Journal of Child Language (2026), **53**, 890–905
doi:10.1017/S0305000925000145

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Learning to comprehend and explain spatial metaphors for time in Chinese

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(Received 28 May 2024; revised 28 January 2025; accepted 04 March 2025; first published online 21 April 2025)

Abstract
Time is frequently structured in terms of motion as moving-time (e.g., "summer is coming"), moving-ego (e.g., "we approach winter"), or sequence-as-position (e.g., "winter follows autumn") across the world's languages, including Chinese – a language that shows greater variability in its expression of such metaphors. Using a metaphor explanation and a metaphor comprehension task, we tested 60 children learning Chinese, equally divided into ages 3–4, 5–6, 7–8. Children's performance improved with age, marking ages 7–8 as the period with significant gains in both comprehension and explanation of metaphors – a later mastery compared to children learning English shown in earlier work. Metaphor type also affected children's performance, but only for the explanation and *not* the comprehension of metaphors. Overall, our findings highlight that the structure of spatial metaphors for time in Chinese influences the *timing* but *not the trajectory* of children's development in learning spatial metaphors for time.

Keywords: metaphor comprehension; metaphor explanation; Chinese; spatial metaphors; time

摘要
世界上的语言对于时间隐喻的表达经常分为三种: "时动隐喻" (比如: 夏天要来了), "我动隐喻" (比如: 我们接近冬天了) 和"序列位置隐喻" (比如: 冬天跟着秋天)。对于三至八岁的中国儿童来说, "序列位置隐喻"比"时动隐喻" 和"我动隐喻"更难以解释。他们在七至八岁这个年龄段对于时间隐喻的理解和解释提高最为显著。

关键词: 隐喻理解; 隐喻解释; 汉语; 空间隐喻; 时间

1. Introduction

Adult speakers rely on a variety of metaphors to talk about time (Lakoff & Johnson, 1980; Lakoff & Kovecses, 1987). Among these, spatial metaphors constitute one such subsystem of metaphors that structures our concept of time across different languages of the world (Evans, 2004; Iwasaki, 2009; Lewandowski & Özçalışkan, 2023; Moore, 2000, 2006; Özçalışkan, 2003,

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2004). However, we know relatively less about the developmental trajectory with which spatial metaphors for time are learned by children, particularly in languages other than English. In this study, we focused on children learning Mandarin Chinese (Chinese hereafter) – a language that shows greater variability in its metaphorical expression of time – compared to English. We asked whether 3- to 8-year-old children learning Chinese would or would not follow a path similar to the one previously observed for their English-speaking peers (Stites & Özçalışkan, 2013) in learning spatial metaphors for time.

1.1. Spatial metaphors for time in adult speech

Spatial metaphors for time are prevalent in adult speech. Adults frequently rely on physical experiences (e.g., motion in space) to structure and express abstract concepts, such as time (Cappelle, 2009; Lakoff & Johnson, 1980; Özçalışkan, 2003, 2005a; Pitt & Casasanto, 2022). The most commonly used spatial metaphors for time in English include: (1) MOVING-TIME, in which time moves in relation to a stationary observer (e.g., "winter approaches"); (2) MOVING-EGO, in which observer of time (i.e., ego) moves in relation to a stationary time point (e.g. "we approach winter"); and (3) SEQUENCE-AS-RELATIVE-POSITION-ON-A-PATH (hereafter sequence-as-position), in which events in time move in relation to one another independent of the observer of time (e.g., "winter follows autumn"; Moore, 2000 & 2006; Stites & Özçalışkan, 2013).

These three metaphors are also commonly observed in languages other than English, including Chinese (Lai & Boroditsky, 2013; Yu, 2012; Zhou & Fan, 2015). Similar to English speakers, Chinese speakers also structure the metaphorical motion of time as spatial motion, using the same three metaphor types. However, different from English speakers – who rely primarily on the horizontal axis to describe time's movement (past located either to the back or left of the speaker's body) – Chinese speakers use both the horizontal axis (sagittal: front to back or lateral: left to right) and the vertical axis (top to down) – situating the past on either the front (or even sometimes the back), the left, or the top of their bodies. In fact, the word for the day before yesterday is "前天 *qiántiān* = front day" and the word for the day after tomorrow is "后天 *hòutiān* = behind day" in Chinese, thus placing time along a sagittal axis with past in the front and future in the back of the speaker's body (Yu, 2012). Chinese speakers also use the left-to-right horizontal axis (i.e., lateral) to express time's movement (e.g., 左手过去, 右手未来 *zuǒshǒu guòqù, yòushǒu wèilái* = in your left hand lies the past and in your right hand is the future; Chen, 2021), placing past in the left and future on the right side of their bodies. In addition, different from English speakers, Chinese speakers also rely on the vertical axis in locating past and future times. For example, the word for last month is "上个月 *shànggèyuè* = upper month" and the word for next month is "下个月 *xiàgèyuè* = lower month" in Chinese, situating past on the top and future on the bottom portion of their bodies (Hong et al., 2017).

Earlier work that examined the relative production of time metaphors in Chinese showed mixed results on the speakers' use of the horizontal and vertical axes. In a series of studies, Boroditsky (2001; 2008) and Boroditsky et al. (2011) found that Chinese speakers talked about time vertically more often than English speakers. However, Chen (2007) failed to replicate Boroditsky's (2001) findings, showing that Chinese speakers used horizontal spatial metaphors (particularly along the sagittal axis) more frequently than vertical ones to describe time's movement. At the same time, a more recent study (Chen, 2021) showed that Chinese speakers express time vertically more often than both French and English speakers. These results thus suggest that the expression of time in adult speech in Chinese shows more variability, particularly compared to English speakers who only rely on the horizontal axis.

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Only a few studies investigated adult Chinese speakers' comprehension or production of the three types of time metaphors. In a comprehension test, Huang and Hsieh (2007) found that Chinese-English bilinguals processed ego-moving metaphors better when they were tested in Chinese – their native language, but processed time-moving metaphors better in English, their second language. This aligns well with earlier research which showed that native English speakers comprehend ego-moving metaphors more quickly than time-moving metaphors (Gentner et al., 2002). There is no existing work that has yet examined either comprehension or production of sequence-as-position time metaphors in Chinese, highlighting it as an area that is in need of further research.

1.2. Spatial metaphors for time in child speech

Children start talking about metaphors around age 2 (Billow, 1981). They initially use *simple perceptual metaphors* to draw comparisons between entities that have similar features – first without the explicit comparison marker "like" (e.g., "ice-cream cone" + point at mushroom) and later on, with the word "like" (e.g., "Mushroom is like an ice-cream cone"; Billow, 1975, 1981; Epstein & Gamlin, 1994; Vosniadou & Ortony, 1983; Özçalışkan & Goldin-Meadow, 2006; Özçalışkan et al., 2009). These early perceptual metaphors lead the way for increasingly more *complex structural metaphors*, beginning around age 5, a time point when children begin to express relational commonalities between distinct entities and/or domains (e.g., texture to personality: "the guard is a hard rock"; physical motion to abstract motion: "she soars with joy"; Özçalışkan, 2005b; Stites & Özçalışkan, 2013; Winner et al., 1976). Importantly, the mastery of structural metaphors spans over a longer developmental timeline, extending all the way to middle school years (Asch & Nerlove, 1960; Vosniadou, 1987; Winner, 1979; Winner et al., 1976). For example, in explaining the metaphorical statement, "a cloud is like a sponge," five-year-old children typically rely on feature-based similarities between objects (e.g., "Both clouds and sponges are *round and fluffy*"), while older children also produce more relational explanations (e.g., "Both clouds and sponges *contain water*"; Asch & Nerlove, 1960; Cicone et al., 1981; Gentner, 1988; Schecter & Broughton, 1991; Winner et al., 1976; see Özçalışkan, 2010, 2014 for reviews). However, most of this earlier work focused on English learners (but see Özçalışkan, 2005b; Cheng et al., 2024 for exceptions), leaving the applicability of these patterns to other languages largely unexamined.

Children's comprehension and production of spatial metaphors for time –as a subcategory of structural metaphors – received considerable attention in the field in the past two decades. One early study (Özçalışkan, 2004, 2005b, 2007) examined moving-time metaphors (along with similar metaphors for mental and bodily states) among children learning either English or Turkish, probing them either with lexical support (e.g., forced-choice response for the meaning of a metaphor embedded in a story) or without lexical support (e.g., free response for metaphorical statements; e.g., "Can time jump from moment to moment?"/"Can ideas run through your mind?"). The results showed that children – learning either English or Turkish – begin to understand moving time metaphors around age 4–5 and to explain them around age 5–6.

A later study (Stites & Özçalışkan, 2013, expanding on this earlier work, examined 3- to 6-year-old children's comprehension and explanation of the three subtypes of spatial metaphors for time (moving-time, moving-ego, sequence-as-position) in English. Similar to Özçalışkan's findings, results showed the early emergence of metaphorical abilities. At the same time, children also showed an effect of metaphor type in both their comprehension and

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explanation of spatial metaphors for time, with earlier mastery of moving-time and moving-ego metaphors than sequence-as-position metaphors (Stites & Özçalışkan, 2013; see also Stites & Özçalışkan, 2021). Apart from this study, there is no other work that has extended these findings to another language. As such, we do not yet know whether the observed patterns are unique to English or are applicable to a broader set of the world's languages.

2. Current study

Previous research suggests that children grasp spatial metaphors for time at a young age. English-speaking children understand moving-time and moving-ego metaphors by age 3–4 and can explain them by age 5–6 (Özçalışkan, 2005a, 2007; Stites & Özçalışkan, 2013). Research also suggests that English-speaking children show later comprehension of sequence-as-position metaphors that require a third-person perspective (observer of time instead of experiencer of time), a difference that is likely an outcome of the greater cognitive demand such metaphors might impose on children, particularly at the early ages (Stites & Özçalışkan, 2013). Different from English, the metaphorical organisation of time may present additional challenges for Chinese children, particularly for sequence-as-position metaphors. This disparity stems from the unique linguistic landscape of Chinese. Unlike English, where time metaphors predominantly follow a horizontal axis, Chinese speakers use both vertical and horizontal axes when describing time (Sun & Zhang, 2021; Yu, 2012). In addition, when relying on the horizontal axis, adult Chinese speakers locate the future in three different ways, by placing it either behind, ahead of (Yu, 1998, 2012) or to the right of their bodies (Chen, 2021). Children learning English typically rely only on the horizontal axis, locating the future either on the front (sagittal) or the right (lateral) of their bodies (Stites & Özçalışkan, 2013). Moreover, unlike Chinese, in English, the sagittal (e.g., "future ahead", "years back") *but not* the lateral axis is lexicalized. For example, there is no expression such as "the rightward month" or "leftward year" in English, highlighting the lack of the use of the left-right axis in lexicalizing metaphorical motion of time in English (Radden, 2004; Santiago et al., 2007). Chinese, on the other hand, lexicalizes time metaphors across both types of horizontal axes, including the sagittal (e.g., 前年 *qián nián* = front year: the year before last year; 后年 *hòu nián* = back year: the year after next year) and the lateral (e.g., 左手历史右手未来 *zuǒ shǒu lì shǐ, yòu shǒu wèi lái* = left hand history right hand future: past history and future times) axes. Chinese speakers also lexicalize time along the vertical axis (e.g., 上个学期 *shàng ge xuéqī* = up semester: last semester & 下个学期 *xià ge xuéqī* = down semester: next semester). This variability, in turn, might result in greater difficulties for children in mastering time metaphors in Chinese, particularly compared to English speakers and in tasks where there is less lexical support (e.g., explanations).

In this study, we focused on 60 children learning Chinese as their native language at the ages 3–4, 5–6, and 7–8; and asked two questions. We first focused on children's *metaphor comprehension* and asked whether the type of metaphor (moving-time, moving-ego, sequence-as-position) would have an effect on the developmental changes in children's *comprehension* of time metaphors. We predicted that children learning Chinese would improve their comprehension over time; but they would also show lower levels of comprehension for sequence-as-position metaphors at each age compared to moving-time and moving-ego spatial metaphors, based on earlier work with children learning English (Stites & Özçalışkan, 2013).

We next focused on children's *metaphor production* and asked whether the type of metaphor (moving-time, moving-ego, sequence-as-position) would have an effect on the

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developmental changes in children's explanation of spatial metaphors for time. Similar to comprehension, we expected an effect of metaphor type, namely that children learning Chinese would show greater difficulty in explaining sequence-as-position metaphors compared to moving-time and moving-ego spatial metaphors – also based on earlier work with English learners (Stites & Özçalışkan, 2013).

Given the greater variability in the expression of time metaphors in Chinese (particularly as compared to English), we also expected that children learning Chinese might also show slightly later achievement of metaphorical abilities in both their comprehension and explanation of spatial metaphors for time, as compared to earlier work on children learning English.

3. Methods

3.1. Participants

The sample consisted of 60 children, equally divided into 3 age groups, including 3- to 4-year-olds (M_{age} = 3;11, range = 3;1–4;10, 12 boys), 5- to 6-year-olds (M_{age}= 5;8, range = 5;0–6;11, 11 boys), and 7- to 8-year-olds (M_{age}= 7;4, range = 7;0–8;8, 11 boys), all learning Chinese as their native language. The age range and sample size (n=20/age group) were based on an earlier study (Stites & Özçalışkan, 2013) that showed significant changes (*ps* < .001) in English-speaking children's metaphor comprehension and production abilities, with medium to large effect sizes (comprehension: η^2_p = .47; explanation: η^2_p = .32). All children were attending preschools or elementary schools in a city in Northeastern China at the time of our observations. The three age groups were comparable in family education, with 80%–85% of parents with college degrees in each group. None of the children were learning another language; but they all spoke the local Dalian dialect of Chinese at the time of our observations. The Dalian dialect, or Dalian Mandarin – primarily spoken in the urban area of Dalian City in Northeastern China – is part of a major Sinitic Mandarin language family that is very similar to Mandarin Chinese (Bi & Chen, 2022; Fong, 2004). The recruitment and data collection protocol were approved by an Institutional Review Board at a research university in the United States and parents provided consent prior to their children's participation in the study.

3.2. Procedure for data collection

Each child was interviewed individually in their school by a native Chinese speaker. During the interview, each child completed (1) a *metaphor explanation task* and (2) a *metaphor comprehension task*, each of which is described below. Both tasks were based on earlier work with children learning English (Stites & Özçalışkan, 2013). Children first completed the free-response metaphor explanation task, followed by the forced-choice metaphor comprehension task to ensure that children's explanations were not affected by the forced-choice responses in the metaphor comprehension task. All responses were videorecorded.

Metaphor explanation task: The children were presented with 6 open-ended questions about different motion metaphors for time, one at a time and in counterbalanced order. Each question contained one of the three metaphor types for time (i.e., moving-time, moving-ego, sequence-as-position), with two questions for each metaphor type; see Table 1 for the interview questions in original Chinese and their translations to English. The experimenter further probed each child to justify their response to each question (e.g., Tell me more, why do you think that is?)

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Table 1. Interview questions for the metaphor explanation task (metaphors are underlined)

Moving time	
(1) 要是你在家跟妈妈一起玩。你妈妈说: "*夏天来了。*"你觉得她说这句话是什么意思呢?	(1) Let's say you are at home with mommy playing. And your mommy says: "*Summer is coming*". What do you think she means?
(2) 要是我告诉你: *紧接着我们在一起的时间, 我会给你一个小粘贴*。你认为什么时候你会得到这个小粘贴呢?	(2) If I told you that *following our time* together, I will give you a sticker, when do you think you will get your sticker?
Moving ego	
(3) 要是现在你正在房子外面玩。你爸爸说:" *我们离吃晚饭越来越近了*。"你觉得他说这句话是什么意思呢?	(3) Let's say you are playing outside, and your daddy says: "*We are getting closer to dinnertime*". What do you think he means?
(4) 要是你吃了早饭以后跑到外面去玩球, 然后你又去玩积木。你觉得当你开始玩积木的时候, *你离吃午饭的时间更近了吗*?(如果孩子的答案是肯定的)怎么离午饭时间更近了呢?	(4) Let's say you had breakfast, and you went out to play ball. And then you played with blocks. Do you think *you got closer to lunchtime* when you started playing with blocks? (If affirmative) How?
Sequence-as-position	
(5) 要是有人告诉你说:" *甜点在晚饭后面*。" 这是什么意思呢?	(5) What would it mean if someone told you that *dessert follows dinner*?
(6) 你觉得*不同的时间段可以像一条线一样一个接着一个*吗?比如说, *睡觉时间可以跟在晚饭时间的后面吗*?(如果孩子的回答是肯定的)睡觉时间是怎么样跟着晚饭时间的呢?	(6) Can *different times follow each other, like in a line*? For example, *can bedtime follow dinnertime?* (If affirmative) How does it follow?

Metaphor comprehension task: Each child was presented with 6 short stories, one at a time and in counterbalanced order. Each story contained one of the three metaphor types for time (i.e., moving-time, moving-ego, and sequence-as-position), with two stories for each metaphor type. Each story was presented with black and white drawings of the two main characters in the story to increase the child's engagement with the content of the stories; see Table 2 for the stimulus stories in original Chinese and their translations to English.

The child was told that s/he would hear several short stories about different people and that after each story s/he would help two puppets (i.e., a dragon and a frog) understand the story. Before each story, the experimenter placed two drawings on the table, depicting the two characters in each story. The experimenter then read each story aloud to the child. Each story ended with the experimenter asking the puppets a question about the meaning of the metaphor used in the story. The two puppets were present in front of the child. One of the puppets provided a correct answer, while the other answered incorrectly. The child was then asked to help by choosing the puppet that gave the correct answer. Each puppet provided the correct answer half of the time, setting chance performance at 50%. The order of the correct choices (first vs. second choice) was counterbalanced across stories and children.

3.3. Procedure for scoring, reliability, and data analysis

Children's response to each interview question in the **metaphor explanation** task was assessed on a 3-point scale as either 0 (irrelevant explanation), 1 (semi-relevant explanation),

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Table 2. Stimulus stories for the metaphor comprehension task (metaphors are underlined, correct choices are bolded)

Moving time	
这是小朋。这是小朋的妈妈。小朋的妈妈告诉*他去动物园的日子马上就要到了*。小朋非常高兴!他大声喊"耶!" 小朋为什么非常高兴? (A) 他现在就要去动物园。 **(B) 他很快就要去动物园。**	This is Patrick. This is Patrick's Mom. Patrick's mom tells him that *his trip to the zoo is coming up.* Patrick gets really excited! He shouts "YEAH!" Why is Patrick excited? (A) His trip to the zoo is now. **(B) His trip to the zoo is soon.**
这是安安。这是安安的哥哥德德。德德告诉安安*睡觉时间已经到了*。安安很难过,她说:"唉"。 安安为什么很难过? (A) 他现在得起床。 **(B) 他现在得去睡觉。**	This is Ann. This is Ann's brother Ed. Ed tells her that *the time for bed has come.* Ann is sad. She says "Ugh!" Why is Ann sad? (A) He has to get up now. **(B) He has to go to sleep now.**
Moving ego	
这是小博。这是小博的朋友凯凯。凯凯告诉小博*从现在到他的生日还有很长的路要走*。小博很失望。他说"唉…"。 小博为什么很失望? **(A) 他的生日聚会还没到。** (B) 他的生日聚会已经结束了。	This is Rob. This is Rob's friend Kyle. Kyle tells Rob that *he has to long way to go until his party.* Rob is disappointed. He says "Ugh". Why is Rob disappointed? **(A) His party is later.** (B) His party is over.
这是艾琳。这是艾琳的老师。艾琳的老师告诉她们*课间休息时间要到了*。艾琳很高兴。她说:"好啊!" 艾琳为什么高兴? (A)现在是课间休息时间。 **(B) 很快是课间休息时间。**	This is Erin. This is Erin's teacher. Erin's teacher tells her that t*hey are coming up on recess.* Erin is happy. She says "alright!" Why is Erin happy? (A) Recess is now. **(B) Recess is soon.**
Sequence-as-position	
这是莎莎。这是莎莎的姐姐小柔。小柔和姐姐在吃午饭。小柔说吃了午饭*紧跟着*是冰淇淋。莎莎非常激动。她说"太棒了!" 莎莎为什么激动? (A) 现在吃冰淇凌。 **(B) 很快要吃冰淇淋。**	This is Stacy. This is Stacy's sister Carol. Carol says that *ice cream follows lunch.* Stacy is excited. She says "Yippee!" Why is Stacy excited? (A) Ice cream is now **(B) Ice cream is soon**
这是丽丽。这是丽丽的妈妈。丽丽的妈妈告诉丽丽洗了澡*紧跟着就要*吃午饭。丽丽很失望。她说"噢"。 丽丽为什么很失望? (A) 午饭结束了。 **(B) 现在要洗澡。**	This is Polly. This is Polly's mom. Polly's mom tells Polly *lunch follows washing up.* Polly is disappointed. She says "oh." Why is Polly disappointed? (A) Lunch is over **(B) Washing-up is now**

or 2 (relevant explanation). *Irrelevant explanations* included responses where the child provided answers that did not focus on the metaphor for time (e.g., *Stimulus story*: "你说冰淇淋在吃晚饭以后, 是什么意思?= What would it mean if someone told you that dessert is after dinner? " *Answer:* "不许吃冰淇淋。= (I am) not allowed to eat ice cream"). *Semi-relevant explanations* consisted of responses that included partial information about the metaphor for time (e.g., *Answer:* "因为冰淇淋是零食, 不容易消化的, 所以不能先吃。= Because ice cream is a snack; it's difficult to digest. So can't eat first."). Relevant

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explanations consisted of responses that directly focused on the metaphor for time (e.g., *Answer*: "先吃晚饭, 然后再吃冰淇淋。 = Eat dinner first, then eat ice cream."). [1] Reliability on the coding of the relevance for the explanations was assessed with a second coder on a randomly selected 20% of data in each age group, which showed 90% agreement between coders.

Children's responses to each forced-choice question in the **metaphor comprehension task** was assessed on a binary scale as either 0 (incorrect response) or 1 (correct response). Incorrect responses included either the choice of the puppet with the incorrect answer or the lack of a choice between the two puppets. Correct responses included the choice of the puppet with the correct answer.

We tallied each child's responses in the explanation and comprehension tasks separately for each metaphor type (score range of 0–4 for explanation and 0–2 for comprehension). We analyzed scores with two separate mixed two-way ANOVAs, with age (3–4-, 5–6-, 7–8-year-olds) as a between-subjects factor and metaphor type (moving-time, moving-ego, sequence-as-position) as a within-subject factor, separately for responses in the metaphor explanation and metaphor comprehension tasks. ANOVAs allowed us to test both main and interaction effects in our two outcome measures. At the same time, however, given the small sample size and the unique characteristics of our measurements, understanding the distribution of the variables was crucial for selecting an appropriate statistical analysis. Visual inspection of QQ plots, coupled with the Shapiro-Wilk test, revealed significant departures from normality in all dependent variables (p-values < 0.01). Consequently, non-parametric statistical tests were employed for subsequent analyses. We therefore further confirmed the patterns of statistical results we obtained for ANOVAs with a set of non-parametric tests (i.e., Kruskal-Wallis, Kendal's W test), which showed the same patterns of statistical significance as the ANOVAs.

4. Results

We first examined children's *comprehension* of metaphors for time. Children's responses showed an effect of age ($F(2, 57) = 36.142$, $p = .000$, $\eta^2_p = .559$), but no effect of metaphor type ($F(2, 114) = 0.208$, $p = .813$) or an interaction between age and metaphor type ($F(4, 114) = 1.119$, $p = .351$). As can be seen in Figure 1A, children's metaphor comprehension improved with age, with children in the oldest age group (ages 7–8) performing significantly better than both of the younger age groups (Bonferroni, *ps* <.003); this pattern remained similar across all three metaphor types (moving-time, moving-ego, or sequence-as-position). [2]

[1] We did not include an assessment of children's understanding of the physical meaning of the metaphorical terms used in our study due to the stricter time limitations in data collection in China. However, to ensure that the patterns we observed in metaphor comprehension or explanation in our study was not due to differences in children's understanding of the physical meaning of the metaphorical terms, we compared our metaphorical terms against a Chinese corpus of young children. More specifically, we used a CHILDES Chinese corpus of conversational interactions between mothers and their 3- to 4-year-old children learning Chinese as their native language (Zhou, 2001). The corpus (Zhou, 2001) showed that, by age 4, all children were able to understand as well as produce the words capturing the physical meaning of the metaphorical terms used in our study (e.g., 来*lái* = to come; 玩 *wán*, 跟*gēn* /接着*jiēzhe* = to follow; 去*qù* = to go).

[2] We further confirmed the patterns of age-related changes for *metaphor comprehension* obtained with ANOVAs, with Kruskal-Wallis tests, separately for each metaphor type. The Kruskal-Wallis test showed significant differences between each age group for each metaphor type, including moving-time, $\chi^2(2) = 23.55$,

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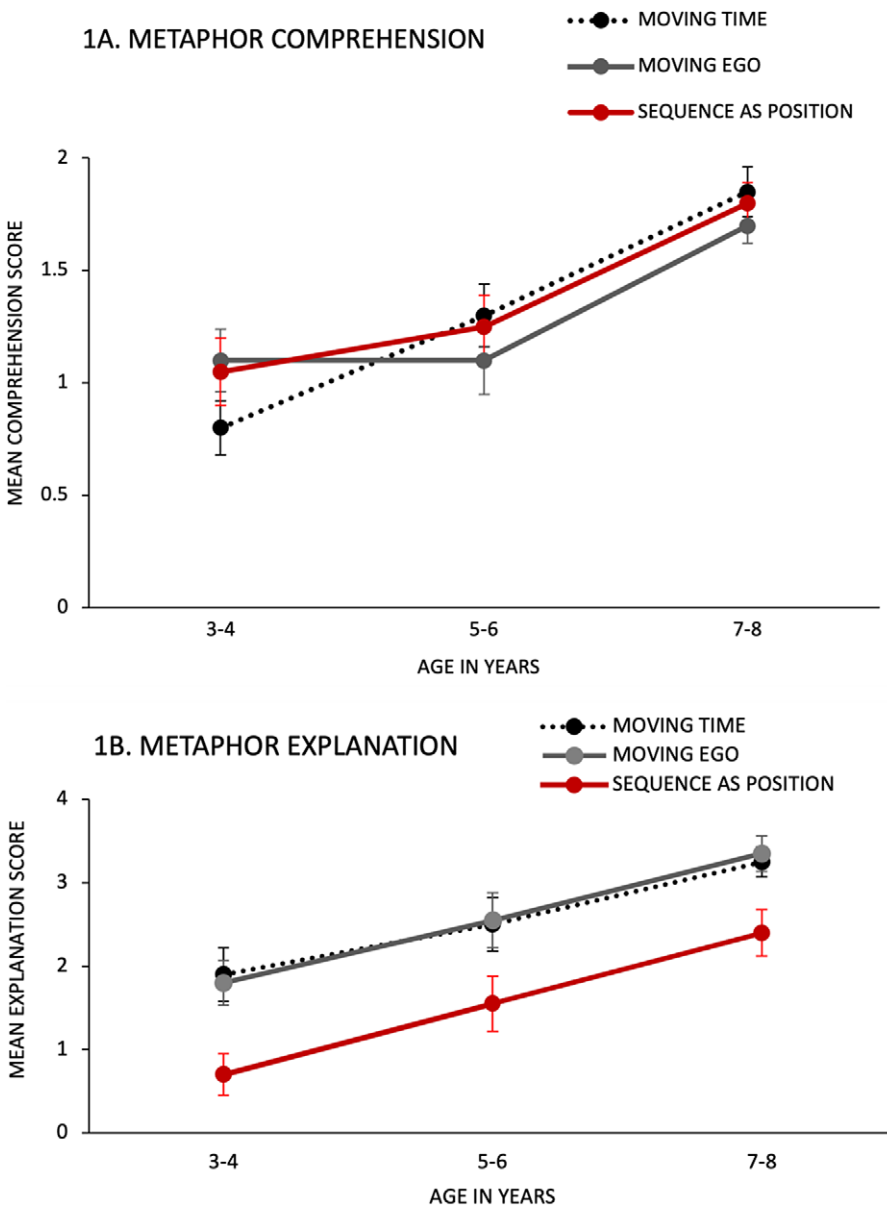


Figure 1. Mean scores of metaphor comprehension & metaphor explanation.

$p < 0.001$, *moving-ego* ($\chi^2(2) = 13.06$, $p < 0.001$), *and sequence-as-position* ($\chi^2(2) = 14.28$, $p < 0.001$) *metaphors, thus confirming the patterns of age-related change we observed with the ANOVAs. We next confirmed the ANOVA results for metaphor type, using Kendall's W test. The analysis showed no effect of metaphor type on comprehension (Kendall's* $W = .005$, $df = 2$, $p = .752$), *also further confirming the ANOVA findings.*

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We next examined developmental changes in children's *metaphorical explanations* for time. Similar to comprehension, our analysis showed an effect of age ($F(2, 57) = 13.482$, $p = .000$, $\eta^2_p = .321$), with children in the oldest age group (7–8) providing better explanations than both groups of younger children (Bonferroni, *ps* <.005). Different from comprehension, children's explanations showed an effect of metaphor type ($F(2, 114 = 19.322$, $p = .000$, $\eta^2_p = .253$), but no interaction with age ($F(4, 114) = .156$, $p = .960$). As can be seen in Figure 1B, children showed better performance in explaining the metaphors for moving-time and moving-ego than sequence-as-position metaphors across all ages (Bonferroni, *ps* < .05)[3]; see Table 3 for sample explanations children provided for each metaphor type.

5. Discussion

English learners can understand and explain spatial metaphors for time at an early age (Özçalışkan, 2005b, 2007); but this early understanding also shows variability by metaphor type, with earlier mastery of moving-time (e.g., *winter approaches*) and moving-ego (e.g., *we approach winter*) metaphors than sequence-as-position metaphors (e.g., "winter follows autumn"; Stites & Özçalışkan, 2013). In this study, we asked whether this pattern remains similar for children learning Chinese – a language that shows greater variability in its spatial metaphors for time (Chen, 2021; Hong et al., 2017). Our findings showed that 3- to 8-year-old children learning Chinese improved in both their comprehension and explanation of all three metaphor types akin to children learning English. The type of metaphor also had an effect on children's performance – an effect that was only evident in the metaphorical explanations.

5.1. Age matters in understanding and explaining spatial metaphors for time

Children learning Chinese showed improvements in their comprehension and explanation of metaphors of time – a pattern consistent with earlier work on children learning Chinese (e.g., Cheng et al., 2024). However, Chinese learners showed above chance performance in their metaphorical abilities by age 7–8, approximately two years later than their English learning peers (Özçalışkan, 2004, 2007; Stites & Özçalışkan, 2013).

What might explain the later mastery of spatial metaphors for time in Chinese? One possible explanation – as aforementioned in the introduction – could be the greater variability in the structure of time metaphors in Chinese. Spatial metaphors in Chinese can be explained both horizontally (Boroditsky, 2001) and vertically (Hong et al., 2017). In fact, horizontal time metaphors – particularly the ones using a sagittal axis (e.g., "前年 *qiánnián* front-year = the year before last year") – and vertical time metaphors (e.g., "上午

[3]We further confirmed the patterns of age-related changes for *metaphor explanation* obtained with ANOVAs, with Kruskal-Wallis tests, separately for each metaphor type. The Kruskal-Wallis test showed significant differences between each age group for each metaphor type, including moving-time, $\chi^2(2) = 9.21$, $p = 0.01$), moving-ego ($\chi^2(2) = 13.73$, $p = 0.001$), and sequence-as-position ($\chi^2(2) = 14.37$, $p < 0.001$) metaphors, thus confirming the patterns of age-related changes we observed with the ANOVAs. We next confirmed the ANOVA results for metaphor type, using Kendall's W test. The analysis showed an effect of metaphor type on explanations (Kendall's W = .27, $df = 2$, $p < .001$), with higher mean rank scores for moving-time and moving-ego metaphors than sequence-as-position metaphors, thus further confirming the ANOVA findings.

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Table 3. Examples of children's explanations for the metaphorical motion of time by metaphor type and age (years; months provided in brackets)

Moving time	
E: 你跟妈妈一起玩, 妈妈说:"夏天要来了。你觉得她说这句话是什么意思呀?	E: Let's say you are at home with mommy playing. And your mommy says: "Summer is coming". What do you think she means?
C: **跟爸爸**妈妈一起出去玩。 [4; 7]	C: go out with mom and dad [4; 7]
C: 就是天气要变暖和了。 [5; 3]	C: It (means) weather will become warmer. [5; 3]
C: 就是夏天就要来了, 暑假就要来了, 我们可以出去玩 。[8; 0]	C: Summer will be coming; summer vacation will be coming; we'll be able to go out to play. [8; 0]
Moving ego	
E: 要是你现在跟爸爸玩, 他说:我们离吃晚饭越来越近了。你觉得他说这个话是什么意思呀?	E: Let's say you are playing outside, and your daddy says: "We are getting closer to dinnertime". What do you think he means?
C: 吃饭。 [4; 11]	C: *eat* [4; 11]
C: 就是时间太长了, 所以就到了晚饭。 [5; 3]	C: *The time is too long, so dinner time has arrived.* [5; 3]
C: 就是马上快要吃饭了。[7; 7]	C: *will be eating dinner soon.* [7; 7]
Sequence as position	
E: 你觉得不同的时间段可以像一条线一样一个接着一个吗?比如说, 睡觉时间可以跟在晚饭时间的后面吗?(如果孩子的回答是肯定的)睡觉时间是怎么样跟着晚饭时间的呢?	E: Can different times follow each other, like in a line? For example, can bedtime follow dinnertime? (If affirmative) How does it follow?
C: 不能。 [3; 7]	C: can't [3; 7]
C: 不能, 得看电视刷牙。[5; 9]	C: can't…must watch TV and brush teeth.[5; 9]
C: 可以, 先吃晚饭后睡觉。[8; 5]	C: can, go to bed after eating dinner [8; 5]

Note. C: child; E: experimenter

shàngwǔ above-noon = morning") frequently co-exist in Chinese speakers' daily language production (Hong et al., 2017). Moreover, time metaphors that use a horizontal sagittal axis line can be expressed from two different perspectives: (1) the front-as-the-past: what happened in the past could be in front of the observer (e.g., "前天 *qiántiān* front-day = the day before yesterday") (Yu, 2012), and (2) the front-as-the future: what happens in the future could be in front of the observer (e.g., "往前看 *wǎngqián kàn* towards-front-look = look at the front/focus on the future") (Alverson, 1994; Yu, 2012). Consequently, mastery of spatial metaphors for time might place greater cognitive demands on its speakers – particularly at the early ages – thus resulting in more extended time in its mastery. Future studies that examine how frequency of different spatial metaphors for time in adult input to children relates to children's comprehension and explanation of similar metaphors can shed further light on this possibility.

Another possible explanation could be the nature of the spatial time metaphors in Chinese. In earlier work Cheng at el. (2024) examined Chinese children's comprehension of perceptual metaphors with high- *vs.* low-saliency (e.g., high-saliency metaphor: "星星是眼睛 *xīngxīng shì yǎnjīng* = stars are eyes" *vs.* "low-saliency metaphor: 彩虹是拱桥

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cǎihóng shì gǒngqiáo = rainbows are arch bridges"), defining saliency across a set of criteria, including conventionality, familiarity, prototypicality, and frequency (Giora, 1997). For example, children were expected to have greater difficulty with metaphors with low-saliency (e.g., "rainbows are arch bridges") because of the rare occurrence and lower familiarity of rainbows in China. Indeed, the authors did find that Chinese children's metaphorical abilities increased with age, with better performance for high-saliency metaphors by age 5 and for low-saliency metaphors by age 8. Structural metaphors for time that we included in our study might be similar to the high-saliency metaphors in this earlier work. Such metaphors are introduced late to Chinese children[4] and are thus less familiar particularly to young Chinese children, also marking their mastery at a later point in time. However, similar to Cheng et al. (2024), our study focused on a subset of metaphorical expressions in Chinese. As such, future work that examines metaphor development across a broader set of metaphor types in Chinese is needed to more firmly establish overall developmental trajectory of metaphorical ability in this group of learners.

The later mastery of metaphors among Chinese learners might also be related to broader language learning trends in Chinese. We know from earlier work that Chinese learners show overall mastery of their native language around age 6–7 (Peng & Chen, 2020) – an achievement that might be necessary to set the stage for children's ability to grasp metaphorical expressions in their language. We also know from earlier work that Chinese learners experience difficulties learning the Chinese orthographic system at a young age; they do not understand radical marking–the basic indexing component of a Chinese character which appears as part of a character – until early elementary school years (ages 6–7; e.g., Luo et al., 2011; Wei et al., 2014). For example, 亻 is the "person" radical marker indicating that the lexical character is human (e.g., 你*nǐ* = you; 他 *t*ā = he/him). As spatial metaphors for time, particularly moving ego and moving time, require locating time or its movement in relation to a person (i.e., human), the later mastery of radical marking for "human" in Chinese might contribute to the later achievement of such metaphors in Chinese, as compared to English.

The Chinese writing system also uses a logographic script that differs significantly from the English alphabetic writing system (Tan et al., 2001). In addition, Chinese speakers rely on a phonemic writing system (i.e., the Chinese romanization) to represent the pronunciation of characters (Li, 2019). This, in turn, presents additional challenges for learning the writing system in Chinese. In fact, earlier work has shown that preschool children learning English perform better than their Chinese peers in identifying spatially transformed words in an alphabetic orthography – a system that is also used in the Chinese phonemic writing system. This thus suggests that young Chinese children were not as familiar as their English-learning peers with the orthographic system of their language, largely due to the relatively more complex orthography of Chinese that relies on both logographic and phonemic systems (Miller, 2002; Miller et al., 2001). Even though the writing system of a language may not directly affect the comprehension and production of spatial metaphors for time, it has an indirect effect, influencing children's early metalinguistic development (Miller, 2002). In fact, as shown in earlier work, young children who perform poorly on metalinguistic tasks also show difficulties in explaining

[4]Structural metaphors are not officially introduced to the children in Chinese until the first grade when they are 6-7 years old, such as the metaphor "春天来了*chūntiān lái le* = Spring has come" is not introduced until the second semester of the first grade Chinese Language and Literature textbook adopted nation-wide in China (see Renjiao, 2024).

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metaphorical concepts – an effect that can be observed all the way to early adolescence years (Asch & Nerlove, 1960; Cometa & Eson, 1978; Smith, 1976). Future cross-linguistic studies that examine the potential links between metalinguistic skills, literacy, and metaphor comprehension-explanation can shed further light on the link between these three potentially related language abilities.

5.2. Metaphor type matters in explaining spatial metaphor types for time

We know from earlier work that English-speaking children show greater difficulty with sequence-as-position metaphors in *both* their comprehension and explanation of such metaphors (Stites & Özçalışkan, 2013). In our study, Chinese children showed this difficulty as well, but only in the explanation of such metaphors. But why do children show greater difficulty with sequence-as-position metaphors – not only in English but also in Chinese?

The sequence-as-position is cognitively more challenging than moving-time and moving-ego metaphors because it involves two events and an implicit observer instead of only two events; it also involves a less embodied conception of time and draws on a third-person perspective on time, making it more difficult for children (Stites & Özçalışkan, 2013) who rely heavily on first-person sensorimotor experiences to form knowledge (Barsalou, 2008).

This difficulty is further compounded when we examine the structure of time in Chinese. In explaining the sequence-as-position metaphor in English, the focus is on the two events (e.g., ice cream and dinner in "ice cream follows dinner") and not the observer. However, Chinese presents a more complex picture, as the observer of time could also be inserted into the sequence-as-position metaphor. For example, when Chinese speakers describe a time-as-sequence event (e.g., "冰淇淋在晚饭后 *bīngqílín zài wǎnfàn hòu* = ice cream is behind dinner"), the observer of time could also be located between the two activities on a horizontal line, such that ice cream is in front of the observer and dinner is behind the observer, and not necessarily outside the timeline as in English. As such when presented with such a metaphor, Chinese children had to decide between these two alternative meanings, which might make the task more difficult for them to explain – particularly during their explanations as it requires an additional task of verbalising their grasp of the different scenarios. In fact, this might be the reason why we did not see an effect of metaphor type in comprehension in Chinese. Despite the ambiguity of the perspective (1st person or 3rd person) of the observer (or ego), the forced choice comprehension prompts did not include the information of the observer with regards to the time's movement. As such, Chinese learners did not need to go through all possible scenarios, regardless of whether the time was vertical or horizontal, whether the past was in front or behind, and whether the human referent was on the axis, thus making sequence-as-position metaphor similar in difficulty to the other two metaphor types in the lexically-supported comprehension task. All of these scenarios, however, were possibilities for the children in the explanation task, thus resulting in lower performance on the explanation of sequence-as-position metaphors compared to the other two metaphor types. Future studies, that elicit more extended justifications for children's forced-choice responses in the comprehension task and free responses in the explanation task could shed further light on this possibility by identifying the type of cognitive reasoning children might be employing in the metaphorical tasks.

In summary, our results showed that children steadily improved their grasp of metaphors for time, akin to earlier work with children learning English, but with a

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2-year lag in both comprehension and explanation of metaphors. We also found an effect of metaphor type for children's explanation but not comprehension of metaphors – a pattern that was partially aligned with earlier work on English learners. Our results thus provide further empirical support for the developmental trajectory of children learning moving-time, moving-ego metaphors before sequence-as-position metaphors in another language, namely Chinese that shows greater variability in its expression of spatial metaphors for time. Overall, our findings highlight that the metaphorical structure of a domain in one's language (i.e., how time is linguistically organized in a given language) influences the *timing* but *not the trajectory* of children's metaphor development in learning spatial metaphors for time.

Acknowledgments. We thank Jingxuan Qiu for helping with the data collection. We thank all the participants for their participation.

Competing interests. The authors declare none.

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Cite this article: Paul, J., Stites, L.J., & Özçalışkan, Ş. (2026). Learning to comprehend and explain spatial metaphors for time in Chinese. *Journal of Child Language* **53,** 890–905, https://doi.org/10.1017/S0305000925000145

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