The psychological reality of spatio-temporal metaphors

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Time provides essential structure to human experience. In this chapter we review the available empirical evidence for a fundamental metaphoric structure such as TIME IS SPACE in figurative language and thought. The chapter is organized into three over-arching themes: *Motion through time*, that is, the influence of ego-moving metaphors (motion of the observer's context along a timeline) and time-moving metaphors (motion of events along a timeline) on the construal of time as moving or stationary; *Temporal succession*, and how it is conceptualized on the specific spatial axes (horizontal and/or vertical) used to sequence events in time; and lastly, *temporal duration*, focusing on the metaphors used to describe the temporal extension of an event and their influence on the perception of duration. A large part of the experimental evidence lends support to the psychological reality of the TIME IS SPACE metaphor, revealing the inextricable link between conceptual metaphor in language and fundamental thinking processes like perception of temporal succession and time estimation,

contributing to the emerging broader picture of the powerful role of linguistic experience in shaping the way conceptual representations are formed and activated. At the same time, the review also reveals that linguistic space-time mappings may be overridden by cultural conventions. Taken together, the evidence available to date suggests that the mental representation of time in humans is the outcome of an intricate interplay between linguistic (i.e. metaphors) and cultural factors, calling for further exploration of this interplay through empirical research.

Keywords: time perception, duration estimation, experimental cognitive linguistics

Introduction

Time is an ever-present dimension of human life. Our experience of reality is permeated by the order in which events occur and the extent to which they last, be they small scale (e.g. the passing of a minute, arriving late) or large scale (e.g. the passing of seasons, cycle of life). The centrality of time in human life is reflected, among other things, in our efforts to keep track of time (clocks, calendars etc.), to grasp the very essence of time (cf. the early philosophical treatises of time by Aristotle, Plato, St Augustine, and Vedic writers), and not least in our endeavour to make the most out of the time available to us. Time being so central to human experience, language offers a wide range of lexical and grammatical means to express temporal relations (e.g. Comrie 1976, 1985; Dahl 1985; Evans 2013). A significant trait of much temporal language is that it relies on analogies from another fundamental domain of human experience: space. Consider the following examples:

(1) The concert was pushed back The wheel was pushed

	back
Spring break lies ahead	The landing strip lies ahead
The dinner was very long	The road was very long
The rehearsal was too short	The rope was too short

These sentences illustrate that events with temporal reference are encoded in the same way as spatial events, thus showing that basic time concepts such as succession and duration are expressed through spatial language (e.g. Casasanto and Boroditsky 2008; Clark 1973; Evans 2004, 2013; Jackendoff 1983; Lakoff and Johnson 1999; Moore 2006; Traugott 1978). The existence of these *spatio-temporal metaphors* raises the important question of whether we use space to construe and understand concepts of time. In their seminal publication on conceptual metaphors, Lakoff and Johnson (1980) posit the metaphor TIME IS SPACE, thus suggesting that our mental representation of time is indeed based on spatial representations. While spatio-temporal metaphors have been subject to extensive debate and analyses in cognitive linguistics, it is more recently that experimental research has sought to elucidate the cognitive consequences of such metaphors. The introduction of experimental paradigms in the study of spatio-temporal metaphors is motivated from at least two points of view: first of all, probing the psychological reality of spatio-temporal metaphors represents an important development in testing the limits of Conceptual Metaphor Theory (henceforth CMT). As Lakoff and Johnson point out in later editions of their 1980 publication, other data than "linguistic forms and inferences" (2003: 249) are necessary to ultimately demonstrate a relationship between metaphors and mental representation. Second, investigating the role of spatio-temporal metaphors in time construal has important implications for the study of linguistic relativity. Even though most languages use spatio-temporal metaphors, there

is considerable crosslinguistic variation in the specific spatial configurations contained in these metaphors. Thus, to the extent that spatio-temporal metaphors influence the construal of time, speakers whose languages convey temporal relations differently should exhibit different mental representations

In this chapter we review the available empirical evidence for a fundamental metaphoric structure such as TIME IS SPACE in figurative language and thought. In accordance with Lakoff and Johnson (2003), and more recently, scholars within cognitive psychology (e.g. Casasanto, Boroditsky), we draw a distinction between linguistic and mental representation of time. The former refers to the specific (spatial) configurations used to express time in language. While studying this level of representation permits the postulation of hypotheses on the role of spatial frames for temporal cognition, it is in and of itself insufficient to draw firm conclusions about actual cognitive temporal behaviour (using linguistic data as a basis for both hypothesis and conclusion would be circular). The mental representation of time, conversely, is defined along a continuum of cognitive behaviours that (i) do not involve overt speech production, and (ii) have an inherent element of categorization (e.g. higher-level, conscious cognitive processes such as categorical judgments, estimations, sorting). The specific question we ask is to what extent mental temporal representation is isomorphic to time-space mappings in language.

The chapter is organized into three over-arching (and to some extent overlapping) themes: *Motion through time*, that is, the influence of ego-moving metaphors (motion of the observer's context along a timeline) and time-moving metaphors (motion of events along a timeline) on the construal of time as moving or stationary; the specific spatial axes (horizontal and/or vertical) used to sequence events in time and their consequences on the construal of *temporal succession*; and lastly, the metaphors used to describe

the temporal extension of an event and their influence on the perception of *duration*.

Motion through time

Boroditsky's (2000) study was one of the first to empirically investigate the hypothesis that abstract concepts come to be represented through metaphorical mappings from more concrete, experiential domains, as Lakoff and Johnson (1980) proposed. The study was a response to the non-existent experimental research on CMT at the time, and moreover an attempt to test the operationalizability of CMT. Boroditsky aimed to explain the acquisition, representation, and use of abstract metaphor, to look for psychological evidence of cross-domain mappings, and see if alternative theories can account for findings. In this way, Boroditsky aimed to develop what she termed the Metaphoric Structuring View as derived from Lakoff and Johnson's theory. Specifically, the Metaphoric Structuring View holds that "metaphors are used for organizing information within abstract domains" and are "imported" from a more concrete domain (2000: 3). For the subject of spatio-temporal metaphors (which the paper focuses on), she proposes that "…aspects of time that are specified through spatial metaphors will be shaped by the metaphors used (…)" (2000: 4). Boroditsky raises two versions of this hypothesis:

a. Weak version: through frequent use, spatial metaphors of time come to be represented in the domain of time itself.
b. Strong version: thinking about time *requires* spatial schemas.

The two main metaphors of time (in English) are ego-moving and time-moving (e.g. 'we are coming up to Christmas' vs. 'Christmas is coming').

Psychological evidence for these distinct conceptual schemas comes from a cost for switching between them. For example, travellers at an airport who were primed with an ego-moving metaphor (e.g. “is Boston ahead or behind us time-wise?”) were faster to respond correctly to a follow-up (target) question using the same ego-moving metaphor type (“So should I turn my watch forward or back?”) than if they were primed with a time-moving metaphor instead (e.g. “Is it earlier or later in Boston than it is here?”) (Gentner, Imai, and Boroditsky 2002). Converging evidence, Boroditsky proposes, comes from a study by McGlone and Harding (1998) which gave participants ambiguous statements such as “The meeting originally scheduled for next Wednesday has been moved forward two days” and asked them when the event in question would occur. Participants who were primed with ego-moving metaphors tended to answer “Friday” and participants who were primed with time-moving metaphors tended to answer “Monday”. Using a similar paradigm, Boroditsky sought to reveal whether priming spatial metaphors could impact the way participants thought about time. Specifically, participants completed a questionnaire with spatial scenarios that primed either ego-moving or object-moving frames of reference and required “true” or “false” responses immediately prior to seeing the ambiguous sentence above (“next Wednesday’s meeting has been moved forward two days”). Participants subsequently indicated on which day the meeting would occur. The results showed that 71.3% of participants responded to the test question in a manner consistent with the metaphor structure that they had been primed with (ego-moving priming led to more “Friday” responses and object-moving priming led to more “Monday” responses). Participants in the control condition (only the target question, without primes) did not perform reliably differently from chance. Boroditsky argues from these results that spatial schemas influence thinking about time.

Although Boroditsky's (2000) findings provide empirical evidence for the psychological reality of spatially grounded construal of time, the spatial primes used in the experiment were both linguistic and pictorial (i.e. sentences accompanied by pictures). It is therefore unclear whether the observed effect is due to priming from language per se, from the visual schematization of the sentence, or from both. For example, it is entirely possible that any effects of this experiment might disappear if they were no longer 'filtered' through language first. This is particularly important in light of the fact that the grammatical structure of the priming sentences in the ego-moving and object-moving conditions (e.g. "The flower is in front of me" vs. "the flower is in front of the hat box") could have primed similar thematic relations for the agents and themes in the grammatical structures in the target questions, in a manner independent of metaphor structure. This would be very hard to prove, since sentences of the type 'the x is in front of the y' are superficially identical whether used in ego-moving or time-moving schemas.

In a second experiment, Boroditsky (2000) asked if the reverse is true – time priming spatial thinking. Evidence of a two-way relationship would be consistent with the "strong" view of Metaphoric Structuring that sees representations of time as necessarily dependent on space. Alternatively, representations of time could become independent from the spatial domain through frequent use. Finally, one-dimensional time could simply be informationally insufficient for spatial representations that are plotted in two or three dimensions. In experiment 2 participants again answered ambiguous questions in a questionnaire, this time about temporal or spatial scenarios, after being primed with ego-moving or time/object-moving metaphors. Spatial schemas (ego-moving or object-moving) primed target questions about time, and time schemas (ego-moving or time-moving) primed target questions about space. Two control groups did either spatial primes before a spatial target question or temporal primes before a temporal

target question. Results showed that spatial schemas primed temporal schemas, and both control tasks (space priming space and time priming time) also showed above-chance levels of schematic consistency in responses to target questions. However, temporal schemas did not prime responses to spatial target questions. Boroditsky argues that this is consistent with the "weak" view of Metaphoric Structuring that temporal schemas do not necessarily influence thinking about space, and space is therefore not necessary in thinking about time (otherwise time would always prime space).

However, in this experiment the spatial primes were represented by pictures with captions (like in experiment 1), whereas the time primes were sentences only using calendric information (e.g. days of the week) as a 'fulcrum' for schematizations. Thus the spatial primes: (i) were more immediately visually available in pre-schematized format; (ii) existed in more than one modality (visual, verbal); and (iii) were not anchored in culturally-shared information such as the days of the week. Although it is not obvious as to whether this would make the spatial primes more or less potent than the temporal ones, if the answer is 'more' then the time/space asymmetry reported could be a result of this imbalance. This is not necessarily a methodological confound. The space domain, by virtue of its concrete nature, is more readily multimodal in its realisation (i.e. both verbal and visual) than the more abstract time domain, and this very fact may be the root of the asymmetry, and by extension, of the spatial grounding of time: talking about something abstract (time) is more vulnerable to priming from something concrete that can be represented both visually and verbally (space) than vice versa.

In experiment 3, Boroditsky (2000) wished to look at the on-line processing of schemas rather than the result of their processing. She also sought to test the possibility that both temporal and spatial schemas adopt 'broader' domain-independent schemas and are not specific to these

domains at all (she calls this the Generic Schema View). Such a view would propose that time is not thought of in terms of space, but that both domains recruit this Generic Schema View. It could also be, she argues, that the asymmetric priming effects of spatial and temporal schemas could be due to spatial schemas being more strongly associated with this more generalised frame of reference. Boroditsky notes that if the Generic Schema View is correct, then space should prime time even more strongly than time might prime itself, since space has the more 'direct' relationship with the schema that serves both. In the experiment, participants received two primes followed by a target, but this time their responses to the target were timed. The format was again a 2 x 2 time/space prime/target crossed design (as experiment 2). Boroditsky predicted that, if the Generic Schema View is correct, then spatial primes rather than temporal primes should lead to faster response times on temporal target questions. Additionally, the "weak" Metaphoric Structuring view would again predict that although we use space to think about time, space is not necessary to think about time – hence a similar priming asymmetry to that found in experiment 2 might be observed. Results showed that participants were faster to respond "true" to a target scenario when the prime was consistent with the domain of the target (time for time, space for space) than when it was not (space for time, time for space), across both ego-moving and object/time-moving schemas. Consistent with the "weak" version of Metaphoric Structuring, spatial information primed faster responses on temporal targets, but temporal information did not prime spatial targets. Contrary to the Generic Schema View, time primed itself more than space primed time.

Núñez, Motz, and Teuscher (2006) extended Boroditsky's (2000) empirical approach whilst proposing a novel theoretical framework that departs from the traditional division between ego-moving and time-moving metaphors of time, where the ego moves through time, or time moves in relation to the ego. Firstly, Núñez and colleagues point out that non-

dynamic spatial metaphors of time also exist, which treat times as locations (e.g. “the appointments are too close together”). They ask whether a ‘thing that moves’ is really a requirement for spatial metaphors of time as a result. Secondly, they argue that in sentences such as “Wednesday follows Tuesday”, no ego reference point is required. Thirdly, they point out that some expressions require no sense of what is ‘future’ or ‘past’ either, such as (again) “Wednesday follows Tuesday”, which is true whether it is a past week or a future week in question. Such expressions require no anchoring in the ‘now’. Instead, Núñez et al. posit Ego-Reference-Point (Ego-RP) and Time-Reference-Point (Time-RP) metaphors. Both ego-moving and time-moving metaphors would be subsumed under Ego-RP, whereas Time-RP incorporates earlier/later (or anteriority/posteriority) relationships with no requirement for a ‘now’/ego anchor.

In experiment 1 the researchers aimed to uncover evidence of the psychological reality of this division of spatio-temporal metaphors. Participants saw frontless objects (boxes) moving in a line on a horizontal plane (not approaching or receding with respect to the observer). Participants were asked some questions regarding the display. For example, participants were asked what colour the box ‘in front’ was. This session was designed to prime Time-RP conceptual mappings. After this priming session, participants were given one of two target questions, much like Boroditsky’s (2000), but this time the target could be in the past or the future:

a. Next Wednesday’s meeting has been moved forward 2 days. On what day will the meeting now take place?

Or

b. Last Wednesday's meeting had been moved forward 2 days. On what day did the meeting take place?

Data were compared to Boroditsky's (2000) unprimed condition for the same target question (present tense) and it was found that participants gave significantly more 'Monday' answers than 'Friday' answers than the chance levels reported in Boroditsky's study, regardless of whether the sentence referred to a past or future time. The researchers conclude that an ego is not an essential ingredient in the disambiguation of spatio-temporal metaphor.

Experiment 2 largely replicated experiment 1, but the boxes in the priming task were made two-dimensional in order to avoid any potential inclusion of the ego by means of representing a three dimensional space, and a control condition showed a static array of the same boxes. Additionally, participants were asked a new question that replicated the old 'meeting' sentence but substituted hours for days. The results confirmed the findings of experiment 1. The primed group gave significantly more 'earlier' responses than 'later' ones for both past and future sentences and 'day' and 'hour' versions of the target. Participants in the control condition did not perform differently from chance.

Rothe-Wulf, Beller, and Bender's more recent (2014) study examined the psychological reality of the TIME IS SPACE metaphor cross-linguistically. The authors begin by highlighting the apparent ambiguity in US English of the sentence "Wednesday's meeting has been moved forward two days". The problem, they say, is that there is no frame of reference without recourse to other, possibly cultural information. The researchers aimed to look at cross-linguistic differences in responses in German, Swedish, and US English speakers. They also, uniquely, wished to investigate consistency in individual responses. Rothe-Wulf et al. define frame of reference as a "coordinate system that allows one to identify relationships between two entities" (2014: 3). They distinguish between

temporal frames of reference (t-FoRs), which include absolute, intrinsic, and relative frames, and spatial frames of reference (s-FoRs), which also include absolute, intrinsic, and relative frames. Absolute frames locate a Figure in reference to a Ground in the context of an oriented field outside of the Figure and Ground. For space, the field is space itself, which could be oriented in terms of the 4 points of the horizon (north, south, east, west), or the direction of another physical entity on which Figure and Ground are located (e.g. the flow of a river, the direction of a moving vehicle, etc.). For time, the field would be time itself. Absolute frames are similar to the termed 'ego-moving' perspective. Intrinsic frames locate Figure in relation to Ground on the basis of the orientation of Ground itself (thus Ground needs a 'front'). A typical Ground is a human. This roughly corresponds to 'time-moving' perspectives. Rothe-Wulf et al. point out that there is debate over how events in time can be seen as 'fronted', although the beginning of a time event is a good candidate for such a front. Relative frames locate a Figure in relation to a Ground according to a Viewpoint. Levinson (2003) divided spatial frames into translation, reflection and rotation types. In reflection, the Viewpoint is reflected in the Ground so that 'front' is what is between the Viewpoint and the Ground. The authors give the example of the word *arrière* ('behind') in French for great-grandparents and great-grandchildren, and the tendency to schematize moving forwards as 'pastwards' or 'futurewards' depending on whether the event was in the past or is yet to come in some speakers of Tongan (an Austronesian language: see Bender, Beller, and Bennardo 2010). In translation, Viewpoint is shifted into Ground, so 'front' is what lies beyond Ground. Rotation does not relate to one-dimensional time, and is not elaborated upon as a result.

In spatial references of time, a number of factors can bring to bear on the frame of reference that might be taken for a given scenario. Experiment 1 sought to assess preferences in temporal frames of reference in Swedish, German, and US English speakers and the consistency of

preferences in individual speakers. Two pairs of two questions were asked in a paper-and-pencil questionnaire. The first pair used days of the week:

a. The concert scheduled for Thursday last week was moved forward two days. On which day of the week did it actually take place?
b. The meeting scheduled for Wednesday next week will be moved forward two days. On which day of the week will it now take place?

The second used hours rather than days:

a. The power cut scheduled for 4 p.m. yesterday was moved forward three hours. At what time did it actually take place?
b. The departure scheduled for 9 a.m. tomorrow will be moved forward three hours. At what time will it now take place?

Frame of reference choices were assessed as follows:

a.	Absolute	=	movement futurewards
b.	Intrinsic	=	movement pastwards
c.	Relative (reflective)	=	futurewards if event in past, pastwards if event in future
d.	Relative (translation)	=	pastwards if event in past, futurewards if event in future

Results showed high levels of consistency within culture/language groups, but wide differences between them in the temporal frames adopted. The Swedish speakers preferred absolute frames, the Germans intrinsic, and the US English speakers were split between the two (albeit with a high proportion of intra-individual consistency in choices across both pairs of questions). Relative frames were largely absent in responses across all participants. Given that all three languages come from the same Proto-

Germanic root, Rothe-Wulf and colleagues (2014) posit that variation in cultural convention might account for the differences between speakers in their preferred frames of reference and hence "…reference preferences do not come enclosed with the linguistic tools used to express them". (2014: 8).

Temporal succession

Part and parcel of construing events, linguistically and mentally, is sequencing them in a given order of occurrence. The issue of whether our mental representation of temporal succession is influenced by linguistic space-time mappings has been subject to a number of studies. Macrae, Miles, and Best (2012) provide converging evidence from various experimental paradigms to demonstrate that the perception-action systems that govern movement through space also provide a scaffold for the mind's journeys through time. They call this phenomenon 'mental time travel' (chronesthesia). They first point to case study evidence of a patient who suffered traumatic brain injury and was unable to recall memories of his own personal experiences, or contemplate future events that might be related to him personally (Tulving 1985). The patient's semantic and short-term memory, however, remained intact, pointing to a unique loss of episodic memory. The concomitant loss of the ability to project into the future, however, lead Macrae et al. to conclude that the patient had lost the ability to "travel through time" in either direction. Similar effects, though weaker and more gradual, occur in ageing, as well as in some mental illness. The link between past and future mental time travel is made further through references to work by Suddendorf (2010), who found that young children (3-4 year olds) who could correctly describe what they had done the day before were more able to generate future possibilities for the day after, to Spreng and Levine (2006), who found that in young adults imagined future

scenarios are reportedly more vivid if they are set in the context of what is already perceptually familiar, and Buckner and Carroll (2007), who provide evidence from brain imaging that also suggests that overlapping cortical regions are activated when thinking about the past or the future.

In one experiment reported in Macrae et al. (2012), participants were presented with a target time on the screen before indicating with the mouse whether the time was in the past or the future. The words *past* and *future* were located on either the left or right of the screen on each trial, and Macrae et al. recorded the curvature of mouse movements towards the left or right. They hypothesised that participants would be most direct in their mouse movement towards *past* when it was on the left of the screen, and *future* when it was on the right. The results confirmed this hypothesis: there was a wider curvature (indicating less direct movement) in mouse trajectories to *past* when it was on the right and *future* when it was on the left. Macrae et al. conclude that the spatial information was an "attractor" for time information. However, Macrae et al. had in their introduction brought up Arabic-speakers right-to-left classification of time (as opposed to Roman script language: Tversky, Kugelmass, and Winter 1991). This result could be an artefact of reading direction, which is socio-cultural rather than metaphorical. Note that no information on participants' language background is provided. Regardless, a learned socio-cultural explanation cannot be ruled out through this design even if all participants were monolingual English speakers.

In another experiment, Macrae et al. (2012) sought to prime mental time travel through the illusion of movement. Participants performed an easy go-no go task that required them to click a mouse button when they saw a target but not when they saw a distractor. There were only six target presentations over the six-minute period of the task. The targets and distractors appeared on a screen that displayed vection, mimicking the environmental change that correlates with forwards or backwards movement

and thus giving a sense of self-motion. The researchers expected that participants would "daydream" owing to the dullness of the task they were performing, and hypothesised that when the vection display mimicked forwards motion, participants would be more inclined to prospect about the future, and when the display mimicked backwards motion, participants would be more inclined to prospect about the past. After the task, participants were asked to report the proportion of their thinking that related to the past or the future. Consistent with the hypothesis, future thoughts were more likely to accompany simulated 'forwards' motion, and past thoughts 'backwards' motion. This is a more robust methodology than the one used in the previous experiment, as reading direction is not a factor. However, neither is language, necessarily, since forwards motion in space correlates with forward motion in time for humans because we face the direction we move in (cf. Lakoff and Johnson 1980).

Miles, Nind, and Macrae (2010) used mental time travel to investigate the processing of spatial information in conjunction with temporal information when one is engaged in thinking about the future or the past. Given other findings that abstract thought can be 'embodied' motorically, they reasoned that retrospection may be accompanied by backwards motion and prospection by forwards motion. Specifically, participants were asked to recall past events or imagine future ones while standing. The researchers surreptitiously measured the participants' tendency to 'sway' or lean forwards or backwards using motion tracking technology while they were engaged in thinking about these past and future scenarios. Results showed that participants did indeed lean forwards when thinking about the future and lean backwards when thinking about the past. The researchers conclude that mental time travel "…appears to be grounded in the perception-action systems that support social-cognitive functioning. In this way, the embodiment of time and space yields an overt behavioural marker of an otherwise invisible mental operation". (2010: 223). This is a

very simple and elegant experiment, but the specific source of the finding is impossible to specify. Is the chronesthesia effect emergent and dependent on linguistic metaphor per se, is the linguistic metaphor a mapping on a pre-linguistic biological perception-action tendency, and if so, what determines the direction of the future-past polarity on the time axis, or is it all arbitrary and a matter of cultural practice? The next few paragraphs focus specifically on the possible role of cultural convention on metaphor comprehension and use.

Two pieces of evidence point to the possibility that the directionality of the TIME IS SPACE metaphor is culture-specific. The first piece of evidence comes from the study of the mental construal of temporal succession in the Aymara people of South America. Núñez and Sweetser (2006) begin by underlining the apparent universality of both ego-/time moving metaphoric models and the conceptualization of time in terms of space. They add that, until the study of the Aymara language, all documented languages conceive of the future as 'in front' and the past as 'behind'. Aymara is an Amerindian language spoken in parts of Peru, Bolivia and Chile. It is, according to the authors, the first recorded case of the inverse of the future/front past/back mappings in all other languages studied to date. In Aymara, the basic word for 'front' (*nayra*, translated as "eye/front/sight") is also the basic word for 'past', and 'back' (*qhipa*, "back/behind") is a basic expression for future meaning. For example:

(2)	*nayra*	*mara*
	eye/sight/front	year
	'last year'	

Nayra is also used to mean 'first' (earliest) in an ordinal sequence (such as 'first', 'second, third' etc.), and can mean 'earlier than' in a Time-RP sense, but not 'earlier than now' (Ego-RP).

(3) *qhipüru*

CONTRACTED FORM OF:

qhipa	*uru*
back/behind	day

'a future day'

Qhipa can also refer to positions in a sequence in a static, non-deictic structure, such as *qhipa sata* meaning 'last planting'. The researchers also note that increasing bilingualism among Aymara speakers has led to the adoption of Spanish terms such as *atrás* ('behind'), but consistent with the metaphor encoded in their native language, the Aymara use the term to mean 'later'. In sum, Aymara speakers use *nayra* and *qhipa* to mean 'earlier' and 'later' in Time-RP metaphors and also 'past' and 'future' in Ego-RP metaphors. However, in the Ego-RP metaphors, the 'ego' is not usually made explicit (e.g. 'a future day').

Núñez and Sweetser (2006) collected data from gesture behaviour in order to corroborate their linguistic findings. Gesture is co-produced with speech, it is universal insofar as gesture-accompanying speech has been observed in all studied languages to date, it is less subject to 'conscious' control on the part of the speaker, and it has been argued to not only accompany but also complement and elaborate meaning (Cienki 1998). As part of their investigations, Núñez and Sweetser analysed Aymara gesture's coherence with linguistic metaphoric mappings. Confirming the language data, they found that younger Aymara speakers with more experience with Spanish tended to use past/behind, future/front gesture patterns consistent with Spanish language spatio-temporal linguistic representations, whereas the older Aymara speakers with less contact with Spanish tended to use past/front, future/behind patterns consistent with Aymara spatio-temporal linguistic representations. Moreover, temporal distances were mapped onto greater gesturing angles, such that nearer times were closer to the ego and

more distant times further. Like speakers of other languages, Aymara gesture tended to use a left-right rather than sagittal mapping when talking about non-deictic time with no ego-reference-point.

Why do Aymara speakers represent the past as in front and the future as behind? Núñez and Sweetser (2006) propose that the logic of KNOWLEDGE IS VISION metaphoric structure might be relevant. The authors postulate that Aymara speakers imagine static mappings of KNOWN IS IN FRONT OF EGO and UNKNOWN IS IN BACK OF EGO, rather than an ego-on-a-path interpretation that where we have already been, rather than what we view ahead of us, is what is known. They suggest that part of the answer for this unusual case in world languages may lie in the importance of information sources in the grammar of Aymara, such that sentences are obligatorily marked for whether information was obtained first hand (e.g. 'seen' by the speaker him or herself) or second hand (e.g. reported to the speaker). If this is the case, then the apparent cultural specificity of Aymara time conceptualization is essentially language-derived, and not a matter of cultural convention.

The second piece of evidence of the cultural-specificity of the directionality of future and past comes from the study of individual differences in the mental construal of temporal succession. De la Fuente et al. (2014) investigated why some people have one or the other of these spatio-temporal mappings. The researchers studied Darija, a dialect of Arabic spoken in Morocco, and Spanish (from Spain). According to past, unpublished research by some of the same authors, Darija speakers gesture in front when talking about the past, while Spanish speakers tend to gesture in front when talking about the future. Interestingly, both languages use future-in-front and past-behind metaphors – it is the co-speech gestures that vary in Darija speakers. The researchers suggest a dissociation between how Darija speakers might think about time and how they speak about time. They (2014) carried out a series of experiments, all employing the basic

paradigm of the 'temporal diagram', a bird-eye view of a human avatar facing forwards (upwards), with one box in front of him and one behind him. Participants were told of one event that happened in Juan/Mohammed's past, and one in his future, and were asked to write them in the boxes. In the first experiment, the majority of Spanish speakers put the future event in the 'front' box and the past event in the box 'behind', but the Moroccan Darija speakers did the opposite.

Thus while Spanish speakers seem to employ the future-in-front mental mapping, the Darija speakers, like the Aymara speakers, appear to employ the KNOWLEDGE IS SEEING metaphor in their mental mappings of temporal succession. However, the authors propose a cultural explanation for this finding that they test in experiment 2. The researchers argue that Moroccans place greater value on tradition, and the Spanish on progress. They hypothesised that such culture-specific attitudes might account for the differing spatio-temporal patterning. They call it the temporal focus hypothesis. In experiment 2, a questionnaire established that the Moroccans agreed more with past-focused statements (e.g. "The young people must preserve the traditions") and the Spanish-speakers agreed more with future-focused statements (e.g. "Technological and economic advances are good for society"). Based on the findings from experiment 2, in experiment 3 the researchers predicted that temporal focus should play a role also within-culture, and compared Spanish senior citizens with Spanish university students in the temporal diagram task. As before, the majority of the young adult Spaniards put the future event as 'in front' and the past event as 'behind' the avatar. The older Spaniards, however, performed at chance levels. However, without corroborating questionnaire evidence regarding individual participants' own 'temporal foci', this is a comparison by age, or by experience with experimental design (presumably the students were psychology students), not directly supporting the temporal focus hypothesis. This does not make the age differences uninteresting, but it does not support

the temporal focus hypothesis without also showing that the older group were more past-focused. The mean age of 76 years also leaves open the possibility of variation in performance on the diagram task owing to unfamiliarity with tasks of this type (hence the chance finding). No data is provided regarding whether the older group tended to match the order of mention of the events to their placement in the boxes. Also, an at-chance response finding does not mean that the older group is more past focused, it just means they are not focused one way or another, if it means anything about temporal focus at all.

In experiment 4, de la Fuente et al. (2014) compared three groups: Spanish university students, older Spaniards (M = 73 years) and Moroccan students at university in Morocco, The temporal focus questionnaire replicated the future-focus of the younger Spaniards and the past-focus of the Moroccans found earlier. The older Spaniards showed no bias one way or another, and in fact appeared to have a higher level of 'agreement' with the statements overall (indicated by similar levels of past focus to the young Moroccans and future-focus to the younger Spaniards). The results of the temporal diagram task were equivocal. As before, the younger Spaniards put the future event 'in front' more often than behind the avatar, whereas the Moroccans did the opposite. The older Spaniards were reportedly at an "intermediate" place between the two in terms of performance, as they were less likely to put the future event 'in front' than the younger Spaniards, but more likely to do so than the young Moroccans. Although the researchers claim the older Spaniards performed at an "intermediate" level between the other two groups, they were significantly more likely to put the future event in front of the avatar than behind it, much like the younger Spaniards. This group of older Spaniards did not perform at chance levels like the group in the previous experiment. The researchers suggest age and independent living were factors in this (the older group in experiment 3 was in assisted living) - this group of older Spaniards was younger than the group in the

previous task, and may therefore have been more future-focused, but the mean difference was a mere 3 years, between 76 and 73. More significantly, participants' temporal focus (past or future) on the questionnaire was a significant predictor of responses on the temporal diagram task. That is, those participants that tended to place the past in front in the temporal diagram task tended to also give more past-oriented responses in the temporal focus questionnaire, and those participants that tended to place the future in front also tended to give more future-oriented responses in the questionnaire. However, it is notable that this result was based on an analysis of all participants collapsed over culture and age. Given the almost identical propensity to agree with past and future statements in the older Spanish group, it is not clear that an analysis of these participants alone would corroborate a link between temporal focus and temporal diagram responses.

In their final experiment, de la Fuente et al. (2014) attempted to establish a causal link between temporal focus and behaviour in the temporal diagram task. Spanish university students were primed to be more past- or future-focused by means of a writing exercise prior to the diagram task. This 'training' session involved written responses to ten questions that focussed entirely on the past (e.g. "Were you happy as a child?") or the future (e.g. "Do you think you will be happy as an old person?"). 'Future-focus' training led to a small but significant increase in the tendency to place the future event in the 'front' box (compared to the combined results from the same population in the previous experiments), whereas 'past-focus' training led to chance-level performance on the diagram – significantly different from the future-trained group. The researchers argue that even a small amount of context-training can alter space-time mappings, and argue that temporal focus can play a causal role in the spatialization of time.

While the rigorous study of de la Fuente et al. (2014) points to the role of individual cultural differences in temporal focus rather than linguistic metaphor per se, there remain a few issues with their approach that future studies may address. For example, a much more ecologically valid and less conscious behavioural measure would be to study speech accompanying gestures like Núñez and Sweetser (2006) did for Aymara speakers. This would reflect real-life behaviour and, if correlations with temporal focus and gesture patterns were shown as in De la Fuente et al.'s (2014) 4th and 5th experiments, this would establish the temporal focus hypothesis as a strong determinant of the directionality of spatialization of time in individuals. Another issue concerns the generalizability of those results to other cultures. Are Moroccans the only past-focused culture? Is it all Moroccans? If not, why? What is the definition of a past-focused culture? Is Japan past-focused socially and future-focused technologically and economically? Would we predict different spatialization of time for different domains of experience within a culture? Clearly, this is an area of investigation still in need of much empirical evidence in order for firm conclusions to be drawn.

Thus far, all the afore-mentioned studies have looked at the construal of temporal succession on a horizontal axis. However, there is cross-linguistic evidence that temporal succession can also be construed vertically (e.g., Boroditsky 2001; Boroditsky, Fuhrman, and McCormick 2011). Miles, Tan, Noble, Lumsden, and Macrae (2011) investigated the possibility that Mandarin-English bilinguals possess two spatio-temporal mappings. Whereas in English time is represented metaphorically as a horizontal continuum from left to right (past to future), in Mandarin the metaphor is equivalent but on a vertical axis (up for past, down for future). Mandarin speakers have been reported to more efficiently process temporal information when it is organised vertically and English speakers when it is organised horizontally (Boroditsky 2001). The suggestion, according to

Miles et al. is that sociolinguistic conventions influence temporal representations. In experiment 1, bilingual Mandarin-English and monolingual English participants were shown images of buildings from the past or future (science-fiction scenes) and responded *past* or *future* by means of a button press on the number keypad. In horizontal blocks, *past* and *future* were located on either the left and right of the screen respectively (compatible), or the right and left respectively (incompatible), and the keys to be pressed were to the left (4) and right (6) of the central '5'. On the vertical blocks *past* and *future* were located at the top and bottom edges respectively (compatible) or bottom and top respectively (incompatible) and the keys were above (2) or below (8) the central '5'. There were four blocks, one for each condition, in a 2 (horizontal vs. vertical) x 2 (compatible vs. incompatible) design. Results showed that the monolingual English speakers were faster on compatible than incompatible trials on the horizontal axis but not the vertical. The bilingual Mandarin-English speakers were faster on compatible than incompatible trials across both horizontal and vertical axes, and overall faster on the horizontal axis than the vertical. The authors concluded that "it appears that the language one speaks can indeed influence how one thinks about time, such that bilinguals possess two mental time lines" (2011: 601). However, the authors present no direct evidence that language and not some other factor is the source for their findings. Reading direction is the obvious one, since Chinese uses vertical directionality of writing.

In experiment 2, Mandarin-English bilinguals were asked to sort three pictures of a famous person into a self-chosen order. The pictures were of Jet Li (a famous Chinese actor) and Brad Pitt (a famous American actor). Each was a portrait of the actor as a young man, an old man (with special effects), and an intermediate age between the two. Testing was in English, and the experimenter first placed the intermediate picture in the middle of a square board. Results showed that Mandarin-English bilinguals tended to

sort the pictures of Brad Pitt (priming a Western cultural context) from left to right, and Jet Li (priming a Chinese cultural context) from top to bottom. Again, the authors are unclear about the underlying cause of this effect. They claim that it is an effect of linguistic metaphor on thinking, and conclude by saying that reading direction does not provide a sufficient explanation for the effects found, since Singaporean Chinese is also written horizontally in Singapore (where the bilinguals came from). But they add in a footnote that Singaporeans are exposed to the traditional vertical arrangement of Chinese letters in their daily lives. So it appears to be impossible to disentangle the relative influence of writing direction and linguistic metaphor on time conceptualization in this study. Obviously, finding a language with vertical metaphors but exclusively horizontal writing direction (or vice versa) would provide a more conclusive test-case, but such a language might be difficult to find because it is also possible that directionality of writing is itself influenced by vertical time metaphors (or vice versa).

Duration estimation

Another basic aspect of temporal cognition relates to estimating the duration of a given event, which is relevant for, for instance, event individuation and sequencing. Casasanto and Boroditsky (2008) examined duration perception to test the potentially asymmetrical cross-dimensional relationship between space and time. They based their hypothesis, namely that space would influence time more than time would influence space, on the relative prevalence of spatial linguistic metaphors of time (e.g. Lakoff and Johnson 1980, 1999; see also studies reviewed above). In a series of experiments, participants saw straight lines that 'grew' from left to right on a screen. They were asked to make one of two judgments for each line that they saw,

specifically (i) how long the line was when it reached full length (spatial judgment), or (ii) how long it took for the line to reach its full length (time judgment). The final displacements and the speed with which the lines grew varied between trials. Spatially shorter lines were perceived to have taken a shorter time to reach full length, but a fast-growing line was not conversely perceived to be spatially longer. The results showed that participants were influenced by the spatial length of the line when making time estimations, but were not influenced by the time it took for the line to reach its final length when making space judgments. This effect persisted regardless of whether participants were primed as to which judgment (time or space) they needed to make before or after the trial began, and it also persisted when the line did not 'grow' but simply appeared on screen for varying durations. Casasanto and Boroditsky concluded that space and time are related asymmetrically, and provided evidence for the psychological reality of a basic tenet of CMT: mental representations of intangible phenomena (such as time) may be partially parasitic upon more concrete experiences (such as space).

Casasanto (2008; see also 2005) investigated time as 'distance' and time as 'quantity' metaphors. While English and Indonesian prefer distance metaphors to express time duration (e.g. a long meeting, a party of short duration), Greek and Spanish prefer to express duration by means of quantity expressions (e.g. a big meeting, a party of small duration). It is noteworthy that the measurement of whether a language was distance- or quantity biased was based on the ratio of collocations on a Google search. For example, quantity expressions to refer to duration were overwhelmingly more frequent than distance durations in the corpus in Greek speakers, and vice versa for English speakers. These naturally occurring tendencies in the language corpus were corroborated in a questionnaire asking participants to rate their preference for distance based and quantity based collocations to refer to temporal duration. Participants rated the expressions roughly in-line

with expectations created by the Google data for each of their specific languages.

Based on the corpus and questionnaire evidence, the next step in Casasanto's (2005) investigation focused on whether the prevalence of distance or quantity metaphors of time in speakers of English, Spanish, Indonesian and Greek would correspond to greater interference from linear or three-dimensional (quantity) input while estimating durations of events. Casasanto employed a 'filling tank' condition to create a 'quantity' interference task alongside the 'growing line' tasks for distance interference used in Casasanto and Boroditsky (2008). Casasanto predicted that different linguistic representations between languages should therefore lead to different spatio-temporal relationships. Such an outcome, Casasanto argued, could constitute evidence of a "deep" effect of language on non-linguistic representation. He specifically predicted that speakers of English and Indonesian, who use distance spatial metaphors of time, would show greater interference from the spatial (distance) information contained in the 'growing line' task than the Spanish and Greek speakers, who in turn would instead show greater interference from the spatial (quantity) information contained in the 'filling tank' task than the English and Indonesian speakers. As predicted, English and Indonesian speakers were strongly influenced by line length in their time duration judgments but only weakly influenced by tank 'fullness', whereas the Greek and Spanish speakers showed the opposite pattern; a strong influence of quantity and only a weak effect of distance. The effect of duration on space estimation did not reach significance, with the exception of the filling tanks task in Indonesian speakers: the time it took to fill the tank to its maximal level correlated with the 'fullness' estimations that Indonesian speakers gave. However, this was the only 'reverse' case of time showing a significant influence on space.

A further experiment examined whether temporal duration metaphors in language had a causal role in duration estimations. To this end,

Casasanto (2005) devised an experimental task to train English-speaking participants to think like Greek speakers when estimating time. Two groups of English native speakers were trained in either distance (the English preference) or quantity (the Greek preference) metaphors. The training required participants to use either the adjectives long/short (distance training) or more/less (quantity training) in filling in gaps before nouns describing physical objects or events. For example, in the 'distance training' group participants had to fill in the gap "A sneeze is ___ than a vacation" using shorter/longer, while the 'quantity training' group had to use more/less. All participants then performed the filling tank task (see previous paragraph). The outcome of the training task was that the group of participants who had received quantity training showed a significant quantity interference effect, but those who received the 'distance training' (or no training, cf. the prior experiments) did not.

Casasanto (2010) discusses the experimental evidence above as casting new light to metaphor theory in terms of the potential relationship between language and abstract thought. Casasanto argues for the use of spatial representations to conceptualise time even when language is not used (what he calls the "deep" view of the relationship between language and abstract thought) versus the "Thinking for Speaking", or "shallow", view of language as influencing thought only when language is involved (such as when planning speech or when comprehending language). The experiments on temporal duration by Casasanto and colleagues suggest that frequency of usage of specific distance or quantity duration metaphors in a specific language may adjust and strengthen time-distance or time-quantity mappings in these (and potentially other) populations. Casasanto claims that these results are inconsistent with a "shallow" view of language influencing thought only when "thinking for speaking" (Slobin 1996). However, the results from the final training experiment point to the ease with which a short period of induced 'quantity bias' could cause lifelong biases in English

speakers to shift towards the biases of Greek and Spanish speakers. The corollary of this is that the effect of a lifelong experience with language-based metaphor bias is very easily overcome, something which might also be viewed as inconsistent with a "deep" view of the language-thought relationship.

A somewhat different approach to the mental representation of temporal duration is taken in a recent study by Alards-Tomalin, Leboe-McGowan, Shaw, and Leboe-McGowan (2014), who investigated the potential for different magnitudes and magnitude codes, specifically number, size and colour saturation stimuli to interfere with time perception. They base their predictions on three effects. The 'kappa' effect (Cohen, Hansel, and Sylvester 1953; Sarrazin, Giraudo, Pailhous, and Bootsma 2004) posits that varying relative physical distances between three sequentially-presented stimuli (A, X, and B) can bias time duration judgments of the two intervals they create (AX and XB), such that longer physical distances lead to perceptions of longer time intervals. The Spatial-Numerical Association of Response Codes (SNARC) effect (Dahaene, Bossini, and Giraux 1993) contends that people from Western cultures have a left-to-right/low-to-high line of mental representation of magnitude. Likewise, shorter times are related to left-sided responses and longer times to right-handed ones (the Spatial-Temporal Association of Response Codes (STARC); Vallesi, Binns, and Shallice 2008).

In the first experiment, participants saw three digits presented one at a time in sequence. The first and third (final) numbers in the sequence were always 1 and 9 (or 9 and 1 in a reverse-order condition), so the second digit controlled the relative numerical 'distances' (henceforth 'magnitude') of the two intervals. For example, participants might see a 1,2,9 sequence, with two blank intervals either side of the '2'. In this case, the *magnitude* of the difference was smaller in the first interval than the second. In terms of *duration*, the 'long' intervals ranged between 735ms to 785ms, and the

‘short’ 635ms to 685ms, and four time differences between interval pairs were created (150ms, 117ms, 84ms, and 50ms). The actual number stimuli themselves appeared for a fixed duration of 200ms each. Participants correctly rated more long-short interval patterns as long-short (and vice-versa), and their accuracy in doing so increased as the disparity between the durations of the two intervals grew. Additionally, and as predicted, the relative difference in the *magnitudes* of each interval also influenced results, such that smaller differences (e.g. 1,2 or 8,9) were perceived to be of shorter duration and larger differences (e.g. 2,9 or 1,8) perceived to be of longer duration. In a second experiment, this result held even when the sequence of numbers was manipulated within-subjects to be either ordered (as previously) or non-ordered and not ‘book-ended’ by the lowest and highest digits ‘1’ and ‘9’ (e.g. 2,1,8 and 2,9,8).

In a similar experiment with discs of four different sizes instead of numbers, participants again had to judge whether the intervals between the stimuli pairs AX and XB were long-short or short-long. This time, it was hypothesised that participants would be influenced by the magnitude of the size difference between the pairs of stimuli that made up AX and XB in a similar way that they were influenced by the size of the numerical differences in experiment 1. As expected, the proportion of long-short responses was lower than the proportion of short-long responses on trials where the size difference between disc A and disc X was smaller than the size difference between disc X and disc B. In other words, participants perceived intervals between two discs with a wider disparity in relative size as longer in duration than the interval between two discs with a smaller size difference. In another experiment, same-sized discs with one of four magnitudes of blue colour saturation were used. Again in line with the predictions, participants perceived the intervals between discs of a relatively similar level of colour saturation (e.g. light blue vs. medium light blue) to be

shorter in duration than the interval between discs with a perceptually stronger saturation difference (e.g. light blue vs. medium dark blue).

There were a number of unexpected interactions. In the 'size' experiment, participants who received non-linear size sequences of disc sizes (i.e., disc sizes did *not* consistently increase or consistently decrease across the three stimulus presentations) were less accurate at making interval duration judgments than participants who received ordered sequences. Additionally, when the stimuli decreased in size across the trial, participants were more likely to classify the intervals as long-short than short-long. The researchers suggest these effects could be due to potential 'depth' interference, with the discs appearing to 'approach' or 'recede' in the ordered condition compared to the non-ordered sequences. In the colour saturation experiment, when presented with low then high-saturation sequences, participants who received the non-ordered condition were more likely to give short-long responses than participants in the ordered condition.

The researchers conclude that magnitude variation of number, size and colour saturation can bias time perceptions. Specifically, they posit the potential for closely-related stimuli (e.g. the number '1' and '2') to be initially integrated, possibly for purposes of efficient processing, and that there may be a shared "mental magnitude line" that is recruited for some spatial, magnitude and time information, and hence these stimulus integrations, and more general experiential links (e.g. 'more' distance typically coincides with 'more' time) may produce cross-dimensional interference. The series of experiments reported by Alards-Tomalin et al. (2014) show that linguistic metaphors of the kind studied by Casasanto and colleagues may not be the only elements affecting conceptual metaphors such as TIME IS SPACE. Such conceptual metaphors may also be affected by non-linguistic experiential elements such as dimensions of magnitude in numbers, size, and colour saturation. It remains to be seen whether these

separable influences of language and non-linguistic experience present with any cross-linguistic and cross-cultural variation.

Indeed, the recent study by Sinha, Sinha, Zinken, and Sampaio (2011) challenges both the idea that the TIME IS SPACE metaphor is universal, and the idea that it is pre-linguistic or innate. Sinha et al. (2011) also suggest that the reason for the preponderance of spatio-temporal metaphors in most languages is in large part due to cultural-historical "cognitive artefacts" such as calendars and clocks that 'anchor' time schematization and introduce numeric symbolic processes and linear number lines into language (the "Mediated Mapping Hypothesis"). In a sense, this process conceives of time as "abstracted from the events [that occur in time] themselves" (2011: 141). Sinha et al. define "Time as Such" as this abstract, linear, and autonomous domain of time. They define "time-based intervals" as segmentations defined by the boundaries of "Time as Such". They are different, therefore, from event-based time intervals such as 'sunrise'. Cognitive schematization of "Time as Such" is not expressed by calendars and clocks, but is reliant on them. They may be motivated by nature, but they are not determined by it. Examples include conventions such as the days of the week. Sinha et al. describe some cultures which do not measure "Time as Such" but instead use an event-based schema. The Nuer do not count or measure units of abstract time but instead view 'time' as a succession of events, cycles, and social activity rhythms (though the authors point out they do have a 'quasi-calendar' of 12 months, which can be enumerated). The Ainu have a 'qualitative' rather than quantitative 'measure' of time, again largely event-based.

Sinha et al.'s (2011) study focused specifically on the Amondawa people. The Amondawa are an indigenous Amazonian tribe of around a hundred people, the majority of whom are now bilingual (Amondawan-Portuguese). They have only four numeral terms, the first two of which (1 and 2) can be considered 'basic'. There is no term for abstract 'time', and no

recorded instance of numerals denoting time intervals. There is a lexicon around time intervals (‘sun’, ‘night’, ‘morning’, tomorrow’, etc.), but no words for weeks, months, or years. Linguistically, time is split into two seasons, which in turn are subdivided into beginning-, middle-, and end-of season parts. Sinha et al. give the example of the Amondawa naming system as indicative of the absence of a numerical calendric system. The Amondawa change their names many times throughout their lifespan according to a sort of ‘life stage’ defined by ‘age’ (roughly – not numerically conceived), social role, gender, and moiety (group). The change of name of a younger person, or the birth of a new child, can lead to a cascade of name changes ‘down the line’. All names come from a finite store, and hence names are informative about people’s lives.

When asked to place paper plates representing intervals of time in a ‘time map’ on the floor, Amondawan participants laid the plates out either left-to-right or right-to-left. The researchers note that the eventual curvilinear layout of the plates is difficult to ‘read’, since it could be an artefact of physical reach. However, the plates were not ‘ordered’ cyclically or rectilinearly. Similar results were found when participants were asked to describe the diurnal cycle. Lexical terms for ‘day’ and some subdivisions were provided, but again no cyclical form was created, and when a circle was used to explain the purpose of the task, the participants still avoided the shape. It does appear, however, that participants may have laid one next to the other one by one in a cumulative or linear fashion at least, even though the ‘lines’ themselves were perhaps somewhat ‘shapeless’. That is, the plates may not have been simply ‘scattered’ in random locations.

Amondawa does, of course, have spatial and motion language, but simply doesn’t map locative or motion terms onto time except in cases where spatial motion is made contextually explicit, such as when presenting the motion of objects that denote time. Their bilingualism in Portuguese may also be affecting their behaviour in this regard. The researchers cite this

as evidence that in Amondawa there are no linguistic restrictions on the spatial mapping of time. They also state that they investigated only mappings that posit a reference point – they therefore make no claim about spatial language for other senses of time, such as 'long' for duration. The researchers conclude that the Amondawa only use spatial terms to describe time if 'artificially induced'. They stress that the Amondawa are not a "people without time" (Sinha et al. 2011: 160), as these speakers linguistically express inter-event relationships and can talk about the past, present and future. They clearly have the capacity talk about time in terms of space, but they are not in the practice of doing so. "Time as Such" is a construct of culture, history and language, and is not a construct of space, or universal. When spatial language is recruited to talk about time, it is by "inter-domain analogic correlation" (2011: 163). Spatial metaphor of time is therefore not universal because it relies on "Time as Such" to be expressed. Condensed into a sentence, Sinha et al. posit that without calendric (or similar) numerical conventions of abstract time to mediate between them as a kind of super-ordinate category, time would not be represented in terms of space. Converging evidence from other similar languages and cultures, or from training paradigms such as the ones used by Casasanto (see previous paragraphs in this section) would be very useful in corroborating the authors' claims. At the moment, this study leaves a few important questions unanswered, the most important of which is the consistent finding of the asymmetrical relationship between space and time (cf. Boroditsky's and colleagues' studies reviewed here). What does Sinha et al.'s theory do to explain the apparent asymmetrical relationship of time and space representation? If "Time as Such" is the conduit by which space and time become connected, and this is achieved through number-based correlative analogy, why does space affect time more than time affects space?

Conclusion

The studies on the mental representation of time reviewed above provide important insights into the psychological reality of spatio-temporal metaphors. A large part of the evidence does lend support to the TIME IS SPACE metaphor. From an associative learning perspective, this suggests that the use of a linguistic metaphor for time activates the corresponding mental metaphor, and as a result this particular associative mapping is strengthened (Casasanto, 2008). The strengthening of the associative mapping is then relative to the frequency with which a given metaphor is used. As seen in Casasanto (2008), more frequently used metaphors for duration (e.g. distance-based in English, as opposed to amount-based in Greek) exert a measurably greater influence on the perception and reproduction of time. However, what has become clear from the review is also that the mental representation of phenomena as complex as time or temporal relations is not solely determined by linguistic form. As several studies have shown, linguistic space-time mappings may be overridden by cultural conventions. This is evident in, for instance, Rothe-Wulf et al.'s (2014) study, where the actual linguistic expressions for motion through time are similar across the languages investigated, but yet give rise to different temporal conceptions. Further evidence in this regard is offered by de la Fuente and colleagues (2014), who showed that attentional focus (towards the past or the future) influences the implicit spatialization of time, regardless of linguistic time-space mappings. Sinha et al.'s (2011) findings on non-spatialized time expressions dovetail with these findings on cultural influences on the mental representation of time, showing that although space is a common source domain for temporal language (and in extension for temporal thought), it is not universal (see also Levinson and Majid, 2013). Taken together, the evidence available to date suggests that the mental representation of time in humans is the outcome of an intricate interplay

between linguistic (i.e. metaphors) and cultural conventions. An essential task for future inquiry consists of further exploring the specific processes of weighting and competition that underlie this interplay. It is far from clear whether metaphors in language are so powerful that they can override time construal derived through cultural convention, or whether the relationship between linguistically derived and culturally derived metaphor is one of coexistence rather than competition. If the latter, then further research is needed to elucidate the contexts that promote one or the other type of metaphor usage. And if cultural convention has an important role to play in the psychological reality of spatio-temporal metaphors, then investigations need to better account for how this convention is constructed and utilized among a cultural group not only synchronically, but also diachronically, to thus shed light on how these cultural conventions come into existence in the first place.

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