	米	扶 /fu^2/		夫 /fu^1/
17	協	流	拱 /kʊŋ^3/		共 /kʊŋ^4/
18	合	求	餅 /pɪŋ^3/		并 /pɪŋ^4/

Appendix. *(continued)*

Item no.	Semantically related (SR) prime	Unrelated control (UC) prime	Target		Phonetic radicals embedded in the target characters
19	牛	電	媽 /ma^{1}/		馬 /ma^{3}/
20	拆	提	份 /fən^{4}/		分 /fən^{1}/
21	古	小	吟 /ɪn^{2}/		今 /tɕɪn^{1}/
22	臣	醫	裙 /tɕ^{h}yn^{2}/		君 /tɕyn^{1}/
23	傲	温	逛 /kwaŋ^{4}/		狂 /k^{h}waŋ^{2}/
24	異	緊	洞 /tʊŋ^{4}/		同 /t^{h}ʊŋ^{2}/
25	多	灰	炒 /ʈʂ^{h}ɑʊ^{3}/	Semi-regular Ideophonetic compounds *(SVDC)*	少 /ʂɑʊ^{3}/
26	難	假	踢 /t^{h}i^{1}/		易 /i^{4}/
27	双	祥	蟬 /ʈʂ^{h}an^{2}/		單 /tan^{1}/
28	妹	錢	梯 /t^{h}i^{1}/		弟 /ti^{4}/
29	百	月	汁 /ʈʂɚ^{1}/		十 /ʂɚ^{2}/
30	唱	攻	凑 /ts^{h}oʊ^{4}/		奏 /tsoʊ^{4}/
31	腳	辮	捉/ʈʂuɔ^{1}/		足 /tsu^{2}/
32	走	夸	涉/ʂɤ^{4}/		步 /pu^{4}/
33	想	拿	腮/saɪ^{1}/		思 /sɯ^{1}/
34	愉	胖	掀/ɕjɛn^{1}/		欣 /ɕɪn^{1}/
35	果	夜	弧/xu^{2}/		瓜 /kwa^{1}/
36	劍	詞	切/tɕ^{h}jɛ^{1}/	Irregular Ideophonetic compounds	刀 /taʊ^{1}/
37	外	輕	納 /na^{4}/		内 /neɪ^{4}/
38	東	平	洒 /sa^{3}/		西 /ɕi^{1}/
39	大	白	柜(櫃) /kweɪ^{4}/		巨 /tɕy^{4}/
40	碗	脖	釣 /tjaʊ4/		勺 /ʂaʊ^{2}/

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