

## Sequential Time Construal is Primary in Temporal Uses of Mandarin Chinese *qian* ‘front’ and *hou* ‘back’

Yongfei Yang<sup>1,2</sup>

Chris Sinha<sup>1,3</sup>

Luna Filipovic<sup>3</sup>

<sup>1</sup>Hunan University

<sup>2</sup>Hunan University of Technology and Business

<sup>3</sup>University of East Anglia

**ACCEPTED FOR PUBLICATION 07/09/2022—CITATION:**

Yang, Yongfei, Sinha, Chris & Filipovic, Luna (in press, 2023). Sequential Time Construal is Primary in Temporal Uses of Mandarin Chinese *qian* ‘front’ and *hou* ‘back’. *Language Sciences* 95.

DOI: 10.1016/j.langsci.2022.101511

**PsyArxiv PREPRINT** Version 12/09/2022 DOI: 10.31234/osf.io/4ah5f

## Abstract

This article addresses two previously unresolved puzzles regarding the relationship between temporal and spatial conceptualizations in Mandarin Chinese. First, apparently conflicting data have led to disagreement over whether temporal usages of the terms *qian* and *hou*, whose spatial meanings of ‘front’ and ‘back’ are often considered to be primary, are based on a canonical facing of Ego towards past or towards future. We argue that this issue can be resolved by positing invariant Sequential (S-)Time meanings of, respectively, EARLIER and LATER for these terms, with variable USES to refer to past and future events and perspectives in Deictic (D-)Time being secondary and contextually governed. Second, the question of which of the sagittal, vertical and lateral orientational axes are more fundamental in spatio-temporal language and cognition for Mandarin Chinese speakers has been much debated. We review these issues, propose solutions based on linguistic analysis and report five experiments to test the analysis. Our findings are consistent with our analysis of the primacy in Mandarin Chinese of the invariant S-time construal of the terms *qian* ‘front’ (=EARLIER) and *hou* ‘back’ (=LATER) over their contextually governed D-time interpretations as referring to pastness and futurity. We find also that the preferred lexicalization of temporal relations between events by Mandarin speakers involves the sagittal axis terms *qian* and *hou*, but this does not mean that this linguistic conceptualization is also imposed by speakers as a preference for the sagittal axis for non-linguistic representations of event sequences. Finally, our data indicate that the temporal meanings of *qian* and *hou* (EARLIER and LATER) are more salient for speakers than their spatial meanings (front and back) in motion event conceptualizations.

**Keywords:** Mandarin Chinese, temporal front/back, S-time, D-time, timeline orientation, space-time mapping.

## 1. Introduction

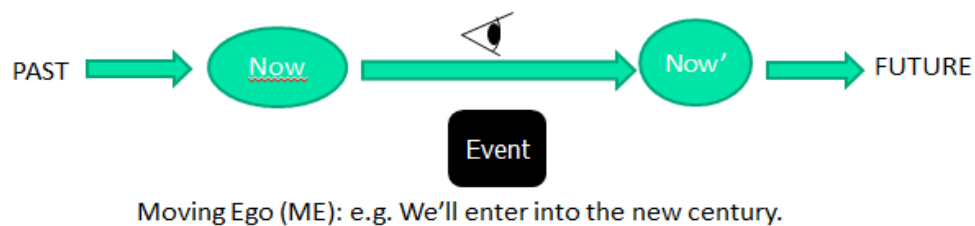
### 1.1 Time as space in language and thought

The use of spatial language to express temporal concepts is documented in languages throughout the world (Haspelmath, 1997). The spatialization of time is also evident in co-speech gesture (Núñez & Sweetser, 2006; Casasanto & Jasmin, 2012; Cooperrider & Núñez, 2009; Cooperrider *et al.*, 2014), in non-linguistic cognitive tasks (Casasanto & Boroditsky, 2008; Casasanto, 2010, 2016; Fuhrman *et al.* 2011; Bender & Beller, 2014) and in symbolic cognitive artefacts (Sinha *et al.*, 2011; Núñez & Cooperrider, 2013; Duffy, 2014). The ubiquity of such space-time mapping has led to claims for the universality of the conceptual metaphor TIME IS SPACE (Lakoff & Johnson, 1999; Fauconnier & Turner, 2008). Although neither linguistic space-time metaphor nor the existence of a “mental timeline” appear to be universal (Sinha *et al.*, 2011; Le Guen & Balam, 2012; Le Guen, 2017; Silva Sinha, 2019), the cognitive capacity for space-time mapping is likely to be universal, and this more nuanced universalist hypothesis is underpinned by neuroscientific evidence and theory (Buzsáki & Tingley, 2018).

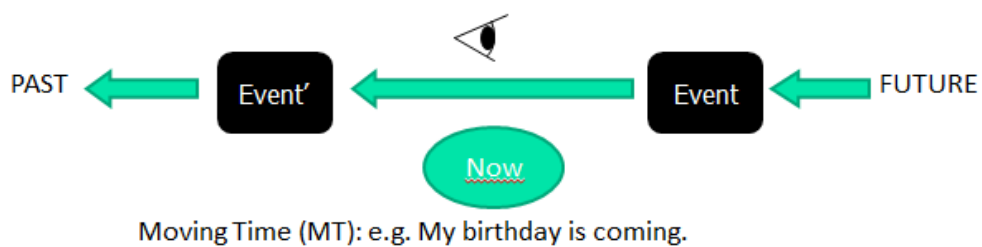
The expression of the pastness and futurity of events often draws on spatial relational terms equivalent to Eng. *front*, *back*, *ahead* and *behind*, and on deictic verbs of motion equivalent to Eng. *come*, *go*, and *pass*. Dynamic constructional space-time metaphors in English and many other languages are framed by schemas of ‘Passage of/in Time’, exemplified by the MOVING EGO schema (e.g. *she is approaching graduation*) and the MOVING TIME schema (e.g. *her birthday is coming*, Clark, 1973). These two PASSAGE schemas (which may be considered as complementary variants of a more general conceptual metaphor TIME IS MOTION: Ahrens & Huang, 2002) are intrinsically deictic, since the time of the moving Figure is referenced to the ‘Now’ of Ego. For this reason such metaphoric constructions have been labelled Ego-Reference-Point (Ego-RP) (Núñez & Sweetser, 2006). Stative constructional space-time metaphors are framed by schemas of ‘Position in Time’ (e.g. *her birthday is ahead of her*; *check-in is ahead of boarding*). The first of these examples exemplifies the Ego-RP

schema, but the second references the temporal position of the Figure (“check-in”) not to the ‘Now’ of Ego, but to the temporal position of a Ground event (“Boarding”). Such metaphoric constructions have therefore been labelled Time-Reference-Point (Time-RP).<sup>1</sup> All PASSAGE constructions and some (Time-RP) POSITIONAL constructions invoke a mental timeline in which, in English, the future is ahead of a forward-facing Ego (Figure 1).

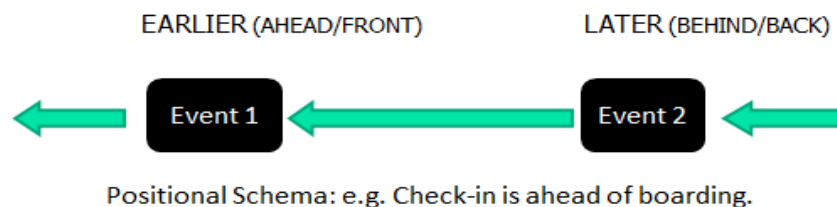
a)



b)



c)



**Figure 1.** Two temporal PASSAGE schemas: MOVING EGO (Fig. 1a, the deictic centre “moves” past an event into the future) and MOVING TIME (Fig. 1b, an event “moves” past the deictic centre into the past); and a POSITIONAL schema (Fig. 1c, two events are related sequentially in terms of temporal antecedence and succession).

The sagittal (front-back/back-front) mental timeline is not the only one employed in English or other languages (Radden, 2011). Speakers of many languages including Mandarin Chinese may employ in linguistic and non-linguistic experimental tasks and in gesture a lateral (left-right/right-left) timeline anchored to Ego (Santiago *et al.*, 2007; Weger & Pratt, 2008; Lakens *et al.*, 2011; Bergen & Chan Lau, 2012; Casasanto & Jasmin, 2012); and speakers of Mandarin Chinese may employ a vertical timeline in which the past is up, and the future is down in relation to Ego in speech (Scott, 1989; Yu, 1998, 2012); gesture (Li, 2017; Gu *et al.*, 2018) and non-linguistic tasks (Boroditsky, 2001, 2008; Fuhrman *et al.*, 2011). Not only the *orientation* of the timeline, but also the *direction* in which Ego faces in the sagittal timeline, varies between languages and cultures. A well-known example is that speakers of the Andean language Aymara conceptualize the future as *behind* and the past as *in front* of Ego in speech and in co-speech gesture (Núñez & Sweetser, 2006). These authors are careful to distinguish between Time-RP and Ego-RP usages of the same lexical items *nayra* ‘eye, sight, front’ and *qhipa* ‘back’, pointing out that confusion between the two would undermine their contention that for Aymara speakers the orientation of the Ego-anchored mental timeline (with Ego facing the past) is the opposite of that for more familiar languages. This potential source of confusion will be important for the analysis below of the temporal meanings and uses of the Chinese terms 前 *qian* ‘front’ and 后 *hou* ‘back’.

## 1.2 D-time and S-time in Mandarin Chinese “front” and “back” temporal constructions

The Ego-RP vs. Time RP distinction has more recently been commonly referred to as between Deictic Time (D-time) and Sequential Time (S-time) (Le Guen & Pool Balam, 2012; Evans, 2013; Núñez & Cooperrider, 2013; Sinha & Bernárdez, 2015; Pamies-Bertrán & Yuan, 2020).<sup>2</sup> In brief, D-time schemas conceptualize events from the standpoint of the present moment. Since the present moment is ever-changing, events ‘pass’ from future to past, hence its designation by some philosophers as “passage time”. D-time is the schematic basis of grammatical tense, in languages which have tenses; of many adverbial deictics like ‘tomorrow’ or ‘yesterday’; and of temporal

landmarks such as ‘next Christmas’. All metaphorical PASSAGE constructions necessarily involve D-time conceptualizations. S-time, in contrast, is tenseless, in that it represents events solely in terms of their ordering in a sequence of events, each of which can be marked as ‘earlier’ or ‘later’ than one or more other Ground events, and in which no event constitutes a privileged deictic centre. S-time is the time in which relations are specified by ‘before’ and ‘after’, by ‘earlier’ and ‘later’, and by ‘first’, ‘last’ and ordinal numbers such as calendric dates. In the remainder of this article the terms D-time and S-time are employed, rather than cognates such as Ego-RP and Time-RP, both to reinforce standardization of terms and because the schematic distinction is rendered more transparent (Walker *et al.*, 2017).

Mandarin Chinese (and some other languages, for example, Yukatec Maya: Bohnemeyer, 2002, 2009) is a language without morphological tense, so that speakers need to rely on “various factors such as the information provided by default aspect, the tense-aspect particles, and pragmatic reasoning to determine the temporal interpretation of sentences” (Lin, 2006: 1).<sup>3</sup> An additional and important lexical resource that can be used by speakers to explicitly mark temporal reference is provided by the spatial terms 前 *qian* ‘front’ and 后 *hou* ‘back’.<sup>4</sup> *Qian* and *hou* are frequently used in a variety of phrasal expressions, including:

1. Compound constructions that have meanings cognate with those of adverbial temporal deictics in English, e.g. *qian-tian*, front-day “the day before yesterday”; *hou-tian*, back-day “the day after tomorrow”; *qian-nian*, front-year “the year before last”; *cong-qian*, from-front “in the past, earlier”; *hou-nian*, back-year “the year after next”; *hou-lai*, back-come “in the future, later”; *jin-hou*, now-back “in the future, later”
2. Noun-modifying quasi-aspectuals, e.g. *qian-qi*, front-wife, “ex-wife”.

In all the above cases, as well as others documented by Izutsu & Izutsu (2016), FRONT maps to PAST and BACK to FUTURE.<sup>5</sup> This has led to the hypothesis that the mapping reflects a canonical facing of

Ego towards the past (similarly to that found in Aymara) (Alverson, 1994). However, other expressions imply an orientation of Ego to the future:

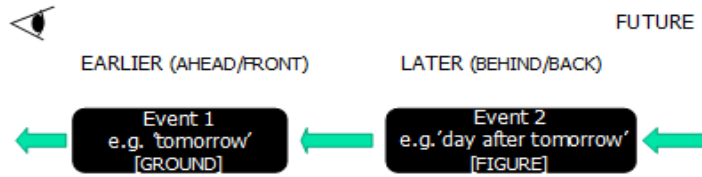
3. *qian-zhan* front-look, “look forward” [to the future]; *qian-tu* “front-road, “future, prospect”

It has been suggested that these apparently contradictory linguistic data attest to an intrinsic ambiguity in the canonical direction in which Ego faces in Mandarin Chinese, with a preferential direction of Ego facing the past (Ahrens & Huang, 2002). Other scholars have proposed, in contrast, that usages like (1) and (2) above instantiate a Moving Time schema, in which “the observer encounters the past first and the future next; the past is earlier and the future later than the present” and “the tip of front of moving time counts as the past, while its back or trace, as the future (Izutsu & Izutsu, 2016: 227; see also Yu, 2012; Cai, 2012; Wang, 2016; Liu *et al.*, 2018).

Note, however, that under this interpretation, the basic underlying schema for the meanings of *qian* and *hou* is one of S-time, a SEQUENCE of events, not just a single moving event as in familiar examples such as “Christmas is approaching”, whose underlying schemas are based only in D-time. Therefore, there is always implicit, in uses such as (1) and (2), both a Figure Event and a Ground Event: even if in the actual expressions the Ground Event in the ordered sequence is absent or elided (*hou-tian* ‘back-day’ = ‘day BACK OF [tomorrow]’ = ‘day after tomorrow’); and even if the S-time schema is frequently deictically anchored in an implicit NOW.

To explicate further: the Ground Event in uses such as (1) and (2) is either a single other event (such as tomorrow or yesterday), or an imagined (fictive) sequence of events, on a mental timeline in which events move from future to past, the earlier events being IN FRONT OF later events. There is then no need to posit a directional orientation of Ego to the past in Mandarin Chinese (as is apparently the case for Aymara), since the earlier (FRONT) event is encountered before the later

(BACK) event by an Ego facing the future (in front or ahead) (Figure 2).



**Figure 2.** Deictically-anchored Moving S-time schema, in which Ego encounters events in an *ordered event sequence*, with EARLIER events followed by LATER events along a timeline. In the example *hou-tian*, back-day ‘the day after tomorrow’, ‘tomorrow’ is conceptualized as the GROUND (Event 1) and ‘day after tomorrow’ is the FIGURE (Event 2); the EARLIER-LATER relation is construed according to the order of encounter by the Experiencer: Event 1 is encountered earlier and Event 2 later.

We therefore agree with Yu (2012: 1352) that earlier analyses proposing that in Mandarin Chinese Ego faces to the past, or that it may face either to the past or to the future, are based upon a “confusion of past with anteriority and of future with posteriority. Without Time-RP, the spatial words *qian* ‘front’ and *hou* ‘back’ in Chinese can only refer to the front and back of the ego, and times or events cannot have their own ‘front’ and ‘back’.”

In order to fully analyse the apparently contradictory data in Mandarin, it is necessary to invoke, in addition to the S-time vs. D-time distinction, a distinction between invariant MEANING and contextually variable USAGE. In cases such as those listed in (1) and (2), the terms *qian* and *hou*, though their meanings are primarily given by S-time, their *usage* is deictic; that is, although they refer to an event in a (virtual or fictive) sequence, they do so with explicit or implicit reference to a deictic NOW. Given that the primary SEQUENTIAL MEANINGS of *qian* and *hou* do not derive from the positioning of the temporal Figure event in relation to Ego, but from its position in an *ordered event sequence*, Ego in Chinese is readily interpreted (consistently with the arguments of Yu, 2012) as canonically facing towards the future. In such cases, *qian* usually (but not always) refers to a past event, and *hou* usually (but not always) refers to a future event. This is entirely consistent with the



(apparently contradictory) strictly deictic expressions *qian-zhan* front-look, “look forward” [to the future]; *qian-tu* “front-road, “future, prospect” (3 above), in which Ego also faces the future (FRONT). Expressions such as these might be regarded as instantiations of a LIFE IS A JOURNEY conceptual metaphor (Lakoff & Johnson, 1980), an interpretation supported by other expressions implying that the past is behind Ego, e.g. *hui-shou* ‘turn-head’ (look back, recollect). Such expressions, in which there is no Ground distinct from Ego, are *not* schematized by S-time, but *solely* by D-time.<sup>6</sup>

The resolution to the apparent inconsistency of the meanings of *qian* and *hou* consists, then, in recognizing that their (variable) temporal deictic (D-time) USES are secondary derivations of their primary (invariant) temporal sequential (S-time) MEANINGS. We submit that this analysis, of *variable*, deictically-anchored USES of *invariant* MEANINGS structured by S-time schematization, is a clearer and less ambiguous formulation than those previously proposed, upon which we have built. Our linguistic analysis receives support from the results of a corpus analytic study by Wu (2020), who concludes that “the primary temporal meaning of *qian* and *hou* is indicating time sequence, with *qian* meaning ‘earlier’ and *hou* meaning ‘later’” (Wu, 2020: 25). Wu goes on to say that “both *qian* and *hou* can refer to the future and the past. Their seemingly contradictory usage arises from the lack of a[n analytical] distinction between Ego-RP and Time-RP (pp. 25-26)”. Wu’s linguistic analysis parallels ours in many but not all respects: we return to the differences in the general discussion.

### 1.3 Previous relevant experimental studies

The above analysis is intuitively plausible, provides a comprehensive explanation of the linguistic facts, and is consistent with corpus data (Xiao, 2012; Wu, 2020). However, what empirical support can be found for its psychological reality? In an adaptation of the methodology employed by Fuhrman *et al.*, (2011), Xiao *et al.* (2018) used a congruency-priming task in a forced-choice paradigm to test temporal relational judgements of earlier/later (S-time) relations between two pictured parts of a sequence of events (e.g. an apple at different stages of being eaten). Participants moved a joystick in either vertical, lateral or sagittal orientation to judge whether the target (Figure)

event was earlier or later than the Ground. Analysis of participants' reaction times (RTs) showed that they responded reliably faster in sagittal FRONT-EARLIER, BACK-LATER trials than FRONT-LATER, BACK-EARLIER trials, and on the other axes there were reliable RT advantages for LEFT-EARLIER, RIGHT-LATER and UP-EARLIER, DOWN-LATER trials than their inverses. The design can be criticized on the grounds that pushing a joystick towards or away from Ego itself prompts or induces a deictic centre, and the words used in the instructions in Experiment 1 refer to spatial directions as well as temporal sequential order. However, the fact that the S-time congruent direction in Experiment 1 (FRONT-EARLIER, BACK-LATER) was preferred over the D-time congruent one (FRONT-FUTURE, BACK-PAST) suggests that a pragmatic inference from S-time "earlier" to D-time "past" was not a factor.

A second experiment used the same paradigm to test judgements of the pastness or futurity (D-time) of familiar and significant life events, presented as words. Consistently with D-time linguistic usages such as (3) above, and contrary to the response preferences in the first experiment, RTs for FRONT-FUTURE, BACK-PAST trials were reliably faster than for BACK-FUTURE, FRONT-PAST trials. Xiao *et al.* (2018) note that this finding is consistent with predictions from Yu's (2012) Time RP vs. Ego-RP distinction. Xiao *et al.* (2018) also found in Experiment 2 that UP-PAST, DOWN-FUTURE and LEFT-PAST, RIGHT-FUTURE reaction times were reliably faster than the inverse ones. It seems, then, that while on the SAGITTAL axis non-linguistic EARLIER and FUTURE map to the same pole, and so do LATER and PAST, on the VERTICAL and LATERAL axes the shared polarities are EARLIER-PAST and LATER-FUTURE, suggesting that there is "something different" about temporal conceptualizations on the sagittal axis, as compared with the lateral and vertical axes, at least as assessed in these nonverbal response tasks. However, another recent congruency-effect study by Ding *et al.* (2020) of PAST/FUTURE mappings found the "exceptional" axis to be the lateral one. Using a similar paradigm to that of Xiao *et al.*'s experiment 2, but with free choice of axis by participants, these investigators found that "the lateral time line could co-exist with the other two, while sagittal and vertical mental time lines could not co-exist with each other" (Ding *et al.* 2020: 103084), suggesting a different space-time mapping mechanism for the lateral axis on the one hand, and the sagittal and vertical axes on the other.

There have been a number of studies of temporal gesturing in both Mandarin Chinese and in Chinese Sign Language (e.g. Gu *et al.*, 2016, 2017, 2018, 2019), but most of these do not incorporate into their design expressions instantiating both S-time and D-time schemas. An exception is Li (2017), who investigated gestures by Mandarin Chinese speakers in sagittal, vertical and lateral axes, in two elicitation conditions. In the first condition, Chinese adaptations of the prompts used by Casasanto & Jasmin (2012: Experiment 1) were employed to elicit deliberate GESTURE-ONLY depictions of both EARLIER/LATER (S-TIME) and PAST/FUTURE (D-TIME) temporal relations. Prompts used either explicitly directional constructions, in either the sagittal or the vertical axis; or constructions without explicit marking of directionality. Results showed that participants' gestures were roughly equally distributed between the three axes (although explicit directional prompts were only presented for sagittal and vertical axes); with a significant influence of directional prompts. Reliably more gestures received 'congruent' codings, with the mappings LEFT=EARLIER=PAST / RIGHT=LATER=FUTURE; UP=EARLIER=PAST / DOWN=LATER=FUTURE; FRONT=EARLIER=PAST / BACK=LATER=FUTURE, than inverse incongruent codings: N.B. 'congruence' in the sagittal axis was defined, although this is not made explicit, by the S-TIME schema and its projection from EARLIER to PAST and from LATER to FUTURE.<sup>7</sup> Unfortunately, no separate analyses of the S-time vs D-time trials are reported. However, it seems that in this condition (as was also the case for Xiao *et al.* 2018 Experiment 1) the S-time mapping schema dominated, or was resistant to being over-ridden by, the D-time schema.

In the second elicitation condition, using the paradigm reported in Walker & Cooperrider (2016), and similarly to Xiao *et al.* (2018), the prompts were single words referring to time-related, past and future referring concepts. Participants were asked (with no mention of gesture) to provide a definition of the words, and their CO-SPEECH GESTURES were coded for 'congruence' with the same definitions as in the first condition. The most interesting finding was that while the overwhelming (and significant) majority of gestures in the lateral and vertical axes received 'congruent' codings, there was a significant majority of 'incongruent'-coded gestures in the sagittal axis. In other words, in a converse pattern to the gestures produced (without speech) in elicitation condition 1,

participants in elicitation condition 2 were more likely to produce co-speech gestures with the D-time mapping pattern FRONT=FUTURE and BACK=PAST.

Although Li (2017) does not draw this conclusion, it is possible that differential priming by different instructional prompts in elicitation conditions 1 and 2 was responsible for inducing different preferential schematizations in sagittal gesture (S-time in condition 1, D-time in condition 2). A more exhaustive analysis of the data would be necessary to test this hypothesis. What does clearly seem to be the case is that the mere presence of the words *qian* and *hou* was not sufficient in elicitation condition 2 to prime an S-time schematization bias in co-speech gesture. This is nicely illustrated by an example of apparently *opposite* directionalities conveyed in the same utterance by lexicalization and by co-speech gesture (Li, 2017: 410): “a speaker says *YI-QIAN jiu-shi guoqu de shi-jian* ‘THE PAST[FRONT] refers to the time period which has passed’ while moving her right hand simultaneously backward.” Li (2017) interprets this as indicating a possible dissociation between temporal language and temporal thinking (Casasanto, 2016). It is also possible, however, that the example is illustrative of the CONVENTIONALIZATION and ENTRENCHMENT of D-time interpretations of S-time schematized expressions lacking Ground specification, such as *yi-qian* ‘in the past, earlier, before’ (Yu, 2012: 1337).

#### 1.4 Research focus and hypotheses

The main focus of our study (FOCUS A) is on the temporal uses of the terms *qian* ‘front’ and *hou* ‘back’. Two principal hypotheses flow directly from our linguistic-conceptual analysis in Section 1.2.

H1: The primary (invariant) temporal sequential (S-time) MEANINGS of *qian* and *hou* are (respectively) ‘earlier’ and ‘later’.

H2: The (variable) temporal deictic (D-time) USES of *qian* and *hou* to refer to ‘past’ and ‘future’ are secondary, and are governed by contextual, discourse pragmatic and constructional constraints.

The secondary focus of the study (FOCUS B) is on the still-unresolved issue of the relative dominance of the three spatial orientational axes that have been identified as underlying the representation of temporal relations by Mandarin Chinese speakers. As well as the sagittal ‘front-back’ axis, the vertical ‘up-down’ and lateral ‘left-right’ axes are also employed by Mandarin Chinese (and Chinese Sign Language) users. This study aims to establish (a) *which of the three orientational axes is dominant* in the spontaneous lexicalization of temporal sequence in Mandarin, and (b) *whether the same axis is dominant in both linguistic and non-linguistic representations of temporal sequence*. The findings of the experimental and elicitation studies reviewed in Section 1.3 suggest complex interactions between production modality (VERBAL VS NONVERBAL ACTION/GESTURE), schematization (S-TIME VS D-TIME) and axis (LATERAL, VERTICAL, SAGITTAL) in Mandarin Chinese space-time mapping. Boroditsky (2001, 2008) proposed that Mandarin Chinese speakers preferentially conceptualize time on the vertical axis as a result of its prevalence in linguistic metaphorical usage. An analysis of news corpora in Mandarin Chinese by Chen (2007: 429) demonstrated, however, that horizontal axis temporal expressions were significantly more frequent than vertical axis temporal expressions, although the analysis did not distinguish sagittal from lateral horizontal expressions. Ding *et al.* (2020)’s congruence study, as well as suggesting a possible different mechanism for lateral axis mapping than for the other two axes, found an advantage for the vertical axis over the sagittal axis. However, in the dataset of non-directionally cued co-speech gestures elicited by Li (2017), reliably more gestures were produced on the lateral than on the vertical axis, and vertical axis gestures were in turn significantly more frequent than sagittal gestures. On the basis of these previous studies, we propose the following hypotheses:

H3: The preferred *lexicalization* of temporal sequence in contemporary Mandarin Chinese employs the sagittal terms *qian* ‘front’ and *hou* ‘back’.

H4: The order of preference for the orientational axes of *nonlinguistic* temporal sequential mappings by contemporary Mandarin Chinese speakers is LATERAL > VERTICAL > SAGITTAL.

The methods used in the five experiments reported below are controlled language elicitation (sentence completion tasks) (Experiments 1, 3, 4 and 5) and non-linguistic reproduction of temporal sequences (Experiment 2). All experimental procedures were approved by the Ethics Committee of the School of Foreign Languages, Hunan University.

## 2. Experiments and Results

### 2.1 Experiment 1: Time sequence lexicalization

*Rationale:* This experiment uses a sentence completion task to establish the preferred lexicalizations by Mandarin speakers of temporal sequences of events viewed from a neutral perspective outside the temporal sequence. The stimuli are pictorial event sequences. The focus of the experiment is therefore on POSITIONAL LINGUISTIC S-TIME CONCEPTUALIZATIONS. Experiment 1 tests H1, that the primary (invariant) temporal sequential (S-time) MEANINGS of *qian* and *hou* are (respectively) EARLIER and LATER; and H3, that the preferred lexicalization of temporal sequence in contemporary Mandarin Chinese employs the sagittal terms *qian* and *hou*, rather than either vertical or lateral terms.

*Participants* were 55 native Mandarin speakers (studying English as their foreign language) from Hunan University (27 male, 28 female, median age 18). Participants were divided into six groups, with approximately 10 in each group. All participants had normal or corrected-to-normal vision and took part with informed consent in exchange for a small payment.

*Materials* Five sets of four pictures each stood for different event sequences: PHASES OF THE MOON; HUMAN LIFE STAGES; CHINESE IMPERIAL DYNASTIES; MONTHS OF THE YEAR; SEASONS. The event sequences were selected to represent natural, historical and conventional sequences that could be assumed to be culturally and linguistically familiar to all participants. Each picture was labelled with the appropriate, conventional Chinese character(s) (e.g., 春 *chun*, 'spring'). The vertical axial spatial terms 上 *shang* 'up', 下 *xia* 'down' appeared in labels for e.g. the moon's phases, but no labels included the sagittal terms *qian* and *hou* or lateral left-right terms.

*Procedure* Participants were not informed of the purpose of the experiment. The five picture sequences were presented on projector screen to all participants simultaneously. The order of presentation *between* sequences was counterbalanced, and the canonical serial order *within* sequences was constant. After presentation of a fixation cross for 5 seconds, four pictures in their canonical temporal sequence appeared, one at a time, in the centre of the screen. After the fourth picture the fixation cross re-appeared and the next sequence was presented. Note-taking was not allowed. A sentence completion task was administered after presentation of all five sequences. Participants were required to fill in the blanks in four sentences per event sequence on a response sheet (self-paced task). The incomplete sentences invited the participant to complete them by specifying a temporal Figure-Ground relationship in terms of a POSITIONAL schema. The sentences with blanks took the form of the first line in Example 1 below, where A and B are picture labels:

1) A        在        B        (的)        \_\_\_\_\_。

*Gloss:*

A        zai.LOC B        (de.GEN)\_\_\_\_\_。

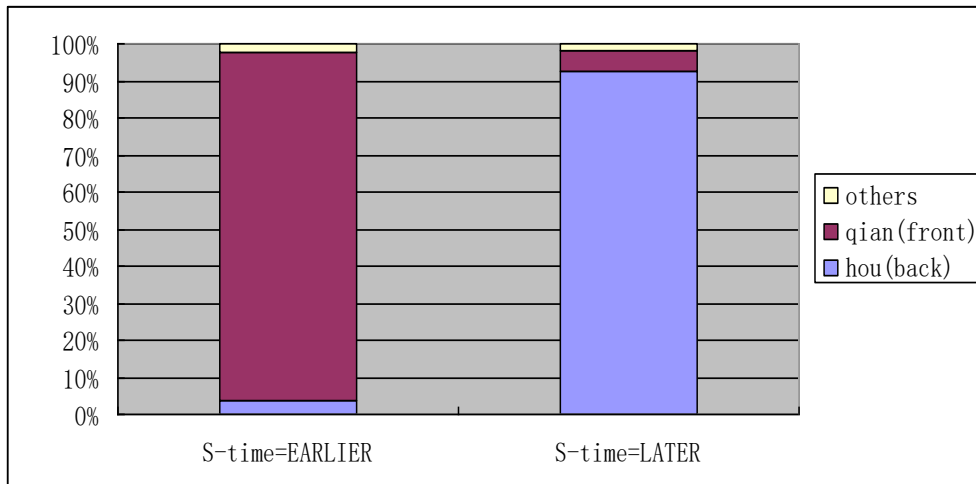
*Translation:*

A        is        \_\_\_\_\_ B

In half the sentences Event A (Figure) came before Event B (Ground) in the previously presented temporal sequence (S-time EARLIER condition); and in the other half Event A came after Event B (S-time LATER). 5 versions of the response protocol were administered so that at least 2 participants in each group received the same protocol. The order of sentences *within* each sequence and the order of sentence groups *between* sequences were counterbalanced in the sentence protocols. No reversal pairs of A and B were included in any response protocol. Note that the Chinese sentence (unlike the English equivalent) grammatically primed a spatialized temporal relational construction employing a locative item. The task is otherwise open-ended, aiming to measure agreement between participants in the relational terms chosen, their direction and orientation, e.g. *qian* 'front' - *hou* 'back' vs. *shang* 'up' - *xia* 'down'.

### Results and discussion

Responses were categorized according to lexicalization: *qian* ('front/before'), *hou* ('back/after'); *shang* ('up'), *xia* ('down'); *zuo* ('left'), *you* ('right'). No responses did not fall into one of these categories; there were no null responses and no erroneous responses. Figure 3 displays percent responses by condition (S-time EARLIER VS LATER).



**Figure 3.** Percent Lexicalization Response Type Frequencies by Condition (Experiment 1). See Table 1.

It is evident that the overwhelming majority (95 %) of responses followed the sagittal mapping of EARLIER- $\rightarrow$  *qian*, LATER- $\rightarrow$  *hou* (Chi-square one-sample sagittal vs non-sagittal = 1012.68,  $p < 0.001$ ). This result ran counter to possible priming effects, since some picture labels included the vertical directional terms *shang* and *xia*, while no labels included the sagittal terms *qian* and *hou*. In terms of directionality, only 5 % of *qian* and *hou* responses showed the *reverse* sagittal mapping of LATER  $\rightarrow$  *qian*, EARLIER  $\rightarrow$  *hou*. This result establishes conclusive baseline data in support of the general consensus that the S-time meanings of *qian* and *hou* are respectively EARLIER and LATER. Most such reverse mappings occurred for the sequences 'Chinese Imperial Dynasties' (which were probably errors due to failure to remember dynastic order), 'Phases of the moon' and 'Seasons of the year'. Interestingly, the latter two were the stimulus sequences that are natural and cyclic in nature (Bender & Beller, 2014). The difference between different sequence types in mapping direction frequencies was, however, non-significant ( $p = 0.972 > 0.05$ , Fisher exact test).



Although responses involving lexicalizations of the vertical and lateral axes were negligible in frequency compared with sagittal axis lexicalizations, there were significantly more vertical than lateral lexicalizations (Chi-square vertical vs lateral=13.5,  $p < 0.001$ ). Overall, these results provide support both for H1 (the primary (invariant) temporal sequential (S-time) MEANINGS of *qian* and *hou* are, respectively, ‘earlier’ and ‘later’) and for H3 (the preferred *lexicalization* of temporal sequence in contemporary Mandarin Chinese employs the sagittal terms *qian* ‘front’ and *hou* ‘back’); and disconfirm the hypothesis that the postulated (but contested) primacy of the vertical axis in the non-linguistic cognition of Mandarin Chinese speakers (Boroditsky, 2001, 2008) is due to its prevalence in spontaneous linguistic space-time expressions. However, the results also indicate that in the lexicalization of temporal sequence the vertical axis terms *shang* ‘up’ and *xia* ‘down’ are preferred to the lateral axis terms *zuo* ‘left’ and *you* ‘right’.

## 2.2 Experiment 2: Time sequence reproduction

*Rationale:* Experiment 1 showed that the order of preference of orientational axes in spontaneous lexicalisations (and by implication linguistic conceptualizations) of temporal sequences in Mandarin Chinese is SAGITTAL > VERTICAL > LATERAL, with the SAGITTAL axis being overwhelmingly preferred. We noted in our literature review, however, that previous studies (Ding *et al.*, 2020; Li, 2017) suggest that hypothesis (H4) that the order of preference of NONLINGUISTIC temporal sequential space-time mappings of contemporary Mandarin Chinese speakers is LATERAL > VERTICAL > SAGITTAL. Experiment 2 tests this hypothesis, employing a well-established picture-card placement paradigm.

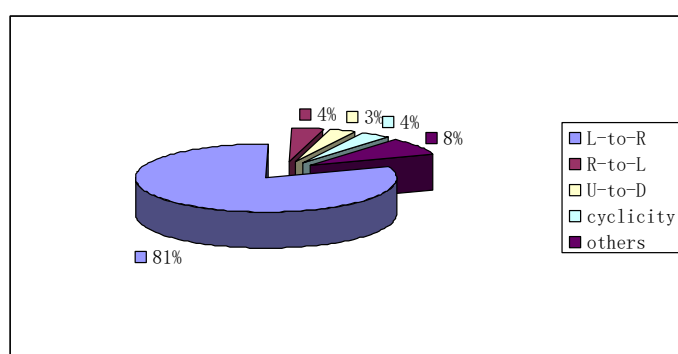
*Participants* were the same as participated in Experiment 1. All participants had normal or corrected-to-normal vision and took part with informed consent in exchange for a gift.

*Materials* The five sets of sequential pictures used in experiment 1 were produced as sets of 7cm×8cm cards. A white paper board (90cm×100cm) was attached to each participant’s desk.

*Procedure* Experiment 2 was administered after Experiment 1. The procedure was similar to that of Bergen & Chan Lau (2012) (see also Tversky *et al.* 1991). Participants were told that there were five sets of cards and to arrange each set on the white board, one set at a time, packing up when finishing each set before arranging the next. They were instructed that the spatial arrangements should reflect the temporal sequence and their answers in task 1. The sets of cards were shuffled and order of presentation of sets was randomized. Tasks were self-paced and video recorded.

### *Results and discussion*

Responses were categorized according to the spatio-temporal order in which participants placed the sets of cards on the white board: LEFT-TO-RIGHT (L-to-R), RIGHT-TO-LEFT (R-to-L), UP-TO-DOWN (U-to-D), in a circular pattern (cyclicity) and others (e.g. a 'Z' shaped sequence).<sup>8</sup> There were no down-to-up responses, and no cases where a participant made no responses. It should be noted that there is a confound in this widely-used design, due to the reduction of the three spatial dimensions of perception and action to a two-dimensional array. U-to-D responses (which are those that are perpendicular to the lateral axis) may therefore be based on either vertical or sagittal axes of conceptualization. Figure 4 shows results as percent frequencies of responses across all trials, excluding inconsistent or uninterpretable responses.



**Figure 4.** Percent Card Placement Response Type Frequencies across all trials (Experiment 2). See Table 2.

The results support the hypothesized primacy (H4) of the LATERAL axis in NONLINGUISTIC temporal sequential mappings of contemporary Mandarin Chinese speakers. The overwhelming

majority of responses followed the lateral axis of orientation (Chi-square one-sample lateral vs. non-lateral =120.62,  $p<0.0001$ ), and within the lateral responses the overwhelming majority followed the mapping direction LEFT-EARLIER / RIGHT-LATER (Chi-square one-sample=173.08,  $p<0.0001$ ), replicating the findings of the previous sequential card placement study by Bergen and Chan Lau (2012) (note that modern mainland Chinese orthography is L-to-R). Even the previous production in Experiment 1 of *qian* ‘front’ and *hou* ‘back’, and explicit reference to Experiment 1 in the instructions to participants, failed to prime the sagittal/vertical UP-DOWN axis in the nonverbal reproduction of the temporal sequences in Experiment 2 (the relatively small number of U-D responses could be interpreted, as we noted above, as resulting from either UP-EARLIER / DOWN-LATER or FRONT-EARLIER / BACK-LATER mappings).

What is most striking is the contrast between the highly significantly preferred SAGITTAL axis for the *lexicalization* of S-time relations (FRONT-EARLIER / BACK-LATER) in Experiment 1, and the highly significantly preferred LATERAL axis for the *nonverbal* representation (LEFT-EARLIER / RIGHT-LATER) of exactly the same sequences, by the same participants, in Experiment 2. The difference between the lateral vs non-lateral axis responses in Experiment 1 and Experiment 2 is highly significant ( $p<0.001$  Fisher exact probability test).<sup>9</sup> This calls to mind the results of co-speech gesture studies by Casasanto and Jasmin (2012) in English and Li (2017) in Mandarin Chinese, reinforcing the argument that there can be a dissociation between ‘thinking for speaking’ (Slobin, 1996) and ‘thinking for action/gesture’ (see also Casasanto, 2016).

### 2.3 Experiment 3: Travelling the subway 1 (Moving Time, sagittal axis)

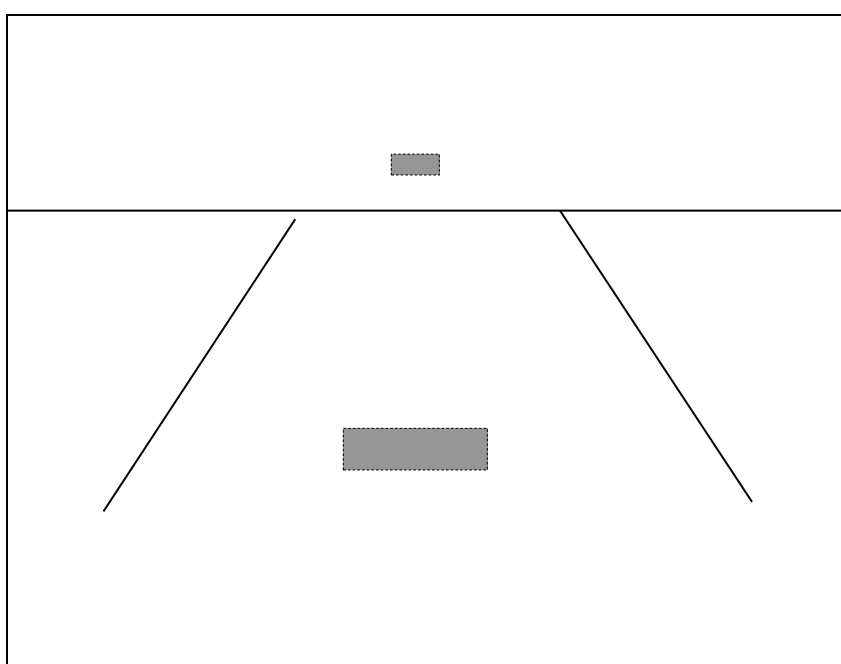
*Rationale:* Recall that H1 (that the primary, invariant S-time MEANINGS of *qian* and *hou* are, respectively, ‘earlier’ and ‘later’, and H3 (that the preferred lexicalization of temporal sequence in contemporary Mandarin Chinese employs the sagittal terms *qian* ‘front’ and *hou* ‘back’), were both supported by Experiment 1. However, the design of Experiment 1 investigated only stative POSITIONAL schematization of S-time relations. In order to investigate the contextual interaction of these

meanings with D-time reference to PAST and FUTURE, it is necessary also to use designs involving relative motion of Ego and Event. Experiment 3 employed an original experimental paradigm to achieve this goal, simulating motion in a Metro (subway) train. A MOVING TIME schema (events passing Ego on a timeline from future to past) was primed by presenting to participants (in the role of Experiencer) a simulation of the subjective experience of the apparent motion of subway stations past an Experiencer sitting in a train; with the Experiencer facing either towards the (FUTURE) destination station (FACING FORWARD condition) or towards the (PAST) origin station (FACING BACKWARD condition).<sup>10</sup> In both conditions the PAST->FUTURE D-time line had the same direction as the EARLIER->LATER S-time line (see Fig. 2 above). In the FACING FORWARD condition Ego faces the FUTURE, while in the FACING BACKWARD condition Ego faces the PAST. Experiment 3 tested H1 and H3 in these two different MT motion event conditions, by eliciting Figure-Ground constructions using spatial directional terms, using the same sentence completion paradigm as in Experiment 1. The goal was to establish whether the lexicalization of this axis follows an invariant S-time mapping (Figure EARLIER/LATER than Ground); and if so whether the preferred lexicalizations encode the sagittal axis of motion using the terms *qian* and *hou*.

*Participants* were 80 native Mandarin Chinese speaking students at Hunan University of Technology and Business (36 male, 44 female, median age 18). All participants had experience of travelling the Changsha Metro and their familiarity with the Metro line was established through pre-test. All participants had normal or corrected-to-normal vision and took part with informed consent in exchange for a gift.

*Materials and procedure* All participants were tested individually in a lab with no prior information about the purpose of the experiment. Half the participants experienced the FACING FORWARD condition, and the other half the FACING BACKWARD condition. 5 station names (containing no orientational directional cues) from the Changsha Metro line were presented in succession along the sagittal line in the centre of computer screen (17-in, refresh rate 75Hz and resolution 1280×1024

pixels), representing a Metro journey. Each trial began with a fixation cross for 800 ms. Following this, in the FACING FORWARD condition, each APPROACHING station name started as a small image, grew and was presented at full size for 600 ms to represent the station stop, before disappearing and being replaced by the next station name. In the FACING BACKWARD condition, each RECEDING station name started as full size and became progressively smaller before vanishing (see Figure 5). The “journey” was accompanied by a realistic (recorded) sound track. The whole animated video clip lasted for 2 minutes and 11 seconds.



**Figure 5.** The schematic “journey” along the metro line. The greyed rectangles represent APPROACHING (FACING FORWARD condition) or RECEDING (FACING BACKWARD condition) station names (Experiment 3).

Participants were then administered a sentence completion task on a response sheet. The sentences took the same form as those used in Experiment 1 (Example 1), except that A and B were station names.

- 1) A      在      B      (的)      \_\_\_\_\_。

*Gloss:*

A      zai.LOC B      (de.GEN)\_\_\_\_\_。

*Translation:*

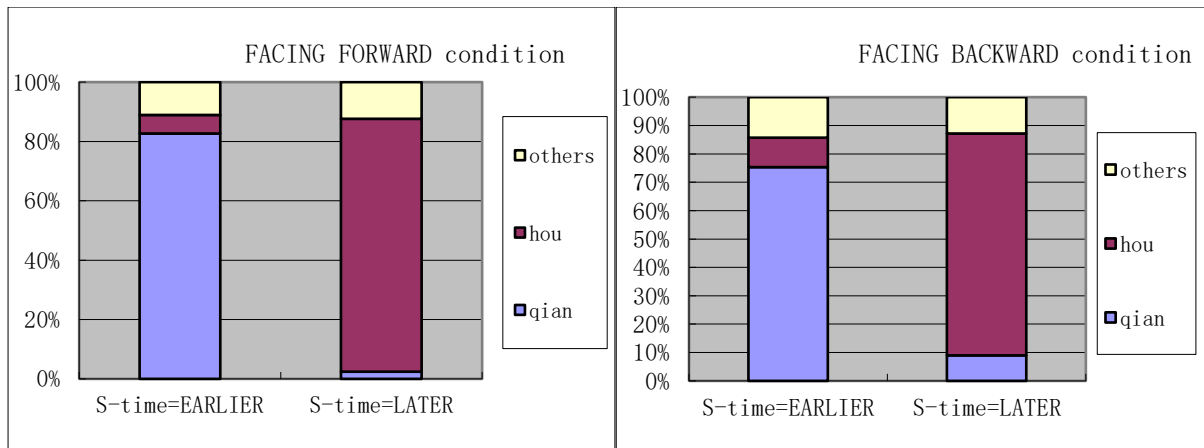
Station A      is      \_\_\_\_\_ Station B

The required response sentences therefore conceptualize Figure-Ground relations, but (unlike in Experiment 1) Ego is inserted in the path of motion of Figure and Ground, according to a deictically-anchored Moving S-time schema in which Ego encounters events in an ordered event sequence, with EARLIER events followed by LATER events along a timeline (Fig. 2 above).

Half the sentences (when correctly filled in) expressed an S-time EARLIER construal and the other half an S-time LATER construal. There were two versions of the response sheet, each consisting of 4 test sentences and 6 prime/filler questions such as “are the stations growing bigger or smaller?”, “are the stations moving close to, or away from, you?”, “are you facing towards the head or tail of the train?”, all of which related specifically to the station stops moving relative to Ego in the train. Since the task involved memory, participants were instructed to play the journey loop as many times as they felt necessary to memorize the sequence.

## *Results*

Responses were categorized according to the lexicalization of the spatio-temporal directional relation *qian* ‘front’, *hou* ‘back’, *shang* ‘up’, *xia* ‘down’, *dong* ‘east’, *xi* ‘west’, *nan* ‘south’ and *bei* ‘north’. There were no responses that did not fall into one of these categories, and there were no null responses. Responses were further divided according to sequential construal type (whether station A was encountered by subjects EARLIER than, or LATER than, station B). Results are shown in Figure 6 as percent frequencies of response types.



**Figure 6.** Percent lexicalization response frequencies by experimental condition (FACING FORWARD VS FACING BACKWARD) and sequential construal type (A LATER THAN VS EARLIER THAN B) (Experiment 3). See Table 3.

The overwhelming majority of responses ( $n=277$ , 87.38%) involved a mapping of the S-time relations EARLIER and LATER to the respective spatial sagittal axis lexicalizations *qian* ‘front’ and *hou* ‘back’. Of the other terms (*shang*, *xia*, *dong*, *xi*, *nan*, *bei* – there were no *zuo* and *you* responses) the majority were vertical axis terms *shang* ‘up’ and *xia* ‘down’. There was no difference between the FACING FORWARD and the FACING BACKWARD conditions in the total response preference patterns for EARLIER and LATER construals. The predicted (H1) mappings of EARLIER- $\rightarrow$ *qian*, and LATER- $\rightarrow$ *hou* were significantly more frequent than the reverse mappings EARLIER- $\rightarrow$ *hou* and LATER- $\rightarrow$ *qian* in both the FACING FORWARD condition and the FACING BACKWARD condition ( $p<0.001$ , Fisher exact probability test, both conditions).<sup>11</sup> The vertical axis mappings of EARLIER- $\rightarrow$ *shang* and LATER- $\rightarrow$ *xia* were also significantly more frequent than the null-frequency reverse mappings of EARLIER- $\rightarrow$ *xia* and LATER- $\rightarrow$ *shang* in both the FACING FORWARD condition ( $p<0.001$ , Fisher exact probability test) and the FACING BACKWARD condition ( $p<0.001$ , Fisher exact probability test). The relative frequency of the reverse mapping EARLIER- $\rightarrow$ *hou* / LATER- $\rightarrow$ *qian* was observably higher in the FACING BACKWARD condition than in the FACING FORWARD condition.

### Discussion

This novel experimental paradigm involved the simulated motion IN BOTH SPACE AND TIME of events/entities (station stops) relative to an Experiencer. Assuming that the terms *qian* and *hou* are

used with temporal (not spatial) meanings, the result that participants in *both* the FACING FORWARD and FACING BACKWARD conditions overwhelmingly employed EARLIER->*qian*, LATER->*hou* mappings supports both H1 and H3, and our analysis of the primacy of the S-time meaning of these terms. These predicted lexicalization mappings held regardless of whether participants were facing the future or the past. A small minority of participants chose to employ vertical axis terms, and did so without error. This experiment also provides clear evidence that participants are indeed using the terms *qian* and *hou* with temporal (not spatial) meanings. In both conditions, the experiencer will encounter the earlier station BEFORE THE LATER ONE in time. In the FACING FORWARD condition, the experiencer will also perceive the earlier station as IN FRONT OF THE LATER ONE in space. In the FACING BACKWARD condition, however, the experiencer will perceive the earlier station AS BEHIND (IN BACK OF) THE LATER ONE in space, provided the experiencer's orientation is maintained. Despite the deictic anchoring of the simulated motion of the stations in Ego's perspective, relatively few participants reversed the mapping pattern in the FACING BACKWARD condition, which argues *against* any hypothesis of the primacy of spatial deictic meaning 'front' over the temporal sequential meaning 'earlier' for *qian* (and the same argument applies to *hou*). This result supports (H2) that in temporal conceptualization, too, the S-time meanings of *qian* and *hou* are not only invariant, but dominate over their variable D-time interpretations.

## 2.4 Experiment 4: Travelling the subway 2 (Moving Ego, lateral axis)

*Rationale:* Recall that in Experiment 3, the simulated spatio-temporal motion was along the sagittal axis. Recall also that in Experiment 2, which involved the non-linguistic reproduction of temporal sequence, the strongly preferred axis employed by participants was lateral LEFT-EARLIER / RIGHT-LATER, in accordance with the conventional orthographic layout of modern Mandarin Chinese characters (Bergen and Chan Lau, 2012). In real life, sitting passengers on the Changsha Metro face the sides of the carriage, and the progress of the train is marked by a light that moves on an electronic display on the carriage side that shows all the stations on the Metro line, displayed on a linear map in both



Chinese characters and Pinyin (Roman) orthography. Depending on which side of the carriage the passenger is sitting, they will see the light marking the next station stop move either from left to right or from right to left. In Experiment 4 we showed participants audio-video recordings of the changing display during actual Metro journeys. There are two principal motivations for this design. First, the moving light indicating the position of the train should prime a Moving Ego schema (as opposed to the Moving Time schema primed in Experiment 3). Second, the light moving from LEFT-TO-RIGHT and RIGHT-TO-LEFT should prime lateral left and right lexicalizations (*zuo* 'left' and *you* 'right') of temporal sequential relations, as opposed to the priming by direction of motion of sagittal axis lexicalizations in Experiment 3.

The aim of Experiment 4 is therefore to test whether H3 (that the preferred lexicalization of temporal sequence in contemporary Mandarin Chinese employs the sagittal terms *qian* 'front' and *hou* 'back') holds even in (simulated) Motion Event contexts in which Ego is moving from left to right or from right to left. Given the dissociation we have found in Experiments 1 and 2 between the preferred axes for linguistic and nonlinguistic space-time mapping, we expect that the axis of simulated motion may modulate the selection of the axis for the linguistic conceptualization of the lexicalized S-time relationship, but not to fully determine it. Experiment 4 also permits us to establish the possible influence of the directionality of Ego's lateral motion (left-to-right vs. right-to-left) on the consistency of the predicted lexicalization patterns on all axes: EARLIER->LEFT, LATER->RIGHT; EARLIER-> FRONT, LATER->BACK; EARLIER->UP, LATER->DOWN.

*Participants* were 32 native Mandarin Chinese speaking students from Hunan University of Technology and Business (18 male, 14 female, median age 18). All participants had experienced travelling the Changsha Metro at least 3 times and their familiarity with the Metro line was established through pre-test. All participants had normal or corrected-to-normal vision and took part with informed consent in exchange for a gift.

**Materials and procedure:** All participants were tested individually in a lab with no prior information about the purpose of the experiment. In the MOTION SALIENT CONDITION, participants were shown on a 14" screen (refresh rate 60 Hz and resolution 1280×800 pixels) a 3'27" video clip with soundtrack filmed on the Changsha metro, recording a journey segment displayed on the train's linear electronic map. The aim was that the video clip should be as realistic as possible. The relative (left-right) positions of the stations remained constant across LEFT-RIGHT and RIGHT-LEFT motion direction trial sets, simulating the two opposite seating positions of metro travellers. Direction of motion was cued by moving illumination of station stops and by arrows pointing LEFT or RIGHT (Figure 7).



**Figure 7:** Screen shots from the LEFT-RIGHT and RIGHT-LEFT presentation types of the MOTION SALIENT CONDITION (Experiment 4).

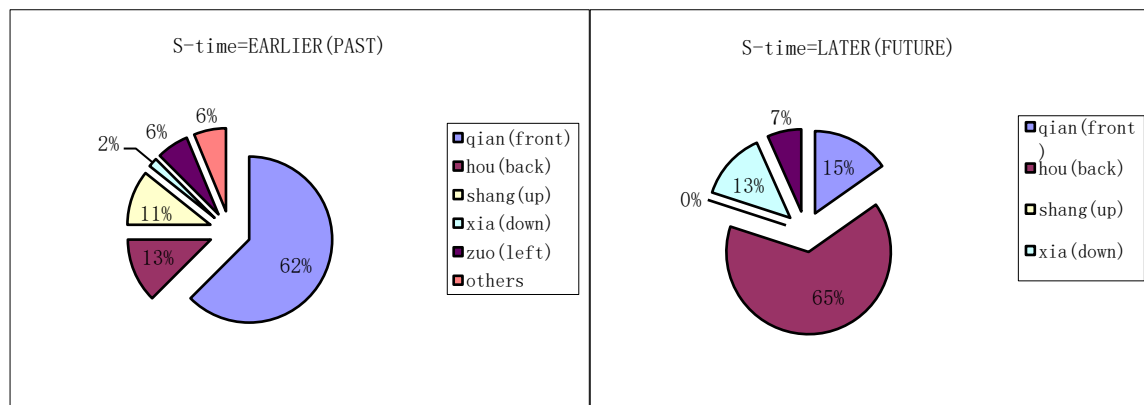
The LEFT-RIGHT and RIGHT-LEFT motion direction trial sets were counterbalanced across subjects. Because the condition was intended to be as realistic as possible, some directional cues were present in the video clip, e.g. the vertical term 下 *xia* 'down' appeared both in the audio channel and on the screen display; and the cardinal directional morphemes 东 *dong* (east), 西 *xi* (west), 南 *nan* (south) occurred in some of the station names. There were no cues that could prime the sagittal terms *qian* and *hou* in either the video clip or in the instructions to participants.

Participants were instructed to complete sentences that had the same form as in Experiment 3 on the response sheet, while watching the videos and wearing earphones. There were two versions of the response sheet, each consisting of 14 test sentences and 11 filler questions, e.g. “where are you standing in the train?”, “what’s the colour of the arrow that you see in the displaying screen?”, “do you move in the same direction as the arrow shows?”, all of which related to the experiencer’s location and motion within the train.

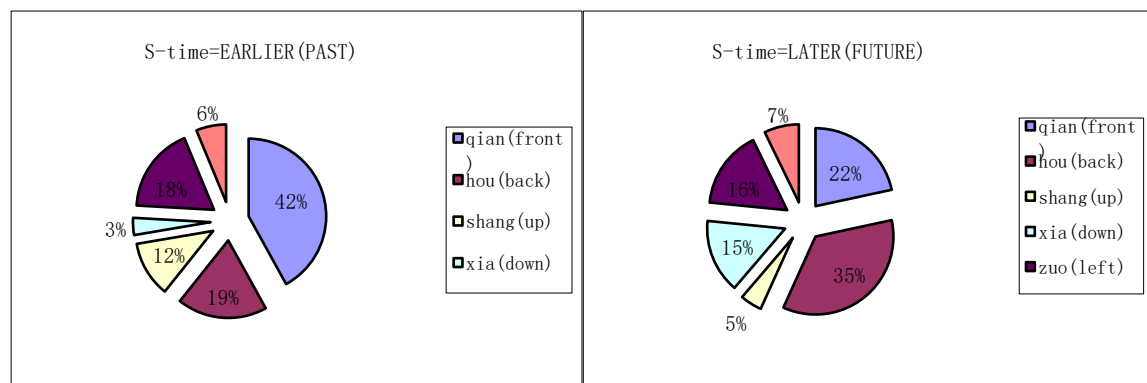
## *Results*

Responses (lexicalizations in the sentence completion task) for the MOTION SALIENT condition were coded according to the following categories: *qian* ‘front’, *hou* ‘back’, *shang* ‘up’, *xia* ‘down’; *zuo* ‘left’, *you* ‘right’; *dong* ‘east’, *xi* ‘west’. There were no responses that did not fall into these categories, and there were no cases in which a participant made no response. Figure 8 shows percent responses for sentences representing event pairs in which station A (Figure) was encountered by subjects either EARLIER than, or LATER than, station B (Ground) (EARLIER vs LATER sequential construals); separately charted for LEFT-TO-RIGHT and RIGHT-TO-LEFT motion direction trial sets.

## LEFT-TO-RIGHT SIMULATED MOTION TRIALS



## RIGHT-TO-LEFT SIMULATED MOTION TRIALS



**Figure 8:** Percent lexicalization responses by simulated direction of motion and EARLIER vs LATER sequential construals (Experiment 4). See Table 4.

It is evident that, despite the priming of the LATERAL axis of simulated motion, the majority ( $n=299$ ) of lexicalizations produced across all trial types were SAGITTALLY ORIENTED (*qian* ‘front’ or *hou* ‘back’). In Experiment 3 the preference for sagittal axis mappings was overwhelming (87.38% of all responses), while in Experiment 4 this preference was significantly less pronounced (66.89% of all responses;  $p < 0.001$ , Fisher exact test). The difference between the proportions of sagittal vs non-sagittal lexicalizations was nonetheless significant for both EARLIER (Chi-square one sample 222.5  $p < 0.001$ ) and LATER (Chi-square one sample 203.49  $p < 0.001$ ) sequential construals, with no significant differences in the frequencies of sagittal mappings between the two construal types (152 vs. 147). This finding underlines the generality of the preference to lexicalize S-time construals in terms of the sagittal axis, as was also found in Experiments 1 and 3.

However, unlike in Experiment 3, direction of simulated motion (in this case LEFT-RIGHT vs RIGHT-LEFT) did have a significant effect on the overall frequency distributions of responses for both EARLIER (Chi-square test of independence 47.63  $p < 0.001$ ) and LATER (Chi-square test of independence 51.25  $p < 0.001$ ) sequential construals of sagittal lexicalizations.<sup>12</sup> In particular, sagittal axis responses were proportionally more frequent than non-sagittal responses in the LEFT-RIGHT than in the RIGHT-LEFT motion direction conditions (Chi-square test of independence 9.157191  $p < 0.001$ ). The proportional difference between responses lexicalizing direction on the sagittal axis vs other axes held for both EARLIER ( $p = 0.032$ , Fisher exact test) and LATER ( $p = 0.005$ , Fisher exact test) sequential construals, with no difference between the two construal types. There were no differences between LEFT-TO-RIGHT and RIGHT-TO-LEFT conditions in the relative frequencies of *qian* and *hou* responses, but there was a significant and salient difference in the S-time sagittal mapping patterns between these conditions. In both conditions, there were more lexicalizations instantiating the predicted mapping of EARLIER->*qian* 'front', LATER->*hou* 'back' than 'reverse sagittal mapping' lexicalizations (EARLIER->*hou*, LATER->*qian*); but the proportion of reverse sagittal mappings was significantly higher in the RIGHT-TO-LEFT condition than in the LEFT-TO-RIGHT condition ( $p < 0.002$ , Fisher exact test).

In this experiment, the second most frequent lexicalization axis ( $n = 67$ ) comprised the VERTICAL terms *shang* 'up' and *xia* 'down'. The predicted mapping of EARLIER->*shang* 'up', LATER->*xia* 'down' was significantly more frequent than the reverse vertical mapping pattern (Chi-square one sample 28.9,  $p < 0.001$ ), with no difference between the LEFT-TO-RIGHT and RIGHT-TO-LEFT conditions. This is consistent both with previous findings and with the nonverbal response pattern in Experiment 2. While in Experiment 3 participants produced no lateral (Left-Right) axis lexicalizations, this was the third most frequent ( $n = 53$ ) axis of lexicalization in Experiment 4, with significantly higher frequency in the RIGHT-LEFT than in the LEFT-RIGHT motion direction condition (Chi-square one sample 10.86,  $p = 0.001$ ). The lexicalization patterns in the lateral axis were effectively determined (with only one exception) by the direction of simulated motion: with EARLIER->*zuo* 'left', LATER->*you* 'right' in the LEFT-TO-RIGHT condition, and EARLIER->*you* 'right' and LATER->*zuo* 'left' in the RIGHT-TO-LEFT condition

( $p < 0.001$ , Fisher exact test). The remaining ( $n = 28$ ) responses produced in Experiment 4 consisted of the complementary pair *dong* 'east' and *xi* 'west'. Here, too, lexicalization patterns were determined (without exception) by the direction of simulated motion: with EARLIER- $\rightarrow$  *dong* 'east', and LATER- $\rightarrow$  *xi* 'west' in the LEFT-TO-RIGHT condition, and vice-versa in the RIGHT-TO-LEFT condition ( $p < 0.001$ , Fisher exact test).

## Discussion

The design of Experiment 4 (unlike that of Experiment 3) involved simulated motion on the lateral axis, but nonetheless the sagittal terms *qian* 'front' and *hou* 'back' were, as predicted by H3, the preferred lexicalizations for EARLIER and LATER S-time relations. The mapping patterns predicted by H1 (EARLIER- $\rightarrow$  *qian*, LATER- $\rightarrow$  *hou*) were reliably more frequent across conditions and S-time construal types than the reverse mapping pattern (EARLIER- $\rightarrow$  *hou*, LATER- $\rightarrow$  *qian*), but this was modulated (as we predicted) by simulated direction of motion: the reverse mapping pattern was reliably more frequent when this direction was RIGHT-TO-LEFT than LEFT-TO-RIGHT. How should this be interpreted?

We know from Experiment 2 that in NONVERBAL experimental conditions the preferred mapping is LEFT-EARLIER / RIGHT-LATER, even though the lexicalization of this mapping pattern is not conventional in Mandarin Chinese. We interpreted this (in accord with Bergen & Chan Lau, 2012) as being due to the bias induced by the LEFT-TO-RIGHT direction of reading and writing Chinese characters. It seems that this nonlinguistic bias interferes with the conventional and preferred lexicalization patterns in the sagittal axis. The 'reverse sagittal mapping' (EARLIER - $\rightarrow$  *hou*, LATER - $\rightarrow$  *qian*) may result from participants' experimentally induced confusion, but it could also be interpreted as an expression of a D-time construal: PAST - $\rightarrow$  *hou*, FUTURE - $\rightarrow$  *qian* in relation to Ego. Although the experimental results taken as a whole confirm the robustness of the primary S-time EARLIER/LATER MEANINGS of *qian/hou*, it seems that reversing the LEFT-TO-RIGHT order of the lateral timeline may have primed participants' D-time INTERPRETATION of the terms *qian* and *hou*.

The sagittal axis and the lateral axis are deictically anchored (ego-centred). Lexicalizations in these axes (in both space and time) are based on a Relative Frame of Reference (FoR) (Levinson, 2003); in other words, lexical choice is determined by the direction that Ego is facing.<sup>13</sup> UP and DOWN lexicalizations on the vertical axis are also deictically anchored, that is they are ego-centred; but lexical choice is governed by the Absolute FoR grounded in gravity and the surface of the earth (what is UP and what is DOWN does not depend on which direction Ego is facing). This probably explains why a difference in simulated direction of motion in the lateral axis interferes with the consistency of S-time uses of *qian* ‘front’ and *hou* ‘back’, but not that of *shang* ‘up’ and *xia* ‘down’.

We have noted that the terms *zuo* ‘left’ and *you* ‘right’ are not conventionally used for expressing temporal relations in Mandarin Chinese, so we cannot predict what would be the most frequent lexicalization pattern should they be used temporally.<sup>14</sup> They were nonetheless produced in this experiment (significantly more frequently in the RIGHT-TO-LEFT simulated motion condition). Unsurprisingly, their usage was not only affected, but essentially determined, by the simulated direction of lateral motion, yielding inverse mapping patterns between EARLIER VS LATER and *zuo* ‘left’ vs *you* ‘right’. The most plausible interpretation of these data is that usages of these terms in this context reflects a *spatial* rather than *temporal* construal of the task by these participants (i.e. the terms refer to the spatial relations between Figure and Ground stations in an Intrinsic FoR). This interpretation is consistent with the elicitation sentence frame (Example 1), but the relative infrequency of such responses provides further confirmation that the experimental design was successful in priming in the great majority of participants a temporal Moving Ego schematization.

The same argument applies to the other lexical pair produced by some participants, *dong* ‘east’ and *xi* ‘west’. Here, too, lexicalization patterns were determined (without exception) by the direction of simulated motion: with EARLIER-> *xi* ‘west’, and LATER-> *dong* ‘east’ in the LEFT-TO-RIGHT condition, and vice-versa in the RIGHT-TO-LEFT condition. It seems that these participants were mapping ‘east’ to ‘left’ and ‘west’ to ‘right’, which can be interpreted as being motivated by the

conventional iconic representation of geocentric space (cardinal directions) in maps. Some station names on the metro map include cardinal directional terms, and the maps themselves instantiate the west=left, east=right convention. This convention is also linguistically expressed in the Chinese saying: 上北下南，左西右东 (literally meaning ‘up-north, down-south, left-west, right-east’).

## 2.5 Experiment 5: Travelling the subway 3 (Implicit Motion)

*Rationale:* The designs of Experiments 3 and 4 involved the simulation of actual spatio-temporal motion. However, the PAST-FUTURE directionality of a visually represented line of travel in space and time can be indexically or iconically signified by markers such as arrows, and by the increasing or diminishing size of objects or events, without any actual real or simulated motion, which can motivate both PASSAGE and POSITIONAL schemas (see Figures 1 and 2). In contrast with the stimuli used in the previous experiments, such visually represented static timelines are relatively enduring artefacts which are not subject to temporal change—even the space-time line of stations in Experiment 4 is marked only by the sequential change of the illuminated station name.

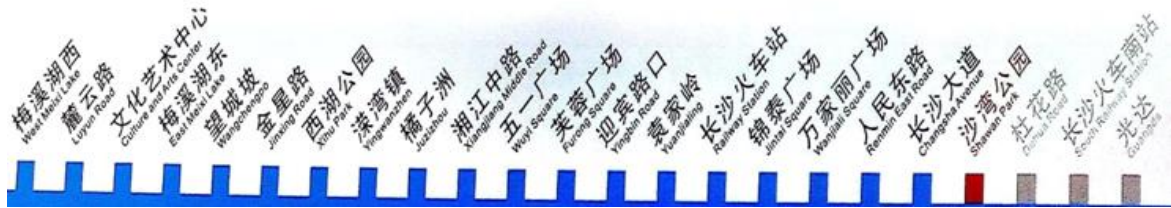
The question addressed by Experiment 5 is whether such a laterally oriented static representation of IMPLICIT spatio-temporal motion will lead speakers of Mandarin to favour sagittal axis lexicalizations, similarly to Experiment 4.<sup>15</sup> Previous research suggests that this should be the case. Boroditsky and Ramscar (2002: 187) concluded on the basis of a series of experiments (including actual experience of travel on a train) that “actual spatial motion is neither necessary nor sufficient to influence people’s thinking about time. Rather, it is thinking about spatial motion that seems to underlie thinking about time.” In Experiment 5 we therefore presented participants with a linear map of the same metro line as that in Experiment 4, without any simulated spatio-temporal motion. Instead of a deictic centre (Ego) in relative motion with respect to the timeline of events/stations, the linear map primes the directionality of the line of time and motion by indicating which stations have already been passed, and which ones are yet to come. In Experiment 5, the two



station S-time sentence completion task was also complemented by a one-station Ego-relative D-time sentence completion task, in order to prime deictic (past vs future) usage of *qian* and *hou*.

*Participants* were the same 32 native Mandarin Chinese speaking students from Hunan University of Technology and Business (18 male, 14 female, median age 18). Experiment 5 was administered to participants immediately after Experiment 4.

*Materials and procedure:* A linear map (Figure 9) of the same metro stations as those represented in Figure 7 was displayed in the centre of a computer screen throughout the trials, with cues to speaker position (current station) and to a right-to-left lateral direction of travel. The map was an image of an actual metro display. No left-to-right motion direction condition was employed in Experiment 5. The current station was marked in red and ‘previously passed’ stations were greyed out.



**Figure 9:** The static metro line of stations (MOTION NON-SALIENT CONDITION). The current station is marked in red and earlier stations on the motion trajectory are greyed out (Experiment 5).

Participants were asked to imagine the route of their journey and draw it as an arrow, before completing the sentence completion tasks. This was intended to strengthen the implicit representation of spatio-temporal motion. The sentence completion tasks were then administered. Two-station test sentences (N=12) were similar in form to those used in Experiments 1, 3 and 4. One-station test sentences (N=6) represented the relationship between station Y and Ego, that is “you” as Experiencer, by asking the participant to imagine that ‘your’ location is station X (Example 2).

2. 假设你在站 X, 那么, 站 Y 在 你 的\_\_\_\_\_。

Jia she ni zai zhan X, na'me, zhan Y zai ni de\_\_\_\_\_。

If        you   LOC station X, so,        station Y LOC you GEN\_\_\_\_\_。

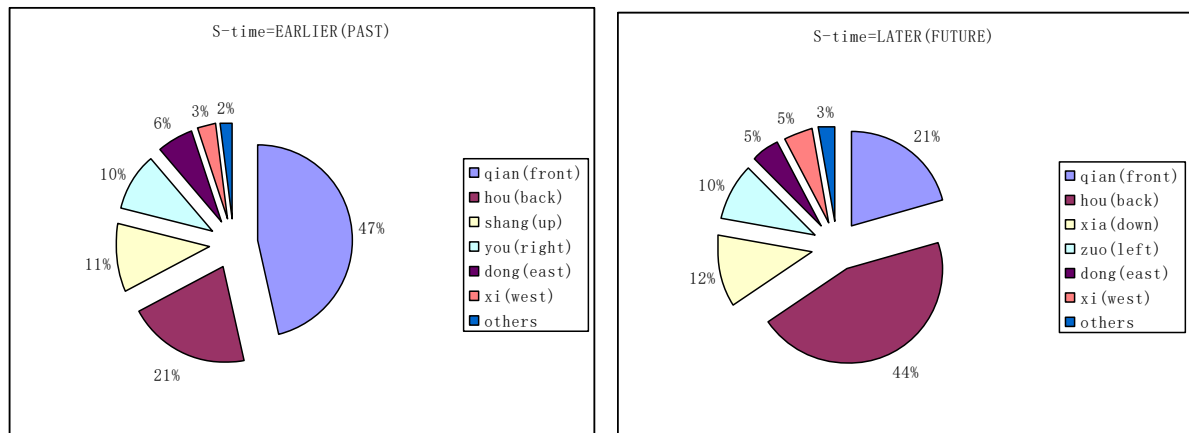
“If you are/would be at station X, so where is station Y in relation to you?”

The purpose of this sentence elicitation frame was to prime participants to take a deictic, first person perspective (Walker *et al.*, 2017). The first presented sentence was always a one-station sentence; thereafter the order of presentation of one-station and two-station sentences was randomized.

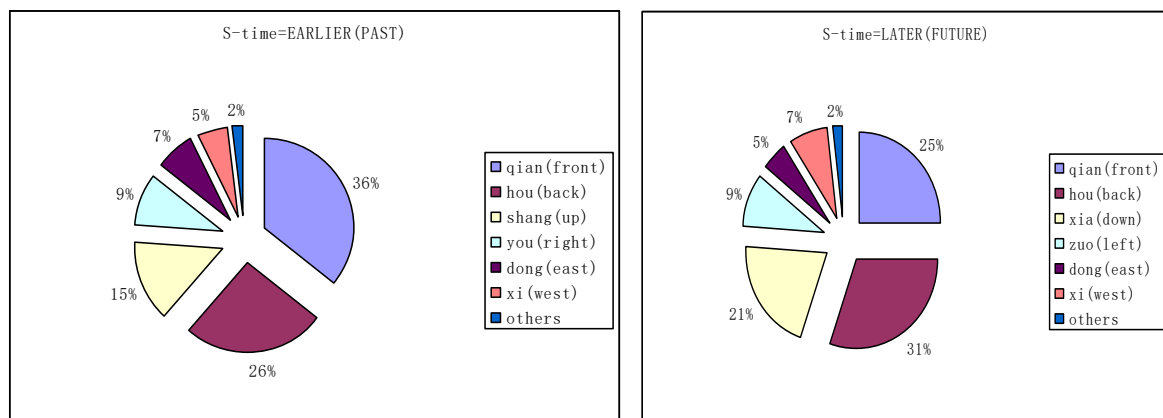
### *Results*

All participants drew the arrow on the map in the correct RIGHT-TO-LEFT direction. Sentence completion responses were coded in as for the MOTION SALIENT condition. Frequencies are charted in Fig. 10. Once again, the majority of participants produced sagittal orientation responses, and the most common response pattern involved the mapping pattern EARLIER-> *qian*, LATER->*hou*.

## TWO-STATION SENTENCE COMPLETION TRIALS



## ONE-STATION SENTENCE COMPLETION TRIALS



**Figure 10:** Percent lexicalization responses for two-station and one-station sentence completion tasks with EARLIER vs LATER sequential construals (Experiment 5, see Table 5).

The primacy of sagittal axis lexicalizations was clear and significant both in the two-station completion task (which was analogous to the RIGHT-TO-LEFT condition in Experiment 4) and the one-station sentence trials. There was no difference between the distributions of responses over sagittal, vertical and lateral axes between the two-station and one-station sentence conditions. For the two-station trials, there was no difference in this respect between EARLIER and LATER construal types. For

the one station trials, this difference was significant (Chi-square test of independence = 8.018262  $p < 0.05$ ), due to the higher frequency in the LATER than in the EARLIER construal types of vertical axis lexicalizations relative to sagittal axis lexicalizations.

In the two-station sentence completion trials the predicted mapping pattern EARLIER > *qian*, LATER > *hou* was clearly dominant, with the lexicalizations in the predicted direction being significantly more frequent than reverse mappings ( $p < 0.001$  for both construal types, Chi-square one sample test), yielding a highly significant difference between the relative frequencies of *qian* and *hou* between the EARLIER and LATER construal types ( $p < 0.001$  Fisher exact test). This was not the case for the one-station sentence completion trials, where there was no dominant mapping pattern between EARLIER/LATER and *qian/hou* for either construal type.

Similarly to the response pattern in Experiment 4, the vertical axis was the second most frequently lexicalized one and mappings were reliably in the predicted direction for both EARLIER and LATER construal types in both one-station and two-station sentence completion trials. LEFT-RIGHT (*zuo/you*) and EAST-WEST (*dong/xi*) axes of lexicalization were of roughly equal frequency. Similarly, again, to the results of Experiment 4, LEFT-RIGHT lexicalizations were determined by the linear spatial relationship between stations (two-stations condition) or between Ego and station (one-station condition), and all of them were correct in terms of this spatial construal. However, unlike in Experiment 4, there were no reliably consistent mappings between EARLIER/LATER construal types and EAST/WEST lexicalizations for either two-station or one-station conditions.

### **Discussion**

It is clear from the results of Experiment 5 that thinking about or imagining spatio-temporal motion (as argued by Alloway et al. 2001 and by Ramscar and Boroditsky 2002) is sufficient to prime a motion schema. The results show that the sagittal axis is preferred over other orientational axes for the lexicalization of temporal relations in Mandarin Chinese even where motion is implicit rather

than explicit. The distribution pattern of sagittal lexicalization patterns produced in Experiment 5 (two-station condition) closely resembled that in the RIGHT-TO-LEFT simulated motion condition of Experiment 4: in both cases reverse lexicalization mappings were about half as frequent as the predicted mappings (and were significantly more frequent than the latter). Experiment 5 therefore provides further support both for H1 and H3.

The one-station sentence completion trials were included in Experiment 5 in order to prime participants to take a deictic, first-person perspective, and the first presented trial was always a one-station trial. For one-station trials, reverse mappings were not significantly less frequent than predicted mappings, occurring with almost 80% of the frequency as the latter. This is a strong indication that both in Experiment 5, and in the RIGHT-TO-LEFT simulated motion condition of Experiment 4, the experimental design prompted significant numbers of participants to adopt in their responses a Deictic schematization, supporting H2, that temporal deictic (D-time) uses of *qian* and *hou* to refer to 'past' and 'future' are secondary, and are governed by contextual, discourse pragmatic and constructional constraints.

In both the two-station and the one-station sentence completion conditions, the second most frequent axis of lexicalization was vertical, with disproportionately more vertical axis lexicalizations being produced in LATER construal contexts in the one-sentence condition. This, and the spatial usage of the terms LEFT and RIGHT, is also consistent with the results of Experiment 4. There was one intriguing difference between the results of Experiments 4 and 5. In Experiment 4, the terms *dong* 'east' and *xi* 'west' were used with complete consistency, and we proposed that this was because they were mapped to the left-right axis of simulated motion, regardless of the direction of motion. It would be expected that in Experiment 5, the same pattern would be found. This was not the case: there was no consistency between participants in their usages of *dong* 'east' and *xi* 'west'.

### 3. General Discussion and Conclusion

The overall goal of this study was to resolve long-standing debates and (we have claimed) confusions regarding:

(FOCUS A) the meaning and use of the terms *qian* ‘front’ and *hou* ‘back’ to represent temporal relations between events and between events and time of utterance in Mandarin Chinese. We have argued that these confusions stem from a persistent failure to clearly distinguish between D-time and S-time representations and interpretations; and that their theoretical resolution requires the recognition of *both* the invariance of S-time MEANINGS of *qian* ‘front’ and *hou* ‘back’ as (respectively) EARLIER and LATER; *and* their contextually determined variable D-time USES to refer to past and future events and perspectives. On this basis we proposed the following hypotheses for empirical test:

H1: The primary (invariant) temporal sequential (S-time) MEANINGS of *qian* and *hou* are (respectively) ‘earlier’ and ‘later’.

H2: The (variable) temporal deictic (D-time) USES of *qian* and *hou* to refer to ‘past’ and ‘future’ are secondary, and are governed by contextual, discourse pragmatic and constructional constraints.

(FOCUS B) the relative dominance of the sagittal, vertical and lateral axes in the representation of the temporal dimension in language and in non-linguistic tasks. On the basis of our review of the existing literature, we proposed that:

H3: The preferred *lexicalization* of temporal sequence in contemporary Mandarin Chinese employs the sagittal terms *qian* ‘front’ and *hou* ‘back’.

H4: The order of preference for the orientational axes of *nonlinguistic* temporal sequential mappings by contemporary Mandarin Chinese speakers is LATERAL > VERTICAL > SAGITTAL.

Experiment 1 was a *language elicitation* task in which participants were asked to specify the temporal relationship between two events depicted as part of a sequence of 4 images presented in

temporal (not spatial) sequence. The overwhelming majority of responses used lexicalizations of the sagittal mapping of EARLIER -> *qian*, LATER -> *hou*. Responses involving lexicalizations of the vertical and lateral axes were negligible in frequency, *consistently with H3 and in opposition to the* hypothesis that the postulated (but contested; Chen, 2007) primacy of the vertical axis in the non-linguistic cognition of Mandarin Chinese speakers is due to its prevalence in linguistic space-time metaphor (Boroditsky, 2001, 2008; see Sun and Zhang, 2020 for a critical review).

Experiment 2 was a *non-linguistic* temporal sequence reproduction task using the same images as those used in Experiment 1, in the form of cards to be spatially placed in accordance with temporal sequence, without any cues regarding the preferred axis of orientation. The results supported the hypothesized primacy (H4) of the lateral axis in *nonlinguistic* temporal sequential mappings of contemporary Mandarin Chinese speakers, with the mapping direction LEFT-EARLIER / RIGHT-LATER, replicating the findings of Bergen and Chan Lau (2012). We noted the striking contrast between the preferred *sagittal* axis for *lexicalization* in Experiment 1 (FRONT-EARLIER / BACK-LATER), and the preferred *lateral* axis for the *nonverbal* representation of the same sequences by the same participants in Experiment 2 (LEFT-EARLIER / RIGHT-LATER). In line with co-speech gesture studies by Casasanto and Jasmin (2012) in English and Li (2017) in Mandarin Chinese, this finding reinforces the argument that there can be a dissociation between ‘thinking for speaking’ (Slobin, 1996) and ‘thinking for action/gesture’ (Casasanto, 2016).

Experiment 3 employed a novel design to simulate the subjective experience of the apparent motion of subway (Metro) stations past an Experiencer sitting in a train, priming a MOVING TIME schema. The results were consistent with H1, in that participants used the terms *qian* and *hou* with invariant S-time meanings EARLIER and LATER, not the experiencer-relative D-time meanings PAST and FUTURE. The fact that the overwhelming majority of lexicalizations employed the sagittal terms *qian* and *hou* provided additional support for H3, and were also consistent with the further hypothesis that the

*temporal* meanings of the terms *qian* and *hou* overrode in this context their spatial meanings. A small minority of participants chose to employ vertical axis terms, and did so without error.

Experiment 4 also involved a simulation of a metro journey, but one that perceptually primed a Moving Ego schema and (because of the way that passengers in the simulated journey sit facing the side of the carriage) a lateral (not a sagittal) axis. Despite the priming of the lateral axis, the majority of produced lexicalizations were SAGITALLY ORIENTED, underlining once again the primacy of the sagittal axis and the terms *qian* ‘front’ - *hou* ‘back’ in the *linguistic* conceptualization of temporal sequence; and a significant majority of responses followed the predicted lexicalization pattern of EARLIER->*qian*, LATER->*hou* irrespective of direction of simulated lateral motion. The results of Experiment 4 also provided support for H2, inasmuch as ‘reverse mapping’ responses that could be accounted for by D-time construals were more frequent when the direction of simulated motion was RIGHT TO LEFT than when it was (in accordance with orthographic convention) LEFT TO RIGHT. Unlike in Experiment 3, in addition to appropriately used vertical axis S-time lexicalizations, some participants used the terms *zuo* ‘left’ and *you* ‘right’, doing so in accordance with their spatial relational meanings; responses employing the terms *dong* ‘east’ and *xi* ‘west’ also systematically mapped these terms to the lateral spatial axis, with west mapping to left and east mapping to right.

Experiment 5 modified the design of Experiment 4 by substituting a static, IMPLICIT display of a line of spatio-temporal motion along the lateral axis instead of dynamically simulated motion. The results when the sentence completion task was identical to that in Experiments 3 and 4 were broadly similar to those of Experiment 4, demonstrating that implicit motion displays can prompt the same schematizations as dynamic (simulated) motion displays; and confirming the proposal that thinking about or imagining spatio-temporal motion is sufficient to prime a motion schema (Alloway et al. 2001; Ramscar and Boroditsky 2002). Experiment 5 also included a condition explicitly intended to prime D-time construals, and in this condition the otherwise dominant mappings of EARLIER -> *qian*, LATER -> *hou* were not significantly more frequent than reverse mappings, supporting



the supposition that a large number of participants did employ D-time construals. The usage in Experiment 5 (unlike in Experiment 4) of *dong* ‘east’ and *xi* ‘west’ was inconsistent, a finding for which we have no clear explanation. It is possible that some participants mapped these terms (like in Experiment 4) to the left and right poles of the lateral spatial axis; while others mapped them to their own spatial memory of the actual cardinal point directions. In neither Experiment 4 nor Experiment 5 is there any indication that participants employed a conventional space-time mapping of the type “East=earlier/past, West=later/future”.

With respect to the linguistic analysis of the Mandarin Chinese terms *qian* ‘front’ and *hou* ‘back’ that we presented in the Introduction, we conclude that: (i) our experimental findings are consistent with our analysis of the primacy in Mandarin Chinese of the invariant S-time construal of the terms *qian* ‘front’ (=EARLIER) and *hou* ‘back’ (=LATER) over their contextually governed D-time interpretation as referring to pastness and futurity; (ii) the preferred lexicalization of temporal relations between events by Mandarin speakers employs the sagittal axis terms *qian* and *hou*. However, this linguistic conceptualization (and the preferred sagittal orientational axis) is not imposed (in a Whorfian fashion) by speakers on spontaneous non-linguistic representations of event sequences, in which the lateral axis is predominant); (iii) the temporal meanings of *qian* and *hou* (earlier and later) are more salient for speakers than their spatial meanings (front and back) in motion event conceptualization. Previous research that we reviewed in the introduction has referred to all of these issues, but has neither synthesized them into a unified account, nor subjected such an account to systematic empirical test.

Our conceptual and linguistic analysis built on that proposed by Yu (2012), but differs from it in proposing that the key issue is not the past/future direction in which Ego faces in Mandarin Chinese (although we agree with Yu 2012 that the canonical direction is indeed towards the future), but the primacy of invariant S-time meaning over contextually variable D-time interpretation. Our analysis is most closely aligned to that proposed by Wu (2020), but differs in the following salient

respects. First, Wu states (and we agree) that the primary temporal meanings of *qian* and *hou* are sequential, but does not point out that these meanings are *strictly invariant*, as can be unequivocally observed in her corpus data, in which the frequencies of what we have labelled ‘reverse’ S-time mapping of EARLIER -> *hou*, LATER -> *qian* are both zero (Wu 2020, Table 3 p. 10).<sup>16</sup> In contrast, as Wu points out, the dominant D-time mapping pattern of PAST->*qian* and FUTURE->*hou* is a *tendency* (and one that is stronger for PAST ->*qian* than for FUTURE ->*hou*). Wu’s own data therefore underline the importance of distinguishing not only between S-time (Time-RP) and D-time (Ego-RP) schemas, and the front/back orientation of Ego, but also (as we do) between invariant *meanings* and variable *usages*.<sup>17</sup> Second, Wu maintains that the “main motivation” for temporal usage of *qian* and *hou* is the metaphorical spatialization of time. We have found no evidence for this, and indeed our evidence suggests rather that the temporal meanings of *qian* and *hou* (EARLIER and LATER) are more salient for speakers in motion event conceptualization than their spatial meanings (FRONT and BACK) (Experiment 3).

In this connection, we may refer to a recent corpus-based study of the use of *qian* and *hou* by Mandarin-acquiring preschool children in a structured communication task. Tsung and Wu (2021) reported that *qian* and *hou* were more frequently used with temporal meanings than spatial meanings by 4.5 and 5.5 year old children, and that a surge in temporal usage between 3.5 years and 4.5 years coincided with a marked increase in what they term “future reference”. From their data, however, it seems likely that this “future reference” was overwhelmingly instantiated by the use of adverbial 然后 *ran hou* ‘then’, ‘afterwards’, ‘after that’. This usage may reflect the acquisition of the expression *ranhou* as a morphologically unanalyzed unit, not necessarily expressing a true temporal relation. The frequencies of the expressions *zhi hou*, *zhi qian*, *hou mian*, *qian mian* (glossed, respectively, by Tsung and Wu as (temporal) ‘after’, ‘before’ and (spatial) ‘back’, ‘in front of’) in the corpus were very low, although the *hou* expressions were reported as being rather more frequent than the *qian* expressions.<sup>18</sup> It should be noted, however, that *hou mian* and *qian mian* can both be used temporally as well as spatially. What is, at least, clear, from the data reported by

Tsung and Wu (2021) is that there is no evidence that, in the course of children's language development, *qian* and *hou* are used for spatial relations before they are used for temporal relations. Further, fully relational usage of these terms in the spatial domain is a relatively late acquisition, a finding that is consistent with findings regarding the acquisition and development of spatial relational terms in different languages (e.g. Sinha *et al.*, 1994).

Tsung and Wu (2021) argue that their data do not support the hypothesis that spatial meanings of *qian* and *hou* are acquired before their temporal meanings, but rather support an interpretation in which the spatial and temporal domains are both representationally and developmentally separate from each other. We would suggest, from our examination of their data, that a more plausible interpretation postulates a single conflated spatio-temporal conceptual semantic domain in early development, which might either (as Liu *et al.*, 2018 propose—see also Sinha & Bernárdez, 2015, on space-time fusion in Andean languages) remain the case into adulthood, or be differentiated into two distinct but related domains in later development.

Turning in conclusion to more general methodological and theoretical points, the detailed analyses that we have presented of our experimental results suggest that, firstly, the novel experimental paradigm employed in Experiments 3 and 4, in which participants experience simulated spatio-temporal motion in a vehicle, could fruitfully be extended by using Virtual Reality technology (see Alloway *et al.* 2001, 2006). Secondly, as has been frequently pointed out, the norms governing the semiotic interpretation of cultural-cognitive artefacts can modulate experimental response patterns (and cognition and language in the real world) even in situations where these artefacts are neither used nor relevant. Much attention has focused on writing systems, calendars, clocks and other symbolic time-reckoning artefacts and practices (e.g. Sinha *et al.*, 2011; Núñez & Cooperrider, 2013; Duffy, 2014; Silva Sinha, 2019). The present study, and in particular Experiment 5, points to the relevance also of maps, and raises an intriguing puzzle about the mapping of cardinal points to temporal sequence that should be explored in future research.

## Acknowledgements and responsibilities

This research was supported by the School of Foreign Languages, Hunan University and by the China Scholarship Council, neither of which were responsible for the specifics of the study or this article. The first and second author were responsible for the conceptualization of the study and the experimental design. The experiments were carried out by the first author. All three authors contributed to the data analysis and interpretation. The second author was mainly responsible for the writing of the text with contributions from the other two authors. We thank two anonymous reviewers for their insightful comments.

<sup>1</sup> Terminology varies between authors. Moore (2006, 2011, 2014a, b) refers to Time-RP as the “field-based” frame of reference, in contrast to the “ego-perspective” frame of reference.

<sup>2</sup> The distinction itself was first introduced by McTaggart (1908).

<sup>3</sup> Huang (2015) argues that the Mandarin Chinese particle *jiang* marks a syntactic future/non-future tense distinction, but this is not relevant for the current discussion.

<sup>4</sup> Liu *et al.* (2018) argue that the temporal use of *qian* and *hou* is not a space-time metaphor, but rather an instance of the conflation of the spatial and temporal domains in Mandarin Chinese (see also Su, 2016). Our main argument regarding the primacy of S-time construals over D-time construals of *qian* and *hou* does not depend on the correctness of either the metaphor or conflation interpretations, but we return to the issue in the General Discussion in relation to the acquisition data of Tsung and Wu (2021)

<sup>5</sup> Izutsu & Izutsu (2016) document and discuss a pattern in which morphemes meaning “front/tip” and “back/trace” deictically refer to, respectively, past/earlier and future/later not only in Chinese, but also in the other East Asian languages Ainu, Japanese, Korean and Ryukyuan. These data are suggestive of a linguistic areal phenomenon, but this question lies outside the scope of the current study.

<sup>6</sup> As Yu (2012: 1338: n5) points out, the Conceptual Metaphor LIFE IS A JOURNEY is ‘the other side of the coin’ (we might say dependent upon) the ME schema. Yu (2012: 1344) proposes a further schema that he labels *Human-RP*, distinct from both Time RP and Ego-RP, and which motivates expressions such as *qian-ren* front/ahead-people “forefathers; ancestors” and *hou-ren* back/behind-people “later generations; descendants”. We suggest, however, that this can be understood in terms of a primary POSITIONAL S-time series in which EARLIER generational cohorts are in front of LATER cohorts, and each cohort in the series is fictively moving in unison along a timeline or path from birth to death. This sequence may be deictically anchored such that Ego faces towards the idealized path of the (coming BEFORE) ancestors, and reproduces this path for the (coming AFTER) descendants; but this does not involve in our view either an ME schema or an MT schema. Such examples attest to the multiplicity of sub-schemas across languages (Pamies-Bertrán & Yuan 2020). Without analyzing these examples in detail, suffice it to say that while we disagree with Yu (2012) on the need to postulate a third fundamental reference frame in addition to S-time and D-time, we concur with him that they do not imply an Ego facing the past.

<sup>7</sup> Li (2017: 400 n.1) cites in support of this definition of “sagittal congruence” the relative frequencies of the temporal mappings of *qian* and *hou* to past and future in the Dictionary of Contemporary Chinese; however, the corpus analysis itself did not distinguish S-time from D-time readings.

<sup>8</sup> There were a total of 24 erroneous responses, the majority of which involved the sequencing of the Chinese Dynasties cards. Erroneous responses were not included in the statistical analyses, although if they had been, this would have made no difference to the outcomes of the statistical tests.

<sup>9</sup> The actual response types and numbers in Experiments 1 and 2 are different, so we treat participants in the experiments for statistical purposes as independent samples in a 2x2 design.

<sup>10</sup> Ning Yu (pc) has objected that this experimental design primes an ME not MT schema, since “regardless of their bodily orientation, passengers know which is the front of the train and in which direction the train is moving.” We admit that the simulated motion events in Experiment 3, based in a deictically-anchored moving S-time schema (Figure 3), may be construed according to either MT or ME. It has been claimed (Huang, 2016) that MT is the predominant construal in Chinese. We suggest that our main finding in this experiment, that the lexicalization patterns produced by the participants were unaffected by the orientation of Ego, does support the assumption that they were employing MT construals, but the conclusions that we draw from the data are unaffected one way or the other.

<sup>11</sup> Because we are testing for the effects of the independent variables (*earlier* and *later* construals) on complementary pairs within several possible responses, we treat them for statistical purposes as applied to independent samples in 2x2 designs.

<sup>12</sup> Df=14, and some cells n<5, in both conditions.

<sup>13</sup> The spatial FoR is mapped directly in D-time expressions to a temporal FoR. Uses of FRONT, BACK, LEFT and RIGHT can also be governed by an Intrinsic spatial FoR, a distinction that is relevant for the D-time vs. S-time distinction.

<sup>14</sup> The compound *zuo-you* can be used temporally to mean ‘around, about’.

<sup>15</sup> We choose the designation IMPLICIT MOTION to distinguish these static representations of actual motion from what is in a way its inverse: dynamic linguistic conceptualizations of static scenes, such as ‘the road goes up the mountain’, analyzed by Talmy (1996) as ‘fictive motion’.

<sup>16</sup> The contrast between our finding that some conditions in Experiments 3, 4 and 5 provoked the use of a relatively small number of reverse sagittal mappings, and Wu (2020)’s finding that there were simply no such reverse mappings in identified S-time usages in a naturalistic corpus, together with our finding that there were only a negligible number of such reverse mappings in the baseline data of Experiment 1, reinforces our interpretation that the relevant experimental conditions in Experiments 3, 4 and 5 induced D-time construals.

<sup>17</sup> It is worth noting here that although Wu (2020) finds inconsistency in the mappings in language usage between PAST/FUTURE AND FRONT/BACK (and we also have evidence of the same inconsistency in Experiments 4 and 5), this does not negate the conclusion by Yu (2012) that Ego canonically faces FUTURE. There is evidence of yet another dissociation between linguistic usage and nonlinguistic space-time mapping: the former is variable, whereas the latter, in which FUTURE IS IN FRONT, appears to be culturally entrenched and invariant over contexts for Mandarin speakers (Qin, 2021). We note, too, that we have not attempted to summarize here the important findings of Wu (2020) regarding the mappings in Mandarin between temporal schema types and the construction types in which *qian* and *hou* appear.

<sup>18</sup> The data in Tsung and Wu (2021) are difficult to re-analyze and construe. The age-aggregated percentage frequencies reported in Table 1 (p. 3) sum to more than 100, and no statistical tests are reported either for these data or for the comparisons charted in Figures 1 and 2 (p.6).

## References

- Alloway, T.P., Corley, M. & Ramscar, M. (2006). Seeing ahead: Experience and language in spatial perspective. *Memory & Cognition* 34, 380–386. Doi 10.3758/BF03193415
- Alloway, T. P., Ramscar, M., & Corley, M. (2001). The roles of thought and experience in the understanding of spatio-temporal metaphors. In Proceedings of the 23rd annual conference of the Cognitive Science Society (pp. 37-42). Edinburgh, England: Cognitive Science Society.
- Alverson, H. (1994). *Semantics and experience: Universal metaphors of time in English, Mandarin, Hindi, and Sesotho*. Baltimore: John Hopkins University.
- Ahrens, K., & Huang C.R. (2002). Time passing is motion. *Language and Linguistics*, 3, 491-519.
- Bergen, B., & Chan Lau, T. T. (2012). Writing direction affects how people map space onto time.

*Frontiers in Psychology* (Section Cultural Psychology) 3: 109. Doi: 10.3389/fpsyg.2012.00109

- Bender, A., & Beller, S. (2014). Mapping Spatial Frames of Reference onto Time: a Review of Theoretical Accounts and Empirical Findings. *Cognition*, 132, 342-382.
- Boroditsky, L. (2001). Does language shape thought? English and Mandarin speakers' conceptions of time. *Cognitive Psychology*, 43, 1–22.
- Boroditsky, L., & Ramscar, M. (2002). The roles of body and mind in abstract thought. *Psychological Science*, 13, 185-189.
- Boroditsky, L. (2008). Do English and Mandarin speakers think differently about time? *Proceedings of the Annual Meeting of the Cognitive Science Society*, 427-431.
- Bohnenmeyer, J. (2002) *The Grammar of Time Reference in Yukatek Maya*. Munich: LINCOM.
- Bohnenmeyer, J. (2009) Temporal anaphora in a tenseless language. In W. Klein and L. Ping (eds.) *Expression of Time*. Berlin: Mouton de Gruyter, 83–128.
- Buzsáki, G., & Tingley, D. (2018). Space and Time: The Hippocampus as a Sequence Generator. *Trends in Cognitive Sciences*, 22, 853-869. DOI: 10.1016/j.tics.2018.07.006
- Clark, Herbert H. (1973). Space, time, semantics, and the child. In Moore, T.E. (ed.), *Cognitive Development and the Acquisition of Language*. New York: Academic Press, 28-64.
- Casasanto, D., & Boroditsky, L. (2008). Time in the mind: Using space to think about time. *Cognition*, 106, 579–593.
- Casasanto, D. (2010). Space for thinking. In P. Chilton & V. Evans (eds.), *Language, cognition, and space: Advances in cognitive linguistics*. London: Equinox Publishing Ltd., 453-478.
- Casasanto, D., & Jasmin, K. (2012). The Hands of Time: Temporal Gestures in English Speakers. *Cognitive Linguistics*, 23, 643-674.

- Casasanto, D. (2016) Temporal language and temporal thinking may not go hand-in-hand. In Barbara Lewandowska-Tomaszczyk (Ed.) *Conceptualizations of Time*. Human Cognitive Processing vol. 53. Amsterdam: John Benjamins, 67-84.
- Cooperrider, K., & Núñez, R. (2009). Across time, across the body: Transversal Temporal Gestures. *Gesture*, 9(2),181-206.
- Cooperrider, K., Núñez, R., & Sweetser, E. (2014). The conceptualization of time in gesture. In Cornelia Müller, Alan Cienki, Ellen Fricke, Silva H. Ladewig, David McNeill, and Sedinha Tessendorf (Eds.), *Body-Language-Communication* (vol. 2). Berlin: Mouton de Gruyter, 1781-1788.
- Cai, S. M. (2012). Xiandai hanyu 'qian', 'hou' shijian zhixiang de renzhi shijiao, renzhi jizhi ji jufa yuyi xianzhi (The time reference of 'qian' and 'hou' in modern Chinese: from the cognitive perspectives, mechanisms to the syntax-semantics constrains). *Dangdai Yuyanxue (Journal of Modern Linguistics)*, 14, 129-144.
- Chen, J.-Y. (2007). Do Chinese and English speakers think about time differently? Failure of replicating Boroditsky (2001). *Cognition*, 104(2), 427-436. doi:10.1016/j.cognition.2006.09.012
- Duffy, S. (2014) The role of cultural artifacts in the interpretation of metaphorical expressions about time. *Metaphor and Symbol*, 29, 94-112. Doi 10.1080/10926488.2014.889989
- Dewell, R. B. (2007). Why Monday comes before Tuesday: the role of a non-deictic conceptualiser. *Southern African Linguistics and Applied Language Studies*, 25, 291-301.
- Ding, X., Feng, N., He, T., Cheng, X and Fan, Z. (2020) Can mental timelines co-exist in 3-D space? *Acta Psychologica* 207 103084 doi 10.1016/j.actpsy.2020.103084
- Evans, V. (2013). *Language and time—A Cognitive linguistics approach*. New York: Cambridge University Press.

- Fauconnier, G., & Turner, M. (2008). Rethinking Metaphor. In Raymond Gibbs (ed.) *The Cambridge Handbook of Metaphor and Thought*. Cambridge: Cambridge University Press, 53–66.
- Fuhrman, O. & Boroditsky, L. (2010). Cross-cultural differences in mental representations of time: Evidence from an implicit non-linguistic task. *Cognitive Science*, 34, 1430-1451.
- Fuhrman, O., McCormick, K., Chen, E., Jiang, H. D., Shu, D. F., Mao, S.M., & Boroditsky, L. (2011). How linguistic and cultural forces shape conceptions of time: English and Mandarin time in 3D. *Cognitive Science*, 35, 1305–1328. DOI: 10.1111/j.1551-6709.2011.01193.x
- Gu, Y., Zheng, Y., & Swerts, M. (2016). Which is in front of Chinese people: Past or future? A study on Chinese people's space-time mapping. In Papafragou, A., Grodner, D., Mirman, D., & Trueswell, J.C. (Eds.). *Proceedings of the 38th Annual Conference of the Cognitive Science Society* (pp. 2603-2608). Austin, TX: Cognitive Science Society.
- Gu, Y., Zheng, Y., & Swerts, M. (2017). Does Mandarin spatial metaphor for time influence Chinese deaf signers' spatio-temporal reasoning? In G. Gunzelmann, A. Howes, T. Tenbrink, E. J. Davelaar (Eds.). *Proceedings of the 39th Annual Conference of the Cognitive Science Society* (pp.445–450). Austin, TX: Cognitive Science Society.
- Gu, Y., Zheng, Y. Q., Swerts, M. (2018). Having a different point of view about the future: the effect of signs on co-speech gestures about time in Mandarin-CSL bimodal bilinguals. *Bilingualism: Language and Cognition*, 1-12. Doi:10.1017/S1366728918000652
- Gu, Y., Zheng, Y., & Swerts, M. (2019). Which is in front of Chinese people, past or future? The effect of language and culture on temporal gestures and spatial conceptions of time. *Cognitive Science* 43(12) e12804. Doi: 10.1111/cogs.12804
- Huang, S. (2016). What is moving? A special case of Chinese time passing is motion. *Athens Journal of Philology* 3 (1). 39, 59(10.30958).



- Huang, Z. Nick. (2015) On syntactic tense in Mandarin Chinese." In *Proceedings of the 27th North American Conference on Chinese Linguistics*, vol. 2, 406-423.
- Haspelmath, M. (1997). *From space to time: Temporal adverbials in the world's languages*. Munich, Germany: Lincom.
- Izutsu, K., & Izutsu, M. N. (2016). Temporal scenery: Experiential bases for deictic concepts of time in East Asian languages. In Barbara Lewandowska-Tomaszczyk (Ed.) *Conceptualizations of Time*. Human Cognitive Processing vol. 53. Amsterdam: John Benjamins, 207-242.
- Jamarian, A., & Tversky, B. (2012). Gestures alter thinking about time. In N. Miyake, D. Peebles and R. Cooper (eds.), *Proceedings of the 34<sup>th</sup> annual conference of the Cognitive Science Society*. Austin: Cognitive Science Society, 503-508.
- Lakens, D., Semin, G. R., & Garrido, M. V. (2011). The sound of time: crossmodal convergence in the spatial structuring of time. *Conscious. Cogn.* 20, 437–443. doi:10.1016/j.concog.2010.09.020
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the Flesh: The embodied mind and its challenge to Western thought*. New York: Basic Books.
- Le Guen, O. (2017). A conception of nonlinear time in two languages: colonial and present-day Yucatec Maya, and Yucatec Mayan Sign Language (in Spanish). *Journal de la société des américanistes* (Maya Times). Online publication 31 December 2017, consulted 13 September 2018. URL : <http://journals.openedition.org/jsa/15327> ; DOI : 10.4000/jsa.15327
- Le Guen, O., & Balam, L. I. P. (2012). No Metaphorical Timeline in Gesture and Cognition among Yucatec Mayas. *Frontiers in Psychology (Section Cultural Psychology)* 3, 271 doi: 10.3389/fpsyg.2012.00271.
- Levinson, S.C. (2003). *Space in language and cognition: Explorations in cognitive diversity*. Cambridge: Cambridge University Press.
- Li, H. (2017). Time on hands: Deliberate and spontaneous temporal gestures by speakers of

Mandarin. *Gesture*, 16, 396-415. DOI 10.1075/gest.00002.li

- Liu, Z. G., Yan, K.F., & Lv, Y.Y. (2018). ying han shijian gainianhua chayi dui 'qian', 'hou' shijian zhixiang duili de jieshi (Differing conceptualizations of time in English and Chinese and the time reference of *qian* and *hou*). *xiandai waiyu (Modern Foreign Languages)*, 41, 608-620.
- Lin, J. W. (2006) Time in a Language Without Tense: The Case of Chinese. *Journal of Semantics*, 23, 1–53, <https://doi.org/10.1093/jos/ffh033>
- Miles, L. K., Tan, L., Noble, G. D., Lumsden, J., & Macrae, C. N. (2011). Can a mind have two time lines? Exploring space-time mapping in Mandarin and English speakers. *Psychon Bull Rev*, 18, 598-604.
- Moore, K. (2006). Space-to-time mappings and temporal concepts. *Cognitive Linguistics*, 17, 199-244.
- Moore, K. (2011). Ego-perspective and field-based frames of reference: temporal meanings of FRONT in Japanese, Wolof, and Aymara. *Journal of Pragmatics*, 43, 759-776.
- Moore, K. (2014a). *The spatial language of time: metaphor, metonymy and frames of reference*. Amsterdam: John Benjamins.
- Moore, K. (2014b). The two-Mover hypothesis and the significance of “direction of motion” in temporal metaphors. *Review of Cognitive Linguistics*, 12, 375-408.
- Moore, K. (2016). Elaborating time in space: the structure and function of space-motion metaphors of time. *Language and Cognition*, 1-63.
- Núñez, R., & Cooperrider, K. (2013). The tangle of space and time in human cognition. *Trends in Cognitive Sciences*, 17(5), 220–229. <https://doi.org/10.1016/j.tics.2013.03.008>

- Núñez, R. E., & Sweetser, E. (2006). With the Future Behind Them: Convergent Evidences from Aymara Language and Gesture in the Cross-linguistic Comparison of Spatial Construals of Time. *Cognitive Science*, 30, 401-450.
- Pamies-Bertrán, A., & Yuan, W. (2020). The spatial conceptualization of time in Spanish and Chinese. *Yearbook of Phraseology*, 11(1), 107-138.
- Qin, Y. T. (2021) Putting time in context: There is no causal link between temporal focus and implicit space–time mappings on the front–back axis. *Australian Journal of Linguistics* 41: 152-165.  
Doi: 10.1080/07268602.2021.1920885
- Radden, G. (2011). Spatial time in the West and the East. In Brdar et al.(eds.), *Space and time in Language*. *Peter Lang*, 1-40.
- Santiago, J., Lupiáñez, J., Pérez, E., & Funes, J. M. (2007). Time (also) flies from left to right. *Psychonomic Bulletin & Review*, 14, 512-516.
- Silva Sinha, V. da. (2019). Event-based time in three indigenous Amazonian and Xinguan cultures of Brazil. *Frontiers in Psychology (Section Cultural Psychology)* 10, 454  
doi:10.3389/fpsyg.2019.00454
- Sinha, C., Silva Sinha, V. da, Zinken, J., & Sampaio, W. (2011). When time is not space: The social and linguistic construction of time intervals and temporal event relations in an Amazonian culture. *Language and Cognition*, 3, 137-169. DOI 10.1515/langcog.2011.006
- Sinha, C., & Gärdenfors, P. (2014). Time, space, and events in language and cognition: a comparative view. *Annals of the New York Academy of Science*, 1326, 72-81.
- Sinha, C., & Bernárdez, E. (2015). Space, time, and space-time: metaphors, maps, and fusions. In Farzad Sharifian (ed.), *The Routledge Handbook of Language and Culture*, Routledge, 309-323.

- Sinha, C., Thorseng, L. A., Hayashi, M., & Plunkett, K. (1994). Comparative spatial semantics and language acquisition: Evidence from Danish, English, and Japanese. *Journal of Semantics*, 11(4), 253-287.
- Slobin, D. I. (1996). From “thought and language” to “thinking for speaking”. In Gumperz, J.J. and Levinson, S.C. *Rethinking Linguistic Relativity*. Cambridge: Cambridge University Press.
- Su, I. W. (2016) Metaphor and thought: Conceptualization of time in Chinese. In Barbara Lewandowska-Tomaszczyk (Ed.) *Conceptualizations of Time*. Human Cognitive Processing vol. 53. Amsterdam: John Benjamins, 187-203.
- Sun, J. & Zhang, Q. (2020) How do Mandarin speakers conceptualize time? Beyond the horizontal and vertical dimensions. *Cogn Process*. <https://doi.org/10.1007/s10339-020-00987-3>
- Yang, W. X., & Sun, Y. (2016). A monolingual mind can have two time lines: Exploring space-time mappings in Mandarin monolinguals. *Psychon Bull Rev.* 23, 857-864.
- Scott, A. (1989). The vertical dimension and time in Mandarin. *Australian Journal of Linguistics*, 9, 295-314.
- Talmy, L. (1996). Fictive motion in language and “ception”. In Bloom, P., Peterson, M., Nadel, L. and Garrett, M. (eds) *Language and Space*. Cambridge, MA: MIT Press, 211-276.
- Tsung, L., & Wu, D. (2021). A corpus-based comparison of the pragmatic use of *qian* and *hou* to examine the applicability of space–time metaphor hypothesis in early child mandarin. *Frontiers in Psychology*, 11, 3765.
- Tversky, B., Kugelmass, S., & Winter, A. (1991). Cross-cultural and developmental trends in graphic productions. *Cognitive Psychology*, 23(4), 515-557.
- Weger, U. W., & Pratt, J. (2008). Time flies like an arrow: space-time compatibility effects suggest the use of a mental timeline. *Psychon. Bull. Rev.* 15, 426–430. doi: 10.3758/PBR.15.2.426

- Walker, E., & Cooperrider, K. (2016). The continuity of metaphor: Evidence from temporal gestures. *Cognitive Science*, 40, 481–495. doi:10.1111/cogs.12254
- Walker, E. J., Bergen, B.K., & Núñez, R. (2017). The spatial alignment of time: differences in alignment of deictic and sequence time along the sagittal and lateral axes. *Acta Psychologica*, 175, 13-20.
- Wu, S. Q.(2020). A corpus-based study of the time orientation of *qian* “front” and *hou* “back” in Chinese. *Corpus Linguistics and Linguistic Theory*, 1-29. doi:10.1515/cllt-2020-0019
- Wang C. L. (2016). ‘qian’, ‘hou’ de zhixiang wenti xintan (New insights into the time reference of ‘qian’ and ‘hou’ in Mandarin Chinese). *Dangdai Yuyanxue (Journal of Modern Linguistics)*, 18, 176-193.
- Xiao, C., Zhao M. & Chen, L. (2018). Both earlier times and the future are “front”: The distinction between time- and ego- reference-points in Mandarin speakers’ temporal representation. *Cognitive Science*, 42: 1026-1040. doi 10.111/cogs.12552.
- Xiao, Y. (2012). *The conceptualization of time and its linguistic representation*. Ph.D dissertation, Southwest University, Chongqing.
- Yu, N. (1998). *The contemporary theory of metaphor: A perspective from Chinese*. Amsterdam: John Benjamins.
- Yu, N. (2012). The metaphorical orientation of time in Chinese. *Journal of Pragmatics*, 44, 1335-1354.

**APPENDIX****Tabulated data from experiments 1-5 (Tables 1-5) with accompanying charts (Figures 3, 4, 6, 8, 10)**

For elicitation tasks (Experiments 1, 3, 4, 5) responses were coded into the following categories:

*Qian* (front)

*Hou* (back)

*Shang* (up)

*Xia* (down)

*Zuo* (left)

*You* (right)

*Dong* (east)

*Xi* (west)

*Nan* (south)

*Bei* (north)

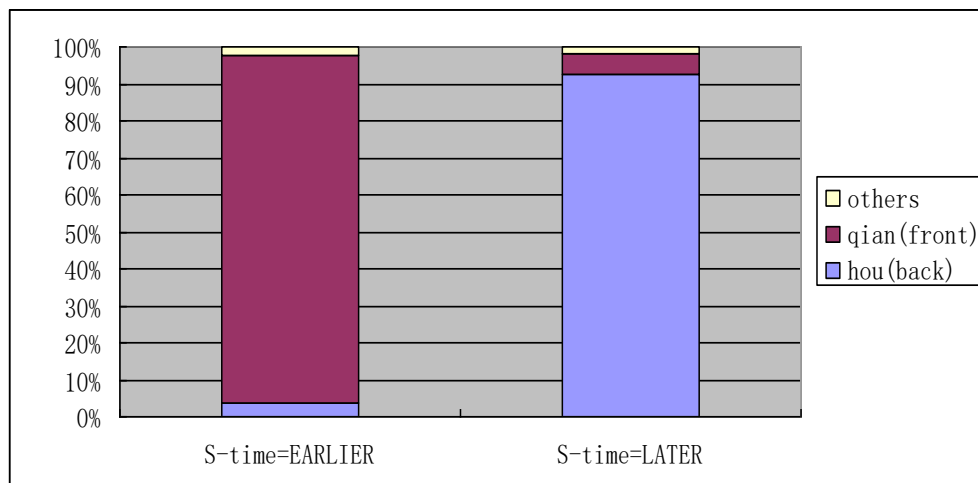
There were no responses that did not fall into one of the above-mentioned categories. There were no cases in which a participant made no response for a sentence.

For Experiment 2 (nonlinguistic time sequence reproduction), responses were categorized according to the spatio-temporal order in which participants placed the sets of cards on the white board: Left-to-Right, Right-to-Left, Up-to-Down, in a circular pattern (Cyclicity) and Others (e.g. a 'Z' shaped sequence).

Erroneous responses (i.e. placements out of the correct sequence) were noted but not included in the statistical analysis.

Sequence Type Lexicalization	S-time construal type	Human life stages	Chinese imperial dynasties	Seasons of the year	Phases of the moon	Months of the year
<i>qian</i>	S-time=EARLIER	107	105	102	97	106
	S-time=LATER	3	9	9	8	1
<i>hou</i>	S-time=EARLIER	1	3	4	10	2
	S-time=LATER	105	99	98	100	107
<i>shang</i>	S-time=EARLIER	2	2	2	3	2
	S-time=LATER	0	0	0	0	0
<i>xia</i>	S-time=EARLIER	0	0	0	0	0
	S-time=LATER	2	2	2	2	2
<i>zuo</i>	S-time=EARLIER	0	0	2	0	0
	S-time=LATER	0	0	0	0	0
<i>you</i>	S-time=EARLIER	0	0	0	0	0
	S-time=LATER	0	0	1	0	0

Table 1 (Experiment 1). Response frequencies: lexicalizations by temporal sequence type and EARLIER vs LATER S-time construal type.

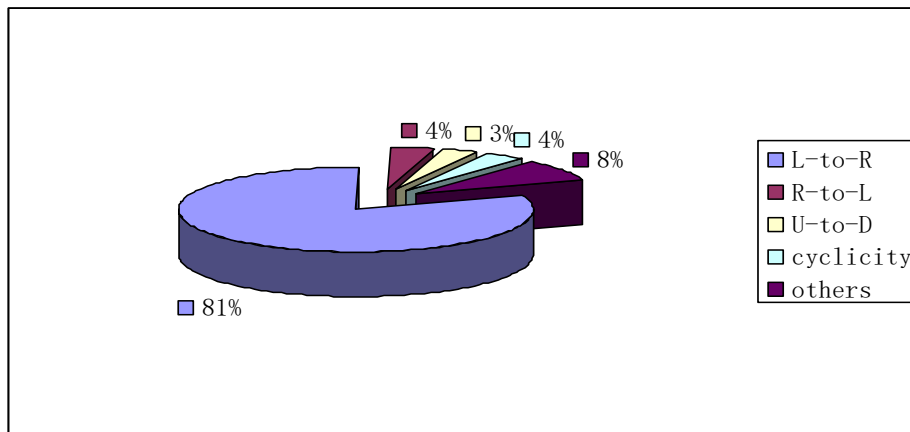


**Figure 3.** Percent Lexicalization Response Type Frequencies by Condition (Experiment 1).

See Table 1.

Sequence Shape & Orientation	Human life stages	Chinese imperial dynasties	Seasons of the year	Phases of the moon	Months of the year
<i>Left-to-right</i>	42	38	42	37	44
<i>Right-to-left</i>	3	1	1	4	1
<i>Up-to-down</i>	3	0	1	3	1
<i>Cyclicity</i>	2	0	3	4	1
<i>Others</i>	4	3	5	2	6
<i>Total Mistakes</i>	1	13	3	5	2

**Table 2 (Experiment 2).** Response frequencies: shape and orientation of card placements by temporal sequence type

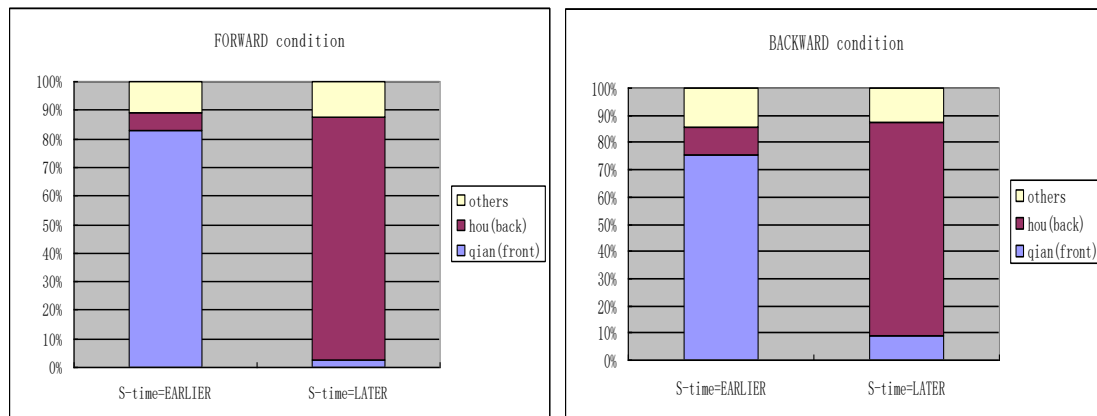


**Figure 4.** Percent Card Placement Response Type Frequencies across all trials (Experiment 2). See Table 2.



Construal type/ facing direction	Terms	S-time=EARLIER (PAST)	S-time=LATER (FUTURE)
<b>Facing forward</b>  (Moving Time, Sagittal Axis)	<i>qian</i>	67	2
	<i>hou</i>	5	69
	<i>shang</i>	5	0
	<i>xia</i>	0	6
	<i>others</i>	4	4
<b>Facing backward</b>  (Moving Time, Sagittal Axis)	<i>qian</i>	58	7
	<i>hou</i>	8	61
	<i>shang</i>	7	0
	<i>xia</i>	0	6
	<i>others</i>	4	4

**Table 3 (Experiment 3).** Response frequencies: lexicalizations by EARLIER vs LATER S-time construal type and experimental condition (participant facing FORWARD vs BACKWARD).



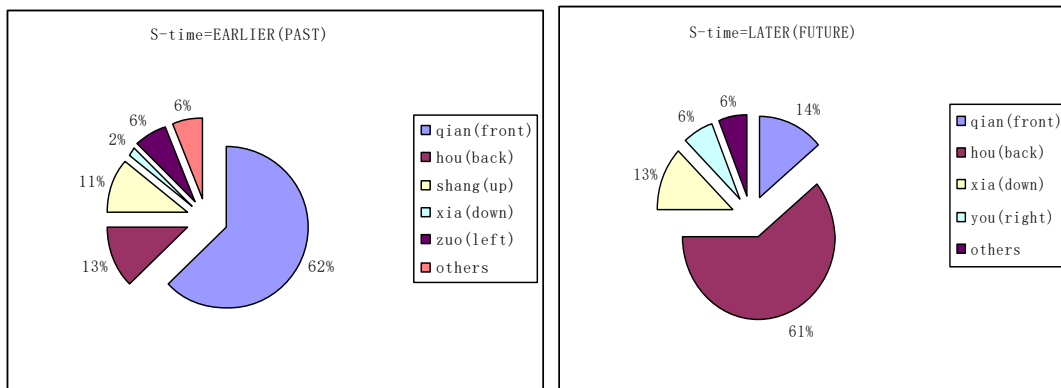
**Figure 6.** Percent response frequencies by experimental condition (FACING FORWARD vs FACING BACKWARD) and S-time construal type (A LATER THAN vs EARLIER THAN B) (Experiment 3).

See Table 3.

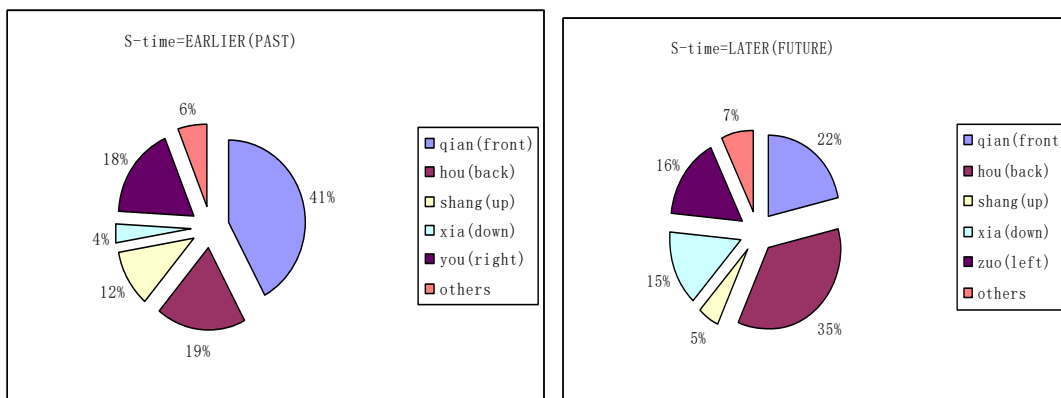
Moving Ego Lateral Axis	Construal type / lexicalization	S-time=EARLIER (PAST)								S-time=LATER (FUTURE)							
		qian/ hou		shang/ xia		zuo/ you		dong/ xi		qian/ hou		shang/ xia		zuo/ you		dong/ xi	
		q	h	s	x	z	y	d	x	q	h	s	x	z	y	d	x
Simulated Direction of Motion	Left-to-right	70	14	12	2	7	0	0	7	16	68	0	14	0	7	7	0
	Right-to-left	47	21	13	4	0	20	7	0	24	39	5	17	18	1	0	7

**Table 4 (Experiment 4).** Response frequencies: lexicalizations by simulated direction of motion and EARLIER VS LATER S-time construal type (sentence frame).

#### LEFT-TO-RIGHT SIMULATED MOTION TRIALS



#### RIGHT-TO-LEFT SIMULATED MOTION TRIALS

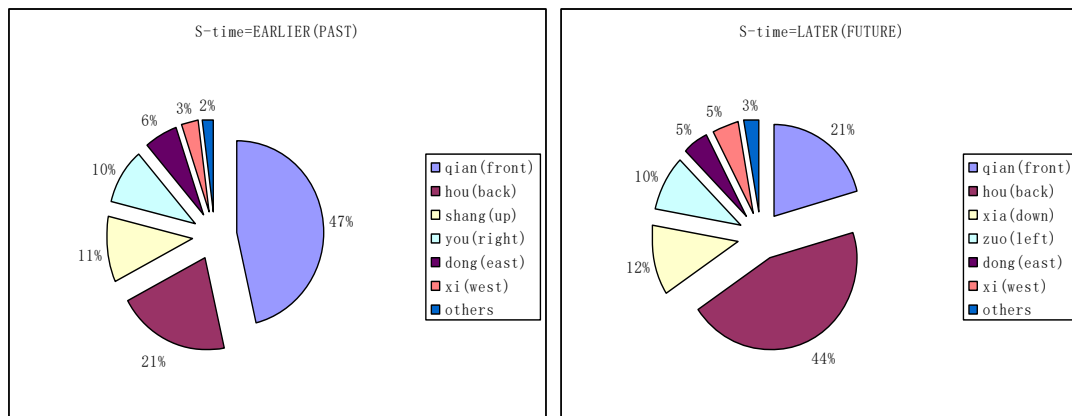


**Figure 8:** Percent lexicalization responses by simulated direction of motion and EARLIER VS LATER S-time construals (Experiment 4). See Table 4.

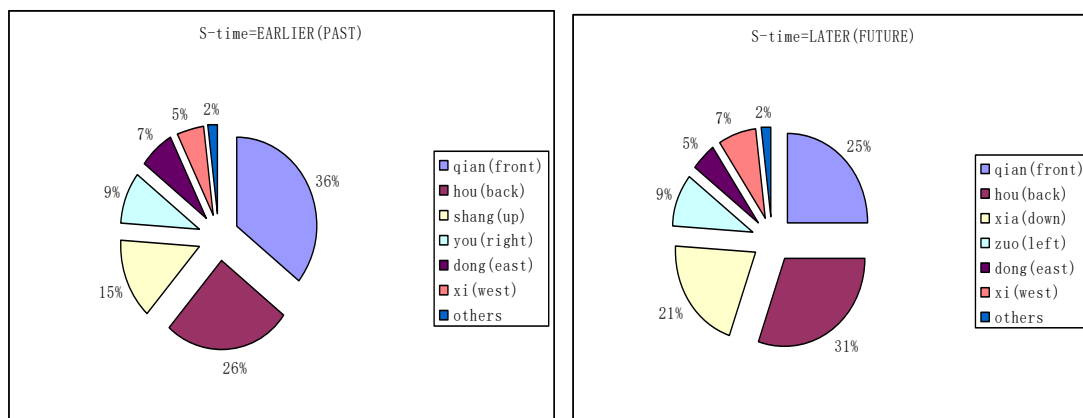
Implicit Motion	Construal type / lexicalization	EARLIER (PAST)								LATER (FUTURE)							
		<i>qian/</i>		<i>shang/</i>		<i>zuo/</i>		<i>dong/</i>		<i>qian/</i>		<i>shang/</i>		<i>zuo/</i>		<i>dong/</i>	
		<i>hou</i>		xia		you		xi		<i>hou</i>		xia		you		xi	
		<i>q</i>	<i>h</i>	<i>s</i>	<i>x</i>	<i>z</i>	<i>y</i>	<i>d</i>	<i>x</i>	<i>q</i>	<i>h</i>	<i>s</i>	<i>x</i>	<i>z</i>	<i>y</i>	<i>d</i>	<i>x</i>
Sentence type	Two-station Ss	8	40	22	4	0	19	12	6	40	86	5	23	19	0	9	10
	One-station Ss	3	25	14	2	0	9	7	5	24	29	2	20	9	0	5	7

**Table 5 (Experiment 5).** Response frequencies: lexicalizations by EARLIER vs LATER S-time construal type and one station vs two stations sentence frame.

#### TWO-STATION SENTENCE COMPLETION TRIALS



#### ONE-STATION SENTENCE COMPLETION TRIALS



**Figure**

**10.** Percent lexicalization responses for two-station and one-station sentence completion tasks with EARLIER vs LATER S-time construals (Experiment 5, see Table 5).