Mental Simulation in Processing Mandarin Fictive Motion Sentences

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Abstract

The study aimed to determine whether people mentally simulate movement when they process fictive motion sentences in Mandarin Chinese (e.g., 小徑走入森林 xiǎo jīng zǒu rù sēn lín "A trail goes into the forest"), which literally involve no movement in space but are implicitly entailed conceptually. We designed a drawing task in which the participants read fictive motion sentences and non-fictive motion sentences in Mandarin Chinese, and then drew what was depicted in the sentences. Three participants who did not take part in the drawing task judged the length of the trajectories in the drawings according to their own perceptions. The experimental results showed that the trajectories depicted for the fictive motion sentences were judged to be significantly longer than those for the non-fictive motion sentences. The findings of our study suggest that even though there is no explicit movement involved in the meaning of fictive motion in Mandarin, people automatically simulate movement and its trajectory. This study has practical implications for computational linguistics in analyzing subtle semantic meanings among motion verbs in Mandarin Chinese.

Keywords

Cognitive linguistics, psycholinguistics, rating scores, motion verbs, a drawing task

1. Introduction

Motion verbs often express an object that is capable of executing a movement in the physical world. For example, in the sentence "A train goes through a tunnel", the noun in the subject position, "train", is capable of moving through space. However, motion verbs in

particular contexts are not interpreted literally; that is, the meanings of these motion verbs display no perceivable physical movement. For example, in the sentences "The railway goes through the tunnel" and "We are entering the holiday", the verbs "goes" and "enter" do not literally refer to any physical movement occurring in the speaking situation since the noun "railway" is not capable of executing movement in physical space. Indeed, the motion verb "goes" indicates the static and spatial state between the railway and the tunnel. In addition, the motion verb "enter" in the other sentence is metaphorically used to describe the abstract concept of TIME and refers to how people perceive the concept of "time" via mapping it to something moveable in space. Indeed, the two types of motion expressions are called "fictive motion" sentences, which refer to the metaphorical motion of an object or abstract concept through space. In this study, we focused on the first type of motion verb sentences (e.g., "The railway goes through the tunnel"), in which the motion verb is applied to a concrete object that is not capable of moving in the physical world. However, most people perceive this sentence as an implicit movement in space. To figure out whether people generate dynamic imagery of movement in processing fictive motion sentences, we conducted an experiment featuring a drawing task. The participants were instructed to read fictive motion (FM) and non-fictive motion (non-FM) sentences in Mandarin Chinese and depict the meanings of these sentences through drawings. The length of the trajectories of the verbs in the fictive and non-fictive motion sentences were then compared.

2. Background

2.1. Motion Verbs

Motion verbs in English such as "go" (or in Mandarin Chinese 走 zǒu "go") are pervasive in all languages. Motion can be perceived as the most fundamental of human activities. Thus, motion verbs exist in all languages and show similar patterns of semantic extension cross-linguistically (Blomberg, 2014; Blomberg and Zlatev, 2014, 2015a, 2015b; Lakoff, 1987; Langacker, 1990; Talmy, 2000; Slobin, 2004; Ungerer and Schmid, 2006). When a motion verb is used literally, it describes how a physical entity moves from one place in space to another place, for example, the sentence "The boy drives from school to home", which means that the subject, "the boy", starts driving at the school and passes through other places before reaching his destination, "home". When a motion verb is used non-literally, the meaning has nothing to do with physical motion. For example, in the sentence "The day is coming", there is no movement of "coming" that occurs in space. Motion verbs can be extended to conceptual metaphors, which enable one to understand a relatively abstract concept via mapping to a relatively concrete one (Talmy, 1996).

Other types of motion verbs can also be used in expressions in which no real physical

movement occurs but implicitly refers to the trajectory of motion verbs (Rojo and Valenzuela, 2003). This is exemplified in (1) and (2) below:

(1) The boy climbed to the top of the mountain.
(2) The path climbed to the top of the mountain.

In sentence (1), the noun in the subject position, "boy", physically moves, changing his location from ground level to the mountaintop, which is the literal meaning of the motion verb "climb". However, in sentence (2), the noun in the subject position, "path", does not move in space. In contrast, sentence (2) evokes the listener to perceive a scene in which the path is observed in a given direction, from ground level up to the top of the mountain. This type of motion has been categorized as fictive motion, or abstract motion/subjective motion (Rojo and Valenzuela, 2003).

2.2. Fictive Motion

According to Talmy's (2000) definitions, fictive motion is considered analogous in some respects to real motion. One example is to "go" or "move" from one imagined point in space to another. Fictive motion is also believed to provide language users with a way to figure out information about the layout of the scene, especially the configuration of the trajectories and their positions relative to other entities (Matsumoto, 1996; Talmy, 2000). Thus, fictive motion refers to figurative representations of motion, which includes inhuman or immobile material objects, states, or abstract notions. In addition, the meanings of fictive motion verbs are semantically extended to express relations that do not involve changes of state in motion (Blomberg, 2014; Blomberg and Zlatev, 2014, 2015a, 2015b; Langacker, 2005, 2008; Metlock 2004a, 2004b, 2010; Talmy, 2000; Stosic, Fagard, Sarda and Colin, 2015; Wong and Frost, 1978; Ungerer and Schmid, 2006).

2.3.1. Empirical Evidence of Dynamic Simulation for Fictive Motion

Is there any evidence to support the concept that fictive motion can evoke mental imagery even though it does not literally refer to dynamic movement in space? Past studies have shown that participants simulated trajectories in processing fictive motion sentences in reading tasks (Matlock and Richardson, 2004), eye-tracking tasks (Richardson and Matlock, 2007), and drawing tasks (Matlock, 2006).

In particular, Matlock (2006) examined a series of cognitive behavioral experiments to look at the comprehension and performance of fictive and non-fictive motion sentences. Matlock discussed the relationship between fictive motion and mental simulation and

conducted experiments using free-style drawing tasks to investigate how trajectories are expressed in depictions of FM sentences and non-FM sentences. The experimental results revealed that the depictions of trajectories were longer for FM sentences than for non-FM sentences. For example, when the participants were instructed to draw the sentence "The birthmark runs between her knee and her ankle", the noun in the subject position, "birthmark", was drawn longer than the "birthmark" in the sentence "The birthmark is between her knee and her ankle". This drawing study suggests that the participants elongated the item "birthmark" in their drawings because they mentally pictured the birthmark as beginning at the knee and going down to the ankle during the processing of the sentence involving the fictive motion verb, "The birthmark runs between her knee and her ankle", compared with the non-fictive motion sentence "The birthmark is between her knee and her ankle".

Furthermore, Matlock (2006) discussed another factor—the speed rate of fictive motion verbs, including slow, fast, and neutral verbs—to see whether it influenced how trajectories would be depicted. In that study, the participants used arrows to represent the dynamic state of fictive motion verbs. For example, the sentence "The road jets from one vista point to another" referred to a fast travel rate; on the other hand, the sentence "The road crawls from one vista point to another" referred to a slow travel rate. The participants were asked to draw an arrow to express the trajectory that they thought the sentence represented. The experimental results showed that the arrows that depicted trajectories for fast motion verbs (e.g., "jet" and "race") were longer, thinner, and less crooked than the arrows that depicted trajectories for slow motion verbs (e.g., "crawl" and "creep"). Therefore, Matlock (2006) concluded that the participants mentally simulated motion or attached motion information to motion verbs when they thought about and formed an image for fictive motion sentences—fast fictive motion verbs caused them to simulate movement quickly and slow fictive motion verbs caused them to simulate movement slowly. These drawings showed the conceptual differences between different types of fictive motion verbs.

2.3.2. Limitations of Past Studies

Much research in English has supported the hypothesis that fictive motion evokes mental simulation during the processing of literal and fictive motion verbs (Matlock, 2006; Matlock and Richardson, 2004; Richardson and Matlock, 2007). However, only a few studies have focused on how fictive motion and movement verbs in Mandarin Chinese phrases are psychologically perceived. In particular, many past studies only discussed the syntactic or semantic structures of motion verbs in Mandarin Chinese, but little research has

determined whether mental simulation occurs in processing fictive motion sentences. Therefore, the current study investigated how people depict Chinese fictive motion sentences that implicitly involve dynamic movement in space to see whether the trajectories of the objects in the fictive motion sentences would be perceived as longer than the ones for the non-fictive motion sentences.

3. Method: A Drawing Task

A drawing task was designed to explore how fictive motion verbs are interpreted and to determine whether the trajectories of the imagined movements are simulated in processing fictive motion sentences in Mandarin Chinese. In the experiment, the participants were instructed to read FM verb sentences and non-FM verb sentences in Mandarin Chinese, and then draw the meanings of these sentences. The pictures drawn by the participants were evaluated by three judges to determine whether the trajectory of an object for an FM sentence was longer than one for a non-FM sentence.

According to the cognitive linguistic theory (Talmy, 2000), we predicted that the trajectories of the FM sentences would be conceptualized differently from the non-FM sentences. To be more specific, compared to the non-FM sentences, we expected that the trajectories of the FM sentences would be longer than the ones of the non-FM sentences.

3.1. Participants

We recruited 27 participants to take part in the drawing task. The mean age of the participants was 22.26 years old (SD = 1.732). They were all native speakers of Mandarin Chinese and Taiwanese, and their education background was college level.

3.2. Materials and Design

We created 12 motion sentences in Mandarin (i.e., six pairs of two sentences), including six FM sentences and six non-FM ones (see Table 1). For example, the sentence 彩虹跨越天空 cǎi hóng kuà yuè tiān kōng “A rainbow crosses the sky” was created as a fictive motion sentence, which did not involve any physical movement by the noun in the subject position, “rainbow”, in space. In contract, the sentence 彩虹在天空 cǎi hóng zài tiān kōng “A rainbow is in the sky” did not include a motion verb in the sentence. Instead, the predicate verb 在 zài was used to connect the noun in the subject position (e.g., 彩虹 cǎi hóng “rainbow”) and the location (e.g., 天空 tiān kōng “sky”), referring to something that exists in space. The complete list of twelve stimuli is shown in Appendix 1.

No.	**Experimental Stimuli**		
	Categories	***Motion Sentences in Mandarin Chinese***	***Translations***
1	Fictive Motion	彩虹跨越天空	*căi hóng kuà yuè tiān kōng* "A rainbow crosses the sky."
	Non-fictive Motion	彩虹在天空	*căi hóng zài tiān kōng* "A rainbow is in the sky."
2	Fictive Motion	鐵道走進鄉村	*tiě dào zǒu jìn xiāng cūn* "The railway goes into the countryside."
	Non-fictive Motion	鐵道在鄉村	tiě dào zài xiāng cūn "The railway is in the countryside."

Table 1: Sample experimental stimuli

Each fictive motion sentence contained one of six motion verbs (i.e., 爬上 pá shàng "climb up", 跨越 kuà yuè "cross through", 走入 zǒu rù "cross through", 通過 tōng guò "through/pass", 進入 jìn rù "enter into", and 走進 zǒu jìn "go/walk into"). In addition, the nouns in the subject position (e.g., 彩虹 căi hóng "rainbow" and 小徑 xiǎo jīng "trail") in the FM sentences and the non-FM sentences represented objects that were not capable of moving in space.

A pretest was conducted to ensure that the FM sentences were semantically similar to their counterparts, the non-FM sentences, in each of the pairs. Ten college-level students evaluated the similarity level of each pair of sentences. The participants were instructed to read a pair of sentences and judge whether their meanings were similar. If they thought that they were semantically similar, they answered YES; if they thought that they were semantically different, they answered NO. The results of the pretest showed that the six pairs of sentences acquired 90% agreement in answering YES, indicating that the meanings of the FM sentences were semantically similar to their counterparts, the non-FM sentences.

3.3. Procedure

The drawing task was divided into two parts. Each participant read three FM sentences and three non-FM sentences and produced the corresponding drawings in the first phase, and then repeated the same procedure with another three FM sentences and three non-FM sentences in the second phase, for a total of 12 sentences. The interval between the two drawing phases was one week. Each phase was 30 minutes in duration. The participants

were instructed to read each sentence carefully, and then quickly sketch the meaning of the sentences on a blank piece of paper.

3.4. Data Analysis

The drawing task was followed by a picture judgment task. Three participants who did not take part in the drawing task participated in the judgment task. The mean age of these three participants was 26 years old (SD = 1.732). They were all native speakers of Chinese and Taiwanese, and their education background was college level.

In the evaluation task, the three judges were instructed to determine the trajectories of the objects in the pictures. If they thought that the trajectory was long, they answered YES; if they thought that it was not long, they answered NO.

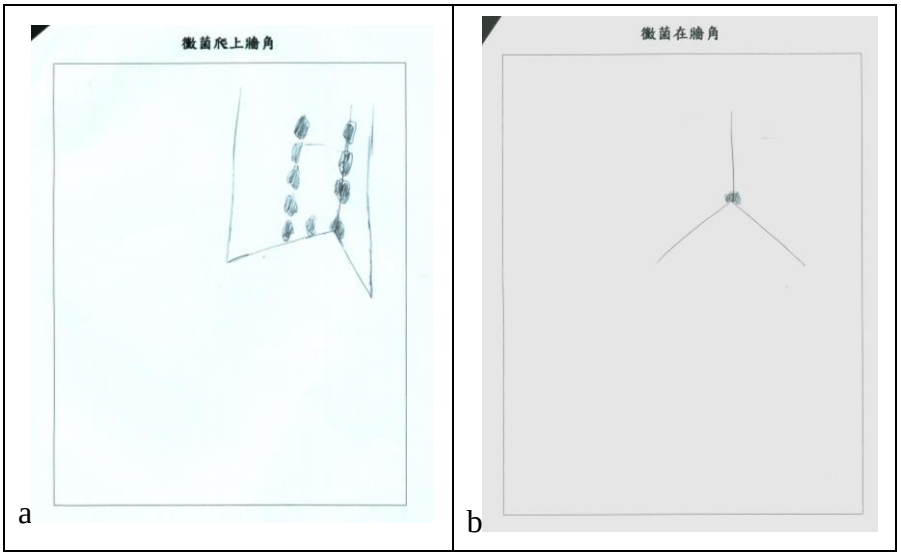

Figure 1: Two sample drawings classifying the trajectory as long in (a) and not long in (b)

For example, in the drawing for the sentence 黴菌爬上牆角 méi jūn pá shàng qiáng jiǎo "Mold climbed up the corner" (Figure 1a), one of the judges evaluated that the noun "mold" was likely to move up from the bottom of the corner. Therefore, the evaluation of this picture by this judge was YES, which means that the trajectory was lengthened in space. On the other hand, the drawing for the sentence 黴菌在牆角 méi jūn zài qiáng jiǎo "Mold is in the corner" (Figure 1b), the noun 黴菌 méi jūn "mold" was likened to a spot in the corner. The judges did not evaluate that the mold formed a trajectory and thus their judgment was NO, which indicates that the trajectory was not lengthened in space.

Based on the judges' decisions, if the trajectories in the drawings were deemed long,

they earned 1 point each; if the trajectories were deemed not long, 0 points was given for each. After computing the total number of points, we calculated the averages of the two types of sentences and conducted statistical tests.

4. Results and Discussion

Table 2 below shows the mean scores of the trajectories of the FM sentences and the non-FM sentences:

	Fictive Motion Sentences	Non-fictive Motion Sentences
Mean scores	0.74	0.35

Table 2: Mean scores of the fictive motion sentences and the non-fictive motion sentences in the judgment task

Two t-test analyses of the data from individual participants and items were performed for the rating scores. The statistical tests showed that a significant difference was found both in rating scores for the participants analysis ($t(26) = -10.843$, $p < .05$) and for the item analysis ($t(5) = -10.138$, $p < .05$.). The rating scores demonstrated that the trajectories of the FM sentences were perceived as longer than the ones of the non-FM sentences.

The drawings shown in Figures 2 and 3 demonstrate how the participants conceptualized FM and non-FM sentences differently. For example, in the pair of experimental sentences 彩虹跨越天空 cǎi hóng kuà yuè tiān kōng "A rainbow crosses the sky" (FM) in Figure (2a) and 彩虹在天空 cǎi hóng zài tiān kōng "A rainbow is in the sky" (non-FM) in Figure (2b), the trajectories were longer for the FM sentence (2a) than for the non-FM one (2b) even though these two sentences were judged to be semantically similar in meaning.

Figure 3 shows how the noun 鐵道 tiě dào "railway" was conceptualized in the sentences 鐵道走進鄉村 tiě dào zǒu jìn xiāng cūn "The railway goes into the village" (FM) in Figure (3a) and 鐵道在進鄉村 tiě dào zài xiāng cūn "The railway is in the village" (non-FM) in Figure (3b). Indeed, the pair of drawings shows a difference in the length of the railway in the two sentences. The length of the railway was perceived to be much longer in the FM sentence than in the non-FM one. In the FM sentence (3a), the participants tended to expand their vision to include the whole railway. However, in the non-FM sentence (3b), the participants were inclined to view just a component of the railway. The different views capes between the sentence pair caused a difference in the length of the trajectories depicting the railway in space.

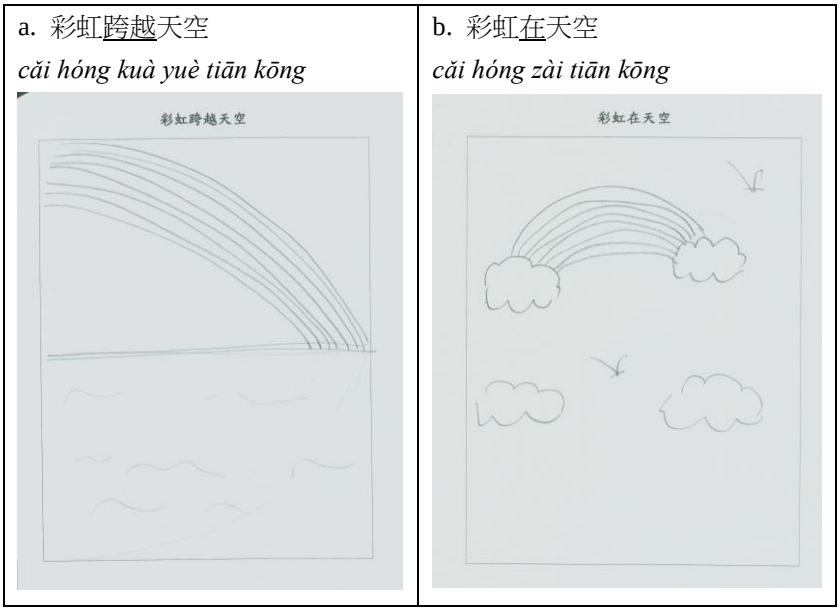

Figure 2: Two sample drawings for the pair of sentences with the motion verb 跨越 *kuà yuè* and the non-motion verb 在 *zài*

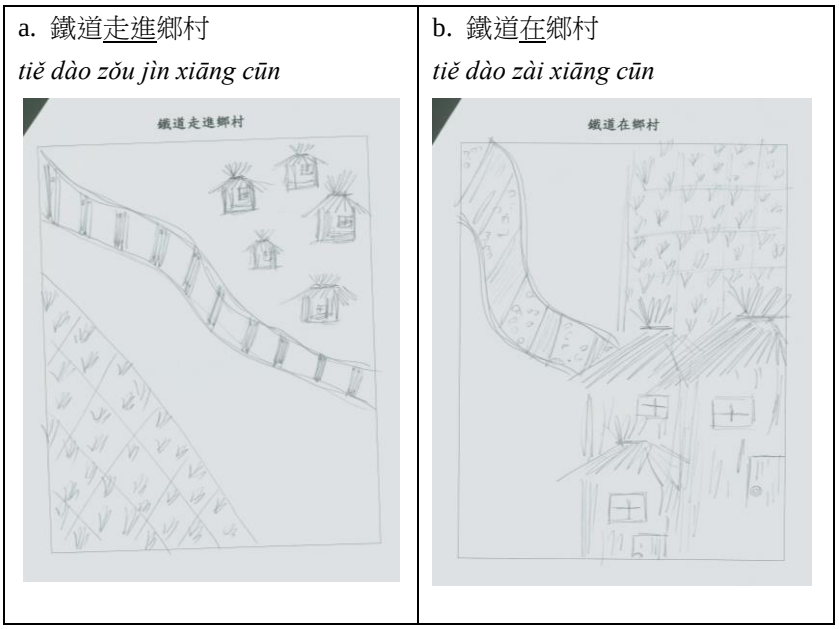

Figure 3: Two sample drawings for the pair of sentences with the motion verb 走進 *zǒu jìn* and the non-motion verb 在 *zài*

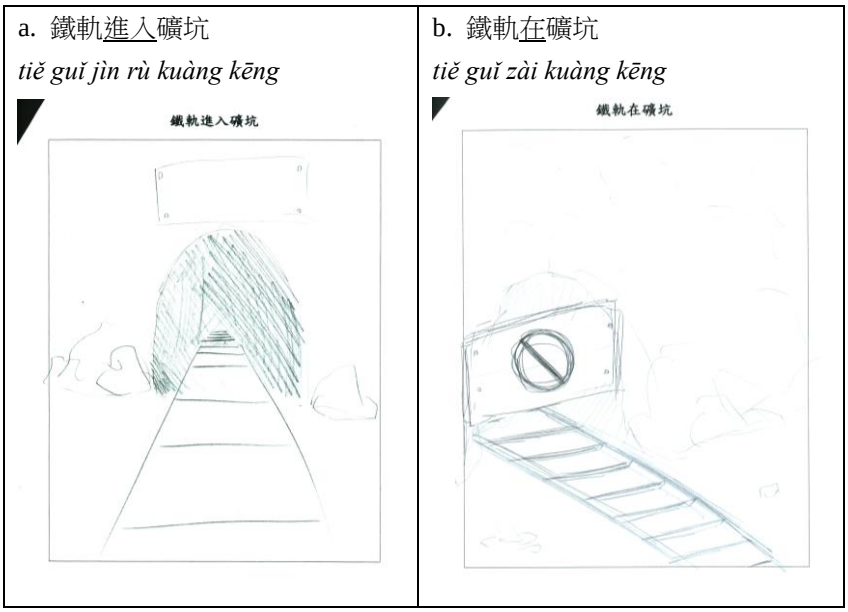

Figure 4: Two sample drawings for the pair of sentences with the motion verb 進入 *jìn rù* and the non-motion verb 在 *zài*

Figure 4 shows that one of participants conceptualized the sentence of 鐵軌進入礦坑 tiě guǐ jìn rù kuàng kēng "The rail goes into the pit" compared with the one of 鐵軌在礦坑 tiě guǐ zài kuàng kēng "The rail is in the pit". Figure 4a demonstrates that the FM sentence could elicit this participant to draw the picture from the first-person perspective whereas he/she depicted the scene from the third-person perspective when reading the non-FM sentence. The use of the first-person perspective reflects that the participant imagined himself/herself as the doer of the motion 進入 jìn rù "go into" in reading this FM sentence. He/She was executing the moving of "go into" and was approach the pit. However, when the participant read the non-FM sentence as shown in Figure 4b, the participant would not think that he/she was the actor of movement. He/She treated himself/herself as an outsider to view the scene when he/she read the sentence the sentence 鐵軌在礦坑 tiě guǐ zài kuàng kēng "The rail is in the pit".

In brief, participants' pictures support the hypothesis of mental simulation through drawing longer trajectories for fictive motion rather than the non-fictive motion. That is, the fictive motion leads to people simulating the movement in the mental lexicon, which causes the trajectories of the objects (e.g., "the railway") for the FM sentences to

be more lengthening than the ones for the non-FM sentences. In addition, we found that the dynamic trajectories in the mental lexicon can also induce the different use in perspectives of drawing (i.e., the first-person perspective versus the third-person perspective).

5. Conclusion and future work

Fictive motion sentences contain non-literal expressions using motion verbs, but their meanings do not involve physical movement in space. Does this mean that fictive motion expressions cannot evoke mental simulation of motion verbs? In this study, we investigated whether the participants would evoke mental movement in space in processing fictive motion in Mandarin Chinese. We designed a drawing task that involved FM sentences and non-FM sentences. For example, the sentence 小徑走入森林 xiǎo jīng zǒu rù sēn lín "A trail goes into the forest" was created for the FM category and the sentence 小徑在森林 xiǎo jīng zài sēn lín "A trail is in the forest" for the non-FM one. The participants read six pairs of FM and non-FM sentences, and then depicted their meanings for experimental stimuli. The experimental results showed that the participants tended to express greater and longer trajectories for the FM sentences than for the non-FM ones. These findings are consistent with those in Matlock's (2006) study, which suggests that even though fictive motion entails non-literal meanings, the dynamic movement in space is still coded in the concept of fictive motion verbs, meaning that the participants automatically activated mental simulation for fictive motion expressions.

As we mentioned previously, we found the some participants used the first-person perspective in their drawing when they read the fictive motion sentences while the third-person perspective was used when they processed the non-fictive motion ones. It is quite reasonable that when people think that they are the actors of the motion, they would like to put themselves in the scenes and imagine they are moving in space. But, the non-FM sentences cannot lead to the kind of reading. Indeed, novelists also use the first-person perspective in their novels in order to induce the empathy of the readers. The strategy of using the first-person perspective in stories more easily triggers readers to act as the main characters, experiencing the stories and feeling the emotions of the main characters. So, the mental simulation could be a process of changing the third-person perspective to the first-person perspective. However, this evidence on the preference using the third-person perspective in reading fictive motion has been merely supported by few participants' pictures. We need to collect more data to prove this point in the near future.

To conclude, this study provides evidence supporting the cognitive linguistic theory that fictive motion evokes dynamic imagery. This study has practical implications for

computational linguists in analyzing subtle semantic meanings among motion verbs. In addition, our study on the psychological state of motion verbs could be useful in machine learning that instructs machines to perceive various motion verbs in Mandarin just as human beings do.

Acknowledgments

This research was supported by grants from the Ministry of Science and Technology (MOST 105-2410-H-415 -025-) to the first author. We would like to thank the anonymous reviewers for their comments on this work. Remaining errors are our sole responsibility.

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Appendix 1: Twelve experimental stimuli, including six fictive motion sentences and six non-fictive motion sentences

No.	FM category	Non-FM category
1	黴菌爬上牆角 *méi jūn pá shàng qiáng jiǎo* "Mold climbs up the corner."	黴菌在牆角 *méi jūn zài qiáng jiǎo* "Mold is in the corner."
2	彩虹跨越天空 *cǎi hóng kuà yuè tiān kōng* "A rainbow crosses the sky."	彩虹在天空 *cǎi hóng zài tiān kōng* "A rainbow is in the sky."
3	小徑走入森林 *xiǎo jīng zǒu rù sēn lín* "A path goes into the forest."	小徑在森林 *xiǎo jīng zài sēn lín* "A path is in the forest."
4	血管通過全身 *xuè guǎn tōng guò quán shēn* "Blood vessels pass through the body."	血管在全身 *xuè guǎn zài quán shēn* "Blood vessels are in the body."
5	鐵軌進入礦坑 *tiě guǐ jìn rù kuàng kēng* "A rail goes into the pit."	鐵軌在礦坑 *tiě guǐ zài kuàng kēng* "A rail is in the pit."
6	鐵道走進鄉村 *tiě dào zǒu jìn xiāng cūn* "A railway goes into the village."	鐵道在鄉村 *tiě dào zài xiāng cūn* "A railway is in the village."