The Role of Sentence Context on Compound Word Processing

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This research was supported by a grant from the National Natural Science Foundation of China (NSFC; 32371156).

The data, code and materials associated with this study are publicly available at OSF and can be accessed at https://osf.io/9vdgp/?view_only=3dd743241faa46b5afdcee075aa7adc5.

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Word count: 2939 (including Introduction, Results, and Discussion)

Abstract

This study examined how sentence context influences the processing of Chinese compound words during reading. More specifically, we investigated whether the processing of compound words—whether they are interpreted as a whole or decomposed into their constituent parts—is influenced by sentence context. We orthogonally manipulated the plausibility of the first constituent word and that of the whole compound word within a sentence. Readers' eye movements were recorded as they read these sentences. Results revealed an interactive effect of whole-word plausibility and constituent-word plausibility on gaze duration. When the whole compound word was temporarily implausible, gaze durations were longer when the first constituent word was plausible than when it was implausible. However, this inhibitory effect of the constituent word disappeared when the compound word was contextually plausible. These findings suggest that sentence context influences an early stage of compound word processing. Readers tend to process a compound word holistically when it is contextually plausible but process constitutes as separate words when the word is implausible in context. Based on these results, we propose improvements to Chinese reading models, emphasizing the role of contextual information in lexical competition—where plausible words supported by context are more likely to be segmented. Our findings contribute to a more nuanced understanding of compound word processing, providing a new perspective other than the traditional dichotomy between holistic and decompositional processing.

Keywords: Chinese reading; compound word processing; prior context; eye movements

The Role of Sentence Context on Compound Word Processing

Compound words are morphologically complex words composed of two or more free morphemes, such as *snow* and *ball* in the compound word *snowball*. Psycholinguists have long been interested in how compound words are processed, as they offer insights into how humans process the hierarchical linguistic structures (Pinker, 2000). In Chinese, the absence of explicit word boundaries requires that words first be segmented from character strings before being integrated with prior context for successful comprehension. Extensive previous research has primarily focused on the properties of individual words to understand the mechanisms underlying compound word processing. However, it remains less clear whether and how sentence-level information interacts with lexical processing, particularly in the identification of compound words within sentences. This issue is relevant not only to alphabetic writing systems but also to logographic systems such as Chinese.

The present study examines how contextual semantics influence Chinese compound word processing during sentence reading. Chinese is ideal for this inquiry due to two key properties. First, over 80% of the vocabulary consists of compound words formed by combining characters (e.g., *马* [meaning "horse"] and *上* [meaning "on"] in *马上* [meaning "about to"]), which serve both as morphemes and independent words (Institute of Language Teaching and Research, 1986). Second, the absence of explicit word boundaries necessitates efficient segmentation strategies using high-level linguistic information (Bai et al., 2008; Huang et al., 2024; Li et al., 2022). For example, *马上* functions as a compound in *我马上要去上学了* ("I'm about to go to school"), but as separate words in *骑在马上的感觉非常美好* ("The feeling of riding *on a horse* is wonderful"). Consequently, compound word processing in Chinese is closely linked to word segmentation challenges during reading, and readers need to determine whether a single character functions as a word or as a constituent of a longer word.

Three types of theories were proposed to explain compound word processing, primarily based on alphabetic studies. Holistic models propose direct whole-word retrieval without constituent involvement (Giraudo & Grainger, 2001). Decomposition models argue that the lexical entry for a compound word is accessed via their constituents (Taft & Forster, 1975, 1976). Dual-route models propose parallel holistic and decomposition processes competing based on factors like word length and frequency (Caramazza et al., 1988; Schreuder & Baayen,

1995). Chinese studies testing these theories through manipulating the frequency of constituent characters yield inconsistent results (see Zhang et al., 2024). While some report faster processing for compounds with high-frequency characters (Yan et al., 2006), others find reversed (Cui et al., 2021; Xiong et al., 2023; Yu et al., 2021) or null effects (Li et al., 2014; Ma et al., 2015), failing to conclusively support any theory.

Because compound words are embedded in sentences in natural reading, an important question is how sentence context influences compound word processing. English compound words appear in three orthographic varieties, including concatenated (e.g., *belltower*), hyphenated (e.g., *bell-tower*), and spaced (e.g., *bell tower*) formats (Kuperman & Bertram, 2013). One eye-movement study found predictable sentence context reduced the effect of beginning lexeme frequency on first fixation and single fixation durations when reading concatenated compounds (Juhasz, 2012). This finding showed that sentence context affects the access to early morpho-orthographic processes. Another research examined this issue by embedding spaced noun-noun compound words in sentences and manipulating the plausibility of the first constituent based on prior context. Previous studies have shown a plausibility effect in sentence reading, with shorter reading times for plausible than for implausible words (Rayner et al., 2004; Warren & McConnell, 2007). Staub et al. (2007) applied this paradigm to spaced compounds and found that plausible constituents (e.g., *visited the cafeteria manager*) led to shorter reading times than implausible ones (e.g., *talked to the cafeteria manager*). These findings indicate that English readers integrate the first constituent into sentence as soon as they encounter it (Abbott & Staub, 2015; Lewis & Vasishth, 2005; Staub, 2011).

Using a similar approach, studies on Chinese reading reported different results, likely due to the absence of word boundaries and shorter word length in Chinese (Wang et al., 2023; Yang et al., 2012). Yang et al. (2012) embedded two-character words (e.g., 门卫, meaning "gatekeeper") into sentences while ensuring that the combinations of the verbs and the full compound word remained plausible (see Table 1). The combinations of the verbs and the first constituents (e.g., 门, meaning "door") were either plausible (e.g., 踢打门, meaning "kicked the door") or implausible (e.g., 哀求门, meaning "entreated the door") at the point they appeared, and the entire sentence was plausible. Yang et al. found no constituent plausibility effect, leading them to conclude that Chinese compound words are processed holistically

during reading.

Table 1

Examples of stimuli in Yang et al. (2012)

Condition	Example/Translation
plausible whole word-plausible constituent	围观的人看着他踢打门卫却无动于衷 People were inattentive when he kicked the gatekeeper
plausible whole word-implausible constituent	围观的人看着他哀求门卫却无动于衷 People were inattentive when he entreated the gatekeeper

Note. The target words are bolded, and the combinations of verbs and nouns are underlined. They were not presented in bold or underline in the experiment.

The argument that compound words are processed holistically aligns with the prediction of Chinese Reading Model (CRM; Li & Pollatsek, 2020), which simulates how Chinese readers segment words during sentence reading. The model assumes that all characters within the perceptual span activate all words they constitute (e.g., both compounds and constituents), and the spatial overlapping compete for recognition. Once a word's activation surpasses a threshold, it is recognized and segmented simultaneously. Because compound words receive stronger activation from more characters, they hold competitive advantages and rapidly inhibit constituent words. Consequently, the whole-word typically wins the competition. Li and Pollatsek's simulation indicate that over 99% of two-character words were segmented holistically, even when low-frequency, suggesting that readers prioritize whole-word processing despite constituent activation.

While the absence of a constituent plausibility effect suggests holistic processing of compound words, a crucial limitation of these studies is that they only examined situations where compound words were always plausible in the given context. This design leaves open important questions about how sentence context influences compound word processing. Two possible interpretations emerge. One is that compound words may be processed holistically regardless of context. Alternatively, context may influence competition, but this effect was undetectable in Yang et al.'s (2012) study because the whole words were always plausible.

According to CRM, longer compounds receive stronger activation from the characters, favoring whole-word recognition. If the whole compound word is plausible in context, contextual information may further strengthen whole-word activation, suppressing constituent plausibility effects. This provides an alternative explanation for the null plausibility effect in Yang et al., and underscores the need to determine whether contextual modulation occur before the whole word is fully identified and segmented.

Evidence from Zhou and Li (2021) supports the influence of context on word segmentation. They manipulated the plausibility of three-character incremental words (e.g., *酒精灯*, meaning "alcohol lamp") and their embedded constituents (e.g., *酒精*, meaning "alcohol") in Chinese sentences. When the whole words were implausible, the sentences remained anomalous even after the entire sentence was read. The results showed a constituent plausibility effect only when the whole word was implausible (e.g., 2c and 2d in Table 2). Readers fixated longer on the incremental words with implausible embedded constituents (e.g., *侵略酒精*, meaning "invade the alcohol") than on plausible ones (e.g., *涂抹酒精*, meaning "smear the alcohol"). No such effect appeared for plausible whole words (e.g., 2a and 2b in Table 2), suggesting that Chinese readers tend to process plausible incremental words as single units, whereas implausible ones lead to segmentation of embedded words. However, the experiment had notable limitations. Anomalous sentences of implausible whole-word conditions lacked correct segmentation, potentially disrupting natural reading and forcing atypical strategies. This raises concerns about whether the observed effects reflect normal processing or artifacts of readers struggling with unreasonable sentences.

Table 2

Examples of stimuli in Experiment 2 in Zhou & Li (2021)

Condition	Example/Translation
2a. plausible whole word-plausible embedded word	陈晓默默地点燃**酒精灯**以便再次实验 Chen silently lit the alcohol lamp in order to do the experiment again
2b. plausible whole word-implausible	陈晓默默地清洗**酒精灯**以便再次实验 Chen silently washed the alcohol lamp in order to do the

embedded word	experiment again
2c. plausible whole word-plausible embedded word	陈晓默默地涂抹**酒精灯**以便再次实验 Chen silently smeared the alcohol lamp in order to do the experiment again
2d. plausible whole word-implausible embedded word	陈晓默默地侵略**酒精灯**以便再次实验 Chen silently invaded the alcohol lamp in order to do the experiment again

Note. The target incremental words are bolded, and the combination of verbs and nouns are underlined. They were not presented in bold or underline in the experiment.

The present study investigated how sentence contexts influence compound word processing, specifically examining whether top-down contextual semantics influence segmentation competition (hereby the *competition hypothesis*) or integration (hereby the *integration hypothesis*). We extended Yang et al. (2012) by introducing conditions where compound words are temporarily implausible when combined with prior verbs, while their first constituents were either contextually plausible or implausible, still the overall sentence remains plausible. This manipulation creates a "fairer" competition, with bottom-up lexical information favoring whole-word segmentation and top-down context supporting the segmentation of constituent-word.

The *competition hypothesis* suggests context influences the competition between constituents and whole words before the compound words are fully identified, and the early eye movement measures can be sensitive to plausibility. Because word segmentation is obligatory in Chinese reading, contextual plausibility can modulate the degree of competition during word identification and segmentation. Conversely, the *integration hypothesis* proposes that sentence context affects compound word processing only when integrating the compound word into the overall sentence context, which reflected in the later eye movement measures. Thus, segmentation is context-independent, and compound words are always segmented because of more activation from the character level.

These hypotheses lead to different predictions regarding reading times in the whole-word region. The competition hypothesis predicts when an implausible compound word contains a

plausible constituent, contextual support intensifies the constituent's competition with the whole-word, delaying segmentation and increasing first-pass reading times (i.e., first fixation duration and gaze duration). Moreover, in this condition, readers may incorrectly segment the compound word as two single-character words if the constituent wins the competition, requiring additional time for correction. In contrast, plausible compound words, benefiting from both contextual and lexical support, are processed holistically, showing no constituent plausibility effects. However, the integration hypothesis predicts that reading times in the whole-word region will remain consistent across conditions, regardless of constituent plausibility. Because segmentation occurs independently of context, compound words are correctly segmented and the entire sentences are reasonable. It also predicts that contextual plausibility influences processing only after compound words are fully recognized, leading to longer reading times (i.e., go-past time) and increased regression-out probabilities for implausible whole words.

In summary, manipulating constituent-word plausibility while keeping whole-words temporarily implausible provides an approach to examine whether and how contextual semantics influence compound word processing. For the implausible compound words, the competition hypothesis predicts longer fixation times in the whole-word region due to plausible constituents, whereas the integration hypothesis predicts no such divergence.

Methods

Participants

A power analysis was conducted using G*Power 3.1.9, based on an anticipated medium effect size ($f = 0.25$) derived from previous research on the plausibility effect during reading (Staub et al., 2017). This calculation indicated that a minimum sample of 58 was required to achieve statistical power of 0.90 with an alpha of .05. To account for potential data exclusion, a total of 80 university students (23 males; age range 18–29 years) were recruited in the experiment, and they received a small monetary compensation for their participation. All of them were native Chinese speakers with normal or corrected-to-normal vision, and no self-reported history of reading or language disorders. Six participants were excluded from the

analysis because they made more than five blinks in more than one-third of the trials. Given the number of trials in each condition, there were 1,554 observations per condition in the analysis, which is approximate to the recommendation of Brysbaert and Stevens (2018)[1].

Materials and Design

Eighty-four two-character words were selected from Modern Chinese Dictionary (Dictionary Editorial Office, Institute of Linguistics, Chinese Academy of Social Sciences, 2016) as target words. All target words were nouns, and their first constituent words were also nouns when used alone. The whole-word frequency of the target words ranged 0.03−445 per million (M = 18, SD = 61), the first constituent frequency ranged 20−5,558 per million (M = 590, SD = 717), and the second constituent frequency ranged 3−8,774 per million (M = 661, SD = 1,444). We orthogonally manipulated the plausibility of the entire target word and the plausibility of its constituent words (formed by the first character of the target word) within the given sentence context by pairing four different verbs with each target word. For example, in the two plausible-whole-word conditions, the combinations of the preceding verb and whole compound word were plausible (e.g., *准备笔试*, meaning "prepare for the written exam"; *完成笔试*, meaning "complete the written exam"). Meanwhile, the combinations of the verb and the first constituent-word (e.g., *笔*, meaning "pen") were either plausible (*准备笔*, meaning "prepare the pen") or implausible (*完成笔*, meaning "complete the pen"). Similarly, in the two implausible-whole-word conditions, the verb-noun combinations for the whole compound word were implausible (e.g., *归还笔试*, meaning "return the written exam"; *复印笔试*, meaning "copy the written exam"). Meanwhile, the combinations for the first constituent-word were either plausible (*归还笔*, meaning "return the pen") or implausible (*复印笔*, meaning "copy the pen"). The verb-noun combinations in the four conditions were embedded in the same sentence frames, resulting in a total of 84 sets of sentences (see Table 3 for examples). We created four lists of experimental sentences, each containing 84 sentences, with 21 sentences from each of the four conditions. Each participant was assigned to one of the lists, and this design ensured that participants did not read sentences with the same prior context or

[1] In the process of data preprocessing, 7.7% of trials were excluded because of blinks, resulting in fewer observations.

target words. The order of sentences within each list was randomized.

Table 3

Examples of Stimuli in the Experiment

Compound-word Plausibility	Constituent-word Plausibility	Introduction	Example/Translation
Plausible	Plausible	Whole sentence	我的同桌在准备**笔试**的材料后感到疲惫。
		Translation	My desk-mate felt tired after preparing the material for the **written exam**.
		Prior verb + Compound word	prepare for the **written exam**
		Prior verb + Constituent word	prepare the *pen*
	Implausible	Whole sentence	我的同桌在完成**笔试**的材料后感到疲惫。
		Translation	My desk-mate felt tired after completing the material for the **written exam**.
		Prior verb + Compound word	complete the **written exam**
		Prior verb + Constituent word	complete the *pen*
Implausible	Plausible	Whole sentence	我的同桌在归还**笔试**的材料后感到疲惫。
		Translation	My desk-mate felt tired after returning the material for the **written exam**.
		Prior verb + Compound word	return the **written exam**
		Prior verb + Constituent word	return the *pen*
	Implausible	Whole sentence	我的同桌在复印**笔试**的材料后感到疲惫。
		Translation	My desk-mate felt tired after copying the material for the **written exam**.
		Prior verb + Compound word	copy the **written exam**

Prior verb + Constituent word	copy the *pen*

Note. The target compound words are bolded, and the constituent words are in italics. They were not presented in bold or italics in the experiment.

The plausibility of compound-word, constituent-word, and whole sentences were assessed by thirty-two participants who did not participate in the eye-tracking experiments on a 7-point scale (1 was very implausible, while 7 was very plausible). The results showed that, for compound words, the plausibility score was significantly higher in the plausible condition (M = 5.4, all were above 4) than that in the implausible condition (M = 2.6, all were below 4), $F(1, 83) = 861$, $p < .001$, $\eta^2 = .912$. For constituent words, there was also a significant difference between the plausible (M = 5.2, all were above 4) and implausible conditions (M = 2.4, all were below 4), $F(1, 83) = 1{,}290$, $p < .001$, $\eta^2 = .940$. Even though the compound words were locally implausible when paired with prior verbs, the complete sentences were always understandable (Ms > 5.2, all was above 4). The word frequency of the verb prior to the target word, character frequency, and the number of strokes of each character of the verb were matched across conditions to the extent that they were not significantly different (ps > .1, see Table 4 for details). To make sure readers do not predict the target word based on the prior context, forty native Chinese speakers who did not participate in the main experiment were recruited to assess the cloze probability of the target words. They were assigned to one of four counterbalanced lists and were asked to write down the words they predicted given the sentence frames prior to the target words. The mean cloze probability scores for the two-character compound words or the one-character constituent words in the four conditions were close to zero (M = 0.01, all were below 0.4). The differences across conditions were not significant, $F(3, 332) = 1.84$, $p = .141$.

Table 4

Characteristics of Materials Used in the Experiment

Characteristics	Plausible compound-word		Implausible compound-word		Compound-word plausibility	Constituent-word plausibility	Interaction
	Plausible constituent-word	Implausible constituent-word	Plausible constituent-word	Implausible constituent-word			
Plausibility of the whole sentence	5.4 (0.7)	5.4 (0.6)	5.2 (0.7)	5.3 (0.7)	$F(1, 83) = 2.67$, $p = .106$	$F(1, 83) = 1.36$, $p = .246$	$F(1, 83) = 0.20$, $p = .658$
Plausibility of the compound word	5.4 (0.8)	5.4 (0.8)	2.6 (0.9)	2.5 (0.9)	$F(1, 83) = 861$, $p < .001$	$F(1, 83) = 0.18$, $p = .671$	$F(1, 83) = 0.08$, $p = .781$
Plausibility of the constituent word	5.2 (0.8)	2.5 (0.9)	5.3 (0.7)	2.3 (0.8)	$F(1, 83) = 0.17$, $p = .683$	$F(1, 83) = 1,290$, $p <.001$	$F(1, 83) = 2.17$, $p = .145$
Word frequency of the verb	2.2 (0.5)	2.2 (0.6)	2.2 (0.6)	2.1 (0.6)	$F(1, 83) = 0.36$, $p = .550$	$F(1, 83) = 0.41$, $p = .523$	$F(1, 83) = 0.14$, $p = .706$
First character stroke of the verb	9.5 (2.8)	9.0 (2.5)	8.7 (2.7)	8.9 (3.0)	$F(1, 83) = 2.36$, $p = .129$	$F(1, 83) = 0.15$, $p = .699$	$F(1, 83) = 1.00$, $p = .322$
Second character stroke of the verb	9.1 (2.8)	8.9 (2.8)	9.4 (3.1)	8.9 (2.9)	$F(1, 83) = 0.34$, $p = .563$	$F(1, 83) = 1.99$, $p = .162$	$F(1, 83) = 0.18$, $p = .671$
First character frequency of the verb	3.8 (0.5)	3.9 (0.6)	3.7 (0.7)	3.9 (0.7)	$F(1, 83) = 0.71$, $p = .403$	$F(1, 83) = 2.61$, $p = .110$	$F(1, 83) = 0.45$, $p = .505$
Second character frequency of the verb	4.0 (0.7)	4.1 (0.6)	4.0 (0.7)	3.9 (0.6)	$F(1, 83) = 2.36$, $p = .129$	$F(1, 83) = 0.03$, $p = .861$	$F(1, 83) = 0.31$, $p = .582$

Note. Word frequency and character frequency were log-transformed. The standard deviations (*SD*) are provided in parentheses.

Apparatus

Participants' eye movements were recorded using an eye-tracker with a sampling rate of 1,000 Hz. The materials were presented on a 21-inch CRT monitor with a resolution of 1024 × 768 pixels and a refresh rate of 150 Hz. Each sentence was displayed on a single line in Song 20-point font, and the characters were shown in black (RGB: 0, 0, 0) on a medium gray background (RGB: 128, 128, 128). Target words were in the middle part of the sentences so that they were not within the first or last five characters of a sentence. Participants were seated at a viewing distance of 58 cm from the computer monitor, with each character subtending a visual angle of approximately 0.7°. Participants stabilized their heads with a chin and forehead rest. For each participant, the viewing was binocular, but only the right eye was monitored. The experiment was programmed with the EyeTrack software developed by the UMASS Eye Tracking Lab.

Procedure

Participants were tested individually. After they read the experimental instructions, the height of the chair and that of the chin rest were adjusted to make them feel comfortable. The eye tracker was calibrated using a three-point calibration and validation procedure, and the maximal error of validation was below 0.5° in the visual angle. A white character-size square firstly appeared at the beginning of each trial, indicating the position of the first character in the sentence. A sentence appeared after participants fixated on the square for 200 ms. After reading each sentence silently, they pressed a response button to start the next trial. Participants read eight sentences for practice, followed by 84 experimental sentences and 84 filler sentences in a random order. Following approximately one third of the sentences (all of them were fillers), participants answered comprehension questions by pressing a button on a button box.

Data analysis

We conducted analyses in the target word region (i.e., the two-character nouns) and analyzed the following eye-movement measures: (1) first fixation duration: the duration of the first fixation on a word during the first-pass reading, can be a single fixation or the first of multiple fixations; (2) gaze duration: the sum of all first-pass fixations on the word before moving to another word; (3) go-past time: the sum of the fixations starting when entering the region until crossing the right boundary of this region; (4) regression-out probability: the percentage of regressions from the word to earlier regions before leaving that word in a forward direction; (5) regression-in probability: the percentage of regressions back to the word after

leaving it. The five measures reflect different stages as well as time-course of word processing and were analyzed to examine the contextual effects on lexical processing during reading (e.g., Huang & Li, 2023; Wang et al., 2023). First fixation duration and gaze duration reflect the procedure of lexical access; other measures, such as regression-out probability, regression-in probability and go-past time, capture later stages of processing, such as sentence integration or error correction (e.g. Rayner, 1998; Reichle et al., 2009).

Eye-movement measurements were analyzed using linear mixed-effects models (LMMs) for continuous variables (e.g., first fixation duration, gaze duration, and go-past time) and generalized linear mixed-effects models (GLMMs) for binary variables (e.g., regression-out probability and regression-in probability) with the *lme4* packages (Bates et al., 2015) in R 4.2 (R Core Team, 2018). Because of the positive skewness of the durational measures, they were log-transformed to meet the distribution assumption of LMMs. In all models, plausibility of whole-word and plausibility of constituent-word were entered as contrast coded fixed factors (plausible was coded as −0.5 and implausible was coded as 0.5), specifying participants and items as crossed random factors, including intercepts and slopes (Baayen et al., 2008). Following Barr et al. (2013), we used the maximal model that could converge. All models were initially constructed with a maximal random factor structure. When the maximal model did not converge, a simpler zero-correlation parameter model was tested, with the random component generating the smallest variances removed (Barr et al., 2013). We report regression coefficients (*b*s), *SE*s, *t* values (for durations) or *z* values (for regression-in probability), and corresponding *p* values of the optimal model (See Appendix Tables A1 for the final random components).

Transparency and Openness

Data and code are available at https://osf.io/9vdgp/?view_only=3dd743241faa46b5afdcee075aa7adc5. The study was not pre-registered.

Results

The mean accuracy of the comprehension questions was 95.1%, indicating that the participants understood the sentences well[2]. Trials were removed when participants made at least one blink within the region of two-character noun (7.7%). Fixations longer than 1,000 ms

[2] The comprehension questions were related to the fillers that were excluded in the analyses, and therefore, the accuracy was no more considered in the following analyses.

or shorter than 80 ms were also removed (1.6%). The means and *SE*s for each eye-movement index and the fixed-effect estimates from the (G)LMMs in all regions are summarized in Tables 5 and 6.

The main effect of whole-word plausibility was significant for go-past time, regression-out probability, and regression-in probability, but not significant for first fixation duration or gaze duration. Specifically, go-past time (b = 0.08, SE = 0.02, t = 4.53, p < .001) was longer, and regression-out probability (b = 0.33, SE = 0.09, z = 3.65, p < .001) was higher when target words were implausible compared to plausible ones. The main effect of constituent-word plausibility was not significant for any measures except regression-out probability, where a higher probability was observed in the implausible constituent condition compared to the plausible condition (b = 0.24, SE = 0.10, z = 2.39, p = .017).

More importantly, an interaction effect between whole-word plausibility and constituent plausibility was observed for gaze duration (b = −0.06, SE = 0.03, t = −2.34, p = .023). For implausible whole words, constituent plausibility showed significant effects (b = −0.04, SE = 0.02, t = −2.25, p = .027), with longer gaze duration observed for words with plausible constituents (M = 305 ms, SE = 7) compared to those with implausible constituents (M = 289 ms, SE = 6). However, for plausible whole-word, constituent plausibility did not significantly affect gaze duration (b = 0.02, SE = 0.02, t = 1.26, p = .213). No significant interaction effects were observed for other measures (ps > .159).

Table 5

Eye-Movement Measures in the Experiment

Eye-Movement Measures	Plausible compound word		Implausible compound word	
	Plausible constituent	Implausible constituent	Plausible constituent	Implausible constituent
First fixation duration (ms)	259 (5)	257 (4)	263 (4)	254 (4)
Gaze duration (ms)	292 (6)	296 (6)	305 (7)	289 (6)
Go-past time (ms)	373 (11)	392 (11)	411 (12)	418 (13)
Regression-out probability	0.12 (0.01)	0.15 (0.01)	0.16 (0.01)	0.18 (0.01)
Regression-in probability	0.30 (0.02)	0.32 (0.02)	0.34 (0.02)	0.34 (0.02)

Table 6

Results of the (Generalized) Linear Mixed-effects Models

Measure	Fixed effect	Estimate	SE	*t/z*	*p*
First fixation duration	Whole-word Plausibility	0.00	0.01	0.29	0.770
	Constituent-word Plausibility	-0.01	0.01	-1.33	0.186
	Interaction	-0.02	0.02	-1.18	0.244
Gaze duration	Whole-word Plausibility	0.02	0.01	1.53	0.125
	Constituent-word Plausibility	-0.01	0.01	-0.75	0.457
	Interaction	**-0.06**	**0.03**	**-2.34**	**0.023**
Go-past time	**Whole-word Plausibility**	**0.08**	**0.02**	**4.53**	**<.001**
	Constituent-word Plausibility	0.03	0.02	1.31	0.197
	Interaction	-0.06	0.04	-1.43	0.159
Regression-out probability	**Whole-word Plausibility**	**0.33**	**0.09**	**3.65**	**<.001**
	Constituent-word Plausibility	**0.24**	**0.10**	**2.39**	**0.017**
	Interaction	-0.06	0.17	-0.36	0.721
Regression-in probability	Whole-word Plausibility	0.13	0.07	1.96	0.050
	Constituent-word Plausibility	0.04	0.06	0.68	0.494
	Interaction	-0.07	0.15	-0.47	0.636

Note. Significant effects are indicated in bold.

Discussion

In the current study, we conducted an eye-tracking experiment to investigate how sentence context affects compound word processing during Chinese reading. We orthogonally manipulated the plausibility of the whole compound word and its first constituent in relation to the preceding context (i.e., the verb). The correct segmentation was always the two-character compound word, and the entire sentences were plausible, although temporary implausibility occurred in the two implausible whole-word conditions. The key finding is an interaction between compound-word plausibility and constituent-word plausibility on gaze duration in the target region. When the whole compound words were plausible, there were no constituent plausibility effects. However, when the whole compound words were implausible, constituent plausibility affected reading time, leading to longer gaze durations when the constituent-word was plausible than when it was implausible.

The interaction between constituent- and whole-word plausibility on gaze duration suggests that contextual information influences compound word segmentation, supporting the competition hypothesis. Notably, plausible words receive shorter fixations than implausible ones during sentence reading (Rayner et al., 2004; Staub et al., 2007). However, in our experiment, plausible constituents resulted in longer gaze durations in the compound word region, indicating that constituent activation may interfere with holistic processing. This reversed plausibility effect is consistent with Chinese Reading Model (CRM; Li & Pollatsek, 2020), which posits the competition between constituent and whole-word representations.

Current findings also align with Juhasz (2012), although the effect emerged in different measures. More specifically, while Juhasz found an interaction between word predictability and beginning lexeme frequency on first fixation duration, we only found an interactive effect of whole-word plausibility and constituent-word plausibility on gaze duration. The data pattern of first fixation duration in our study were similar to gaze duration, but the effect was not significant. These differences may reflect methodological differences. Juhasz manipulated predictability, which might affect earlier stages of processing than plausibility manipulation in our study (Rayner, 1998). Therefore, the effect on first fixation duration might be too small to detect in our study.

Two reasons account for the inhibitory plausibility effects. First, when the whole compound words were temporarily implausible, the plausible constituent-word received stronger contextual support, increasing its initial activation and the possibility of being

segmented. However, since the implausibility of the whole-word was temporary, readers needed to correct the initial error and combine the two constituents as a whole word. Second, even without full segmentation, competition between constituent and whole-word representations may require additional time to resolve. These possibilities explain why gaze durations increased when constituent words were plausible in implausible whole-word conditions. The absence of constituent plausibility effects under plausible-compound conditions aligns with previous findings, reflecting the processing advantage of long compounds (Yang et al., 2012; Wang et al., 2023).

Our findings differ from Zhou and Li (2021), who reported facilitative effects of plausible constituents on implausible whole words, reflected in shorter total reading time. In contrast, we observed inhibitory effects during first-pass reading, without influence on later measures. A key difference is the nature of implausibility: Zhou and Li used sentences with globally anomalous structures and no correct segmentation, whereas our stimuli preserved correct compound segmentation and only introduced temporary implausibility. Therefore, our results more likely reflect natural reading processes.

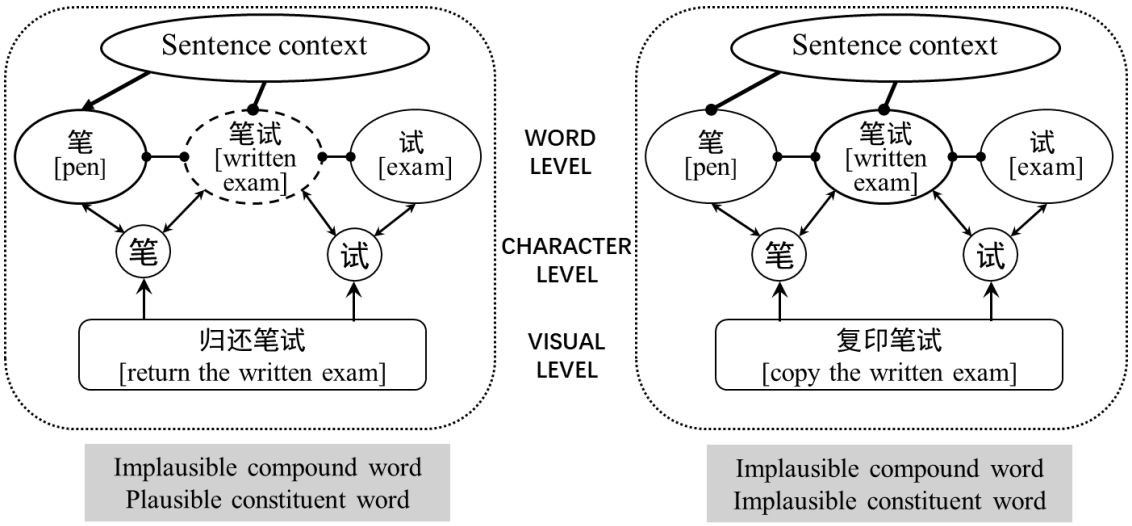
Moreover, we observed main effects of whole-word plausibility on go-past time and regression-out probability in the target word region. Readers spent more time processing temporarily implausible words, indicating the typical plausibility effect during sentence reading. This implies that the two-character words were finally segmented and integrated with contexts, although it took longer for the whole-word to win the competition or correct initial segmentation errors. After segmenting compound words as a whole unit, readers immediately perform semantic integration, consistent with previous findings (e.g., Yang et al., 2012).

These findings have important implications for theories of Chinese compound word processing, showing that sentence context influences the competitive dynamics between whole words and constituent words very early. CRM does not explicitly account for the role of sentence context in word segmentation competition. However, it can be revised to incorporate semantic context, allowing for dynamic interactions between bottom-up lexical information and top-down contextual factors during word segmentation (Figure 1). We can make additional assumptions that plausible words are activated while implausible words are inhibited by contextual semantics. The whole-word is always activated by more characters than the constituent-word, regardless of contextual plausibility. In cases where the whole-word is implausible but the constituent-word is plausible, the constituent-word may initially dominate due to contextual bias, leading to intense competition. Conversely, if both the whole-word and constituent-word are implausible, or the whole-word is plausible, the whole-word will

dominate and be quickly segmented. This revised model would better capture the context-dependent nature of Chinese compound word processing.

Figure 1

Proposed Model of Word Segmentation with Contextual Effects



Note. Arrows on lines indicate excitatory connections; circles on lines represent inhibitory links.

The current findings indicate that sentence context plays a crucial role in modulating the dynamic competition between whole-word and constituent representations during compound word processing. In plausible contexts, whole-word representations dominate, and processing appears holistic, with minimal competition; in implausible contexts, constituent information gains a temporary advantage, complicating segmentation of the compound. This provides a new perspective regarding how compound words are processed during reading.

Conclusions

This study extends our understanding of compound word processing. Evidence indicates that constituent words and whole words are both activated during reading, and they compete; critically, sentence context modulates the intensity of this competition. When a compound word is plausible in sentence context, it is processed holistically. However, when a compound word is implausible, its plausible constituent may initially be processed as an independent word, making segmentation of the whole word more difficult. Readers actively use contextual information to complete word recognition and segmentation, with constituent words competing with the whole compound word at the segmentation stage.

Declarations

Funding

This research was supported by a grant from [anonymized source].

Conflict of interest statement

The authors declare no conflicts of interest.

Data availability statement

The data and materials of this study are available at OSF and can be accessed at https://osf.io/9vdgp/?view_only=3dd743241faa46b5afdcee075aa7adc5.

Code availability statement

The code of this study is available at OSF and can be accessed at https://osf.io/9vdgp/?view_only=3dd743241faa46b5afdcee075aa7adc5.

Ethics approval

The study was approved by the ethics committee of the Institute of Psychology, Chinese Academy of Sciences.

Consent to participate

All participants gave their informed consent prior to their inclusion in the study.

Consent for publication

The participant has consented to the submission of their data to the journal.

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Appendix

Table A1

Optimal (Generalized) Linear Mixed-effects Models in the Target Noun Region

Measures	Formula
First fixation duration	log(DV)~ 1 + WordP + CharP + WordP:CharP + (1 + WordP + WordP:CharP||subj) + (1 + WordP + CharP + WordP:CharP||item)
Gaze duration	log(DV)~ 1 + WordP + CharP + WordP:CharP + (1 + CharP+ WordP:CharP||subj) + (1 + CharP+ WordP:CharP||item)
Go-past time	log(DV)~ 1 + WordP + CharP + WordP:CharP + (1 + CharP + WordP:CharP||subj) + (1 + WordP + CharP + WordP:CharP||item)
	DV~ 1 + WordP + CharP + WordP:CharP + (1 |subj) + (1 + WordP + CharP + WordP:CharP||item)
Regression-in probability	DV~ 1 + WordP + CharP + WordP:CharP + (1 + WordP:CharP||subj) + (1 + WordP + WordP:CharP||item)

Note. DV, dependent variable. WordP, plausibility of whole word. CharP, plausibility of constituent word. Subj, subject.