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An E-Prime Study on the Cognitive Mechanisms of English Predicative Metaphor Comprehension by Chinese EFL Learners

Yuanlian Su[1] & Jie Liu[1]

[1] School of Foreign Studies, Guangzhou University, Guangzhou, China

Correspondence: Yuanlian Su, School of Foreign Studies, Guangzhou University, Guangzhou, Guangdong, China.

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Abstract

Studies on predicative metaphors like *The rumor flew through the office* have not received due attention until recently. Through a behavioural experiment, this study investigates the cognitive mechanisms as well as the effects of familiarity on Chinese EFL learners' comprehension of English predicative metaphors, adopting a two factors within-subject design: 2 (degree of familiarity: high-familiarity, low-familiarity) × 3 (priming condition: matching priming condition (MP), mismatching priming condition (MMP) and, no priming condition (NP)). Forty-five third-year Chinese undergraduate students participated in the experiment by completing a metaphor semantic comprehension test. Their reaction times (RTs) and accuracy rate of comprehension were recorded and a two-way ANOVA analysis of the results reveals that: Embodied simulation mechanism plays an important role in English predicative metaphor processing, especially when the metaphors being processed are unfamiliar. Yet its role diminishes when the metaphors being processed are highly familiar, which encourages the use of the language processing mechanism. To conclude, Chinese EFL learners make use of either the embodied simulation mechanism or the language processing mechanism in comprehending predicative metaphors, depending on their varying degrees of familiarity. These findings shed light on predicative metaphor instruction in L2 English teaching.

Keywords: English predicative metaphors, the embodied simulation mechanism, the language processing mechanism, familiarity

1. Introduction

The past decades have witnessed increasing advances of metaphor studies in the field of philosophy, linguistics, psycholinguistics and, neurolinguistics (e.g., Lakoff & Johnson, 1980; Blasko & Connie, 1993; Glucksberg, 2003; Torreano, Cacciari, & Glucksberg, 2005; Gibbs, 2006; Desai, Binder, & Conant, 2011; Obert, Gierski, Calmus, Portefaix, Declercq, Pierot, & Caillies, 2014). Metaphor comprehension has generally been regarded as one of the most sophisticated cognitive activities of human language processing. When someone says *The student grasped the concept*, it is obvious that the speaker does not literally mean that s/he was holding a physical entity, but rather that s/he understood the abstract notion "*concept*". This type of metaphor (i.e. the figurative use of a verb) is commonly known as predicative metaphors (Utsumi & Sakamoto, 2007, 2011; Obert, Gierski, & Caillies, 2018), verb metaphors (Gibbs, 2006; Wilson & Gibbs, 2007), or predicate metaphors (Chen, Widick, & Chatterjee, 2008; Stamenković, Ichien, & Holyoak, 2019). Although predicative metaphors are found to be used more frequently than nominal metaphors (i.e. the figurative use of a noun, cf. Cameron, 2003) in everyday communication, how they are comprehended has been under-researched until recently, as shown by a number of multi-disciplinary studies that examined the ontological basis, the mental processing mechanisms and the neurocognitive mechanisms involved in the comprehension of predicative metaphors (For an extensive review, see Su, 2017). Despite the current advances in the field, however, so far no attempt has been made to investigate whether L2 learners comprehend predicative metaphors the same way as native speakers. This study aims to fill the gap by adopting E-prime procedures to investigate the cognitive mechanisms underlying the English predicative metaphor comprehension by Chinese EFL learners.

2. Literature Review

2.1 Psycholinguistic and Neurolinguistic Studies on English Predictive Metaphors

How metaphorical meaning is extracted and created from language has been the focus of debates in recent years. The traditional disembodied cognition posits that meaning can be extracted computationally and that there are similarities between computational algorithms and cognitive processing (Landauer, Mcnamara, & Dennis, 2014). Lakoff and Johnson (1980), taking a huge body of common metaphors in daily life as examples, claimed that cognition is embodied. The embodied cognition view emphasizes the importance of the simulation of sensory and motor experiences in metaphor comprehension (Basalou, 1999; Gibbs, 2006).

Over the past two decades, a growing body of psycholinguistic and neurolinguistic studies have set out to explore the relation between embodied simulation and predicative metaphor processing (e.g., Gibbs, 2006; Wilson & Gibbs, 2007; Gibbs & Matlock, 2008; Gibbs, 2013; Desai et al., 2011; Lauro, Mattavelli, Papagno, & Tettamanti, 2013). Gibbs (2006), by asking participants to perform or imagine performing a bodily action referred to in a statement that contained the related verb (e.g., doing a stamping motion before forming a mental image for the statement *stamp out a fear*), found that people's embodied simulation would affect their mental processing of predicative metaphorical phrases. Wilson and Gibbs (2007) further confirmed the validity of embodied simulation by asking participants to express their formed mental images when processing predicative metaphorical phrases. In Gibbs and Matlock (2008)'s study, the effects of embodied simulation on predicative metaphor comprehension were further examined under three experimental conditions, i.e., watching the performer doing the action referred to in a statement containing the related verb, watching the performer doing the action and then imitating the action, and watching the performer doing the action and then imagining performing the action. The results testified the previous findings that many predicative metaphors are understood through the embodied simulation. Neural studies indicate that areas of human brain associated with sensorimotor perception are activated in the process of both literal and figurative language comprehension. Lauro et al.'s (2013) fMRI study compared the comprehension of motion verbs used in four different ways, i.e., literal, fictive, metaphorical, and idiomatic, and found that figurative sentences produced more activation of a bilateral fronto-temporal network than literal ones, supporting the weak embodied views that the motor system enhances the comprehension of linguistically encoded actions. Using fMRI, Desai et al. (2011) compared the comprehension of sentences of varying degree of familiarity, i.e., literal (*e.g., The little girl grasped the flowers*), metaphorical (*e.g., The public grasped the idea*) and abstract (*e.g., The public understood the idea*). The results suggested the effect of familiarity of metaphor on the mode of processing used in comprehension, with embodied simulation becoming less detailed and the use of sensori-motor processing becoming more frequent as the familiarity increases.

2.2 Factors Affecting Metaphor Processing

In recent years, psycholinguistic studies have found that characteristics of metaphors, such as comprehensibility (Chiappe, Kennedy, & Chiappe, 2003), frequency of occurrence (Connine, Mullennix, & Shernoff, 1990; Thibodeau & Durgin, 2011) and familiarity (Blank, 1988; Blasko & Connie,1993; Blasko & Briihl, 1997; Schmidt, DeBuse, & Seger, 2007; Obert et al., 2018), can affect metaphor processing.

Comprehensibility

Comprehensibility is defined as "how readily it is to interpret an expression" (Chiappe et al., 2003: 52). Previous studies found that ease of comprehension might arise if the mappings between source domains and target domains are common in the daily life. For instance, the mappings between "ARGUMENT" and "WAR" and between "LIFE" and "JOURNEY"(Lakoff & Johnson, 1980) may cause ready interpretation. Gibbs (2006) found that comprehensibility might influence the speed of metaphor processing. Chiappe et al. (2003) also found that comprehensibility predicts preference for nominal metaphors or similes.

Frequency of occurrence

Over the past few years, there have been heated discussions among linguists in the field of second language acquisition on the role of frequency of occurrence. Thibodeau and Durgin (2011) found that conventionality and aptness of metaphorical sentences have a high correlation with frequency of occurrence and that the frequency can predict the processing speed of comprehension. Louwerse and Jeuniaux (2008) emphasized the vital role that frequency of co-occurrence plays in language processing in their Symbol Inter-dependency Theory, according to which language comprehension is both symbolic and embodied, meaning that embodied simulation mechanism and language processing mechanism work together during the processing of language. In other words, language comprehension can be achieved through either the association between symbols or the perceptual simulation,

depending on how frequent words appear together. For example, *chopstick* and *bowl* have strong word associations due to their high co-occurrence frequency, thus facilitating the use of the language processing mechanism. By contrast, for concepts with low co-occurrence frequency, for instance, *bridle* and *fury*, deep processing is required, thus facilitating the activation of the bodily experiences relevant to the event during the comprehension.

Recent studies have provided much evidence for the Symbol Inter-dependency Theory (Louwerse & Jeuniaux, 2008; Louwerse & Jeuniaux, 2010; Louwerse, 2011; Louwerse & Hutchinson, 2012). Louwerse and Jeuniaux (2008, 2010) found that in shallow conceptual processing tasks (lexical decision and iconicity judgment), language processing system plays a dominant role, indicating the symbolic nature of comprehension. However, in deep conceptual processing tasks (semantic judgment and semantic similarity judgment), relevant bodily experience has to be activated, thus allowing the perceptual simulation to play a dominant role in conceptual processing. Louwerse and Hutchinson (2012) also confirmed that areas of the human brain that control language processing are more likely to be triggered in the early stage of language processing, while those that are associated with perceptual simulation are more likely to be activated in the later stage.

Familiarity

Familiarity, the frequency of experience with an expression and its meaning or how well-known an expression seems to be (Blasko & Connine, 1993), is also found to be one of the major factors which may influence the processing of metaphors (e.g., Bowdle & Gentner, 2005; Desai et al., 2011; Cardillo, Watson, Schmidt, Kranjec, & Chatterjee, 2012; Obert et al., 2018). Some studies have shown that high-familiar metaphors are read and comprehended faster than low-familiar metaphors (e.g., Blank, 1988; Blasko & Connine, 1993; Blasko & Briihl, 1997; Brisard, Frisson, & Sandra, 2001; Caillies & Declercq, 2011; Columbus, Sheikh, & Côté-Lecaldare, 2015). Using a lexical naming task, Blank (1988) found that the processing time was comparable when the metaphors were highly familiar and conventional, but when the metaphors are novel, longer time was needed to complete the task. Blasko and Connie (1993), by adopting a cross-modal priming paradigm in four experiments, confirmed that in processing metaphors, and nominal metaphors in particular, the degree of understanding varies with the degree of metaphor familiarity and aptness. Blasko and Briihl (1997) further demonstrated, through an eye movement experiment and a recall test, that high-familiar metaphorical sentences are read more quickly than low-familiar ones. Further evidence came from Schmidt et al. (2007) and Cardillo et al. (2012), who found that there are different processing time advantages between left and right hemispheres and that high-familiar metaphorical sentences are read more quickly than low-familiar metaphorical sentences.

Although a considerable amount of evidence shows the effect of familiarity on predicative metaphor comprehension, no studies have been reported to have investigated its effect on L2 predicative metaphor comprehension, nor have taken other variables such as comprehensibility into consideration. In addition, by far, no particular investigation is reported regarding second language learners' cognitive mechanism of predicative metaphor processing. Therefore, this study, taking metaphor familiarity as an independent variable and ease of comprehension as a control variable, aims to explore whether embodied simulation (i.e., the psychological reality of embodied simulation) influences Chinese EFL learners' processing of predicative metaphors, and whether the degree of familiarity affects their processing of English predicative metaphors.

3. Method

3.1 Research Design

The experiment adopts a two-factor within-subjects design with two independent variables: the first one is the degree of familiarity with two levels, i.e., high-familiarity and low-familiarity; the second one is priming condition with three levels: (1) matching prime (MP), namely responding to a picture that matches the action of the verb of a metaphorical sentence; (2) mismatching prime (MMP), namely responding to a picture that does not match the action of the verb of a metaphorical sentence; and (3) no prime (NP), namely responding directly to a metaphorical sentence. It can be seen from the design that each participant had to undergo 6 different treatments.

3.2 Hypotheses

Based on the research findings reviewed in the previous sections, two hypotheses are formulated as follows:

Hypothesis 1: Participants will understand the target English predicative metaphors significantly faster under MP condition than under MMP condition or NP condition.

Hypothesis 2: Participants will understand high-familiar target English predicative metaphors faster than low-familiar target English predicative metaphors.

3.3 Participants

Ninety-one third-year undergraduates (mean age = 20.5, mean time of English learning = 12.6 years) from a university in southern China participated in the study. They all had passed the national Test for English Majors Band-4 (Note 1) (TEM4 hereafter) and their English proficiency showed no significant differences ($p > .05$).

Among them, 46 took either a familiarity rating test or a comprehensibility rating test. The purpose of these tests was twofold: (1) finding out how familiar and comprehensible the test items were to the participants, and (2) selecting 24 target metaphors for the main experiment. The rest of the participants (45) participated in the main experiment, in which they were asked to complete a metaphor semantic comprehension test with the aim to examine the cognitive mechanisms involved when processing English predicative metaphors and to investigate the effects of metaphor familiarity on English predicative metaphor processing.

3.4 Materials

Thirty-six predicative metaphorical phrases or sentences were chosen from earlier studies (Torreano et al., 2005; Gibbs, 2006; Wilson & Gibbs, 2007; Chen et al., 2008; Gibbs & Matlock, 2008; Ge & Zhao, 2010; Jamrozik, McQuire, Cardillo, & Chatterjee, 2016). The following measures were taken to ensure that the target metaphors had equal semantic difficulty and syntactic complexity. Firstly, most words in the test items came from the 8,000 words prescribed by TEM4; for the few not prescribed in TEM4, i.e., *unleash, hover, toss, gallop*, and *lumber*, Chinese equivalents were provided. Secondly, the target metaphors were kept similar in length. Finally, the sentence structures of the target metaphors were kept simple. They were: Subject + Verb, Subject + Verb + Object, and Subject + Verb + Preposition + Object.

Familiarity Rating Test Twenty third-year undergraduates who did not participate in the main experiment were given 20 minutes to rate 36 predicative metaphors on a 7-point scale ranging from 1 (very unfamiliar) to 7 (very familiar), based on how familiar the metaphors seem to them. The overall mean of these metaphors is 3.58 (SD = .755), ranging from 2.45 to 5.7. Eighteen of them were rated as low-familiar ($M = 3.0$, $SD = 0.3$), and the rest were rated as high-familiar ($M= 4.167$, $SD = 0.596$), with the ratings for the high- and low-familiar groups differ significantly, $p < 0.001$.

Comprehensibility Rating Test Another 26 third-year undergraduates who did not participate in the main experiment were asked to rate on a 7-point scale ranging from 1 (very easy to understand) to 7 (very difficult to understand) how easy it is to understand the 36 predicative metaphors. They were given 20 minutes to complete the test. The overall mean is 5.104 (SD = .453), ranging from 4.12 to 5.88, suggesting that all test items are highly comprehensible to these Chinese EFL learners.

Based on the results of the above two tests, 24 predicative metaphors ($M_{familiarity} = 3.654$, $SD_{familiarity} = 0.796$; $M_{comprehensibility} = 5.073$, $SD_{comprehensibility} = 0.46$) were selected as target metaphors for the main experiment. Among them 12 were high-familiar and high-comprehensible, and the other 12 were low-familiar but high-comprehensible (For details, see the Appendix). These metaphors were counter-balanced to generate 3 sets of experimental materials, with 4 high-familiar and 4 low-familiar in each set under each experimental condition, so that each target metaphor could only be encountered once. The participants ($N = 45$) were randomly assigned to one of the three sets of experimental materials.

Note that before the metaphor semantic comprehension test started, participants were asked to watch a 3-minute video which showed a woman performing, one by one, the actions of the 27 verbs in the 24 target metaphors and 3 practice metaphors. The performance of each action was synchronized with the presentation of a corresponding picture (cf. Wilson & Gibbs, 2007). To ensure there is no ambiguity or mismatching meaning of the actions with the pictures, another 8 EFL learners sharing similar academic background were invited to respectively read or watch the 27 pictures and the 27 actions and then to speak out what action in each picture or in the video stands for. If they yielded an irrelevant verb for any picture or action, another new picture or action would replace it until there is no ambiguity for them.

3.5 Procedures

The experiment was implemented in a quiet psychology lab and all the experimental materials were presented randomly on E-prime 2.0, a behavioural experiment software. The participants' task is to complete a semantic comprehension test of the 24 target metaphors.

Firstly, the participants tried to imitate the actions while watching the aforementioned video until they could perform the actions well, and then guessed what each action meant. After watching the video, the participants took a practice test to familiarize themselves with the procedures. The test had only 3 items. Each item was presented under one of the three experimental conditions, i.e., MP, MPP, and NP. Before the test began, they

were told that they would see a series of trials in one of the following conditions: (1) a picture with a matching action, (2) a picture with a mismatching action, and (3) a sentence with no accompanying picture. When a picture appeared with an action, be it matching or mismatching, the participants had to imagine themselves performing the corresponding action in accordance with what they had watched in the video before and then pressed the space bar. After that, a predicative metaphor would appear and they had to press the space bar as quickly as they understood its meaning. When only a sentence appeared, they had to press the space bar as soon as they understood its meaning. Once they gave a response (pressing the space bar), the predicative metaphor would disappear immediately and the next trial would begin within 3 seconds. To examine whether participants understood the target metaphors or not, a semantic matching task was assigned during the process of the comprehension test. Following Wilson and Gibbs (2007), 30 percent (i.e., eight) of the 24 target metaphors were randomly selected for the task, in which the participants needed to judge whether the coming two sentences had the same meaning or not (for instance, *They chewed on the idea* vs. *They thought over the idea)*, and the participants should press "J" when their answer was "Yes", or "F" when their answer was "No".

After making sure that the participants fully comprehended the requirements and procedure, the formal test started. The software automatically recorded the participants' RT and the accuracy rate to each predicative metaphor. The experimental procedures are diagrammatically summarized in Figure 1.

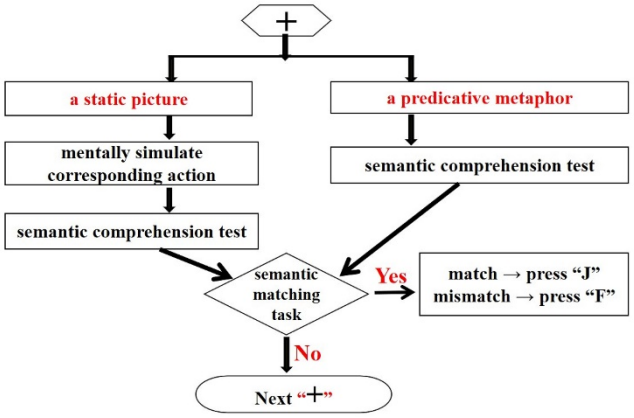

Figure 1. A Flowchart of the Experimental Procedures

4. Results

4.1 Overall Results

The two research questions of this study can be answered by measuring (a) participants' RTs under MP, MMP and NP and (b) participants' RTs under high- or low-familiarity conditions. Table 1 and Table 2 respectively present the descriptive statistics and Two-way ANOVA results for RTs (ms) of the 24 target metaphors.

Table 1. Descriptive Statistics of RTs (ms) of the 24 Target Metaphors

	Trials	Minimum	Maximum	Mean	St. Deviation
Total	948	492	15099	5038.78	2433.462
Valid N (listwise)	948				

Note. Valid N = Number of valid trials; RTs (ms) = Reaction Times (millisecond)

Table 2. Results of Two-way ANOVA for RTs (ms) of the 24 Target Metaphors

Factors	df	Mean Square	F	Sig.	η2
Familiarity (A)	1	47922586.87	46.514	.000	.503
Error (Familiarity)	43	1030290.89			
Priming Condition (B)	2	6208125.08	6.204	.003	.126
Error (Priming Condition)	86	1000713.77			
A×B	2	847049.987	.633	.533	.015
Error (A×B)	86				

As shown in the above tables, the mean RT for processing the 24 target metaphors is 5038.78 ms (SD = 2433.462 ms), ranging from 492 ms to 15099 ms. A two-way ANOVA reveals significant differences in main effect for familiarity (F = (1, 43) = 46.514, p = .000, and η^2= .503) and, in prime condition (F = (2, 86) = 6.204, p = .003, and η^2 = .126). However, there is no significant interactive effect on the degree of metaphor familiarity × prime condition: (F (2, 86) = .633, p= .533, η^2 = .015).

4.2 Results for Hypothesis 1

For Hypothesis 1 to be confirmed, the following empirical manifestations should be observed simultaneously: (a) the RTs under MP should be significantly shorter than under MMP, (b) the RTs under MP should be significantly shorter than under NP. Descriptive statistics as well pairwise comparison results are presented respectively in Table 3 and Table 4.

Table 3. Descriptive Statistics of RTs under MP, MMP and NP conditions

Prime Condition	Mean (ms)	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
MP	4945.22	184.337	4573.47	5316.97
MMP	5379.06	213.12	4949.24	5808.89
NP	4896.67	223.53	4445.88	5347.46

Note. MP = Matching Priming; MMP = Mismatching Priming; NP = No Priming

Table 4. Pairwise Comparisons of RTs under MP, MMP and NP conditions

(I) PC	(J) PC	Mean Difference(I-J) (ms)	Std. Error	sig. [a]	95% Confidence Interval for Difference [a]	
					Lower Bound	Upper Bound
1	2	-433.841*	150.715	.006	-737.786	-129.896
1	3	48.555	153.582	.753	-261.173	358.283
2	3	482.396*	148.081	.002	183.762	781.030

Note. PC = Prime Condition; 1 = Matching Priming; 2 = Mismatching Priming; 3 = No Priming; p < 0.05*.

As shown in Table 3, the mean RTs are 4945.22 ms under MP condition, 5379.06 ms under MMP condition, and 4896.67 ms under NP condition. Pairwise comparisons (Table 4) show that there is a significant difference between MP condition and MMP condition (p = .006), but the difference between MP condition and NP condition is not significant (p = .753). This suggests that, as predicted, the match between picture and action, when compared with the mismatch between the two, is more conducive to the understanding of relevant English predicative metaphors. However, contrary to the Hypothesis, the advantage of the match is not obvious when compared with the no priming condition. Hence Hypothesis 1 is only partially confirmed.

4.3 Results for Hypothesis 2

For Hypothesis 2 to be confirmed, the RT under high-familiar condition should be significantly shorter than that under low-familiar condition.

As can be seen in Table 2, the main effect of familiarity (F = (1, 43) = 46.514, p = .000, and η^2 = .503) is significant, indicating that 50.3% of the variances in the semantic comprehension test can be predicted by familiarity. Table 5 below presents the mean RTs and standard deviations (SDs) for metaphors with different degrees of familiarity.

Table 5. Descriptive Statistics of RT (ms) for High- and Low-familiar metaphors

Factors		N	Mean	Std. Deviation
Familiarity	Priming Condition		(ms)	(ms)
High	MP	45	4624.5530	1271.74597
(M = 4647.593)	MMP	45	4864.3182	1379.93673
	NP	45	4453.9072	1703.11405
Low	MP	45	5265.8902	1515.12306
(M = 5499.708)	MMP	45	5893.8068	1877.62361
	NP	45	5339.4261	1687.42342
Total	Valid N (listwise)	948	5038.78	2433.462

Note. MP = Matching Priming; MMP = Mismatching Priming; NP = No Priming; Valid N = Number of valid trials

As shown in the table, the mean RT for high-familiar metaphors (4647.593 ms) is shorter than that for low-familiar metaphors (5499.708 ms), indicating a general faster time when processing high-familiar English predicative metaphors. To be more specific, in the high-familiar condition, the RTs under MP (M = 4624.553 ms) are significantly faster than the MMP (M = 4864.3182 ms). However, in the low-familiar condition, the findings are slightly different. Both the RTs (MP < NP < MMP) under MP (M = 5265.8902 ms) and NP (M = 5339.4261 ms) are significantly faster than the MMP (M = 5893.8068 ms). Moreover, the RTs under MP are slightly faster than the RTs under NP. Taken together, the above results reveal that participants' processing time changes with the degree of metaphor familiarity. To find out whether the observed difference is significant, a Scheffe test was performed. The results are summarized in Table 6.

Table 6. Results of Scheffe test on RTs for High- and Low-familiar Metaphors

					95% Confidence Interval for difference [a]	
(I) familiarity	(J) familiarity	Mean difference (I-J)	Std. Error	Sig. [a]	Lower Bound	Upper Bound
1	2	-852.115*	124.942	.000	-1104.084	-600.146
2	1	852.115*	124.942	.000	600.146	1104.084

As the above table shows, the difference is significant ($p < .001$), indicating that the participants process English predicative metaphors much faster when the target metaphor is highly familiar to them. Thus, Hypothesis 2 is fully confirmed.

5. Discussion

5.1 The Psychological Reality of Embodied Simulation Mechanism

The results of the experiment demonstrate an advantage of MP condition on Chinese EFL learners' processing speed of English predicative metaphors: when the action of the picture corresponds to the action represented by the verb of the target metaphor, the comprehension of the target metaphor would be greatly facilitated. By contrast, if the action of the picture does not match the action represented by the verb of the target metaphor, processing speed would slow down. These findings are consistent with Gibbs (2006) and Wilson and Gibbs (2007), who also found that participants reacted much faster to the verb metaphorical phrases matching the preceding actions than to those which mismatched the earlier actions. Gibbs and Matlock (2008) also discovered that participants who performed or imagined performing an appropriate bodily action had a better comprehension of a metaphorical phrase which contains the action word.

On the other hand, beyond our prediction, the results of the RTs under MMP condition (M = 5379.06 ms) and under NP condition (M = 4896.67 ms) revealed a significant difference ($p = .002$) between them. One possibility is that as watching the preceding picture promoted the participants to think of the action of that picture (e.g., a chewing picture leads people to think of a chewing action), when the preceding picture did not match the verb of the predicative metaphor presented subsequently, it might slow down the participants' processing speed of the subsequently presented metaphorical sentence. However, if there were no pictures used to prime participants' bodily experience, they could process the target English predicative metaphors immediately they saw them. Therefore, participants did not need to think of any action, especially mismatching actions so that less time was spent.

In general, participants activate their embodied experience related to the specific pictures when processing target English predicative metaphors. If participants activate relevant embodied experiences, it will facilitate their processing of predicative metaphors; if participants activate irrelevant bodily simulation, inhibition may appear, which results in more processing time under MMP condition than under NP condition or MP condition. To conclude, the results between MP and NP are not consistent with our prediction, suggesting that Chinese EFL learners only make use of partial, not complete, embodied simulation when processing English predicative metaphors, corroborating the findings by Gibbs, Lima and Francuzo (2004), Gibbs (2006) and Gibbs (2013).

5.2 Other Processing Mechanisms Underlying Predicative Metaphor Comprehension

The results of pairwise comparisons of participants' RTs under MP condition and NP condition reveal no significant main effect between them ($p = 0.753$), namely, to present or not to present an associated action represented by a picture before presenting an English predicative metaphor makes no difference to participants. This suggests that participants do not always understand predicative metaphors by activating their relevant

embodied experience, and it is likely that other processing mechanisms are also at work during this process. These interesting findings are beyond our expectations but indicate some possible explanations.

For one thing, research results by Glucksberg and Keysar (1990, 2003) and Torreano et al. (2005) indicated that people understood predicative metaphors through a categorization-based mechanism. In other words, their comprehension of predicative metaphors is achieved by directly classifying the topic into an *ad hoc* of a category of action derived from the vehicles. According to Utsumi and Sakamoto (2007, 2011), indirect categorization is used to process predicative metaphors, i.e., due to the default of the source domain of a predicative metaphor, people cannot directly generate an *ad hoc* category but first generate an intermediate category.

For another thing, some studies both in behavioral and neural research on metaphor understanding have affirmed that metaphor comprehension is not completely based on embodied simulation but also relies on the language processing system or abstract lexical-semantic code (Louwerse & Jeuniaux, 2008, 2010; Desai et al, 2011; Louwerse & Hutchinson, 2012). The dual processing account proposes (Louwerse, 2011; Louwerse & Jeuniaux, 2010) that language comprehension is both embodied and symbolic, namely, both the embodied simulation mechanism and the language processing mechanism might be at work. Furthermore, the findings of the present study are consistent with the result by Desai et al.'s (2010) fMRI study, who also found that both sensorimotor system and language processing system in our brain areas are activated when processing predicative metaphors, concluding that not only embodied simulation but also language processing system play an important part in metaphoric language comprehension. Additionally, Cardillo et al. (2012) also manifest peoples' activated brain areas involving a multi-brain region both on the right and left brains when they are comprehending metaphorical sentences, inferring that perhaps the language processing mechanism works together with the embodied simulation mechanism to process metaphorical language.

To summarize, based on the above discussions, the embodied simulation mechanism does make a big difference when Chinese EFL learners are comprehending English predicative metaphors. However, it is very likely that another mechanism, like the language processing mechanism, is also at work at the same time. More interestingly, metaphor familiarity seems to play a critical role in processing English predicative metaphors, to be delineated in the following section.

5.3 The Effect of Metaphor Familiarity on Processing Predicative Metaphors

To examine the effect of metaphor familiarity on Chinese EFL learners' processing of English predicative metaphors, our prediction is that participants are significantly faster to comprehend high-familiar predicative metaphors than low-familiarity ones. The ANOVA results revealed that the main effect of high- and low-familiarity is significant ($p < .001$; $M_{\text{high-familiarity}} = 4647.593$ milliseconds; $M_{\text{low-familiarity}} = 5499.708$ ms), suggesting that the learners spend less time processing English predicative metaphors when target metaphors are more familiar to them than when less familiar, confirming the effects of familiarity on English predicative metaphor processing. This finding is in good agreement with the results of many other past studies that demonstrate novel metaphors need extra processing time, compared with high-familiar metaphors. According to Brisard et al. (2001), Columbus et al. (2015) and Obert et al. (2018), unfamiliar nominal or verbal predicative metaphors need additional processing time than conventional or literal expressions.

For the high-familiar metaphors, participants' RTs are the fastest under NP, followed by MP, and their RTs are the lowest under MMP. Evidence also shows facilitative effect of comprehension under MP and inhibitive effect of comprehension under MMP. Specifically, the RTs of MP are faster than that of MMP, showing that for high-familiar metaphors, preceding corresponding pictures can promote the understanding of predicative metaphors, while preceding mismatching pictures can slow down the processing speed. However, the RTs of NP are less than MP, indicating that participants do not always trigger their bodily experience when processing high-familiar English predicative metaphors. As analyzed above, it is very likely that the language processing mechanism is working when Chinese EFL learners understand familiar predicative metaphors.

For low-familiar metaphors, the RTs under MP are faster than both under MMP and NP, revealing that learners are faster to comprehend the target metaphors when they first imagined doing a corresponding physical movement than when they first did a mismatching physical action or no bodily action. What is more, for low-familiar metaphors, learners' RTs under MP are shorter than those under MMP and NP, showing obvious facilitation when processing unfamiliar predicative metaphors under MP. According to the Symbol Inter-dependency Theory, when the degree of frequency, or in some sense, familiarity is low, people will automatically activate their corresponding embodied experience relating to that concept to enhance their comprehension, i.e., the embodied simulation mechanism thus plays a leading role now. Therefore, the Symbol Inter-dependency Theory seems to offer a reasonable explanation for our findings. As predicted, Chinese EFL

learners' processing of English predicative metaphors varies with the changes in the degree of metaphor familiarity.

To sum up, Chinese EFL learners do make use of the embodied simulation mechanism to process English predicative metaphors, but owing to the difference of metaphor familiarity, they only make partial use of it. They make use of the embodied simulation mechanism to process unfamiliar English predicative metaphors but employ the language processing mechanism to understand familiar ones.

5.4. General Discussion

With regard to the cognitive mechanisms of English predicative metaphor processing, it is found that Chinese EFL learners make use of partial embodied simulation when they process English predicative metaphors. On the one hand, the results of the RTs under MP and MMP conditions suggest that Chinese EFL learners' real or imagined acting out of verbs facilitates learners' processing of English predicative metaphors, which has a close relation to their embodied experiences. Furthermore, the results of the RTs under MMP and NP show that irrelevant bodily movements may impede L2 learners' processing of English predicative metaphors. On the other hand, although Chinese EFL learners do activate their embodied experiences to process English predicative metaphors, they do not always do so. Psycholinguistic factors, specifically, familiarity decides the processing mechanism involved.

In terms of the effect of metaphor familiarity on processing English predicative metaphors, low-familiar predicative metaphors require additional processing time, compared with high-familiar predicative metaphors. In addition, the degree of familiarity influences what processing mechanism Chinese EFL learners employ to understand English predicative metaphors. To be more specific, for high-familiar metaphors, Chinese EFL learners comprehend predicative metaphors faster under NP than under MP, indicating that they do not trigger their embodied experiences but comprehend predicative metaphors directly through the language processing mechanism. However, for low-familiar metaphors, they process metaphors faster under MP than both under MMP and NP, demonstrating that their embodied experience relating to the specific concept is automatically activated when the language processing system fails to meet the processing needs, hence, the embodied simulation mechanism is thus at work at this moment.

In conclusion, this study found that Chinese EFL learners may employ both the embodied simulation mechanism and the language processing mechanism to process English predicative metaphors depending on the degree of metaphor familiarity. To be more specific, Chinese EFL learners activate the use of embodied simulation mechanism when it comes to the processing of unfamiliar predicative metaphors, but its use appears to give way to the language processing mechanism when the metaphor is highly familiar.

6. Pedagogical Implications

Illuminated by the work of Lakoff and Johnson, applied linguists have come to recognize the ubiquity of metaphor in language and its significance in L2 learning and teaching (Danesi, 1986; Low, 1988; Kecskes, 2000; Littlemore & Low, 2006), advocating that metaphor should be given an important place in L2 teaching and that L2 learners' metaphoric competence should form an integral part of advanced language proficiency. The findings of this study shed some light on cultivation of L2 learners' metaphoric competence.

In terms of classroom procedure, the teacher could design different types of cognitive tasks (e.g., shallow and deep processing tasks) and make use of different stimuli (e.g., linguistic stimulus and picture stimulus) to aid L2 learners in comprehending and memorizing predicative metaphors. As embodied simulation was found an important strategy that L2 learners adopted to process English predicative metaphors (Su & Chen, 2020), it is suggested that teachers design activities practicing the use of this strategy. This could be done through a metaphor interpretation task in which the teacher guides the learners to report their thought process of understanding, raising their awareness of the interpretation process and, encouraging them to perform or imagine other people performing the action of the verb. For instance, when understanding *She bridled her fury*, the teacher could show learners a picture of a horse in bridle or guide them to imagine themselves or others putting a bridle on a horse.

In terms of learning materials, the teacher is suggested to expose L2 learners to predicative metaphors used in different contexts such as academic or literary works, or in daily communication. As Lakoff and Turner (1989) discovered, metaphors that are conventional to native speakers may seem novel to L2 learners as they are unfamiliar with them, hence would engage more of their cognitive resources. Therefore, adequate contact with metaphoric language is not only necessary but also important. It is advised that the teacher draw learners' attention to the metaphors in use and give necessary explanation and practice so as to raise their metaphoric

awareness. Hopefully, in the long run, this accumulation of metaphoric awareness might contribute to their metaphoric competence as well as their overall language proficiency.

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References

Barsalou, L. W. (1999). Perceptions of perceptual symbols. *Behavioral & Brain Sciences, 22*(4), 637-660. https://doi.org/10.1017/S0140525X99002149

Blank, G. D. (1988). Metaphors in the lexicon. *Metaphor and Symbolic Activity, 3*(1), 21-36. https://doi.org/10.1207/s15327868ms0301_2

Blasko, D. G., & Briihl, D. S. (1997). Reading and recall of metaphorical sentences: Effects of familiarity and context. *Metaphor & Symbol, 12*(4), 261-285. https://doi.org/10.1207/s15327868ms1204_4

Blasko, D. G., & Connine, C. M. (1993). Effects of familiarity and aptness on metaphor processing. *Journal of Experimental Psychology Learning Memory & Cognition, 19*(2), 295-308. https://doi.org/10.1037/0278-7393.19.2.295

Bowdle, B. F., & Gentner, D. (2005). The career of metaphor. *Psychological Review, 112*(1), 193-216. https://doi.org/10.1037/0033-295X.112.1.193

Brisard, F., Frisson, S., & Sandra, D. (2001). Processing unfamiliar metaphors in a self-paced reading task. *Metaphor and Symbol, 16*(1), 87-108. https://doi.org/10.1080/10926488.2001.9678888

Caillies, S., & Declercq, C. (2011). Kill the song-steal the show: What does distinguish predicative metaphors from decomposable idioms? *Journal of Psycholinguistic Research, 40*(3), 205-223. https://doi.org/10.1007/s10936-010-9165-8

Cameron, L. (2003). *Metaphor in Education Discourse*. London: Continuum.

Cardillo, E. R., Watson, C. E., Schmidt, G. L., Kranjec, A., & Chatterjee, A. (2012). From novel to familiar: Tuning the brain for metaphors. *NeuroImage, 59*, 3212-3221. https://doi.org/10.1016/j.neuroimage.2011.11.079

Chen, E., Widick, P., & Chatterjee, A. (2008). Functional-anatomical organization of predicate metaphor processing. *Brain & Language, 107*(3), 194-202. https://doi.org/10.1016/j.bandl.2008.06.007

Chiappe, D., Kennedy, J. M., & Chiappe, P. (2003). Aptness is more important than comprehensibility in predicting recognition bias and preference for metaphors and similes. *Poetics, 31*(1), 51-68. https://doi.org/10.1016/S0304-422X(03)00003-2

Columbus, G., Sheikh, N. A., & Côté-Lecaldare, M. (2015). Individual differences in executive control relate to metaphor processing: an eye movement study of sentence reading. *Frontiers in Human Neuroscience, 8*, 1057. https://doi.org/10.3389/fnhum.2014.01057

Connine, C. M., Mullennix. J., & Shernoff, E. (1990). Word familiarity and frequency in visual and auditory word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*(6), 1084-1096. https://doi.org/10.1037/0278-7393.16.6.1084

Danesi, M. (1986). Le coordinate neurologiche dell' apprendimento linguistico: osservazioni psi-copedagogiche. In: M. De Lellis (ed.), *Atti del Convegno "Il codice della mente"*, 1-24. L'Aquila: Sigma-Tau.

Desai, R. H., Binder, J. R., & Conant, L. L. (2010). Activation of sensory-motor areas in sentence comprehension. *Cerebral Cortex, 20*(2), 468-478. https://doi.org/10.1093/cercor/bhp115

Desai, R. H., Binder, J. R., & Conant, L. L. (2011). The neural career of sensory-motor metaphors. *Cogn Neurosci, 23*(9), 2376-2386. https://doi.org/10.1162/jocn.2010.21596

Ge, J. M., & Zhao, F. F. (2010). On Conceptual metaphors of motion verbs and their mechanism. *Foreign Language Research, 154*(3), 43-46.

Gibbs, R. W. (2006). Metaphor interpretation as embodied simulation. *Mind and Language, 21*(3), 434-458. https://doi.org/10.1111/j.1468-0017.2006.00285.x

Gibbs, R. W. (2013). Walking the walk while thinking about the talk: Embodied interpretation of metaphorical

narratives. *Journal of Psycholinguistic Research, 42*(4), 363-378. https://doi.org/10.1007/s10936-012-9222-6

Gibbs, R. W., & Matlock, T. (2008). Metaphor, imagination, and simulation: Psycho-linguistic evidence. In R. W. Gibbs (Ed.), *The Cambridge Handbook of Metaphor and Thought* (pp. 161-176). Cambridge: CUP. https://doi.org/10.1017/CBO9780511816802.011

Gibbs, R. W., Lima, P. L. C., & Francozo, E. (2004). Metaphor is grounded in embodied experience. *Journal of Pragmatics, 36*(7), 1189-1210. https://doi.org/10.1016/j.pragma.2003.10.009

Glucksberg, S. (2003). The Psycholinguistics of metaphor. *Trends in Cognitive Sciences, 7*(2), 92-96. https://doi.org/10.1016/S1364-6613(02)00040-2

Glucksberg, S., & Keysar, B. (1990). Understanding metaphoric comparisons: Beyond similarity. *Psychological Review, 97*(1), 3-18. https://doi.org/10.1037/0033-295X.97.1.3

Jamrozik, A., McQuire, M., Cardillo, E. R., & Chatterjee, A. (2016). Metaphor: Bridging embodiment to abstraction. *Psychonomic Bulletin & Review, 23*(4), 1080-1089. https://doi.org/10.3758/s13423-015-0861-0

Kecskes, I. (2000). Conceptual fluency and the use of situation-bound utterances in L2. *Links & Letters, 7*, 145-161.

Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By*. Chicago, IL: University of Chicago Publisher.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought*. New York, NY: Basic Books.

Lakoff, G., & Turner. (1989). M. *More than cool reason: A field guide to poetic metaphor* [M]. Chicago: The University of Chicago Press. https://doi.org/10.7208/chicago/9780226470986.001.0001

Landauer, T. K., Mcnamara, D. S., & Dennis, S. (2014). Handbook of latent semantic analysis. *Wiley Interdisciplinary Reviews Cognitive Science, 4*(6), 683-692. https://doi.org/10.1002/wcs.1254

Lauro, L. J. R., Mattavelli, G., Papagno, C, & Tettamanti, M. (2013). She runs, the road runs, my mind runs, bad blood runs between us: Literal and figurative motion verbs: An fMRI study. *Neuroimage, 83*, 361-371. https://doi.org/10.1016/j.neuroimage.2013.06.050

Littlemore, J., & Low, G. (2006). *Figurative thinking in foreign language learning*. New York, NY: Pilgrave McMillan. https://doi.org/10.1057/9780230627567

Louwerse, M. (2011). Symbol interdependency in symbolic and embodied cognition. *Topics in Cognitive Science, 3*(2), 273-302. https://doi.org/10.1111/j.1756-8765.2010.01106.x

Louwerse, M., & Hutchinson, S. (2012). Neurological evidence linguistic processes precede perceptual simulation in conceptual processing. *Frontiers in Psychology, 3*, 385. https://doi.org/10.3389/fpsyg.2012.00385

Louwerse, M., & Jeuniaux, P. (2008). Language comprehension is both symbolic and embodied. In M. de Vega, A. Glenberg, & A. C. Graesser (Eds.), *Symbols, embodiment, and meaning* (pp. 309-326). Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199217274.003.0015

Louwerse, M., & Jeuniaux, P. (2010). The linguistic and embodied nature of conceptual processing. *Cognition, 114*(1), 96-104. https://doi.org/10.1016/j.cognition.2009.09.002

Low, G. D. (1988). On teaching metaphor. *Applied Linguistics, 9*(2), 125-147. https://doi.org/10.1093/applin/9.2.125

Noble, C. E., & Clyde, E. (1954). The familiarity-frequency relationship. *Journal of Experimental Psychology, 47*(1), 13. https://doi.org/10.1037/h0060025

Obert, A., Gierski, F., & Caillies, S. (2018). He catapulted his words from the dais: An ERP investigation of novel verbal metaphors. *Journal of Neurolinguistics, 47*, 59-70. https://doi.org/10.1016/j.jneuroling.2018.02.008

Obert, A., Gierski, F., Calmus, A., Portefaix, C., Declercq, C., Pierot, L., & Caillies, S. (2014). Differential bilateral involvement of the parietal gyrus during predicative metaphor processing: An auditory fMRI study. *Brain and language, 137*, 112-119. https://doi.org/10.1016/j.bandl.2014.08.002

Schmidt, G. L., DeBuse, C. J., & Seger, C. A. (2007). Right hemisphere metaphor processing? Characterizing the lateralization of semantic processes. *Brain & language, 100*(2), 127-141.

https://doi.org/10.1016/j.bandl.2005.03.002

Stamenković, D., Ichien, N. T., & Holyoak, K. J. (2019). Metaphor comprehension: An individual-differences approach. *Journal of Memory and Language, 105*, 108-118. https://doi.org/10.1016/j.jml.2018.12.003

Su, Y. L. (2017). A review of multi-disciplinary studies on predicative metaphor. *Modern Foreign Languages, 40*(5), 705-714.

Su, Y. L, Chen, H. Y. (2020). Strategies involved in Chinese L2 learners' comprehension of English predicative metaphors. *Foreign Language Education and Research, 8*(2), 36-44.

Thibodeau, P. H., & Durgin, F. H. (2011). Metaphor aptness and conventionality: A processing fluency account. *Metaphor & Symbol, 26*(3), 206-226. https://doi.org/10.1080/10926488.2011.583196

Torreano, L. A., Cacciari, C., & Glucksberg, S. (2005). When dogs can fly: Level of abstraction as a cue to metaphorical use of verbs. *Metaphor & Symbol, 20*(4), 259-274. https://doi.org/10.1207/s15327868ms2004_2

Utsumi, A., & Sakamoto, M. (2007). Predicative metaphors are understood as two-stage categorization: Computational evidence by latent semantic analysis. *Proceedings of the Annual Meeting of the Cognitive Science Society, 29*, 1587-1592.

Utsumi, A., & Sakamoto, M. (2011). Indirect categorization as a process of predicative metaphor comprehension. *Metaphor & Symbol, 26*(4), 299-313. https://doi.org/10.1080/10926488.2011.609120

Wilson, N. L., & Gibbs, R. W. (2007). Real and imagined body movement primes metaphor comprehension. *Cognitive Science, 31*(4), 721-731. https://doi.org/10.1080/15326900701399962

Note

Note 1. This is a national test designed for English majors who have completed their first two years of study.

Appendix

24 Target Metaphors with Familiarity and Comprehensibility Ratings

Number	Target metaphors	Familiarity rating (M)	Comprehensibility rating (M)
		3.654	Mean = 5.073
1	*John stamped out his fear.*	2.45	5.15
2	*She elbowed her way into the upper class.*	2.65	4.73
3	*The speaker stirred up the crowd.*	2.85	4.46
4	*The politician dragged out the speech.*	2.9	4.69
5	*The light danced on the wall.*	2.95	5.04
6	*He put his finger on the truth.*	3	4.85
7	*The lawyer wrapped up the case.*	3.05	4.12
8	*They pushed the argument.*	3.2	4.46
9	*Their despair crawled up to a peak.*	3.25	4.77
10	*The merchant drove up the price.*	3.3	5.19
11	*They unleashed（解开）her worries.*	3.4	5.73
12	*He tossed（投掷）out a plan.*	3.45	5.58
13	*The woman walked out on her marriage.*	3.55	5.46
14	*The boy fell for the trick.*	3.6	4.77
15	*He coughed up a secret.*	3.7	4.62
16	*The girl ate up the story.*	3.85	5.19
17	*They chewed on the idea.*	4.05	5.77
18	*The reporter spit out the facts.*	4.1	5.54
19	*The woman jumped at the chance.*	4.15	4.73
20	*They stretched for further understanding.*	4.3	5.12
21	*He shook off a feeling of fear.*	4.45	5.31
22	*John exploded with anger.*	4.85	5.85
23	*The public grasped the concept.*	4.95	5.15
24	*He covered up the truth.*	5.7	5.46