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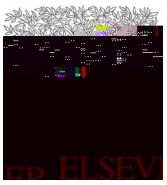

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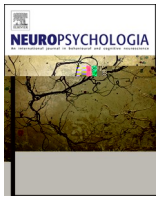

An alternative structure rescues failed semantics? Strong global expectancy reduces local-mismatch N400 in Chinese flexible structures

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ABSTRACT

During comprehension of a hierarchical structure, semantic integration between sequential, mismatched sentential constituents does not proceed when the later word in the sequence (e.g., the noun in the verb + classifier + noun) can be assigned an alternative role in the sentence (e.g., as a modifier of a subsequent object noun) (Zhang et al., 2011). Using electrophysiological measures, we examined how the availability of an alternative structure and whether the reader is motivated to generate an alternative structure affect semantic integration in a hierarchical structure. The same set of sentences was employed in three experiments in which the semantic congruency between the adjective and the object noun in the local structure and the sentential-contextual expectancy towards a noun were manipulated simultaneously. The reader's motivation was manipulated by tasks in which they made semantic acceptability judgment (Experiment 1), passively viewed sentences for comprehension (Experiment 2), or actively predicted the upcoming word and monitored the compatibility between the anticipated and the actual input (Experiment 3). Stronger contextual expectancy reduced N400 responses to the object noun regardless of semantic congruency, indicating that strengthening the constraints of an alternative argument decreased the effort of semantic integration between incompatible local constituents. Relative to weaker expectancy, the incongruent noun preceded by a stronger expectancy context elicited reduced N400 responses when no active prediction was demanded but showed equal amplitudes when such a demand was high. These findings demonstrate that the semantic failure in a flexible structure is likely to be resolved by the comprehender's motivation to generate an alternative structure based on the active use of contextual expectancy information, thus highlighting the "role-dependent semantic processing" during sentence comprehension.

1. Introduction

Dynamic sentence processing involves cognitive operations at multiple linguistic levels (e.g., lexical, semantic/pragmatic and structural) that act in concert to incrementally form a contextual representation, which prepares for the interpretation of upcoming input (Federmeier et al., 2007; Jiang et al., 2013; Kutas and Federmeier, 2000; Wang et al., 2009; Ye et al., 2007). When integrated into the established representation, the incoming information updates (or revises) the initially built representation (Brouwer et al., 2012; Nieuwland and Van Berkum, 2006; Zhang et al., 2011). One important question for the syntax-semantics interface research is how the structural complexity, ambivalence or failure could interfere with the semantic processes (e.g., Friederici et al., 2004; Hahne and Friederici, 2002; Hagoort, 2003; Kolk et al., 2003; Wang et al., 2013; Yang et al., 2015; Ye and Zhou, 2008; Yu and Zhang, 2008). Findings concerning this issue may shed lights on the nature of how structural and lexico-semantic factors interact during dynamic sentence comprehension (Steinhauer and Drury, 2012).

A recent group of studies addressed how semantic processes are constrained by structural hierarchy/flexibility in a hierarchical sentence structure, as in (1), in which the object noun ( ) was constrained by both a local determiner/classifier ( ) and a distant verb ( ) at a higher level. A unique feature of this type of structure is that the object noun is grammatically ambiguous, meaning that the is also licensed to become the modifier of a direct object, as in (2), even when the local classifier is kept the same, i.e., using

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instead of in (2). Neurophysiological evidence has revealed that the local vs. higher-level semantic processes are differential and interactive (Jiang and Zhou, 2012; Nam and Hong, 2016; Zhang et al., 2011; Zhang et al., 2011), and in some languages the local semantic process dominates over the process at other levels (Zhang et al., 2011). For example, Zhang et al. (2011) demonstrated that the mismatch of the local semantic constraint (i.e., determiner + object noun) elicited a monophasic N400 and the mismatch of the higher-level constraint (i.e., verb + object noun) or of both constraints (i.e., double mismatch) elicited a biphasic N400-late positivity on the object noun. The double mismatch elicited a N400 of comparable size to the local mismatch but of a larger size than the higher-level mismatch. A study on German using a similar structure with adjective as the local determiner revealed a N400 and late positivity for all mismatches (Zhang et al., 2011). While the double mismatch elicited a larger N400 as compared with both types of single mismatch, the magnitude of the mismatching effect at either the local or the higher-level was attenuated by the failure at the other level. These findings point to a neurocognitive mechanism when the semantic process of a word is constrained by constituents at different levels of structural hierarchy.

(1) Laoshi tuijian yi ben jiaocai

The teacher recommended one ben$_{\text{book-classifier}}$ textbook. (The teacher recommended a textbook).

(2) Laoshi tuijian yi shou jiaocai tidao de gequ

[1]

).

Yet it is unclear how the availability of an alternative structure (given the structural flexibility) on the object noun affects the semantic process. It is hypothesized that the local semantic incongruence (e.g., in) may serve as a contextual cue for triggering the flexibility in structural (re-)parsing, especially in languages that lack case marking (i.e., the grammatical marker that distinguishes direct object from modifier, Wu et al., 2014, 2018). The current study aims to address how the local combinatorial process (e.g., in) embedded in a hierarchical structure is affected by the availability of such an alternative structure and by the reader's active use of this alternative. The structural availability was manipulated by using different sentences with differential contextual expectancy towards a word other than the mismatching object noun. The reader's motivation during sentence reading was manipulated by placing different task demands (whether to passively view or actively predict the upcoming word) on the reader. We first review neurocognitive findings (mainly with event-related potentials) concerning semantic processes on structurally ambiguous and non-ambiguous words before we move on to the current experimental design.

Wu et al. (2014) embedded a structurally ambiguous noun in the relative clause of a sentence head and manipulated its semantic congruency with a locally preceded classifier which constrained the head noun. By using the visual world paradigm, they showed that participants' proportional looking at the picture of the embedded noun was reduced upon hearing the embedded noun following a mismatching (e.g.) than matching classifier (e.g.). Moreover, in self-paced reading, the reading time was shortened when readers encountered the disambiguating word following the mismatching than when they encountered an equivalent word following the matching noun. These findings suggest that the locally incongruent semantics can facilitate an alternative structure building rather than disrupt an existing local combinatorial reading, when the alternative structure is overly present and serves as the ultimate reading.

When an alternative structure is not overtly given as the ultimate solution, the structural alternative can also be activated under certain circumstances, affecting the neural (the N400) responses towards the local semantic mismatch. One important caveat is the language of interest. The ERP studies (Zhang et al., 2011; Zhang et al., 2011) mentioned above revealed inconsistent patterns concerning whether the semantic process at the higher-level proceeds when the local constraint is violated. While in both studies the verb-noun mismatch elicited an increased N400 response relative to the matched condition, suggesting a stronger effort of accessing or integrating the target word (Kutas and Federmeier, 2000, 2011), the N400 did not show further increase in Chinese (Zhang et al., 2011) but was observable in German (Zhang et al., 2011) when the local constraint was further mismatched (i.e., double mismatch vs. local mismatch), suggesting that upon local mismatch, the semantic process at the higher-level does not proceed in Chinese but still function in German.

This cross-language discrepancy can be accommodated by a "role-dependent semantic processing" hypothesis (Jiang and Zhou, 2012; Zhang et al., 2011). The N400 response is enlarged in face of an additional mismatch only when no other possible roles can be assigned to the object noun mismatching the local constraint, as in German. The availability of multiple syntactic possibilities depends on the syntactic flexibility in different languages. In Chinese, due to the lack of case marking that differentiates syntactic functions, a target noun can either be an object or a modifier that constrains a subsequent noun under certain circumstances. For example, a sentence containing a classifier-noun and verb-noun mismatch, as in (3), is possible to continue if [2] is reassigned a role as a pre-nominal modifier (e.g.,). In (3), the is not constrained directly by the verb or classifier whereas the new object noun is. Thus, the semantic integration at the higher-level structure maybe suspended or blocked in face of the local semantic failure when the mismatching noun can be recovered structurally, leading to no N400 increase in the double mismatch condition as compared with the local mismatch condition in Zhang et al. (2011).

(3) *Zhao xiulile yi tai xinzhi.

* Zhao repaired one tai $_{\text{electric-appliance-classifier}}$ paper.(Zhao repaired paper).

However, in German, a masculine object noun was grammatically unambiguous given its accusative case marking, and a neutral or feminine noun was unambiguous when thematic/semantic relation between verb and noun is certain. No alternative structure is available when both constraints are mismatched and the noun has to be integrated as the direct object of the noun as assigned by case, leading to a larger semantic difficulty and a larger N400 effect for additional verb-noun incongruence in the double mismatch as compared with the local mismatch.

In languages that allow structural flexibility, the contextual coherence also constrains the availability of an alternative structure. Jiang and Zhou (2012) manipulated the availability of an alternative structure by maintaining or breaking the contextual coherence in Chinese sentences and investigated the impact of contextual incoherence on the

[1] We provide both literal and free translation (in brackets) for this sentence example and the rest of the examples. "DE" in Chinese serves an auxiliary which indicates that its preceding noun or a relative clause functions as a modifier of another noun that follows "DE". Here, the is part of the relative clause that modifies .

[2] The word in Chinese and its free translation in English are separated by "/".

semantic process, such as (4) and (5). In (4), the semantic constraints between verb, classifier and object were all mismatched while in (5), the constraint between verb and classifier and the constraint between classifier and object were sequentially mismatched. In both sentences, the semantic mismatch prior to the object noun prevents the system from generating a possible relative clause structure. The additional mismatch (at the higher-level) in the triple mismatch condition elicited a larger N400 effect on the object noun than the sequential mismatch. These findings are consistent with Zhang et al. (2011) that when the structural alternative is canceled by the contextual incoherence, the semantic integration process at the higher-level proceeds in face of a local failure. Moreover, the sequential mismatch elicited a larger N400 as compared with the single, local mismatch, suggesting that the integration effort is enhanced in a sentence with no structural alternative even when the semantic constraint at the other level (higher-level) is intact.

(4) Xiaoli fengbu yi tai xinzhi

Xiaoli sew one $tai_{appliance\text{-}classifier}$ writing letter. (Xiaoli sewed writing letter).

(5) Xiaoli fengbu yi tai kuzi

Xiaoli sew one $tai_{appliance\text{-}classifier}$ trousers. (Xiaoli sewed a pair of trousers).

One limitation in Jiang and Zhou (2012) is that the manipulation of contextual coherence was confounded with the number limal

disconfirms a high-expectancy (relative to a low-expectancy) context. However, it is not clear yet whether the N400 or the late positivity reflects the disconfirmed expectancy (Van Petten and Luka, 2012).

In these studies, the target words were all syntactically unambiguous and the semantic processes on the target words took place based on the existing compositional rules (e.g., the object of a verb argument structure). The majority of these studies were conducted with a language in which the syntactic role of a word is fixed by grammatical case marking (i.e., a noun without a genitive marker cannot be a modifier) and the word order is inflexible (i.e., a prenominal modifier is not commonly used). Thus, the structural reanalysis cannot be applied as a possible resolution of the semantic incongruence. It is largely unknown how the neurophysiological responses towards the
could be altered when the possibility of structural reanalysis is high. In Chinese, the prenominal modifier is prevalent and the case marking system is undeveloped. The unmarked object noun in a
structure can be served as a prenominal modifier of a new object noun if additional information follows the modifier (i.e., a
). This structural flexibility allows us to examine how structural reanalysis strategy can impact the processing of the object noun on which the semantic constraint fails.

One unresolved question is how a reader's willingness of using contextual information affects the brain responses towards the semantic integration/access of a critical word (Baggio, 2012; DeLong, Groppe, Urbach, Kutas, 2012; Jiang et al., 2009; Roehm et al., 2007). A word strongly associated with the meaning of the prime word elicits a reduced N400 and this effect is more pronounced when readers are encouraged to retrieve the word meaning (e.g., when given a strongly predictive context or when asked to judge the lexical association) as compared with passively reading (Roehm et al., 2007). Reader's willingness to make active prediction, which varies between elderly (low-motivation) vs. young adults (high-motivation), leads to differential brain responses towards a mismatch to prediction, with elderly adults not showing an N400 effect towards a gender-incongruent article (Delong et al., 2012). It is therefore of great interest how an individual's motivation during sentence reading would affect their strategy of using the contextual expectancy to process a word in a flexible structure.

In this study, we aim to investigate the "role-dependent semantic processing" by examining how contextual expectancy affects the local semantic process on a noun that was mostly expected or was incongruent with the contexts as an object, as the noun can be temporarily and syntactically ambiguous. To this end, we employed a Chinese structure (" + + + ") similar to Zhang et al. (2011) in which the ambiguous object noun can either be a verb argument that is constrained by both verb and local AP, or a modifier that constrains a new noun to form a new object phrase. By manipulating both the contextual expectancy and the local congruency between AP and noun in the structure, we created four types of sentences: low-expectancy, congruent, low-expectancy incongruent, high-expectancy congruent, high-expectancy incongruent (see Table 1). The congruent object noun was always the mostly used continuation of the context and the incongruent noun was unexpected and impossible as a direct object following the context.

As demonstrated by Wu et al. (2014), the local incongruence serves as a cue for the reader to reanalyze the structure into a structure in which the object noun can be reassigned a role of prenominal modifier. Thus the adjective-noun mismatch increases the availability of an alternative structure relative to the match condition. In (6), the mismatched sentence can be re-interpreted as being congruent when is reassigned a modifier of a new object , which is the head of a relative clause (see (7)). The new object is congruent with the context (subject-verb-AP-modifier noun) and also matches the constraints from both the adjective and the verb.

Under which contextual expectancy the structural reanalysis is easier to initiate in face of a word that is incongruent with the context? The "High-Expectancy-Easy" hypothesis assumes that, relative to the low-expectancy, the high-expectancy context encourages the reader more to pursue a structural reanalysis. The structural reanalysis strategy is highly viable in the mismatched high-expectancy condition since it strongly predicts a word as an alternative object ( ) and a strong new representation is available, e.g. , see (7).

(6) *Wang Li tingjian ci'er de jiemu/Wang Li heard a sharp DE program (Wang Li heard a sharp program)

(7) Wang Li tingjian ci'er de jiemu zhongjian fachu de shengyin/Wang Li heard sharp program in the middle of DE sound (Wang Li heard sharp sound in the middle of the program)

According to the "High-Expectancy-Easy" hypothesis, the structural reanalysis strategy is less viable when the contextual information does not consistently predict a word, since there can be many possibilities, e.g. etc. to continue the sentence (8) and no particular representation can be formed (see example 9 for one possibility). Normally the comprehension system does not take endeavor to search for an alternative structure. However, it is not unexpected that the object noun becomes more likely to be reassigned a new role when the prediction is heavily demanded (e.g., when readers actively think ahead during sentence comprehension). Note, the "High-Expectancy-Easy" hypothesis is motivated empirically. The increased positivity on the incongruent words in the highly-vs. lowly-expectancy context (as reviewed in the last section) suggest that readers engage some additional processes to reconcile the mismatch between the predicted and the actually-presented words (Kuperberg et al., 2020; Van Petten and Luka, 2012). The highly predictive context could facilitate the initiation of the structural reanalysis of the noun and prevent the comprehension system from engaging further integration of the noun into the local context. Moreover, the semantic similarity between the incongruent word and the context words and/or between the incongruent word and the

T 1

Conditions and sentence exemplars in the experiment. Both literal and free English translations were provided. Segments were separated by space.

Contextual expectancy	Local semantic congruency	Sentence Exemplar						
High-expectancy	Congruent	王莉/听到/刺耳/的/声音/和/紧张的/尖叫。						
		Wang Li	heard	sharp	de	sound	and	immediately	screamed
	Incongruent	王莉/听到/刺耳/的/节目/和/柔和的/乐曲。						
		Wang Li	heard	sharp	de	program	and	soft	music
Low-expectancy	Congruent	王凌/穿过/狭窄/的/街道/之后/拐进/院子。						
		Ling Wang	walked through	narrow	de	street	and	turned into	a yard
	Incongruent	王凌/穿过/狭窄/的/森林/之后/躺下/休息。						
		Ling Wang	walked through	narrow	de	forest	and	laid down	for a rest

contextually-expected word is often higher when the sentential context is more constraining (Nieuwland et al., 2019). The combined increase of contextual expectancy and semantic similarity could further ease the structural reanalysis by facilitating the access to the mostly-expected noun and the restructuring of the sentence.

(8) *Wangling chuanguo xiazhai de senlin/Wangling walked through a narrow DE forest. (Wangling walked through a narrow forest.)
(9) Wangling chuanguo xiazhai de senlin houmian de jiedao/ Wangling walked through a narrow DE forest behind DE path. (Wangling walked through the narrow path behind the forest.)

In contrast, the "Low-Expectancy-Easy" hypothesis assumes that if the reader is highly committed to an object interpretation based on the high-expectancy context, it would be difficult for them to abandon this analysis and re-commit themselves to an alternative one. When the contextual expectation is less constraining, the structural reanalysis is easier and the alternatives are more available.

Although both hypotheses seem reasonable, from both empirical and practical perspectives, the "High-Expectancy-Easy" hypothesis is more favored. Firstly, the "Low-Expectancy-Easy" hypothesis receives less support from evidence in the empirical literature. Some psycholinguistic studies showed that as the depth of processing an initially-assigned incorrect syntactic structure increases (e.g., when additional information appears before the disambiguation point "was" in), the cost of reanalysis became higher and the grammatical acceptability of the sentence became lower (Ferreira and Henderson, 1991;

neurological or psychiatric disorders. This study was approved by the Ethics Committee of the School of Psychological and Cognitive Sciences at Peking University.

Ninety pairs of sentences were created. All sentences took the structure of "Subject noun + verb + adjective phrase (AP, constituted by an adjective and an adhesive auxiliary – , see Jiang and Zhou, 2009 for a linguistic description) + object noun + complement phrase". Each pair of sentences began with the same sentence context "Subject noun + verb + AP" but differed on the object noun and the phrase following the object noun (see below). Among all pairs, half (n = 45) contained high-expectancy contexts while the other half contained low-expectancy contexts. The contextual expectancy of each sentence fragment was determined by the percentage of the mostly produced word in a separate cloze probability test (see below). Sentences with high-expectancy contexts were continued with words that were mostly, and highly, produced in the cloze probability test whereas those with low-expectancy contexts were continued with words that were mostly produced but with much lower probability. These two types of sentences formed the congruent conditions in which the object noun of each sentence was semantically congruent with both AP and the verb. For the incongruent conditions, the object nouns in the congruent conditions were replaced by new ones which mismatched the local adjectives but matched the distant verbs. These incongruent nouns could nevertheless serve as modifiers of other nouns which fulfil the constraint of the context. None of the object nouns in the incongruent conditions mismatched the animacy constraints of the adjective (e.g.

). Across the four conditions, the object nouns were matched in frequency (frequency of occurrences per million: 73.69 for high-expectancy, congruent; 73.59 for high-expectancy, incongruent; 74.63 for low-expectancy, congruent; and 71.88 for low-expectancy, incongruent) and visual complexity (number of stroke: 15.62 for high-expectancy, congruent; 15.62 for high-expectancy, incongruent; 16.20 for low-expectancy, congruent; and 15.82 for low-expectancy, incongruent) across conditions, s < 0.1. All object nouns were two-character words, and they appeared in each condition only once.

Additional forty filler sentences were created with various types of sentence structures. Sixteen filler sentences were of the subject-verb-object structure and the object was composed of a modifier noun, a preposition, DE and a head noun (e.g.

). In these sentences, both the modifier noun and the head noun can be constrained by the verb and the head noun was interpreted as the object. The modifier noun was temporarily ambiguous as it could be initially interpreted as the direct object of the verb. Another 24 fillers were of active ( ) construction (subject – – object – verb – complement phrase), or passive ( ) construction (subject – – verb – complement phrase), or object-initial structure (object – subject – verb – complement phrase).

Six pretests, including two phrase acceptability rating tests, one global acceptability rating test, one cloze probability test and two lexical generation tests were administered to validate the materials. To ensure that the object noun and the local adjective were felicitous in the congruent condition but mismatched in the incongruent condition, thirty-two participants who did not take part in the ERP experiment or other pretests were asked to rate the semantic acceptability of each adjective-noun combination in each condition. One hundred and eighty adjective-noun combinations were included in the test. The results revealed that the incongruent adjective-noun combinations (for the high-expectancy incongruent: Mean = 2.04, SD = 1.26; for the low-expectancy incongruent: Mean = 2.22, SD = 0.60) was rated with much lower acceptability than the combinations in the congruent conditions (for high-expectancy congruent: Mean = 6.63, SD = 0.73; for low-expectancy congruent: Mean = 6.58, SD = 0.08), F (1, 44) = 1485.01, p < 0.001. The local acceptability did not differ between high- and low-expectancy conditions, nor did expectancy interact with local congruency, Fs < 1, suggesting the incongruent conditions were matched in the local acceptability between high- and low-expectancy contexts.

To ensure that the object noun matched the distant verb in each condition, another thirty-two participants rated the semantic acceptability of 180 verb – object noun combinations. The results did not reveal any main effect of contextual expectancy or local congruency or the interaction between the two (high-expectancy, congruent: Mean = 6.48, SD = 0.46; high-expectancy, incongruent: Mean = 6.33, SD = 0.38; low-expectancy, congruent, Mean = 6.48, SD = 0.46; low-expectancy, incongruent: Mean = 6.45, SD = 0.38), Fs < 1. The verb - object noun combination was equally acceptable whether the object noun was congruent or incongruent with the local adjective and whether the contextual expectancy was high or low.

To examine how the global acceptability was affected by the relationship between the object noun and sentential context, a new group of fourteen participants were asked to judge the general acceptability of the 180 critical sentences. Overall, the incongruent sentences =

performed based on the semantic space trained on a comprehensive corpus of Chinese Wikipedia (http://dumps.widimedia.org; see also Feng et al., 2017). The LSA between the target word and the context words did not reveal a significant effect between high- and low-expectancy contexts for the incongruent target (Mean = 0.15; SD = 0.13; Mean = 0.12; SD = 0.11; F (1, 88) = 1.33, p = 0.25) and the congruent target (Mean = 0.26; SD = 0.22; Mean = 0.26; SD = 0.21, F < 1). We also calculated the LSA between incongruent word (in the incongruent condition) and the mostly-expected word in the context for both the high- or the low-expectancy conditions (based on the semantic space: http://www.lsa.url.tw/modules/lsa/lsa_pairwise_comparison.php; with 300 dimensions). Lexical stems were used whenever the words did not appear in the corpus (influencing 6 pairs out of 90 ones). The LSA for the target word and the mostly-expected word was marginally different between the high- (Mean = 0.12; SD = 0.14) and the low-expectancy condition (Mean = 0.08; SD = 0.09), F (1, 88) = 3.26, p = 0.07.

Participants were seated in a comfortable chair in a sound-attenuated and electrically-shielded chamber. They were instructed to move their head or body as little as possible and to keep their eyes fixated on a sign at the center of the computer screen. This fixation sign was at the eye-level and was approximately 1 m away. Sentences were presented 700 ms after the fixation sign, and were presented segment-by-segment in rapid serial visual presentation (RSVP) mode at the center of the screen, with both horizontal and vertical visual angles lower than 1°. Each sentence consisted of 8 segments (i.e., ' See Table 1). Each segment was presented in white against black background, with a 400 ms duration followed by 400 ms blank screen. Following each sentence, a short-delayed question mark appeared at the center of the screen and participants were asked to judge whether the sentence was semantically acceptable by pressing buttons with right or left index finger. The assignment of response buttons was counter-balanced across participants. Sentences were pseudo-randomized with the constraints that 1) no more than three consecutive sentences were from the same condition; 2) No more than four consecutive sentences contained a high- or a low-expectancy context; 3) no more than four consecutive sentences required the same button response. To reduce the potential repetition effect, sentences with the same context were separated by at least thirty other sentences. Each participant received a different experimental sequence. Each sequence contained 220 sentences in total, with 45 sentences per critical condition, and was evenly divided into four testing blocks. There were 24 practice trials prior to the formal test.

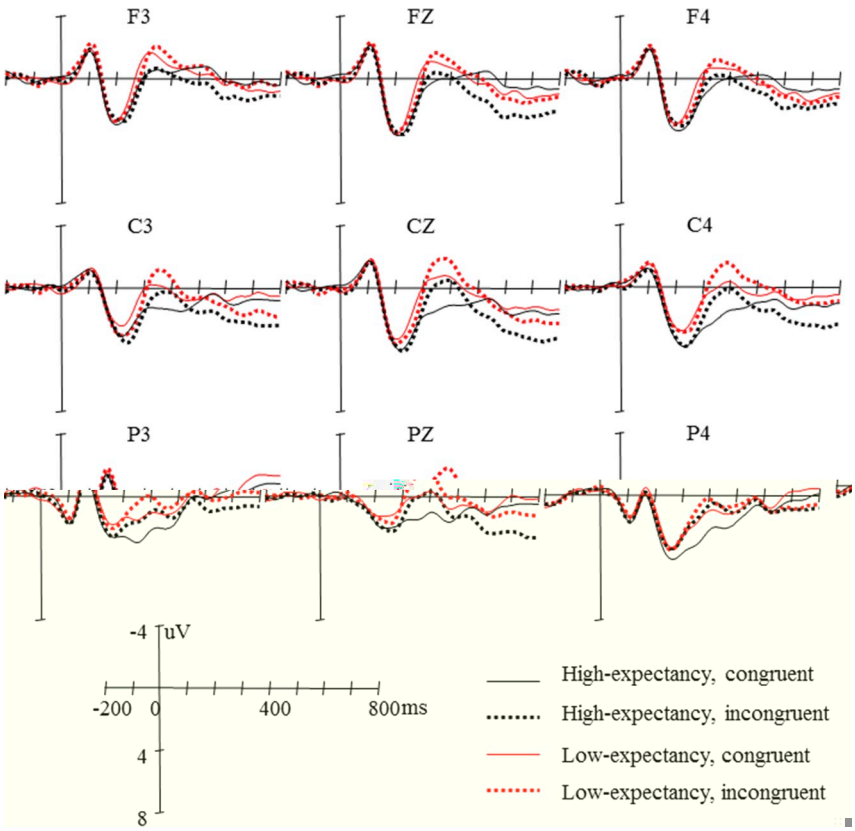
The EEGs were recorded from 62 electrodes in a secured elastic cap (Electrocap International in NeuroScan Inc., Herndon, Virginia, USA) localized over the midline (i.e. FPz, Fz, FCz, Cz, CPz, Pz, POz and Oz), the left hemisphere (i.e. AF7, AF3, FP1, F7, F5, F3, F1, FT7, FC5, FC3, FC1, T7, C5, C3, C1, TP7, CP5, CP3, CP1, P7, P5, P3, P1, PO7, PO5, PO3 and O1) and the corresponding locations in the right hemisphere. The vertical electro-oculogram (VEOG) was recorded from electrodes placed above and below the left eye. The horizontal EOG (HEOG) was recorded from electrodes placed at the outer canthus of each eye. The linked bilateral mastoids served as reference and the GND electrode on the cap served as ground. Electrode impedance was kept below 5 kΩ. The biosignals were amplified with a band pass between 0.05 and 100 Hz. The EEG and EOG were digitized on-line with a sampling frequency of 500 Hz.

Incorrectly judged sentences and sentences contaminated by EEG artifacts (with potentials exceeding ± 70 μV) were rejected before the averaging procedure, resulting in 86.7% artifact-free trials on average (40 the high-expectancy, congruent, 38 in high-expectancy incongruent, 39 in low-expectancy congruent and 39 in low-expectancy incongruent conditions). The EEGs were segmented from −200 ms before to 800 ms after the onset of the object nouns, and were corrected with 200 ms pre-stimulus interval as baseline. The ERPs were computed per participant per condition. Based on visual inspection of grand averages and previous findings, two time windows were selected: 300–450 ms for the N400, 450–800 ms for the late positivity. The repeated-measures ANOVAs were conducted with contextual expectancy (high vs. low) and local adjective-noun congruency (congruent vs. incongruent) as within-participant factors. Topographic factors were also included for the midline and the lateral analysis. The midline analysis had one factor: electrode (Fz, FCz, Cz, CPz, Pz and POz). The lateral analysis had three factors: hemisphere (left vs. right), region (anterior vs. central vs. posterior) and electrode. The hemisphere and region were crossed, forming 6 regions of interest (ROIs), each of which represented by 6 electrodes: left anterior (F1, F3, F5, FC1, FC3, FC5), left central (C1, C3, C5, CP1, CP3, CP5), left posterior (P1, P3, P5, P7, PO3, PO7), right anterior (F2, F4, F6, FC2, FC4, FC6), right central (C2, C4, C6, CP2, CP4, CP6) and right posterior (P2, P4, P6, P8, PO4, PO8). Significant interactions involving contextual expectancy and/or local congruency were followed by pairwise comparisons. Greenhouse-Geisser correction was applied when necessary (Geisser and Greenhouse, 1959).

A repeated measures ANOVA was conducted on the percentage of the correctly responded trials for all the 17 participants, taking contextual expectancy (high vs. low) and local congruency (congruent vs. incongruent) as within-participant factors. There was a significant interaction between contextual expectancy and congruency, F (1, 18) = 8.00, p < 0.05. No main effect reached significance: contextual expectancy, F (1, 18) = 2.12, p > 0.1, local congruency, F (1, 18) = 2.41, p > 0.1. The mean accuracy was the highest for the high-expectancy, congruent condition (94.0%), and did not differ between the other three conditions (88.0%–89.8%).

As is shown in Fig. 1, the adjective-noun mismatch elicited larger N400 responses, followed by larger late positivity responses, than the match conditions on the object noun. The high-expectancy conditions elicited reduced N400 responses as compared with the low-expectancy conditions regardless of the local adjective-object noun congruency. These observations were confirmed by statistical analyses.

– The ANOVA taking contextual expectancy, local congruency, and topographic factors as within-participant variables revealed a significant main effect of local congruency in the midline, F (1, 16) = 20.19, p < 0.001, and in the lateral analysis, F (1, 16) = 13.26, p < 0.005. The local incongruent conditions elicited larger N400 responses as compared with the congruent conditions (with the effect being −1.28 μV in the midline and −0.96 μV in the lateral). This main effect interacted with electrode in the midline, F (5, 80) = 3.97, p < 0.05, and with region in the lateral analysis, F (2, 32) = 4.96, p < 0.05, suggesting a central and posterior distribution of the N400 effect (see Fig. 1). The effect of contextual expectancy was significant in the midline, F (1, 16) = 6.82, p < 0.05, and in the lateral analysis, F (1, 16) = 7.63, p < 0.05, suggesting that the high-expectancy elicited reduced N400 responses as compared with the low-expectancy on the object



i . 1. Grand average waveforms on 9 representative electrodes, time-locked to the object noun from −200 ms pre-onset and 800 ms post-onset, in the acceptability judgment task.

noun (with the effect being −1.01 μV in the midline and −0.89 μV in the lateral). Contextual expectancy and local congruency interacted in the midline, F (1, 16) = 4.84, p < 0.05, and in the lateral analysis, F (1, 16) = 4.02, 0.05 < p < 0.1. Separate analysis revealed a significant effect of contextual expectancy for both the congruent (F (1, 16) = 11.72, p < 0.005 in the midline, F (1, 16) = 12.51, p < 0.005 in the lateral) and incongruent conditions (F (1, 16) = 3.98, p < 0.05 in the midline, F (1, 16) = 3.67, p < 0.05 in the lateral analysis), with the effect being larger in the former than in the latter. The high-expectancy conditions elicited reduced N400 responses than the low-expectancy conditions on the object nouns, for both the congruent (with effect being −1.62 μV in the midline and −1.32 μV in the lateral) and the incongruent nouns (−0.72 μV in the midline and −0.66 μV in the lateral).

– The ANOVA revealed a marginally significant main effect of local congruency in the midline, F (1, 16) = 3.08, 0.05 < p < 0.1, suggesting that the incongruent conditions tended to elicit larger positive responses as compared with the congruent conditions (with the effect being 0.72 μV in the midline). Neither the main effect of contextual expectancy, F (1, 16) = 1.02, p > 0.1, nor the interaction between contextual expectancy and local congruency reached significance, F < 1. However, there was a significant three-way interaction between contextual expectancy, congruency and electrode in the midline, F (5, 80) = 3.70, p < 0.05 and between contextual expectancy, congruency and region in the lateral analysis, F (2, 32) = 9.77, p < 0.005. Separate analysis on each level of contextual expectancy revealed a significant effect of local congruency for the high-expectancy conditions on Fz, F (1, 16) = 4.91, p < 0.05; FCz, F (1, 16) = 4.70, p < 0.05 and lateral anterior region: F (1, 16) = 3.98, p < 0.05, suggesting an anterior positivity effect in the incongruent vs. the congruent comparison (see Fig. 1). For the low-expectancy condition, a significant effect of local congruency was shown only on CPz, F (1, 16) = 4.36, p < 0.05 (see Fig. 1). The comparison between high- and low-expectancy conditions on each level of congruency revealed a significant effect of expectancy only for the incongruent sentences in the anterior-central, Fz, F (1, 16) = 3.25, p < 0.05; Cz, F (1, 16) = 4.06, p < 0.05; lateral anterior, F (1, 16) = 4.18, p < 0.05, and lateral central regions, F (1, 16) = 3.78, p < 0.05, with more positive responses for the high-expectancy sentences than for the low-expectancy sentences.

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Employing a “subject + verb + AP + object” structure in which the object noun permitted an alternative role, we observed an increased N400 followed by a late positivity on the object noun mismatching the local AP semantic constraints. The biphasic pattern was observed previously for semantic mismatches in sentences with a hierarchical structure in which the object noun is syntactically ambiguous (e.g., local mismatch: Jiang and Zhou, 2012; higher-level mismatch: Zhang et al., 2011). The increased N400 reflected a difficulty in integrating an incongruent word into the local combination. The occurrence of an N400 effect suggests that the intact constraint from the higher-level structure between verb and noun and the availability of an alternative structure on the mismatching noun cannot completely eliminate the semantic integration difficulty on the object noun.

Importantly, we found a contextual effect on the N400, with the high-expectancy eliciting a reduced response than the low-expectancy on both the congruent and the incongruent nouns. The reduction of N400 (and in some studies, an increase of P300, see Molinaro and Carreiras, 2010; Vespignani et al., 2010) on the congruent noun may reflect the contextual facilitation on the lexical access of the target word (or a direct access to the word that best matches the contextual expectation, Molinaro and Carreiras, 2010; Nieuwland, 2019; see Exp. 3 for further discussion). The finding of a contextual modulation on the

incongruent word is not inconsistent with the notion of in previous reports. In these experiments, no alternative structures were available on the target word and the integration of the word into the context it mismatched could not benefit from the word being reassigned a new role of the sentence. Some studies showed an increased N400 on impossible words embedded in a highly-predictive vs. a lowly-predictive

preprocessing of EEG data revealed an average of 84.4% artifact-free trials (including 38.1, 37.7, 37.8 and 38.1 trials for each condition).

On average, participants false alarmed to 5.2 out of the 80 unseen words while correctly recognizing 30.6 out of the 80 experiment words in the recognition test (6.5% vs. 38.3%), suggesting that they were able to discriminate between words they had seen and those they never came across in the experiment (Federmeier et al., 2007; Wlotko and Federmeier, 2007). The proportion of words correctly recognized over the critical conditions was subjected to repeated measures ANOVA with contextual expectancy (high vs. low) and congruency (congruent vs. incongruent, Table 2). The main effect of contextual expectancy was significant, $F(1, 17) = 15.25$, $p < 0.005$, suggesting that participants recognized words better in sentences with higher contextual expectancy (on average 17.3 out of 40) than those in sentences with lower expectancy (on average 13.3 out of 40). Neither the congruency effect nor the interaction between the contextual expectancy and congruency reached any difference, $Fs < 1$.

– The ANOVA revealed a significant main effect of local congruency in the midline, $F(1, 17) = 21.81$, $p < 0.001$, and in the lateral analysis, $F(1, 17) = 13.55$, $p < 0.005$, suggesting a stronger N400 on the incongruent relative to the congruent noun (−1.10 μV on the midline, −0.86 μV on the lateral). This congruency effect interacted with electrode in the midline, $F(5, 85) = 13.51$, $p < 0.001$, and in the lateral analysis, $F(2, 34) = 10.88$, $p < 0.005$, suggesting that this effect was more pronounced in the centro-posterior region (see Fig. 2). The main effect of contextual expectancy was significant in the midline, $F(1, 17) = 13.90$, $p < 0.005$, in the lateral, $F(1, 17) = 9.95$, $p < 0.01$, suggesting that the high-expectancy condition elicited a reduced N400 than low-expectancy condition (−1.26 μV on the midline, −0.90 μV on the lateral electrodes).

Although the two-way interaction between contextual expectancy and local congruency was not significant, $Fs < 1$, the three-way interaction between contextual expectancy, local congruency and electrode was marginally significant in the midline, $F(1, 17) = 2.76$, $0.05 < p < 0.1$. Separate analysis revealed that, relative to the low-expectancy condition, the high-expectancy condition elicited a stronger central and posterior N400 (Fig. 2) on congruent object noun (maximally on CPz, −2.32 μV, $F(1, 17) = 14.16$, $p < 0.005$ and lateral posterior region: 1.28 μV, $F(1, 17) = 8.34$, $p < 0.05$) and a stronger N400 response on the medial posterior electrodes on the incongruent noun (on Pz, −0.97 μV, $F(1, 17) = 3.96$, $p < 0.05$, POz, −0.94 μV, $F(1, 17) = 3.87$, $p < 0.05$).

– The ANOVA revealed no effect of congruency, $Fs < 1$, contextual expectancy, $Fs < 1$, or interaction of the two, $ps > 0.1$. However, there was a significant three-way interaction between contextual expectancy, local congruency and hemisphere, $F(1, 17) = 4.59$, $p < 0.05$. Separate analysis on the high-expectancy condition revealed that, relative to the congruent noun, the incongruent noun elicited a stronger late positivity in the left hemisphere (0.86 μV), $F(1, 17) = 5.48$, $p < 0.05$, but not in the right hemisphere, $F < 1$; no congruence effect was shown for the low-expectancy conditions, $Fs < 1$. Separate analysis on the congruent word revealed that, relative to the high-expectancy condition, the low-expectancy condition elicited a stronger late positivity in the left hemisphere, $F(1, 17) = 3.31$, $p < 0.05$ (1.01 μV in the lateral), but not in the right hemisphere, $F < 1$; no contextual effect was found on the incongruent noun, $F < 1$.

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Mean and standard deviation of the percentage of hit responses for items that had been seen in each critical condition and false alarmed responses for items that had not been seen.

	Condition	Experiment 2		Experiment 3	
		Mean	SD	Mean	SD
Seen	High expectancy, Congruent	46.0%	19.0%	62.5%	18.5%
	High expectancy, Incongruent	40.5%	18.5%	36.5%	17.0%
	Low expectancy, Congruent	34.5%	18.0%	59.5%	16.5%
	Low expectancy, Incongruent	32.0%	18.0%	34.5%	14.5%
Unseen		13.0%	10.0%	10.8%	4.8%

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In this experiment, participants were asked to read sentences for comprehension alone. Similar to Exp. 1, relative to the low-expectancy context, the high-expectancy context elicited a reduced N400 on the incongruent noun, although this effect was more restricted to the medial and posterior regions. This finding suggested that the effort of integrating an incongruent noun into a context was reduced given stronger contextual expectancy and perhaps given the associated increase in its semantic similarity to the context-expected word. This finding is inconsistent with the view that the incongruent word is forced to be integrated into a subject-verb-argument representation as a direct object, which would produce a larger N400 for the high-vs. low-expectancy on the incongruent noun. However, it is most likely that the initiation of a structural reanalysis is facilitated by the highly predictive context, assigning an alternative role to the object noun and releasing the effort of integrating the incongruent noun into the verb-argument structure. The availability of the structural reanalysis and perhaps the increased semantic similarity reduced N400 when the contextual constraint was high. Importantly, the observation of an N400 reduction in response to the high-expectancy context even without an explicit emphasis on the congruency judgment suggests that, whether the reader's attention is guided to the local congruency or not, a strong global contextual expectancy facilitates a structural reanalysis strategy when the reader encounters a local mismatch. In Exp. 3, we verified whether the local integration effort can be facilitated by an active prediction.

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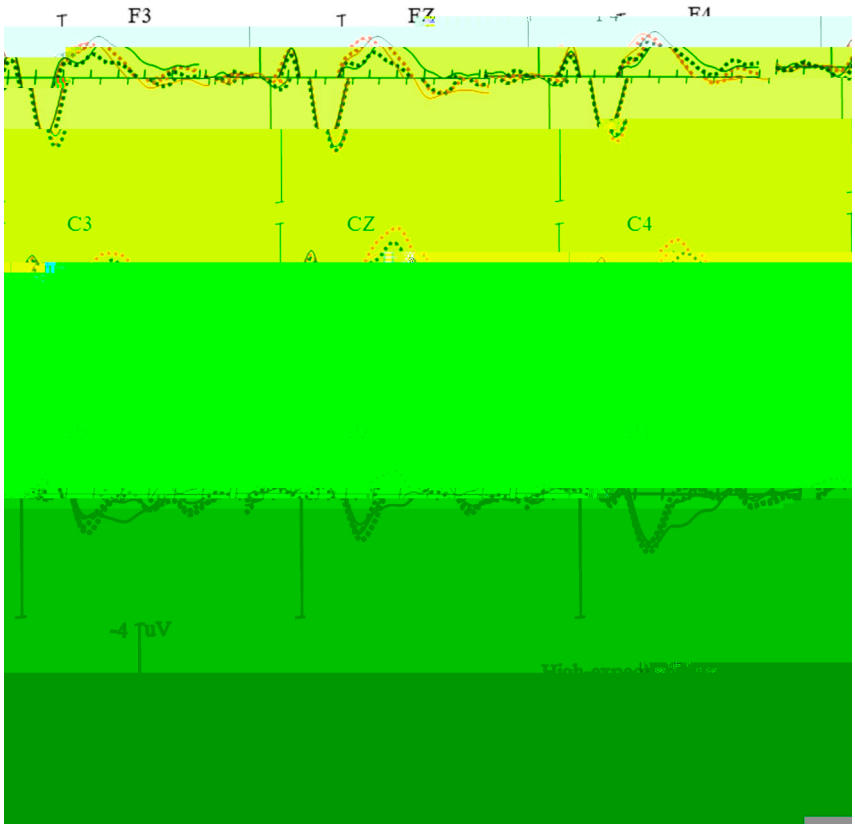
Sixteen native Chinese students in Peking University (including 7 males and 9 females, Mean age = 21.8, ranging from 18 to 24) who did not participate in the previous experiments were recruited in Exp. 3. All participants had normal or corrected-to-normal vision. None of them suffered from any neurological or psychiatric disorder. This study was approved by the Ethics Committee of the School of Psychological and Cognitive Sciences at Peking University.

The critical sentences and the procedures were the same in Exp. 3 as in Exps. 1 and 2, except that the participants were encouraged to predict the upcoming word as far as they can during sentence reading. In addition, to check whether the participants made predictions during reading, twenty-four new congruent sentences with the same structure as the critical ones were included as "catch trials". In these sentences, the sentential context highly constrained an object noun position, or the word position immediately following the object noun, or the sentence-final position (the average cloze probability toward a particular word given these contexts was 64.3%, e.g.

). The actual words used in these positions were either the mostly expected words in one half sentences or unexpected but plausible ones in the other half, and were all marked laterally by asterisks (e.g. *** trees ***) during the RSVP. After these sentences, a



i . . Grand average waveforms on 9 representative electrodes, time-locked to the object noun from −200 ms pre-onset and 800 ms post-onset, in the passive reading task.

question mark was presented for 2000 ms at the center of the screen and the participants were asked to judge whether the marked words were the most appropriate word following the highly-constraining sentence context, by pressing a left or right button on the joystick. The hand-button assignment was counterbalanced across participants. In total each participant read 244 sentences. Before the formal test, participants received 26 practice trials, with 2 sentences requiring a response. A word recognition test was administered to each participant after the recording (with the procedure same as in Exp. 2). The EEG acquisition and data analysis were the same as in Exp. 1 and 2. A cross-experiment ANOVA was implemented on both N400 and late positivity by taking experiment as a between-participant factor, and contextual expectancy, local congruency and topographic factors as within-participant factors. On average, there were 94.7% artifact-free trials (including 42.5, 42.4, 42.7 and 43 trials for each condition).

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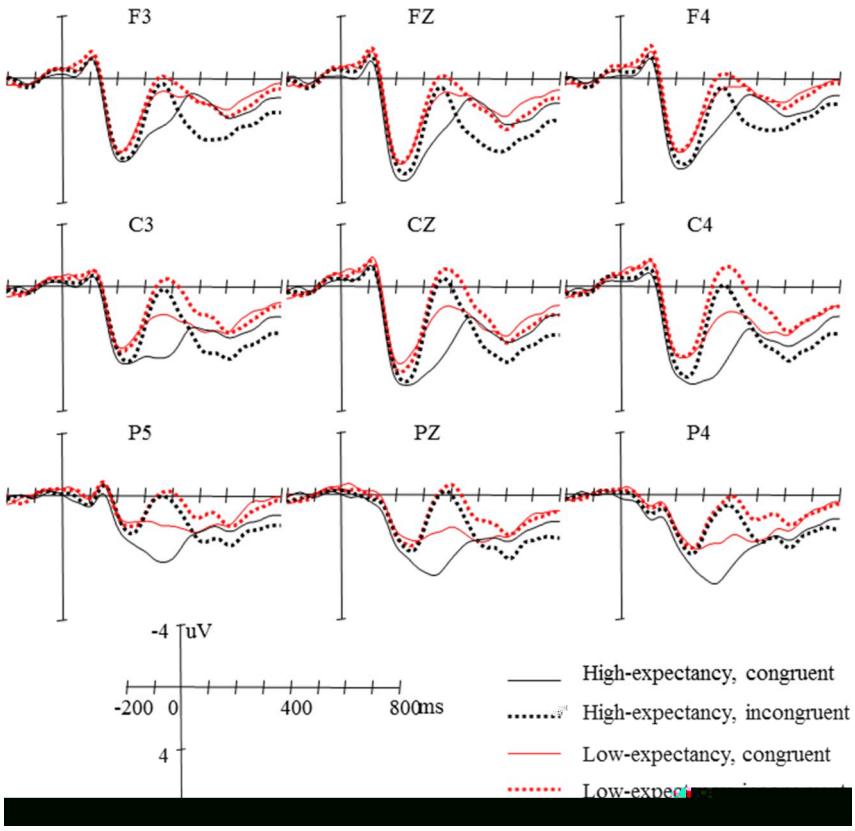
Participants were capable of distinguishing words that had been seen and those that had not been seen. On average, participants false alarmed to 4.3 of the 80 unseen words and correctly recognized 38.6 out of the 80 experimental words (5.3% vs. 48.2%). Table 2 showed recognition accuracy over experimental conditions. The ANOVA over contextual expectancy and congruency between adjective and noun showed a significant main effect of congruency, $F(1, 15) = 59.24$, $p < 0.001$, suggesting that participants recognized congruent words (on average 24.4 out of 40) better than incongruent words (on average 14.2 out of 40). Neither the contextual expectancy nor the interaction between the contextual expectancy and congruency reached any difference, $Fs < 1$.

On average, participants correctly guessed 19.9 (82.9%) out of 24 target words in the "catch-trial" sentences (ranging from 19 to 22). This finding ensured that the participants were making predictions during online sentence reading.

– The ANOVA revealed a significant effect of local congruency in the midline, $F(1, 15) = 45.63$, $p < 0.001$, and in the lateral analysis, $F(1, 15) = 31.00$, $p < 0.001$, suggesting that the incongruent condition elicited an increased N400 as compared with the congruent one (−2.68 μV in the midline, −2.23 μV in the lateral electrodes). The local congruency interacted with electrode in the midline, $F(5, 75) = 14.19$, $p < 0.001$, and with region in the lateral analysis, $F(2, 30) = 5.93$, $p < 0.05$, suggesting that this N400 effect was maximal in the central and posterior regions (see Fig. 3). The local congruency also interacted with hemisphere in the lateral analysis, $F(1, 15) = 5.38$, $p < 0.05$, suggesting that this effect was larger in the right hemisphere (see Fig. 3). The effect of contextual expectancy was significant in the midline, $F(1, 15) = 18.68$, $p < 0.005$, and in the lateral analysis, $F(1, 15) = 17.23$, $p < 0.005$, suggesting that the high-expectancy condition elicited a reduced N400 response as compared with the low-expectancy condition (−1.51 μV in the midline, −1.56 μV in the lateral electrodes). The local congruency interacted with contextual expectancy marginally in the midline, $F(1, 15) = 3.68$, $0.05 < p < 0.1$, with contextual expectancy and hemisphere, $F(1, 15) = 4.08$, $p < 0.05$ and marginally with contextual expectancy, hemisphere and region in the lateral, $F(2, 30) = 3.86$, $0.05 < p < 0.1$. Separate analysis on the congruent noun revealed that, relative to the low-expectancy condition, the high-expectancy condition elicited a decreased N400 in the midline (−2.33 μV, $F(1, 15) = 15.58$, $p < 0.005$) and the lateral analysis (left



i . . Grand average waveforms on 9 representative electrodes, time-locked to the object noun from −200 ms pre-onset to 800 ms post-onset, in the active prediction task.

hemisphere: 1.72 μV, F (1, 15) = 5.26, p < 0.05 and right hemisphere: 2.26 μV, F (1, 15) = 15.58, p < 0.005). The analysis on the incongruent noun revealed a decreased negative response for the high-expectancy condition (or an increased negative response for the low-expectancy condition) in left anterior (−0.96 μV, F (1, 15) = 3.75, 0.05 < p < 1), right anterior (−1.40 μV, F (1, 15) = 6.44, p < 0.05) and right central regions (−1.28 μV, F (1, 15) = 5.10, p < 0.05).

– The ANOVA did not reveal a significant effect of local congruency, Fs < 1, but a significant two-way interaction between local congruency and electrode in the midline, F (1, 15) = 4.37, p < 0.05. The congruency effect was only significant on Fz, F (1, 15) = 4.09, p < 0.05, suggesting that the incongruent condition elicited a stronger frontal positivity as compared with the congruent one (1.12 μV in the midline and 1.20 μV in the lateral electrode). The effect of contextual expectancy was significant in the midline, F (1, 15) = 4.51, p < 0.05, and in the lateral analysis, F (1, 15) = 7.74, p < 0.05, suggesting that the high-expectancy condition elicited a stronger positive response as compared with the low-expectancy condition (0.99 μV in the midline and 1.18 μV in the lateral electrode). The lateral analysis revealed a significant three-way interaction between contextual expectancy, local congruency and hemisphere, F (1, 15) = 4.61, p < 0.05, and a significant four-way interaction between contextual expectancy, local congruency, hemisphere and region, F (1, 15) = 3.93, p < 0.05. Separate analysis on the high-expectancy condition revealed a congruency effect in the left hemisphere, F (1, 15) = 5.84, p < 0.05, which was largest in the left anterior region (1.38 μV), F (1, 15) = 5.68, p < 0.05, suggesting a left-lateralized, anteriorly-maximized positivity elicited by the incongruent noun relative to the congruent noun. The effect of contextual expectancy was only observed on the incongruent noun, with the effect being larger in the left, F (1, 15) = 11.15, p < 0.01, than the right hemisphere, F (1, 15) = 8.81, p < 0.05, and being largest in the left anterior regions (1.81 μV), F (1, 15) = 9.32, p < 0.05, suggesting that the high-expectancy condition elicited a left-anteriorly-maximized positivity as compared with the low-expectancy condition. Although the analysis in the 450–800 ms time window did not reveal any significant effect of contextual expectancy, Fs < 1, relative to the low-expectancy condition, the high-expectancy condition tended to elicit a positivity in the 650–800 ms time window, F (1, 15) = 4.10, 0.05 < p < 0.1 on the lateral electrodes (see Fig. 3).

– Given that a same set of material was used between experiments, we conducted an ANOVA based on altogether 51 participants, taking contextual expectancy, local congruency and topographic factors as within-participant factors and experiment as a between-participant factor. The result revealed a significant effect of local congruency in the midline, F (1, 48) = 90.38, p < 0.001, and in the lateral analysis, F (1, 48) = 60.03, p < 0.001, suggesting a stronger N400 elicited by the incongruent noun relative to the congruent noun. There was a significant interaction between local congruency and experiment in the midline, F (2, 48) = 7.61, p < 0.005, and in the lateral analysis, F (2, 48) = 6.11, p < 0.005. These findings suggested that the N400 effect elicited by incongruent relative to the congruent condition was larger in Exp. 3 (−2.68 μV in the midline; −0.96 μV in the lateral) relative to Exp. 1 (−1.28 μV in the midline; −0.86 μV in the lateral) and Exp. 2 (−1.10 μV in the midline; −2.22 μV in the lateral).

There was also a significant effect of contextual expectancy in the midline, F (1, 48) = 36.89, p < 0.001, and in the lateral analysis, F (1, 48) = 34.97, p < 0.001. But no interaction between contextual expectancy and experiment was observed, Fs < 1. In all the experiments, the low-expectancy conditions elicited a larger N400 response relative to the high-expectancy conditions, although this effect tended to be larger in Exp. 3 (−1.52 μV in the midline; −0.90 μV in the lateral).

There was a significant interaction between contextual expectancy and local congruency in the midline, $F(1, 48) = 6.46$, $p < 0.05$, in the lateral analysis, $F(1, 48) = 2.89$, $0.05 < p < 0.1$. Separate analysis revealed that, the increased N400 in the low-expectancy vs. high-expectancy condition was more pronounced in the congruent ($F(1, 48) = 34.25$, $p < 0.001$ in the midline; $F(1, 48) = 24.17$, $p < 0.001$ in the lateral) than in the incongruent condition ($F(1, 48) = 5.36$, $p < 0.05$ in the midline; $F(1, 48) = 7.41$, $p < 0.01$ in the lateral).

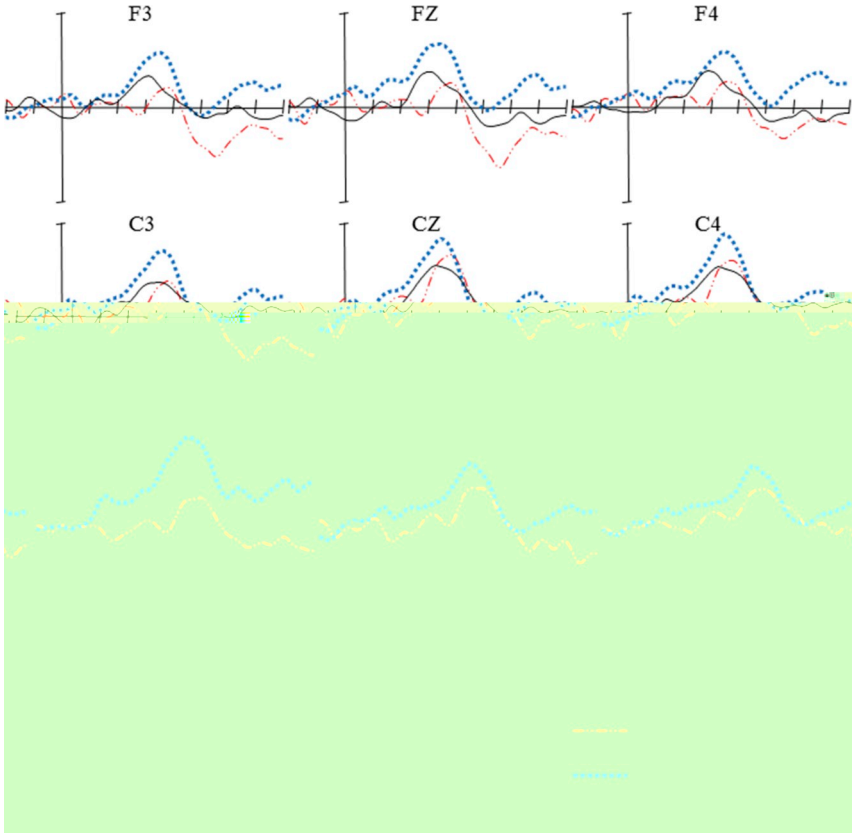
Importantly, a five-way interaction between contextual expectancy, local congruency, experiment, region and hemisphere was demonstrated in the lateral analysis, $F(4, 96) = 3.39$, $p < 0.05$. This finding suggested that the size of the N400 reduction elicited by the high-expectancy relative to the low-expectancy condition was modulated by experimental demand to different degrees on the congruent and the incongruent noun (Fig. 6). We calculated the N400 effect by subtracting the magnitude of ERP responses to the high-from that to the low-expectancy condition in each region of interest for the congruent and the incongruent nouns. The ANOVA on the congruent noun, which took electrode as within-participant factor and experiment as between-participant factor, revealed a significant effect of experiment in the left anterior, $F(2, 48) = 3.99$, $p < 0.05$, the left central, $F(2, 48) = 2.70$, $0.05 < p < 0.1$ and the left posterior region, $F(2, 48) = 4.26$, $p < 0.05$, suggesting that the reduction of N400 effect in the high-than the low-expectancy condition was more pronounced in Exp. 3 relative to Exps. 1 and 2, and tended to be larger in Exp. 1 than in Exp. 2, in the left hemisphere (left anterior: 0.83 μV, −0.65 μV, −1.89 μV; left central: 1.57 μV, −1.13 μV, −2.09 μV, and left posterior: 1.31 μV, −1.18 μV, −2.40 μV for Exps. 1, 2, and 3, respectively, see Figs. 4 and 6).

In contrast, the ANOVA on the incongruent noun revealed an effect of experiment in the right anterior, $F(2, 48) = 3.29$, $p < 0.05$, and the left posterior region, $F(2, 48) = 3.49$, $p < 0.05$. On the left posterior region, the reduction of the N400 effect for the high-expectancy relative to the low-expectancy condition was less pronounced in Exp. 3 than in Exps. 1 and 2 (−0.73 μV, −0.88 μV, −0.21 μV for Exps 1, 2, and 3, respectively, see Fig. 5). On the right-anterior region, the negativity elicited by the low-vs. the high-expectancy condition was more pronounced (−0.85 μV, −0.69 μV, −1.79 μV for the three tasks) in Exp. 3 as compared with Exps 1 and 2. It is seen from Fig. 5 that the larger anterior negativity for the low-expectancy condition was due to an early influence of late positivity for the high-expectancy condition which was maximized in the anterior region.

The ANOVA revealed a significant effect of contextual expectancy in the midline, $F(1, 48) = 3.12$, $0.05 < p < 0.1$, and in the lateral analysis, $F(1, 48) = 4.33$, $p < 0.05$, suggesting that the high-expectancy elicited a stronger positivity as compared with the low-expectancy condition (0.42 μV in the midline and 0.43 μV in the lateral analysis). The contextual expectancy interacted with experiment in the lateral analysis, $F(2, 48) = 4.14$, $p < 0.05$, suggesting the positivity effect elicited by the high-expectancy condition was only significant in Exp. 3 (−1.19 μV).

Although there was no main effect of local congruency, $F(1, 48) = 2.09$, $p > 0.1$ in the midline, or $F(1, 48) = 1.95$, $p > 0.1$ in the lateral analysis, the local congruency interacted with hemisphere in the lateral sites, $F(1, 48) = 9.19$, $p < 0.005$. A significant effect of local congruency was only shown in the left hemisphere, $F(1, 48) = 3.85$, $p < 0.05$, suggesting that across tasks, the incongruent condition elicited a larger left-lateralized positivity effect (0.56 μV, 0.49 μV, 0.68 μV for Exps 1, 2, and 3, respectively).

There was a significant interaction between contextual expectancy and local congruency, $F(1, 48) = 4.55$, $p < 0.05$ in the lateral analysis. Separate analysis revealed a significant main effect of local congruency for the high-expectancy condition, $F(1, 48) = 7.78$, $p < 0.01$, but not for the low-expectancy condition, $F < 1$. This finding suggested that, relative to the congruent noun, the incongruent noun elicited a larger



i . . Difference waveforms on 9 representative electrodes, time-locked to the object noun from −200 ms pre-onset to 800 ms post-onset, between low-expectancy, congruent and high-expectancy congruent condition, for the judgment, the passive reading and the active reading task.

positivity effect when preceded by the high-expectancy context (0.76 μV). Moreover, there was a significant effect of contextual expectancy on the incongruent noun, $F(1, 48) = 11.30$, $p < 0.005$, but not on the congruent noun, $F < 1$. The finding suggested that, relative to the low-expectancy condition, the high-expectancy condition elicited a larger positivity on the incongruent noun (0.89 μV).

There was a five-way interaction between expectancy, congruency, hemisphere, region and experiment, $F(4, 96) = 3.83$, $p < 0.05$. To examine how the stronger positive response elicited by the high-expectancy vs. the low-expectancy incongruent condition was modulated by experimental task, we calculated the positivity effect by subtracting the magnitude of ERPs to the low-expectancy condition from that to the high-expectancy condition in each region of interest in the incongruent condition. The ANOVA revealed a significant effect of experiment in the left central, $F(2, 48) = 4.10$, $p < 0.05$, the right anterior, $F(2, 48) = 3.75$, $p < 0.05$, and the right posterior region, $F(2, 48) = 2.66$, $0.05 < p < 0.1$, suggesting that the positivity effect was larger in Exp. 3 than in Exps. 1 and 2 (see Fig. 5).

In Exp.3, we attempted to increase the reader's motivation of reading by asking them to actively anticipate the upcoming words and to verify the compatibility between the anticipated and the actual word in the sentence. As is shown in Fig. 6, the N400 amplitude was much less negative in the prediction task than in the other two tasks, as was reflected by the main effect of experiment in the cross-task analysis, $F(1, 48) = 6.01$, $p < 0.01$, in the midline, $F(1, 48) = 5.78$, $p < 0.01$, in the lateral. This finding suggested that the semantic process on the object noun was generally less effortful when the readers actively made predictions in sentence reading. According to Nieuwland (2019), the prediction task could activate a task-relevant ERP response towards the word expected by the context (e.g., a P300 which temporally overlapped with N400 window and typically had a centro-posteriorly distribution, or P3b) and the latency of the elicited positivity may be delayed when the word did not fulfill the contextual expectancy. Although in Exp. 3, the congruent noun of the critical sentences could elicit a task-related P300, especially when the contextual expectancy was high (Fig. 3), the prediction instruction on the critical sentences was made less salient given that the reader was only asked to make verification on an additional group of "catch" stimuli. On the incongruent noun, relative to the low-expectancy, the high-expectancy condition did not elicit a reduced negativity in the typical N400 regions but a reduced negativity in the bilateral anterior and the right central regions in the 300–450 ms time window. Given the similarity between this negativity and the positivity in the later time window, it is possible that this reduced anterior negativity was not a reduced N400 effect but reflected an earlier portion of the late anterior positivity (Fig. 5; see later for further discussion).

task encouraged the readers to use the contextual information to restructure the sentence, the viability of the structural reanalysis strategy could be as strong in the low-expectancy as in the high-expectancy condition, resulting in an equally low level of integration in both conditions on the incongruent noun. Here the pattern of N400 for different expectancy conditions cannot easily be accommodated by the semantic similarity between the incongruent noun and the context-expected words. It is unclear how the potential effect of semantic similarity on the access to the expected word could be modulated by task demand.

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By manipulating the local congruency between adjective and object noun in a sentence with high- or low-expectancy towards the noun and by manipulating the task demand during sentence reading, we tested if the structural reanalysis would be employed as a way to mitigate the difficulty in the semantic integration of incongruent word into the sentence context. In particular, we hypothesize that, the comprehension system would initiate a structural reanalysis and reassign a modifier role to the object noun to make sense of the sentence

Late positivities were shown on object nouns mismatching the local constraint and varied in the topographic distribution as a function of the contextual expectancy and task demand. For the high-expectancy context, the incongruent word elicited an anteriorly-distributed positivity across tasks, which was more left-lateralized in passive reading and active prediction; for the low-expectancy context, the incongruent word elicited a centro-posterior positivity in judgment task. The functional dichotomy of the anterior-vs. posterior-maximized positivity in response to lexical semantic disruption has been revealed. Delong et al. (2014) and Kuperberg et al. (2020) manipulated the predictability and possibility of a word as continuation of a sentence context. They observed two types of post-N400 positivity which varied in the topographic distribution: an anterior (frontal) positivity to the unpredictable but possible word and a centro-posterior positivity to the impossible word.

The anterior positivity in the high-expectancy condition is consistent with the finding that this positivity is typically present when a word continuation disconfirms a strong prediction from the contextual constraint (Federmeier et al., 2007, 2010; Kuperberg et al., 2020; Wlotko and Federmeier, 2012). For example, in Kuperberg et al. (2020), the critical word that violated a strongly-constraining context (e.g.,

_____ …) elicited a stronger anterior positivity (recorded at the prefrontal channel) than the word violating a weakly constraining context (e.g., Grant

_____ …), or the word impossible to be integrated into the context (e.g., when in the first strongly-constraining context was replaced by). The anterior positivity may reflect an inhibitory process, i.e., a suppression of the pre-activated lexical representation based on the prediction in face of a plausible alternative word, to minimize interference with ongoing meaning construction (Delong et al., 2014) or to update the prior situation model to a new model on the basis of new bottom-up input (Kuperberg et al., 2020). In all these studies, the critical word was unexpected and was assigned a fixed syntactic role; but this word was nevertheless a possible continuation. This characteristic allows the comprehension system to ignore the mostly-expected word and update a representation based on the unexpected word. In the present study, although the object violated the expectancy of the local adjective constraint and was impossible to integrate into the sentential representation as an object, its syntactic role was temporarily ambiguous and can be reassigned another role. It is likely that the contextually-constrained lexical representation was inhibited by a competing representation which arose due to the restructuring of the sentence (Kuperberg et al., 2020; Van Petten and Luka, 2012).

Previous studies have demonstrated a task/motivational modulation of the anterior positivity on a linguistic input that mismatched a strong contextual constraint (Delong et al., 2012; Roehm et al., 2007). The frontal positivity was present when readers judged whether a statement of antonym was correct (e.g., the antonym of white was yellow) or verified the anonymous relation of a word pair, however, it was absent when a word pair was passively read (e.g. black – yellow, Roehm et al., 2007). The frontal positivity on the less probable continuation was found in young adults and in older adults with high verbal fluency (Delong et al., 2012). Consistently, in the current study, the anterior positivity found on the incongruent noun preceded by a high-expectancy context occurred the earliest and was the most pronounced when the readers made explicit verification of whether an upcoming word was predicted, the task which emphasized the use of contextual information to form an alternative representation. Therefore, the effort to suppress an expected representation was the strongest when readers were actively engaged to anticipate upcoming information and therefore we observed a strongest anterior positivity on the incongruent word in the active prediction task.

The centro-posterior positivity in the low-expectancy condition was consistent with a positivity on the object noun mismatching the local or more distant sentential constituents in a hierarchical structure (Jiang and Zhou, 2012; Zhang et al., 2011; Zhang et al., 2011). Distinct from the positivity elicited in the anterior region, this positivity could be related with the failure to update the current situation model with the new input and could be related with processes to resolve failure in language comprehension (Kuperberg et al., 2020). This post-N400 positivity is most typically seen as reflecting an increased effort to coordinate multiple and parallel semantic processes at different syntactic levels to build an integrated sentence representation (Jiang and Zhou, 2012; Zhang et al., 2011; Zhang et al., 2011), or other processing demands in face of a semantic failure (i.e., continued analysis of a conflict between rule-based and thematic-based representations, Kuperberg, 2007; general monitoring of processing errors, Kolk and Chwilla, 2007; Van de Meerendonk et al., 2010, 2013; Vissers et al., 2006, 2010; validation of well-formedness of input, Bornkessel-Schlesewsky et al., 2011; Bornkessel-Schlesewsky and Schlesewsky, 2008; Frenzel et al., 2011; update of mental representation, Brouwer et al., 2012).

The coordination process involves the redeployment of the attentional or processing focus from the syntactic level where the semantic constraint is mismatched to other possible constraints, in order to achieve a comprehension goal relevant to the current task demand (Jiang and Zhou, 2012; Zhang et al., 2011; Zhang et al., 2011). The common feature between these studies is that the possibility of structural reanalysis on the critical mismatching word is low. For example, in Zhang et al. (2011), the object noun of a German sentence was case-marked and structurally unambiguous. In Jiang and Zhou (2012), the object noun could be ambiguous but the contextual expectancy was low (39.2%), making the structural reanalysis less viable. In face of local incongruence, the system may redeploy the attentional or processing focus from the mismatched local relation to the higher-level verb-noun constraint in searching for partially coherent information to mitigate the local difficulty, resulting in a larger late centro-posteriorly distributed positivity in incongruent conditions than congruent ones (Egidi and Caramazza, 2016; Zhang et al., 2011).

The attempt to initiate a coordination process could be susceptible to the task demand at hand and may therefore reflect a task-related process. Jiang et al. (2009) compared the ERP responses to the universal quantifier preceded by a singular entity (quantifier mismatch, where was impossible to continue) with preceded by a plural entity (quantifier match, where can be predicted but not necessary). The quantifier mismatch elicited a positivity on only when readers were asked to judge the plausibility of the sentence but a sustained negativity when the participants passively read sentence for comprehension, suggesting that the initiation of coordination is subjective to the task demand, with acceptability judgment demanding higher effort of coordination. Similarly here, the attempt to initiate coordination on the incongruent noun was modulated by the task demand. The centro-posterior positivity was evident when readers verified the correctness of an actual input as a continuation of the sentence (Exps. 1 and 3). In the passive reading task (Exp. 2), the demand of acceptability judgment was low and no coordination process was initiated, rendering the positivity equally large. The task-related nature of the positivity in the post-N400 time window is consistent with the idea that the coordination process underlying the late positivity may not be linguistic-specific and may reflect a domain-general process which is moderated by the availability of the predictive context and the instruction to encourage the reader/viewer to use the context (Nieuwland, 2019; Sassenhagen and Bornkessel-Schlesewsky, 2015; Sassenhagen et al., 2014).

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In three ERP experiments, the present study examined if and how the processing of a semantically incongruent noun can be affected by the availability of an alternative representation (i.e., reassigning a modifier role to this mismatching noun). The availability of structural alternative was manipulated by the strength of the contextual expectancy and reader's motivation to actively use the contextual information. The incongruent noun elicited a reduced N400 in the high-relative to the low-expectancy condition in judgment and passive reading tasks, and elicited equal N400s in the two conditions in the active prediction task. Note that, here the contribution of context-driven structural reanalysis and the contribution of the possibly covaried semantic similarity (or association) between the target word and the context words or the context-expected word to the contextual modulation of N400 could not be fully teased apart, warranting further research (see Nieuwland, 2019 for an example). Nevertheless, the current findings suggest that the viability of structural reanalysis strategy (due to the enhanced level of contextual expectancy and possibly also due to the increased semantic similarity) can mitigate the difficulty in semantic integration and provide further evidence for the "role-dependent semantic processing hypothesis".

Comparing several relevant studies with the current study, we argue that several factors may affect the initiation of the role-dependent analysis; among them, whether the comprehension system is dealing with a flexible structure is a major factor. When the syntactic structure is flexible (e.g., the syntactic role can be ambiguous due to the lack of case marking), the combinatorial-based semantic integration effort maybe released if the given structure is reanalyzed. In contrast, the integration effort persists when no alternative role assignment is permitted. The present study went further to show that the role-dependent analysis is driven by contextual information and is relevant to reader's motivation. The semantic integration effort is released in the high-expectancy context when the reader is not explicitly asked to predict the upcoming words. Moreover, this effort is released in both the high- and low-expectancy context when the reader is explicitly asked to make such a prediction.

Furthermore, the incongruent noun elicited an additional anteriorly-distributed positivity in the high-expectancy condition, which was the most pronounced in the active prediction task. It elicited a centro-posterior positivity in the low-expectancy condition, which was the most pronounced in the acceptability judgment task. These findings may suggest that the use of multiple mechanisms to resolve semantic failure depends on the interplay of contextual constraint and task instruction. The existence of an alternative structure facilitates the inhibition of a contextually-based representation. When no structural alternatives exist, an attempt to coordinate semantic processes at multiple levels of syntactic hierarchy is initiated.

In sum, the current findings demonstrate the structural reanalysis and reader's motivation serve as alternative routes to process temporarily failed semantics and highlight the importance of hierarchical structure as a testing case to study the processing flexibility in dynamic sentence processing.

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