

Semantic-Based Mental Representation of Chinese Counterfactuals: Evidence from a Psycholinguistic Study of *Yaobushi**

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The purpose of this study is to investigate whether *yaobushi* is a counterfactual conjunction in Chinese by comparing mental operations of counterfactual representations (constituent comparison model (CCM)). Because of the mismatch between the syntactic structures and semantic intentions of counterfactuals, two possible mental representations of counterfactuals were generated: form-based and meaning-based. Based on the CCM, the processing order of the test sentences indexed by truth value and polarity was different. Different presentation times were applied to induce a genuine mental representation of Chinese counterfactuals. Participants were presented with counterfactual clauses and test sentences, which were matched or mismatched to the meanings of the target clauses. The results reveal that, regardless of the presentation time, meaning-based mental representations were constructed. Additional analyses clarified that *yaobushi* is an authentic counterfactual conjunctive rather than the combination of a conditional conjunction *yaoshi* and a negation *bushi*. Our empirical findings were confirmed by a search through the corpus database of Academia Sinica; therefore, in Chinese, *yaobushi* differentiates the imaginative world from reality without the absolute necessity of the context.

Key words: Chinese negation, counterfactual, mental representation, proposition comparison, *yaobushi*

1. Introduction

Context-appropriate counterfactual interpretations in Chinese are believed to be available in discourse because no morphological alternations and grammatical frames exist. Discourse is claimed to play a key role in determining causal reasoning between antecedents and consequents, and disambiguating counterfactual interpretations in Chinese. However, in this paper, we argue that discourse is not absolutely required for Chinese counterfactuality. We identified *yaobushi* (if it were not) as a contrary-to-fact indicator based on empirical online evidence and offline corpus observations of the Chinese language.

The mental model is documented as a crucial cognitive process of the effective comprehension required to achieve successful communication. To understand the intended meaning of sentences, correct representations should be formed in the mental model. Representations are constructed in the mental model through information integration. Valuable information may be obtained locally and globally. Both local and global information must be coherent to prevent the breakdown of integration (Albrecht & O'Brien 1993). Comprehending counterfactuals involves connecting

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interrelated propositions and bridging causal inferences between antecedents and consequents. This causal cohesion was proved to be influential for making inferences in the mental model (Keenan et al. 1984).

Counterfactuals are linguistic structures with causal antecedents that are used as local information to infer consequents and reach correct interpretations in a global context. In languages with subjunctive moods (like English), the differentiation of hypothetical alternatives from reality is obviously expressed through morphological inflections. However, in languages without inflections, such as Chinese, it is believed that context from discourse is vital in counterfactual reasoning (Li & Thompson 1981). Hsu (2013) applied psycholinguistic experimental research methods and determined that Chinese counterfactuals are accessible by combining a conditional conjunction *ruguo* and a negation *meiyou* in antecedent clauses with another negation *buhui* and an aspectual particle *le* (了) in consequent clauses. For example, consider 如果我沒有遲到, 車子就不會開走了 (*If I had not been late, the car would not have left*). This really means 我遲到了 (*I was late*) and 車子開走了 (*the car had left*). Therefore, context is not necessarily required for counterfactual reasoning in Chinese. This finding confirms that counterfactuality is embedded in cognition rather than in linguistic forms (McNeill 1987).

The function of negation in combined counterfactuals in Chinese is distinct from the function of subjunctive mood in English. The overt negation in Chinese counterfactuals does not falsify propositions, but combines with propositions to express desired alternatives contrastive to actual situations. For example, 如果我沒有遲到, 車子就不會開走了 (*If I had not been late, the car would not have left*) really indicates the narrator's wish not to have been late and to have been in the car on time. In contrast, the subjunctive mood in English functions as a covert negation of propositions. For example, consider *If Mary had lived, the doctor would have stayed* (Carpenter 1973). The intended meaning is *Mary did not live* (Mary died) and *the doctor did not stay* (the doctor left). By applying the contrastive functions of overt and covert negation in Chinese and English, respectively, speakers of these languages express counterfactuality in distinct linguistic ways. Therefore, mental representations of counterfactuals in Chinese depend on intended meanings, but not linguistic forms.

This follow-up study aims to determine whether any lexical expression is sufficient for Chinese speakers to attain counterfactuality. Other than coercion of lexical words, the purpose is more specifically to determine whether a single phrase such as *yaobushi* functions as a counterfactual conjunctive in Chinese. If so, counterfactuality without the absolute requirement of context in Chinese receives further support.

Another goal of this study is to determine whether the mismatch between the form and meaning of counterfactuals in Chinese generates different mental representations as counterfactuals do in languages with subjunctive mood, such as English. The subjunctive mood in English functions as an indicator to enter the imaginary world of counterfactual reasoning; thus, no context is required to access contrary-to-fact interpretations. For example, consider the sentence *If Mary had lived, the doctor would have stayed* (Carpenter 1973). It was found that, given a limited processing time (called simultaneous task in the current study), English speakers form structure-based representations such as (not [lived, Mary]) and (not [stayed, doctor]). The representations of the same counterfactuals became (died, Mary) and (left, doctor) when the processing time was prolonged (called delay task in this study). The distinction of time frames conveyed by the subjunctive mood is clear. However, in Chinese, no counterpart is found. It is unclear whether representations of successful

counterfactuality with *yaobushi* are construed according to linguistic forms or semantic contents. To answer these questions, comparisons of mental operations between counterfactual clauses and test sentences were performed using a constituent comparison model (Chase & Clark 1972; Clark & Chase 1972; Carpenter 1973; Carpenter & Just 1975) on sentences with *yaobushi*.

2. Method

2.1 Participants

For the simultaneous task, 24 students from National Tsing Hua University were recruited (21 females and three males, mean age = 19.5 years). For the delay task, 20 students from National Yang Ming University were recruited (five females and 15 males, mean age = 20.1 years).

2.2 Materials and design

To test the comprehension of counterfactual conditionals, three types of counterfactual sentences were included, based on their roles as antecedents or consequents: (1) counterfactual-counterfactual (CC), (2) counterfactual-factual (CF), (3) factual-counterfactual (FC), and (4) factual-factual (FF) (used as the baseline sentence for comparisons with counterfactuals). In CC sentences, the conjunction *yaobushi* occurred at the beginning of the antecedent clauses, with the aspectual marker *le* (了) in the consequent clauses, as in 要不是我遲到了, 車子就不會開走了 (*Yaobushi I had been late, the car would not have left*). In CF sentences, the method of expressing counterfactual meaning in antecedent clauses was the same as in CC sentences; for example, 要不是我遲到了, 車子也提早開走了 (*Yaobushi I had been late, the car had left earlier*). Although this type of parent sentence is uncommon, participants accepted and understood the sentence type according to post-experiment interviews. In FC sentences, the counterfactual expression is rendered by *fouze* (否則, otherwise) and *buhui* (不會, not), as in 我遲到了, 否則車子就不會開走了 (*I was late, otherwise the car would not have left*). The conjunction *fouze* is not an equivalent counterfactual conditional marker as *yaobushi* is in CC and CF sentences, but conveys the opposite interpretation and wish of the narrator regarding the event that happened. The FF sentences were controlled sentences, such as 我遲到了, 車子也開走了 (*I was late, the car had left*). The parent sentences are listed in Appendix A.

Four scenarios were presented to the participants. Each scenario was expressed in the four types of parent sentences. Hence, 32 clauses with antecedents and consequents were generated as stimuli. All scenarios were familiar to the participants (e.g. lateness resulting in missing a bus).

To evaluate the understanding of the participants regarding each type of counterfactual sentence, test sentences describing true or false statements with different polarities (affirmative, negative) were displayed. Thus, four types of test sentences were generated: true affirmatives (TA), false affirmatives (FA), true negatives (TN), and false negatives (FN). For the target clause 要不是我遲到了 (*Yaobushi I had been late*), half of the test sentences were true in the TA condition, such as 我遲到了 (*I was late*), and in the TN condition, such as 我沒有準時到 (*I was not on time*). The proposition in the TA condition was the intended meaning of the counterfactuals and contained the exact proposition 遲到 (*late*) mentioned in the surface structures. However, in the TN condition, the

intended meaning was expressed using a negation, falsifying the desired proposition, as in 我沒有準時到 (*I was not on time*). The remaining test sentences were false, with a negation in the FN condition, such as 我沒有遲到 (*I was not late*), and in the FA condition, such as 我準時到 (*I was on time*). In the FN condition, the original proposition was a parent sentence with a negation that falsely expressed the opposite meaning. Similarly, the desired situation was incorrectly stated as the actual event in the FA condition. Each clause in the parent sentences was tested based on these four types of test sentences according to the truth value of the target clauses.

One hundred and twenty-eight experimental trials were presented to all participants, who were required to respond to the truth value of each test sentence based on their comprehension of target clauses. All test sentences are listed in Appendix B. Practice trials were conducted before the experiment began. Filler sentences stating situations opposite to the parent sentences were randomly presented. These are shown in Appendix C.

2.3 Procedure

In the simultaneous task, a parent sentence and a test sentence for testing the antecedent or the consequent were displayed on the computer screen at the same time. Participants were asked to read both sentences as quickly as possible. After two seconds, the parent sentence disappeared and the test sentence remained on the screen. Participants were instructed to judge whether the test sentence matched the meaning of the target clause by pressing buttons on the keyboard. The test sentence disappeared when a response was detected. The response latency was recorded immediately after the parent sentence was removed.

In the delay task, a parent sentence was presented on the computer screen for five seconds. After this period, the parent sentence disappeared and the test sentence was displayed on the screen. Participants were asked to make judgments based on the truth value of the test sentence regarding the targeted testing clause in the parent sentence. The response latency was measured immediately after a test sentence was displayed.

Participants were tested in a quiet room and received payment after participation. In both tasks, a 500 ms fixation was displayed before presenting a parent sentence. Antecedent clauses were presented before consequent clauses.

2.4 Prediction

According to the constituent comparison model (CCM), sentences were transformed into representations in the mental model, and intermediate stages of comprehension could be inferred by comparing propositions embedded in the sentences. Two factors were designed as probes to elicit possible representations of complex sentences such as counterfactuals: truth value (true, false) and polarity (affirmative, negative). The CCM hypothesized that more mental operations are needed for processing complex structures than are needed for simple structures. We suggested three proposals for Chinese counterfactual representations using *yaobushi* based on the hypothetical mental operations of the CCM. First, the intended meaning is extracted immediately after the sentences are read, and the syntactic structure plays no role in forming mental representations for Chinese speakers. In this situation, the order of test sentences proposed for comprehending counterfactual clauses is TA,

FA, FN, and TN, as shown in Table 1. Although there was a negation, *bu* (不) or *buhui* (不會), embedded in the counterfactual target clauses, no negation was embedded in the representations.

In the three tables, which are based on the three proposals, the plus sign indicates the match of propositions between a target clause and a test sentence, and the minus sign indicates the mismatch between them. Once all propositions were matched from the innermost proposition to the outermost, a response label was assigned a check-mark indicating true or an X-mark indicating false, according to the response index. The minimum required mental operations were used as baseline comparisons needed to perform the matching process (i.e., the K comparison), and additional mental processes were conducted in addition to the baseline comparison (i.e., $K + 1$, $K + 2$, $K + 3$). Complex linguistic structures required more mental operations than simple linguistic structures because participants encountered greater difficulty in the mental process. The Chinese examples of a target clause and a test sentence were given for each condition listed in the tables.

According to the second proposal, the conjunctive *yaobushi* is represented as a frozen counterfactual marker, which led the participants into an imaginative world different from reality. In this case (Table 2), the processing order of the test sentences to the counterfactual target clauses is $TA < FA < FN < TN$. Although the processing order is the same as that of the proposal in Table 1, the number of mental operations is different. More comparisons are involved in the mental process in Table 2. The key to differentiate between the representations in Tables 1 and 2 was to identify any differences in response latencies and accuracy rates between counterfactual clauses and factual clauses. If the results revealed a difference between these two clause types, the conjunctive *yaobushi* demanded additional mental processing.

In the third proposal, the conjunctive *yaobushi* was composed of *yaoshi* (要是, if) and *bushi* (不是, not) or *meiyou* (沒有, not). In other words, the overt negation falsified the proposition in counterfactual clauses to express a desired wish; for instance, 要是我不是遲到(了) or 要是我沒有遲到, 車子就不會開走了 (*If I had not been late, the car would not have left*). According to the CCM, the processing order of test sentences to the counterfactual target clauses changes to $FN < TN < TA < FA$, as shown in Table 3. The test sentences with negation (FN, TN) were hypothesized to be processed faster than those without negation because of the syntactic match of the negation in the counterfactual target clauses. However, the negation does not truly function as a falsifier to the following propositions. When a narrator states that 要是我沒有遲到 (*If I had not been late*), the intended meaning is consistent with the proposition (i.e. 我遲到了, *I was late*). Because of the mismatched functions between form (with negation) and meaning (without negation), counterfactual clauses require additional time for mental processing.

To investigate whether syntactic structures might influence the formation of mental representations for counterfactual clauses, the difference in exposure durations of the parent sentences was crucial in this study. Given limited comprehension time (i.e. two seconds for the simultaneous task), we predicted that the participants would form structure-based representations, as shown in Table 3. When time passed, meaning-based representations formed.

3. Results

The reaction times and accuracy of the test sentences in each task are dependent variables. The correct responses for the target clauses were submitted for analysis. A four-way repeated measure

Table 1: Hypothetical mental operations of representations for factual clauses and counterfactual clauses extracted intended meanings

Condition		True Affirmative	False Affirmative
Target		I was late	I was late
Test		I was late	I was on time
Target representation		[aff, (late, I)]	[aff, (late, I)]
Test representation		[aff, (late, I)]	[aff, (on time, I)]
Mental operations		+ + <input checked="" type="checkbox"/>	- <input checked="" type="checkbox"/>
Response index:	false <input checked="" type="checkbox"/> true <input checked="" type="checkbox"/>	response = true K comparison (K = 2)	response = false K + 1 comparison
Chinese	Target Test	我遲到了, 我遲到了,	我遲到了, 我準時到,
Condition		True Negative	False Negative
Target		I was late	I was late
Test		I was not on time	I was not late
Target representation		[aff, (late, I)]	[aff, (late, I)]
Test representation		[neg, (on time, I)]	[neg, (late, I)]
Mental operations		- <input checked="" type="checkbox"/> - + <input checked="" type="checkbox"/>	- + <input checked="" type="checkbox"/>
Response index:	false <input checked="" type="checkbox"/> true <input checked="" type="checkbox"/>	+ + response = true K + 3 comparisons	+ + response = false K + 2 comparisons
Chinese	Target Test	我遲到了, 我沒有準時到,	我遲到了, 我沒有遲到,

analysis of variance (ANOVA) was conducted using clause types (factual, counterfactual), truth value (true, false), and polarity (affirmative, negative) as within-subjects factors and tasks (simultaneous, delay) as the between-subjects factor. Four types of comparisons were considered in the analyses: tasks, clause types, clause positions, and representation confirmation.

3.1 Task comparison

A comparison of tasks was performed to explore whether the time difference of presentation caused an effect on counterfactual comprehension. The results are listed in Table 4. The delay task (1760 ms) prompted faster responses than did the simultaneous task (2362 ms), ($F(1, 42) = 27.4$, $p < .001$). The interaction between clause type and task was significant ($F(1, 42) = 10.9$, $p = .002$). The simple main effect showed faster reaction times in the delay task than it did in the simultaneous task for factual clauses ($F(1, 42) = 21.4$, $p < .001$) and counterfactual clauses ($F(1, 42) = 28.6$, $p < .001$). In both tasks, factual clauses were understood faster than counterfactual clauses were. Counterfactual clauses exhibited slower responses than factual clauses did in test sentences with true statements (FT < CT, $t(43) = -2.9$, $p = .006$) and test sentences with false statements (FF < CF, $t(43) = -6.4$, $p < .001$; clause type \times truth value interaction, $F(1, 43) = 12.6$, $p = .001$). The inter-

Table 2: Hypothetical mental operations of representations for counterfactual target clauses without negation

Condition		True Affirmative	False Affirmative
Target		CF ^a I had been late	CF I had been late
Test		I was late	I was on time
Target representation		{CF, [aff, (late, I)]}	{CF, [aff, (late, I)]}
Test representation		[aff, (late, I)]	[aff, (on time, I)]
Mental operations		– + + ☒ + + + ☑	– + + ☒ – + + ☑ + + + ☒
Response index:	false ☒ true ☑	response = true K comparisons (K = 6)	response = false K + 1 comparison
Chinese	Target Test	要不是我遲到了, 我遲到了,	要不是我遲到了, 我準時到,
Condition		True Negative	False Negative
Target		CF I had been late	CF I had been late
Test		I was not on time	I was not late
Target representation		{CF, [aff, (late, I)]}	{CF, [aff, (late, I)]}
Test representation		[neg, (on time, I)]	[neg, (late, I)]
Mental operations		– – + ☒ – + + ☒ – + + ☒ + + + ☑	– + + ☒ – + + ☑ + + + ☒
Response index:	false ☒ true ☑	response = true K + 3 comparisons	response = false K + 2 comparisons
Chinese	Target Test	要不是我遲到, 我沒有準時到,	要不是我遲到了, 我沒有遲到,

^a CF stands for the counterfactual conjunctive *yaobushi*.

action between truth value and polarity was also significant ($F(1, 43) = 69.0, p < .001$), and the simple main effects resulted from the polarity effect on sentences with different truth values (TA < TN, $t(43) = -14.5, p < .001$; FA < FN, $t(43) = -2.9, p = .005$), as well as from the truth value effect on sentences with different polarities (TA < FA, $t(43) = -10.4, p < .001$; FN < TN, $t(43) = 2.7, p = .009$). Figure 1 shows the graph of the reaction times for the two tasks, concerning the responses to the test sentences for factual clauses and counterfactual clauses. The order of the test sentences in each task was TA < FA < FN < TN. No interaction between the test sentences and the task was observed ($F < 1$). The same processing order was observed regardless of the exposure time difference of the parent sentences. Thus, we excluded the third proposal regarding the influence of syntactic structures of the formation of counterfactuals with *yaobushi* in Chinese.

The error rates of the two tasks were similar (simultaneous task, 0.9; delay task, 0.8; $F(1, 42) = 2.8, p = .10$), suggesting there was no tradeoff effect between reaction times and error rates in the simultaneous task. Because the error rates were considerably low (< 1%) in both tasks, investigating each condition was unnecessary.

Table 3: Hypothetical mental operations of representations for counterfactual target clauses with negation

Condition			True Affirmative	False Affirmative
Target			IF I had not been late	IF I had not been late
Test			I was late	I was on time
Target representation			{if, [neg, (late, I)]}	{if, [neg, (late, I)]}
Test representation			[aff, (late, I)]	[aff, (on time, I)]
Mental operations			<div> <div>– + ☒</div> <div>– + + ☑</div> <div>+ + +</div> </div>	<div> <div>– + ☒</div> <div>– + + ☑</div> <div>+ + + ☒</div> </div>
Response index:	false ☒		response = true K + 2 comparisons	response = false K + 3 comparisons
Chinese	Target Test		要不是我遲到了, 我遲到了,	要不是我遲到了, 我準時到,
Condition			True Negative	False Negative
Target			IF I had not been late	IF I had not been late
Test			I was not on time	I was not late
Target representation			{if, [neg, (late, I)]}	{if, [neg, (late, I)]}
Test representation			[neg, (on time, I)]	[neg, (late, I)]
Mental operations			<div> <div>– + ☒</div> <div>– + + ☑</div> <div>+ + +</div> </div>	<div> <div>– + + ☒</div> <div>+ + +</div> </div>
Response index:	false ☒		response = true K + 1 comparison	response = false K comparison (K = 6)
Chinese	Target Test		要不是我遲到了, 我沒有準時到,	要不是我遲到了, 我沒有遲到,

Table 4: Reaction times and comparison results of clause types in the simultaneous and delay tasks

Simultaneous Task	Factual	Counterfactual	Comparison
Response Latency (ms)	2201	2522	$t(23) = -5.67, p < .001$
Delay Task			
Response Latency (ms)	1718	1801	$t(19) = -2.11, p = .048$

3.2 Clause type comparison

Additional analyses were conducted to determine whether counterfactual target clauses embedded in different parent-sentence types caused distinct processing patterns. Four types of counterfactual target clauses were analyzed: the antecedents of the CC parent sentences (hereafter, CC1), the consequents of the CC sentences (CC2), the counterfactual target clauses of the CF parent sentences in the antecedent position (CF1), and the counterfactual clauses of the FC parent

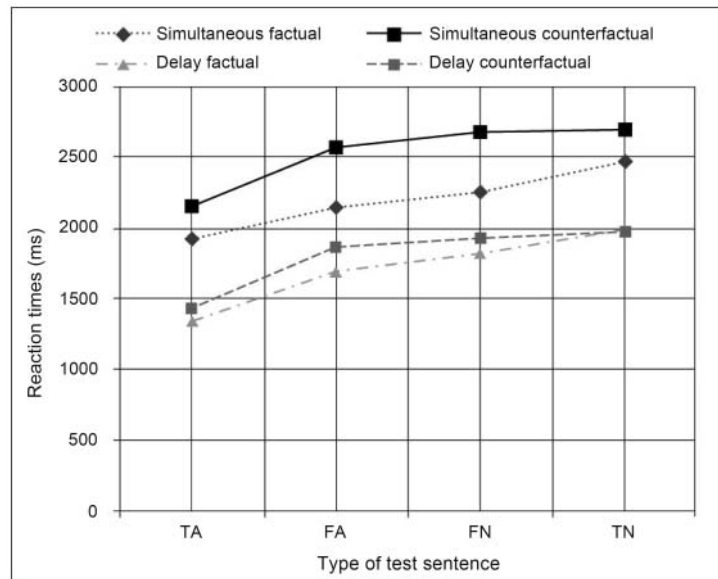


Figure 1: Reaction times of four test sentence types for factual clauses and counterfactual clauses in the simultaneous and delay tasks

sentences in the consequent position (FC2). The clause types (CC1, CC2, CF1, FC2) and the test sentence types (TA, FA, FN, TN) were analyzed as the within-subjects factors and the tasks were used as the between-subjects factor.

A three-way repeated measure ANOVA revealed an interaction among the three factors ($F(9, 378) = 2.3, p = .02$). The simple interactions between the task and test-sentence types were significant in the CC1 ($F(3, 126) = 5.4, p = .002$) and CC2 clause types ($F(3, 126) = 2.8, p = .04$). The simple main effect was derived from the difference among tasks in all the test sentences. These results suggested that when both the antecedents and consequents were counterfactual, the participants processed antecedents with *yaobushi* as contrary-to-fact expressions, and required additional time to disengage reality from its alternatives. The CF1 and FC2 parent sentences performed similarly in both tasks, as no interaction was observed. Consistent with the generally faster responses to the delay task compared with the simultaneous task, the same pattern was observed in all clause types (main effect: CC1, $F(1, 42) = 17.2, p < .001$; CC2, $F(1, 42) = 11.9, p < .001$; CF1, $F(1, 42) = 15.7, p < .001$; FC2, $F(1, 42) = 6.6, p = .01$). Moreover, the four test sentence types exhibited different responses to each other in each clause type (CC1, $F(3, 126) = 24.3, p < .001$; CC2, $F(3, 126) = 10.5, p < .001$; CF1, $F(3, 126) = 11.7, p < .001$; FC2, $F(3, 126) = 7.9, p < .001$). Post-hoc comparisons revealed that the shortest response latency corresponded to the TA condition, whereas the longest latency corresponded to the TN condition, with the FA and FN conditions in between. This processing order was observed for most of the clause types, including CC1, CC2, and CF1. Because the FC2 parent sentences were uncommon in utterances (i.e. factual antecedents with counterfactual inferences), we observe that the processing order is based on truth value (true statements < false statements) rather than polarity (affirmatives < negatives) as proposed in the CCM.

Figure 2 displays the response latencies of each clause type in both tasks. This graph shows that counterfactual target clauses embedded in different parent-sentence types resulted in distinct processing patterns, which is the typicality effect in counterfactual reasoning.

3.3 Clause position comparison

As the typicality effect reveals, the position of the counterfactual target clauses might be another influential factor in Chinese counterfactual reasoning. The position of the clause as the antecedent (CC1 and CF1; hereafter, Clause 1) or consequent (CC2 and FC2; hereafter, Clause 2) was used as a within-subjects factor. Advanced four-way ANOVA analyses using clause positions (Clause 1, Clause 2), truth values (true, false), and polarities (affirmative, negative) as the within-subjects factors and tasks as the between-subjects factor were performed.

The main effect of clause position is significant ($F(1, 42) = 5.6, p = .02$), suggesting that the responses to Clause 1 (2116 ms) were faster than those to Clause 2 (2414 ms). Separate analyses of each task revealed a significant difference between the simultaneous tasks (Clause 1, 2482 ms < Clause 2, 2973 ms, $F(1, 23) = 4.8, p = .04$) and a similar trend but non-significant difference between the delay tasks (Clause 1, 1749 ms < Clause 2, 1854 ms, $F < 1$). In the delay task, the clause position significantly interacted with truth value and polarity ($F(1, 19) = 9.9, p = .005$), and the simple main effect occurred on Clause 1 ($F(1, 19) = 39.8, p < .001$). The processing order of Clause 1 matched the hypothetical mental operations in the CCM (i.e. TA < FA < FN < TN). No interaction in Clause 2 was observed ($F < 1$). Figure 3 displays the response latencies of each clause position in the two tasks. Additional analyses on each clause position in the simultaneous task revealed the same processing order in the test sentences (Clause 1, $F(1, 23) = 6.4, p = .02$; Clause 2, $F(1, 23) = 4.9, p = .04$).

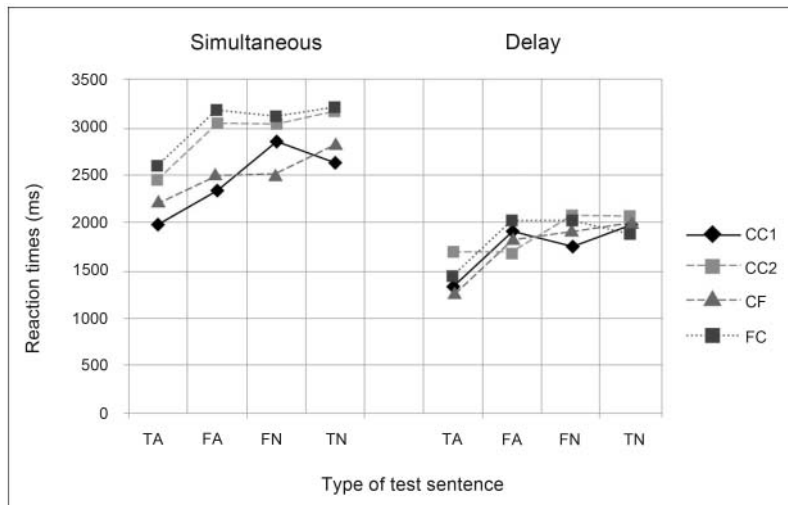


Figure 2: Reaction times of four parent sentence types for counterfactual target clauses in the simultaneous and delay tasks

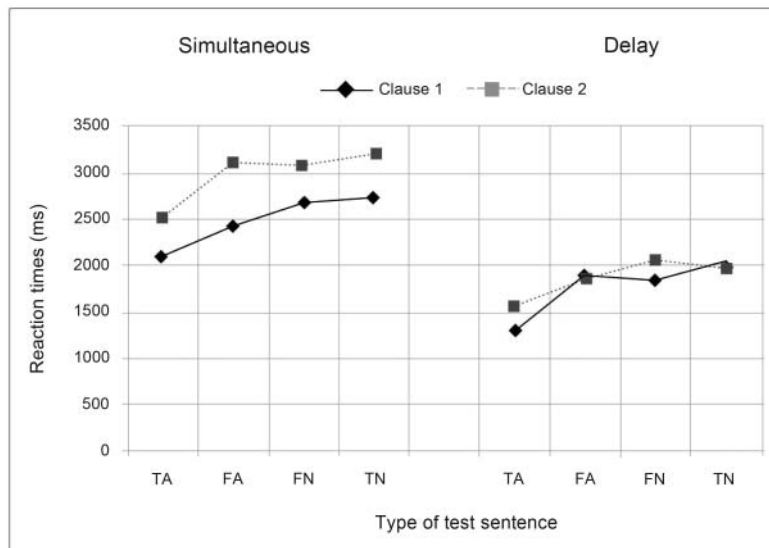


Figure 3: Reaction times of antecedent (Clause 1) and consequent (Clause 2) positions for counterfactual target clauses in the simultaneous and delay tasks

3.4 Representation confirmation comparison

Because the inferred processing order for counterfactual target clauses matched the representation proposals in Table 1 and Table 2, additional analyses were conducted to determine the correct order. We analyzed the most typical counterfactual parent sentences (CC) and factual parent sentences (FF) of the two tasks to investigate whether the conditional conjunctive *yaobushi* was represented in the mental model. These two types of parent sentences (CC, FF) require different processing times when additional processes are needed for representing the conjunctive *yaobushi*. A four-way repeated measure ANOVA was performed according to the clause positions, and clause types (factual, counterfactual), truth values (true, false), and polarities (affirmative, negative) were used as the within-subjects factors and tasks as the between-subjects factor.

The results revealed that, in Clause 1, the task interacted with clause type ($F(1, 42) = 9.0$, $p = .004$) and polarity ($F(1, 42) = 7.3$, $p = .01$). In the simultaneous task, longer response latencies for counterfactual clauses (4449 ms) compared with factual clauses (4005 ms) were observed ($t(23) = -4.9$, $p < .001$). A similar but non-significant pattern was observed for the comparison between two clause types in the delay task (counterfactual, 1745 ms; factual, 1646 ms; $t(19) = -1.6$, $p > .1$). Moreover, another simple major effect revealed that comparing mental representations between counterfactual clauses and test sentences with negation in the simultaneous task required longer reaction times (affirmative, 3957 ms; negative, 4497 ms; $t(23) = -6.8$, $p < .001$) than it did the delay task (affirmative, 1561 ms; negative, 1830 ms; $t(19) = -4.9$, $p < .001$).

In Clause 2 analyses, an interaction was observed between the task and clause type ($F(1, 42) = 8.4$, $p = .006$), and the simple main effect was derived from the faster response latencies for factual clauses (4108 ms) than for counterfactual clauses (4925 ms) in the simultaneous task ($t(23)$

$= -3.5, p = .002$). Although a similar pattern was observed in the delay task, the results did not show significant differences (factual, 1807 ms; counterfactual, 1872 ms; $t(19) = -1.3, p > .2$). Overall, the Chinese-speaking participants form mental representations for counterfactual target clauses as displayed in Table 2. Participants process the conditional conjunctive *yaobushi* as a frozen counterfactual marker requiring additional time for comprehension.

4. Discussion

The purpose of this study was to explore the mental representation of Chinese counterfactuals with *yaobushi*. Based on the constituent comparison model (Carpenter & Just 1975), three possible representations were proposed for processing complex structures such as counterfactual conditionals. The hypothetical mental operations of counterfactuals with *yaobushi* are displayed in Tables 1 to 3. The participants were presented with counterfactual sentences and test sentences to test their comprehension of targeted counterfactual clauses. The participants were asked to make judgments on whether the meaning of the test sentences matched or mismatched the target clauses. According to the hypothesis of the CCM, the processing order of the test sentences, with truth value (true, false) and polarity (positive, negative) as comprehension indexes, reflected the mental operations for sentence processing. As Table 1 and Table 2 show, the processing order reflects meaning-based representations to counterfactual conditionals; however, the order in Table 3 reflects form-based representations. I also manipulated the presentation time difference of target clauses and test sentences to determine whether it caused an effect on the processing of counterfactuals. The CCM predicted that, given presentation time limitations, form-based representations would be constructed, and, given sufficient processing time, meaning-based representations would be formed. The results partially confirmed the predictions. In the simultaneous task, when there was a time limitation, the participants formed meaning-based mental representations of counterfactual clauses, as they did in the delay task. Hence, the processing orders based on the hypothetical mental operations in Tables 1 and 2 are suitable for further testing. Additional analyses reveal that counterfactual clauses are comprehended more slowly than factual clauses are, suggesting that these two types of clauses are different, and the mental operations in Table 2 were correct. I conclude that counterfactuals with the conjunctive *yaobushi* successfully induced counter-to-fact and alternate-to-past interpretations, and the conjunction *yaobushi* is processed as a counterfactual marker for Chinese-speaking people.

Apart from the subjunctive mood, logical reasoning through counterfactuality in Chinese is expressed in a distinct linguistic manner. Counterfactual thoughts are activated by negative emotions, including sadness, anger, and regret. Based on this universality, counterfactuality is embodied in cognition rather than in linguistic forms (Hsu 2013; McNeill 1987). In English, the subjunctive mood is the indicator for denoting contrary-to-fact thought. However, in Chinese, using the counterfactual conjunctive *yaobushi* at the lexical level achieves the same function. Chinese speakers use *yaobushi* to express hypothetical situations by stating the real situation as a proposition (i.e. 要不是我遲到了 *Yaobushi I had been late*). In Chinese, counterfactuals without a subjunctive mood, but instead containing the lexical expression *yaobushi*, successfully differentiate alternative situations from reality.

The psycholinguistic method used in this study demonstrates that counterfactual processing in Chinese without discourse (other than an antecedent or a consequent) is possible. The interpretation of the negation *bu(shi)* in the conjunctive *yaobushi* is the key to generating two distinct counterfactual representations. One representation lacks negation in front of propositions, but *yaobushi* is used as a non-decomposable frozen conjunctive for accessing counterfactuality (Table 2). The other representation includes negation, and the conjunctive is separated as a conditional *yaoshi* and a negation *bushi* or *meiyou* (Table 3). The experimental results indicate that the representations in Table 2 reflect the nature of counterfactuals in the mental model of Chinese speakers more accurately than those proposed in Table 3. The processing order was the same for both tasks, suggesting that the time difference of parent-sentence exposure between tasks did not alter mental representations. Given a limited presentation time, the participants formed meaning-based representations but not structure-based representations (with negation *bushi* or *meiyou*). Even with visual help on the screen, overt negation embedded in the conjunctive *yaobushi* fails to function as a negative, as was expected. Analyses on the most typical counterfactual target clauses (CC1, CC2) reveal that the processing times of counterfactual clauses and factual clauses differ, indicating that *yaobushi* is a counterfactual conjunction that enables counterfactual reasoning in Chinese. Hence, context in discourse is not an absolute requirement for Chinese counterfactuality.

I obtained further confirmation that counterfactuals with *yaobushi* denoted contrary-to-fact expressions in the open database of the Academia Sinica Balanced Corpus of Modern Chinese (中央研究院現代漢語平衡語料庫). For example, consider 要不是我撥了電話, 恐怕你連中飯都省了 (*Yaobushi I had made the phone call, you would have skipped lunch*), 我要不是傻瓜, 當初怎麼會嫁給一個傻瓜? (*Yaobushi I were a fool, why would (I) have married a fool?*), 歷史上要不是有劉備的三顧茅廬 (*Yaobushi it had been Liu Bei's insistence to visit (Zhuge Liang) in history*), 要不是趙樹理, 我們早餓死了 (*Yaobushi we had had help from Zhao Shuli, we would have been hungry to death*). Regardless of temporal adverb modification (e.g. 歷史上 *in history*, 當時 *at that time*), all 38 sentences with *yaobushi* found in the corpus were alternatives to past events. Hence, the conditional conjunctive *yaobushi* is truly a counterfactual conditional conjunction with pragmatic use. However, in disagreement with the analyses of Eifring (1988) and Wu (1994), *yaobushi* is not equal to the combination of *yaoshi* (要是, *if*) and *bushi* (不是, *not*) or *meiyou* (沒有, *not*). In our corpus, most sentences with this combination simply describe possible conditional situations. For instance, consider 要是不肯努力, 就不容易成功 (*If (you) do not work hard, (you) will not succeed*), 要是你沒看夠, 以後可以再來看一次 (*If you want to have one more visit, you can come again later*), and 要是還有不認識的字, 就查字典 (*If (you) encounter unknown words, (you) can look them up in the dictionary*). Based on the corpus data, we consider *yaobushi* as a frozen phrase for counterfactual expression that is not equivalent to the combination of *yaoshi* and *bushi* (要是...不是..., *if...not...*) or *yaoshi* and *meiyou* (要是...沒有..., *if...not...*). This confirmed my empirical observations that the mental representations of counterfactuals in Chinese are not embedded negations. Moreover, the counterfactual expression rendered by *yaobushi* in Chinese is compatible with the contrast effect mechanism of counterfactual thinking (Roese 1997). The function of the negation (不, *not*) in the conjunctive *yaobushi* is not to negate the proposition, but to state a desired alternative situation. Although the participants comprehended a statement such as 要不是我遲到了 (*Yaobushi I had been late*), they interpreted it as meaning the narrator was late and wished that this situation could be changed, as 我沒有遲到 (*I was not late*) or 我不是(真的)遲到 (*I was*

not truly late). Without contextual aids, we argue that counterfactuality in Chinese occurs when using the conjunctive *yaobushi*.

A similar function of negation was observed in my previous study on the development of counterfactuals in Chinese (Hsu 2013). Counterfactual interpretation was successfully elicited by combining the conditional conjunction *ruguo* (如果, if) with *meiyou* (沒有, not) in the antecedent clauses, and the negation *buhui* (不會, not) with the aspectual particle *le* (了, indexing the completion of an action) in the consequent clauses. For example, consider 如果我沒有遲到, 車子就不會開走了 (*If I had not been late, the car would not have left*). In the CCM proposition comparison task, the participants interpreted the sentences as counterfactual statements. Further demonstration from different developmental stages (elementary school children and junior high teenagers) was observed. This combination induces counterfactual expressions in Chinese as the subjunctive mood does in English. Based on this finding, I checked the corpus data to identify any combinations of *yaoshi* (要是, if) and *bushi* (不是, not) denoting counterfactual interpretations. Only nine of the 343 sentences with this combination in the corpus expressed the same counterfactual function as sentences with *yaobushi*. As previously mentioned, these nine sentences have temporal adverbs to help contrast the past and present time frames, such as 那時 (*at that time*), 兩千多年前 (*two thousand years ago*), and 當時 (*then*). One of the nine sentences is the combination of *yaoshi* (要是, if) and *bushi* (不是, not), as in 要是那時他不(是)自殺, 恐怕也只能再活不多久 (*If he had not committed suicide at that time, he would not have lived long anyway*). The other eight sentences included combinations of *yaoshi* (要是, if) and *meiyou* (沒有, not), as in 要是沒有兩千多年前李冰父子設計修築 (*If Li Bing and his son had not constructed buildings two thousand years ago*), and 當時要是沒有他的妻子的幫助 (*If his wife had not helped then*). Without modifying temporal adverbs in these sentences, it is not clear whether they have contrary-to-fact interpretations. From the corpus data, it is clear that the counterfactual conjunctive *yaobushi* is not equivalent to the combination of *yaoshi* and *bushi* or *meiyou*. In addition to the combination, I conclude that the conjunctive *yaobushi* is an authentic counterfactual phrase in Chinese.

Although both antecedents and consequents are present in contrary-to-fact expressions, according to the typicality effect of counterfactuals with *yaobushi* that were observed in this study, we observed that consistency helps to connect antecedents and consequents for counterfactual comprehension. As Lewis (1973) stated, counterfactuals require negating the truth value of antecedents and consequents to reach the intended interpretations. For every test sentence type, the counterfactual antecedents (CC1) and counterfactual consequents (CC2) were processed faster in the delay task than they were in the simultaneous task, and the processing order was the same as that of the hypothetical mental operations proposed in the CCM. However, the other two types (CF, FC) did not show interaction between the task and the test sentence type. Semifactual clauses (CF, FC) were processed similarly, regardless of the duration of presentation. Furthermore, the main effect revealed distinct processing orders for CF and FC. The CF parent-sentence type followed an order based on polarity (affirmatives < negatives), but the FC parent-sentence type followed an order of truth value (true statements < false statements). These results indicated that counterfactual processing is, from most to least typicality, in the order CC, CF, and FC. This effect is consistent with the observation of Goodman (1983) in defining the counterfactual feature as the falsification of its antecedent; therefore, the consequent may be or may not be false. These results suggest that antecedent falsification is close to the comprehension of the counterfactual world in Chinese.

Several potential factors may influence counterfactual reasoning, including the two-stage counterfactuality model regarding the negative emotions and normality, content representativeness, and valence (Bouts et al. 1992; Kahneman & Tversky 1982). This study shows that a semantic-based mental representation was formed when processing Chinese counterfactual conditionals, and *yaobushi* is truly a counterfactual conditional conjunctive in Chinese. Furthermore, discourse is not absolutely required in Chinese counterfactuality, but the conjunctive *yaobushi* sufficed with empirical support. Counterfactual thinking is beneficial for problem-solving and causal chain establishment. People make connections to understand the thoughts and intentions of other people and derive a precise attribution for making decisions or plans. Incomplete understanding may result in incorrect inferences or conclusions that lead to undesired results. Based on this cognitive premise, I propose that Chinese speakers lexically develop counterfactual phrases (like *yaobushi*) in logical reasoning but not morphological inflections, without the absolute necessity of context in discourse. Future research may falsify the proposal with longitudinal studies from developmental perspectives.

Appendix A

Parent sentences

A.1 Counterfactual-Counterfactual

要不是我遲到了
yaobushi wo chidao le
'*yaobushi I had been late*'

要不是病人死了
yaobushi bingren si le
'*yaobushi the patient had died*'

要不是颱風來了
yaobushi taifeng lai le
'*yaobushi the hurricane had come*'

要不是貓來了
yaobushi mao lai le
'*yaobushi the cat had come*'

車子就不會開走了
chezi jiu buhui kaizou le
'*the car would not have left*'

醫生就不會離開了
yisheng jiu buhui likai le
'*the doctor would not have left*'

機場就不會關閉了
jichang jiu buhui guanbi le
'*the airport would not have been closed*'

老鼠就不會跑走了
laoshu jiu buhui paozou le
'*the mice would not have run away*'

A.2 Counterfactual-Factual

要不是我遲到了
yaobushi wo chidao le
'*yaobushi I had been late*'

要不是病人死了
yaobushi bingren si le
'*yaobushi the patient had died*'

要不是颱風來了
yaobushi taifeng lai le
'*yaobushi the hurricane had come*'

車子也提早開走了
chezi ye tizao kaizou le
'*the car had left earlier*'

醫生也會先離開
yisheng ye hui xian likai
'*the doctor had left already*'

機場也會關閉一陣子
jichang ye hui guanbi yizhenzi
'*the airport had been closed shortly*'

要不是貓來了
yaobushi mao lai le
'*yaobushi the cat had come*'

老鼠也都跑走了
laoshu ye dou paozou le
'*the mice had all run away*'

A.3 Factual-Counterfactual

我遲到了
wo chidao le
'*I was late*'
病人死了
bingren si le
'*the patient died*'
颱風來了
taifeng lai le
'*the hurricane came*'
貓來了
mao lai le
'*the cat came*'

否則車子就不會開走了
fouze chezi jiu buhui kaizou le
'*otherwise the car would not have left*'
否則醫生就不會離開了
fouze yisheng jiu buhui likai le
'*otherwise the doctor would not have left*'
否則機場就不會關閉了
fouze jichang jiu buhui guanbi le
'*otherwise the airport would not have been closed*'
否則老鼠就不會跑走了
fouze laoshu jiu buhui paozou le
'*otherwise the mice would not have run away*'

A.4 Factual-Factual

我遲到了
wo chidao le
'*I was late*'
病人死了
bingren si le
'*the patient died*'
颱風來了
taifeng lai le
'*the hurricane came*'
貓來了
mao lai le
'*the cat came*'

車子也開走了
chezi ye kaizou le
'*the car had left*'
醫生也離開了
yisheng ye likai le
'*the doctor left*'
機場也關閉了
jichang ye guanbi le
'*the airport was closed*'
老鼠都跑走了
laoshu dou paozou le
'*the mice all ran away*'

Appendix B Test sentences

B.1 True-Affirmative

我遲到了
wo chidao le
'*I was late*'

車子開走了
chezi kaizou le
'*the car had left*'

病人死了
bingren si le
'the patient died'
颱風來了
taifeng lai le
'the hurricane came'
貓來了
mao lai le
'the cat came'

醫生離開了
yisheng likai le
'the doctor left'
機場關閉了
jichang guanbi le
'the airport was closed'
老鼠跑走了
laoshu paozou le
'the mice ran away'

B.2 False-Negative

我沒有遲到
wo meiyou chidao
'I was not late'
病人沒有死
bingren meiyou si
'the patient did not die'
颱風沒有來
taifeng meiyou lai
'the hurricane did not come'
貓沒有來
mao meiyou lai
'the cat did not come'

車子沒有開走
chezi meiyou kaizou
'the car did not leave'
醫生沒有離開
yisheng meiyou likai
'the doctor did not leave'
機場沒有關閉
jichang meiyou guanbi
'the airport was not closed'
老鼠沒有跑走
laoshu meiyou paozou
'the mice did not run away'

B.3 False-Affirmative

我準時到
wo zhunshi dao
'I was on time'
病人活著
bingren huozhe
'the patient was alive'
颱風遠離了
taifeng yuanli le
'the hurricane was far away'
貓走掉了
mao zoudiao le
'the cat ran away'

車子還在原地
chezi haizai yuandi
'the car was still there'
醫生留下來
yisheng liu xialai
'the doctor stayed'
機場開放著
jichang kaifang zhe
'the airport was open'
老鼠留下來
laoshu liu xialai
'the mice stayed'

B.4 True-Negative

我沒有準時到
wo meiyou zhunshi dao
'I was not on time'

車子不在原地
chezi buzai yuandi
'the car was not there'

病人沒有活著
bingren meiyou huozhe
'the patient was not alive'

颱風沒有遠離
taifeng meiyou yuanli
'the hurricane was not far away'

貓沒有走掉
mao meiyou zoudiao
'the cat did not run away'

醫生沒有留下
yisheng meiyou liuxia
'the doctor did not stay'

機場沒有開放
jichang meiyou kaifang
'the airport was not open'

老鼠沒有留下來
laoshu meiyou liu xialai
'the mice did not stay'

Appendix C

Filler sentences

C.1 Filler 1

我準時到了
wo zhunshi dao le
'I was on time'

我沒有遲到
wo meiyou chidao
'I was not late'

車子還在原地
chezi haizai yuandi
'the car was still there'

車子也還在原地
chezi ye haizai yuandi
'the car was still there'

C.2 Filler 2

病人活著
bingren huozhe
'the patient was alive'

病人沒有死
bingren meiyou si
'the patient did not die'

醫生也留下來了
yisheng ye liu xialai le
'the doctor still stayed'

醫生也留下來了
yisheng ye liu xialai le
'the doctor still stayed'

C.3 Filler 3

颱風遠離了
taifeng yuanli le
'the hurricane was far away'

颱風沒有來
taifeng meiyou lai
'the hurricane did not come'

機場也開放了
jichang ye kaifang le
'the airport was still open'

機場也開放了
jichang ye kaifang le
'the airport was still open'

C.4 Filler 4

貓走掉了
mao zoudiao le
'the cat ran away'

貓沒有出現
mao meiyou chuxian
'the cat did not show up'

老鼠又跑出來了
laoshu you pao chulai le
'the mice showed up again'

老鼠又跑出來了
laoshu you pao chulai le
'the mice showed up again'

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以語意為心理表徵基礎之 中文與過去事實相反假設語氣： 來自「要不是」心理語言學研究證據

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本篇研究目的探討「要不是」是否為中文與過去事實相反假設語氣連接詞，研究方法運用詞組比較模型 (constituent comparison model)，透過比較以「要不是」起首條件句形成之心理表徵所含命題，藉由其句法與語意不一致特性，提出兩種可能心理表徵並加以驗證，一為句法層次心理表徵，二為語意層次心理表徵，操弄刺激呈現時間差驗證表徵假設。受試者坐在電腦前閱讀以「要不是」起首條件句及語意測試句，分為同時呈現（實驗一）及分開呈現（實驗二），判斷兩句是否語意相同。實驗結果顯示，以中文為母語受試者處理「要不是」條件句形成語意心理表徵，而非句法心理表徵，證明「要不是」為中文與過去事實相反假設語氣連接詞。此研究結果與中央研究院現代漢語平衡語料庫詞庫資料一致，「要不是」並非只是結合假設連接詞「要是」與否定詞「不是」，而是與過去事實相反假設語氣連接詞，「要不是」區分中文母語使用者想像世界與真實，研究結果進一步支持文章脈絡在中文與過去事實相反假設語氣並非必要條件。

關鍵詞：假設語氣連接詞，心理表徵，命題比較，中文否定詞