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CHAPTER 8

Temporal language and temporal thinking may not go hand in hand

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Do people think about time the way they talk about it? This chapter examines dissociations between temporal language and temporal thinking in speakers of English and of Darija, a dialect of Moroccan Arabic. In both languages, conventional metaphors suggest that the future is *ahead* of the speaker and the past is *behind*. Yet, English speakers typically conceptualize the future as *rightward* and the past as *leftward* – a spatial mapping that is not conventionalized in any known spoken language. Darija speakers typically conceptualize the past as *ahead* and the future as *behind* them – a spatial mapping that directly contradicts their verbal metaphors. Darija speakers’ “backward” mapping of time does not appear to arise from any feature of their language, or from their physical experience with the natural world, but rather from their cultural bias to focus on the past (i.e., to value their ancestry and practice ancient traditions). Analyses of verbal space-time metaphors reveal that humans’ temporal thinking depends, in part, on spatial mappings. Yet, essential features of these mappings, including their spatial orientation and direction, may be absent from language and can only be discovered using extra-linguistic methods. Beyond the influences of language and of physical experience, cultural values and non-linguistic cultural practices can play important roles in shaping our mental representations of time. As a result, at any moment people may be thinking about time differently from the way they are talking about it, using different spatial schemas.

Keywords: cultural values, Darija, gestures, metaphor, space-time mapping

1. Introduction

When people talk about time, they usually use spatial metaphors (Alverson 1994; Clark 1973; Evans 2004; Lakoff & Johnson 1980; Moore 2006; Traugott 1978). Do people think about time the same way they talk about it? Not necessarily. This chapter examines some striking dissociations between temporal language and

temporal thinking: dissociations that are made visible in speakers' spontaneous co-speech gestures, and are evidenced by a variety of behavioral tests.

In spoken English, time appears to flow along the sagittal axis (front/back): the future is *ahead* and the past is *behind* us. Yet, when English speakers produce co-speech gestures spontaneously, they use the lateral axis (left/right) overwhelmingly more often, gesturing leftward for earlier times and rightward for later times (Casasanto and Jasmin 2012; Cienki 1998; Cooperrider and Núñez 2009). This left-right mapping of time is consistent with the flow of time on calendars and graphs in English-speaking cultures, but is completely absent from spoken metaphors. Co-speech gestures, therefore, reveal an implicit spatial conceptualization of time that cannot be inferred from language.

In what follows, I will first analyze which spatial expressions can (and cannot) be extended to describe temporal sequences in conventional English, and then review experimental evidence for an implicit mental timeline in English speakers' minds that flows along the lateral axis. Next, I will review experiments on spontaneous co-speech gestures suggesting that this lateral space-time mapping may be the dominant timeline in English speakers' minds, then describe experiments testing the experiential origins of this space-time mapping, and explore some reasons why a lateral mapping of time might be advantageous (despite its absence from language). Finally, I will describe another dissociation between temporal language and temporal thinking discovered in speakers of Darija, a Moroccan dialect of Modern Standard Arabic, and discuss how such dissociations between language and thought appear to arise from interaction with non-linguistic cultural artifacts or from culture-specific attitudes toward time.

2. The sagittal timeline in English

Nearly every aspect of time can be expressed in spatial words: instants in time can be *points*; durations can be *long* or *short*; events can be *moved forward* or *pushed back*. Linguistic analyses of English space-time metaphors are abundant (e.g. Alverson 1994; Clark 1973; Evans 2004; Lakoff and Johnson 1980; Moore 2006; Núñez and Sweetser 2006; Radden 2004; Traugott 1978). Since extensive analyses are available, only the most relevant aspects of English space-time mappings will be analyzed here: those pertaining to the spatial direction and orientation of temporal sequences. These space-time metaphors imply either a deictic, speaker-centered perspective or a sequence-based, speaker-independent perspective, as explained below.

2.1 Directionality in deictic space-time metaphors

Typically in English metaphors, time appears to flow along the speaker's sagittal axis: deadlines lie *ahead of us* or *behind us*; we can *look forward* to our golden days or *look back* on our childhood. Time is metaphorized as a horizontal line extending indefinitely ahead of and behind the speaker (Clark 1973; Núñez and Sweetser 2006). These expressions are deictic inasmuch as earlier and later times are located on a mental timeline with respect to a speaker who stands metaphorically at a now point, facing toward the future (which is ahead) and away from the past (which is behind the speaker).

Deictic expressions about earlier and later times often use spatial terms that specify a direction on the sagittal axis (1a–b).

- (1) a. It will happen *far ahead* in the future.
- b. It happened *way back* in the past.

It is possible, however, to express these ideas using spatial metaphors that leave direction unspecified (2a–b).

- (2) a. It will happen *far from* now in the future.
- b. It happened in the *distant* past.

The italicized expressions (1) and (2) are all spatial metaphors, but only those in (1) specify that the past is in back of the deictic origo and the future in front of it.

It would be unsurprising for a speaker to mix together directional and non-directional spatial metaphors within a discourse, or even within the same utterance (3a–b).

- (3) a. I like to dream about what will happen *far ahead* in the future and about what happened in the *distant* past.
- b. I like to dream about what will happen in the *distant* future and about what happened *way back* in the past.

In (3), all of the italicized expressions are spatial metaphors, but only the underlined words specify a spatial direction. Words like “distant” specify spatial extent but not orientation or direction. Directional and non-directional metaphors can be used interchangeably, or even in combination with one another, as in (3). It is natural to assume, therefore, that the future stands in the same spatial relation with respect to the origo in non-directional expressions like *in the distant future* as in directional expressions like *far ahead in the future*.

2.2 Directionality in sequence space-time metaphors

Some expressions describe sequences of events that are located in time relative to one another, and not relative to a deictic origo (4).

- (4) a. Monday comes *before* Tuesday.
- b. Tuesday comes *after* Monday.

Purely spatial uses of “before” and “after” are rare, but arguably the temporal expressions in (4) are metaphors from spatio-temporal scenarios like (5).

- (5) a. Maple Street comes *before* Elm Street.
- b. Elm Street comes *after* Maple Street.

Although “Maple Street” and “Elm Street” have fixed locations in space, whether one street comes before or after the other depends on the experiencer’s direction of travel (i.e., if Maple is west of Elm, then Maple comes before Elm for an experiencer traveling from the West, but Elm comes before Maple for an experiencer traveling from the East). For events like days of the week, however, there is no such deictic reversal of before and after. People can only travel through time in one direction, away from the past and toward the future, therefore there is no ambiguity about whether Monday comes before or after Tuesday: This before/after relationship is the same for all experiencers.

Does the before/after relationship imply that sequences of events are spatialized along a particular axis? It does if we assume that language users conceptualize themselves as facing forward, toward the future, as implied by deictic space-time metaphors (1–3). On this assumption, experiencers should encounter events described by sequence metaphors (4) serially, as they move forward through time (when they adopt an ego-moving perspective) or as events approach them from the front (when they adopt a time-moving perspective). Analogously, it is natural to assume that experiencers should encounter the streets in (5) as they travel along a sagittally-oriented path through space. (This sagittal orientation is implied but not necessary; Maple could still be said to come before Elm if the westbound traveler were riding sideways in a bus or walking sideways like a crab, in which case “before” is defined with respect to the direction of motion, not the body’s intrinsic front.) On the basis of sequence metaphors like (4), it is possible to infer that events follow one another along a sagittally-oriented mental timeline, but this sagittal orientation is implied more strongly by deictic metaphors (1) than by sequence metaphors (4).

2.3 Are there any other timelines in English?

Standard English makes systematic use of only one timeline: the sagittal timeline, with the future ahead and the past behind. In isolated idioms, it appears that time may be metaphorized on the vertical axis in English (as in Mandarin Chinese, e.g., Scott 1989). For example (6):

- (6) a. We're *coming up* on the deadline.
 b. The deadline is *coming up*.

Yet, upon examination, it is clear that these expressions in (6) are not systematic: The “up” metaphors are not complemented by “down” metaphors with opposite temporal meanings (see Casasanto 2009a). Sagittal metaphors are systematic. Metaphors referring to later times (e.g., *moving the meeting forward*) are inferentially linked to metaphors referring to earlier times (e.g., *moving the meeting back*). This is not the case, however, on the vertical axis. It is sensible to *move a meeting up* but not to *move a meeting down*. Likewise, heirlooms can be *handed down* the generations but not *handed up* them.

Furthermore, the “up” in (6) may not be a metaphorical projection from vertical space, at all: There are spatial uses of “up” that imply horizontal (probably sagittal) motion (7).

- (7) a. The driver should *pull up* to the curb.
 b. Elm Street is *coming up*.

In Example (7a), the speaker does not expect the car to levitate. “Pulling up” to the curb means driving the car forward, horizontally, along the driver’s sagittal axis. In (7b), arguably “coming up” may have temporal (i.e., aspectual) meaning, but to the extent that it refers to the spatial location of Elm Street relative to the speaker’s origo, it signals that the street is nearby in horizontal distance (Casasanto 2009b).

This leaves one axis to consider, the lateral (left-right) axis. Consideration can be brief: there are simply no conventional expressions in English that specify orientation, direction, location, or motion in time on the lateral axis. This is not for lack of lexical or constructional resources. *Monday is to the left of Tuesday* is syntactically well formed, but this expression is not an acceptable substitute for expressions that imply a sagittal spatialization of time (4) or for purely temporal expressions (e.g., *Monday is earlier than Tuesday*; see Clark 1973; Cienki 1998; Evans 2004).

Not every space-time metaphor in English specifies a direction or orientation in space (2). But when orientation and direction are specified, the metaphors imply a sagittal mental timeline.

3. Evidence for a laterally-oriented mental timeline

Despite the total absence of left-right metaphors in spoken language, there is strong evidence that English speakers have an implicit mental timeline that runs along the lateral axis, with earlier times on the left and later times on the right of body-centered space. In one experiment (Weger and Pratt 2008), participants judged whether celebrities had become famous before or after the participant was born, as quickly as possible. To respond, participants pressed a button either on the left or the right of the keyboard. For half of the experiment the “before” key was on the left and the “after” key on the right, and for the other half the key mapping was reversed. Responses were fastest when the key mapping was consistent with the left-to-right time mapping.

The direction in which time is arranged along people’s lateral mental timeline varies systematically across cultures. In one study, Tversky and colleagues (1991) asked children and adults to place stickers on a page to indicate where breakfast and dinner should appear relative to the lunch sticker, in the middle of the page. Whereas English speakers placed breakfast on the left and dinner on the right of lunch, Arabic speakers preferred the opposite arrangement, consistent with the directions of reading and writing in English and Arabic, and with the lateral organization of time on calendars in English- and Arabic-speaking cultures. Similar patterns have been found in reaction time tasks comparing English with Hebrew speakers (Fuhrman and Boroditsky 2010) and comparing Spanish speakers with Hebrew speakers (who, like Arabic speakers, read and write from right to left; Ouellet et al. 2010).

4. An experiment: What is the dominant timeline in English speakers’ minds?

When English speakers use space-time metaphors in language, what spatial representations are they activating in their minds? Is it possible that people think about time using different spatial schemas than they use to talk about it? Specifically, do English speakers tend to spatialize time on the lateral axis implicitly, even while they are producing sagittal space-time metaphors in language, explicitly? If both sagittal and lateral mental timelines are available, which timeline do English speakers use to conceptualize sequences of events most often?

To address these questions, Casasanto and Jasmin (2012) conducted a quantitative study of co-speech gestures in English speakers (for related qualitative studies see Cienki 1998 and Cooperrider and Núñez 2009). We analyzed the spontaneous gestures that pairs of English speakers produced as they told each other

brief stories with pastward or futureward narrative trajectories. There were four temporal stories in all (amid filler stories), each between 50 and 100 words long, which participants studied briefly and then retold to their partners in the first person, as if they were talking about their own experiences. Two of these stories used primarily deictic temporal reference and the other two described sequences of events whose temporal reference could be understood independent of a deictic 'now' point. There were two versions of each story, one using space-time metaphors (e.g., *before*; *long ago*; *in the near future*) and the other using non-spatial, purely temporal language with approximately the same meaning (e.g. *earlier*; *many years ago*; *soon*). Each pair of participants received only one version of each story, with either metaphorical spatial or non-spatial wording; each partner told one story of each type. Participants knew they were being videotaped, but did not know their gestures were of interest.

Gestures and speech were coded separately. Independent coding of the speech (blind to the gestures) and of the gestures ("deaf" to the speech) allowed speech-gesture relationships to be tested objectively (see also Casasanto and Jasmin 2010). The goal of the speech coding was to determine the temporal content of each spoken clause. Each clause was rated for its temporal content: whether it referred to events in the past, the future, or had no clear temporal reference. Temporal clauses were further classified as using either metaphorical spatial or non-spatial (purely temporal) language, and as using either deictic or sequence-based temporal reference. The goal of the gesture coding was to determine the direction and orientation of each gesture stroke (the meaning-bearing part of the gesture; McNeill 1992). Finally, the stroke directions of the gestures were compared with the "direction" in time implied by the co-occurring spoken clauses. "Congruent" gestures showed the expected spatialization of time for the axis on which they were produced (i.e., Lateral: left for past, right for future; Sagittal: backward or toward the body for past, ahead for future). "Incongruent" gestures showed the opposite spatialization of time. The rate of congruent gestures was analyzed, overall, and as a function of axis (lateral, sagittal) and temporal reference type (deictic, sequence).

Overall, gestures accompanying temporal speech were much more common on the lateral axis than on the sagittal axis. Furthermore, speakers used the two axes differentially for expressions with different kinds of temporal reference: deictic vs. sequence-based. Congruent lateral gestures were more strongly associated with sequence language, and congruent sagittal gestures with deictic language. This relationship between axis and temporal reference echoes the organization of the sequence and deictic timelines in American Sign Language (ASL; Emmorey 2001).

Of primary interest, temporal gestures on the lateral axis were not only more numerous, they were also more systematic: The rate of congruent gestures (past = left, future = right) was significantly greater than the rate of incongruent

gestures. By contrast, temporal gestures on the sagittal axis showed no such systematicity: The rate of congruent gestures (past = back, future = ahead) did not differ significantly from the rate of incongruent gestures. Systematic lateral gestures and unsystematic sagittal gestures were observed both during clauses with metaphorical spatial language (e.g., *back*, *farther ahead*) and clauses with non-spatial equivalents (e.g., *earlier*, *later*), and the presence or absence of spatial language did not affect the rates of congruent vs. incongruent gestures.

To summarize Casasanto and Jasmin's (2012) main results, the space-time mappings found in English speakers' spontaneous gestures diverged strikingly from the mappings in the accompanying speech. Lateral gestures outnumbered sagittal gestures by about 3 to 1, and whereas lateral gestures reliably mapped earlier times to the speakers' left and the later times to their right, sagittal gestures showed no reliable mapping between "directions" in time and space – contrary to expectations based on spoken metaphors in English.

Prior to this study, little was known about the typical orientation of English speakers' spontaneous time gestures. In a footnote, Núñez and Sweetser (2006) mentioned that, "gesture researchers generally agree on the presence of the front-back timeline pattern in English, though it has not been explicitly analyzed very much" (p. 444; see also Parrill and Sweetser 2004). Cienki (1998) observed lateral time gestures, but did not report any sagittal gestures or compare gesture rates across axes. Cooperrider and Núñez (2009) observed primarily lateral gestures for time in English speakers who were recounting the history of the universe based on an illustrated cosmological timeline, which was oriented laterally. Given that their stimulus was a lateral representation of time, it was natural for Cooperrider and Núñez to conclude that the "observed imbalance between sagittal and [lateral] gestures is almost certainly due to the specifics of our paradigm" (p. 188). Yet based on Casasanto and Jasmin's data, the left-to-right mental timeline appears to be dominant in English speakers' spontaneous co-speech gestures more generally, and by inference in their thoughts.

5. When are gestures more informative than words?

The inference that English speakers tend to think about temporal sequences laterally, despite the way they talk about them, requires interpreting patterns observed in spontaneous gesture to be more informative about people's spatial conceptions of time than patterns observed in language. What licenses this inference? In most cases, it is not possible to infer what sort of spatial representations speakers form when uttering "spatial" words. Casasanto and Jasmin reported that their participants produced the following expressions (8):

- (8) a. "...what it would have been like to live *back* then."
 b. "...and then I found a letter... from even *farther back*."

What spatial representations were speakers forming in their minds when they said "back"? First, it is possible that they were forming mental representations of spatial anteriority. On a second alternative, however, they might not have been forming any spatial representations, at all. In principle "back" could be fully polysemous, having distinct spatial and temporal meanings, in which case speakers could have been activating purely temporal representations (i.e., "back" simply means "in the past"). Yet, the participants' co-speech gestures support a third possibility. During these clauses containing the word "back," they gestured leftward. Whereas the word "back" may or may not correspond to a mental representation of spatial anteriority, a leftward gesture is unequivocal evidence for a spatio-motor representation of leftness in speakers' minds: A leftward spatio-motor representation is necessary for the gesture to be produced. As such, gestures have sovereignty over speech as indices of the spatial representations people are forming in the privacy of their thoughts.

Casanto and Jasmin's data, therefore, provide clear evidence that speakers were thinking about time laterally (even while using sagittal language), and no clear evidence that they were thinking about time sagittally.

6. Why do English speakers use a lateral mental timeline?

The dominance of the lateral axis for time in English speakers' minds runs counter to decades of theorizing in linguistics and psychology. Since Clark's (1973) seminal analysis, linguists and psychologists have generally assumed that the sagittal axis is the dominant axis (if not the *only* axis) that English speakers use to talk and think about time. Here Radden (2004) summarizes the modal view:

Of the three geometrical axes, the longitudinal axis with its front-back orientation apparently captures our experience of time better than either the vertical axis with a top-down orientation or the lateral axis with a left-right orientation. *The latter does not seem to offer any sensible spatial basis for our understanding of time at all.* The preference for the longitudinal axis may be due to our spatial experience of motion, which is almost invariably directed to the front. The front-back orientation of time shows up in expressions such as the "weeks ahead of us" or "the worst behind us". In Western cultures, the front-back orientation predominates in temporal scenes. We do not see a vertical or lateral movement underlying temporal expressions such as "this coming month", "the days gone by" or "the following week", i.e., we do not visualize a month approaching from above or from the left side. (Radden 2004: 3, italics added)

According to Radden and others, the lateral axis is not used for time, in language or thought. But this conclusion is difficult to maintain in light of the data reviewed here.

The conclusion that the mental timeline is sagittal has been based primarily on analyses of metaphors in language. These, in turn, are believed to arise from the way humans typically move through space, as a function of our front-to-back asymmetric bodies (Clark 1973; Lakoff and Johnson 1980). As we walk forward (or drive, bicycle, or skate forward), the points in space that we will come to in the future lie literally ahead of us; the points that we have already passed lie literally behind us. This correlation between progress through space and time along the sagittal axis forms a natural basis for sagittal space-time mappings in language and thought.

There is no analogous correlation between our experience of progress through space and time laterally – at least not in the natural world: We do not typically walk sideways, or encounter later events on our right and earlier events on our left. We do, however, experience systematic progress through space and time laterally as we read and write. For speakers of English, and of other languages that use the Roman alphabet, we begin reading or writing each line of text on the left, and move gradually to the right with our hand or eyes, arriving on the right side of the page or computer screen at a later time. Via reading or writing, therefore, we experience the same correlation of movement through space and time on the lateral axis that we experience via natural locomotion on the sagittal axis.

The left-right flow of time in people's minds is not merely correlated with the direction of orthography: Reading and writing direction can also play a causal role in shaping people's implicit lateral timelines. Casasanto and Bottini (2013) showed Dutch-speakers phrases like "a year before" (*een jaar daarvoor*) or "a decade after" (*een decennium daarna*). Participants pressed a button on the left or right of a keyboard (with the key mapping reversed mid-experiment) to indicate whether the phrases referred to a time in the past or the future. For half of the participants, the phrases were presented in standard Dutch orthography. For the other half, phrases appeared in mirror-reversed Dutch. Participants in the standard Dutch condition were fastest to judge past-oriented phrases by pressing the left button and future-oriented phrases by pressing the right button. By the second presentation of the stimuli, however, participants in the mirror-reversed Dutch condition showed the opposite pattern of reaction times, consistent with results found previously in native Arabic and Hebrew speakers (Fuhrman and Boroditsky 2010; Ouellet et al. 2010; Tversky et al. 1991). Experience reading a reversed orthography is sufficient to reverse the flow of time in readers' minds.

As this experiment shows, the flow of time along the lateral timeline can change independently of any change in people's use of linguistic metaphors (which

were the same across Casasanto and Bottini's standard orthography and mirror-reversed orthography conditions). Furthermore, these results suggest that people automatically activate lateral space-time mappings even while they are using before/after metaphors in language, which are commonly analyzed as projections from the sagittal axis (Clark 1973; Evans 2004; Lakoff and Johnson 1980; Moore 2006; Núñez and Sweetser 2006; Radden 2004; Traugott 1978). Although orthographic experience is sufficient to determine the direction of the lateral mental timeline, it is unlikely to be the only cultural practice that contributes to this implicit space-time mapping. Cultures that use rightward or leftward orthographies also tend to spatialize time the same way on calendars, graphs, and written timelines (Tversky et al. 1991) – and as I discuss below, to gesture accordingly. Any or all of these non-linguistic cultural practices could help to establish the lateral flow of time in people's minds.

Yet, the fact that the lateral mental timeline has a sensible and demonstrable experiential basis does not explain why English speakers should use this space-time mapping preferentially, as Casasanto and Jasmin's (2012) data suggest they do. There are several possible pragmatic, kinematic, and mnemonic motivations to prefer the lateral mapping over the sagittal mapping (for discussion see Cienki 1998; Casasanto and Jasmin 2012). For example, perhaps gesturers tend to use the lateral axis because of its greater information value. During face-to-face communication, a change in depth on the sagittal axis is harder for an interlocutor to perceive visually than a change in lateral position of the same size. Lateral movements optimize the visibility of gestures, conveying more information for the same amount of physical motion.

The kinematics of lateral hand movements may further motivate lateral gestures, in two ways. First, one's reach extends about twice as far on the lateral axis as on the sagittal axis. This allows for a greater number of discriminable points (or intervals) in time to be illustrated. Second, although the body divides both the lateral and sagittal axes into poles, both poles of the lateral axis are available motorically, whereas only one pole on the sagittal axis can be used easily. Casasanto and Jasmin's (2012) data show productive use of an analog spatial continuum on the lateral axis. For example, within the same utterances, speakers sometimes gestured leftward for one timepoint in the past, and then farther leftward for an even earlier timepoint. It would be difficult to create such an analog spatialization of past events on the sagittal axis that takes advantage of the body as midpoint, reaching behind one's head for one point in time, and then even farther behind one's head for the next.

Finally, the lateral axis may also provide an imaginary timeline that is easier for speakers to inspect with the mind's eye. To "view" the past and future on a lateral mental timeline, the imaginer only needs to turn the mind's eye to the left

and the right. To view both poles of a sagittal mental timeline however, where the future is in front and the past in back of the imaginer it would be necessary to turn around 180 degrees (or to have a second set of the mind's eyes in the back of the mind's head). As such, the lateral timeline might be easier to use than the sagittal not only for gesturing about time, but also for thinking about time.

6.1 Do speakers ever use a sagittal timeline in gesture or thought?

The finding that English speakers prefer the lateral axis for gesturing (and apparently for thinking) about temporal sequences should not be interpreted as indicating that English speakers never use the sagittal axis in gesture or thought: The axis on which English speakers conceptualize time undoubtedly depends on context. For example, when Casasanto and Jasmin (2012) asked participants to gesture deliberately about time (rather than allowing them to gesture spontaneously), participants used both the lateral and sagittal axes systematically, for both deictic and sequence-based temporal expressions, apparently activating the mappings made salient by their linguistic metaphors.

Furthermore, the pattern of gestures observed in English speakers should not be assumed to obtain for speakers of other languages (though see results for Spaniards, below). For example, although Casasanto and Jasmin (2012) did not observe any over-the-shoulder (backward) gestures for the past in English speakers, speakers of some Northern Italian dialects routinely gesture over their shoulders spontaneously when producing expressions like, “*molti anni fa*” (*tr.* many years ago). Much more quantitative research is needed to determine how speakers of different languages spatialize time in gesture and thought, and when their implicit mental timelines will follow patterns in language and natural experience or patterns of interaction with non-linguistic aspects of culture.

7. Mental timelines in Darija speakers: Another dissociation between temporal language and thought

Casasanto and Jasmin's (2012) study on spontaneous gestures for time was replicated in speakers of Spanish and Darija (a Moroccan dialect of Modern Arabic), in collaboration with a team of researchers led by Julio Santiago and colleagues at the University of Granada. As predicted, Spaniards tended to gesture leftward for the past and rightward for the future, whereas Moroccans showed the opposite tendency, consistent with the left-to-right direction of written Spanish and the right-to-left direction of written Arabic. Unexpectedly, front-back gestures also

differed between Spaniards and Moroccans. Whereas Spaniards showed a weak tendency to gesture according to the future-in-front mapping, Moroccans showed a strong tendency to gesture according to the *past-in-front* mapping – despite using future-in-front metaphors in speech.

Gestures consistent with a past-in-front / future-in-back mapping have been observed in the Aymara, an Andean people whose spoken space-time metaphors place the past in front of the speaker and the future behind: *nayra mara* (tr. “front year”) means last year, and *qhipa marana* (tr. “back year”) means next year (Núñez and Sweetser 2006). This space-time mapping, which is the reverse of what should follow from the universal tendency to walk forward, may be based on another universal aspect of bodily experience: We can see what is in front of us, but not what is behind us. The past can be known, and therefore “seen,” because past events have already occurred; the future is unknown, and therefore cannot be seen. In support of this proposal, Núñez and Sweetser (2006) note that the same word in Aymara can be used to mean “past,” “front,” and “sight.”

Yet, no such reversed spoken metaphors exist in Arabic: The future is ahead (e.g., *masiro chababi ila l amam*, tr. “young people have the future in front”) and the past is behind (e.g., *ayyamo l majdi dallat warae*, tr. “glorious days were left behind”; de la Fuente, Santiago, Román, Dumitrache, and Casasanto 2014). On the basis of their co-speech gestures, it appears that Arabic speakers think about time like the Aymara, even though they talk about it like speakers of English, Spanish, and other familiar future-in-front languages.

To investigate the unexpected dissociation between Moroccan participants’ language and co-speech gestures, we administered a temporal diagram task to new groups of Darija-speaking Moroccans and Spanish-speaking Spaniards (adapted from Casasanto 2009, Experiment 1). Each participant saw a cartoon head, viewed from above, with one box directly ahead of him and another box behind him. They read that yesterday this character (named Juan or Mohammed) went to visit a friend who liked plants, and tomorrow he would be going to visit a friend who likes animals (or vice versa, depending on the version of the task the participant received). Participants were asked to write the initial letter of the word for “plant” in the box that corresponded to past events and the initial letter of “animal” in the box that corresponded to future events (or vice versa). The order of mention of the plants and animals was counterbalanced, as were their pairings with “yesterday” and “tomorrow.” The results were clear: Most of the Spaniards placed the future event in the box ahead of the character and the past event in the box behind him. By contrast, most of the Moroccans showed the opposite pattern, placing the past event in the box ahead of the character and the future event in the box behind him – consistent with the spontaneous gestures we had observed, but inconsistent with conventional space-time metaphors in spoken Arabic.

Why do Moroccan Darija speakers conceptualize the past as in front of them and the future behind them? In the absence of any clear linguistic or body-based motivation for the Moroccan group's observed space-time mapping, we turned to aspects of their culture. Compared to many Europeans and Americans, Moroccans tend to focus more on past times and older generations, they are more observant of ancient rituals, and they place more value on tradition (Mateo 2010). Spaniards, by contrast, appear to focus on the future, valuing economic development, globalization, and technological progress. Could this cross-cultural difference in attitudes toward the past and future be responsible for the observed difference in the spatial mapping of time?

We hypothesized that people who “focus” on the past metaphorically (i.e., who devote attention to it) should tend to place the past in front of them, in the location where they could focus on the past literally with their eyes if past events were physical objects that could be seen. If the end of the temporal continuum one tends to conceptualize as “in front” is determined by one's focus on either the past or the future, then people should tend to conceptualize the future as in front of them to the extent that their culture (or subculture) encourages them to be future-focused, and conceptualize the past as in front of them to the extent that their culture encourages them to be past-focused. We call this the Temporal Focus Hypothesis (de la Fuente et al. 2014).

A series of experiments in Spaniards and Moroccans supported the Temporal Focus Hypothesis. First, Spaniards and Moroccans completed a temporal focus questionnaire designed to probe their attitudes about the past and future. As predicted, Moroccans showed greater agreement with past-focused statements than Spaniards (e.g., “young people must preserve the traditions”), whereas Spaniards showed greater agreement with future-focused statements than Moroccans (e.g., “technological and economic advances are good for society”). Participants' responses on this questionnaire were a significant predictor of their responses on the Juan/Mohammed diagram task, demonstrating a correlation between people's culture-specific attitudes toward time and their tendency to place the past or future ahead of them spatially in their mental models of time.

To test for a causal role of temporal focus in determining how people spatialize time, de la Fuente and colleagues asked Spaniards to perform a writing exercise designed to manipulate their temporal focus. About half of the participants were assigned to write about personal experiences they'd had in the past, and the other half to write about experiences they expected to have in the future, temporarily focusing their attention on one pole of the past-future continuum or the other. After completing the writing exercise, participants performed the temporal diagram task. Participants who had been assigned to write about the future showed a strong bias to locate the future ahead, but this tendency was extinguished in

participants who had been assigned to write about the past: compared with the future-trained participants, a significantly greater proportion of past-trained participants placed the past in front, like Moroccans. These results provide evidence that temporal focus can play a causal role in determining how people spatialize the past and future in their minds, and show that this implicit spatialization can vary independent of any variation in space-time metaphors in language.

The motivation for the Moroccan's past-in-front mapping that de la Fuente and colleagues proposed is different from the motivation Núñez and Sweetser (2006) proposed for the Aymara, who are believed to place the past in front because the past is known (i.e., seen) and the future unknown (i.e., unseen). Placing what is known in front of us is not the same as placing what we focus on in front of us: The future can be placed in front because we focus our attention on it, even though it cannot be known. The past- and future-focus training task described above, which changed the Spanish participants' likelihood of placing the future in front, presumably did *not* change the extent to which they could know the future. Rather, the writing exercise changed participants' temporal focus, making them more likely to place either the knowable past or the unknowable future in front of them.

8. Conclusions

When people talk about time they often use spatial language, but their spoken space-time metaphors may not reflect the implicit mental metaphors they are using to conceptualize time, which can be revealed by their spontaneous co-speech gestures and by behavioral experiments. Whereas spoken metaphors in English suggest that time flows along the sagittal axis, English speakers' spontaneous gestures show that time is also spatialized on the lateral axis, with earlier points on the left and later points on the right of an imaginary mental timeline. Based on the relative frequency of systematic lateral and sagittal gestures, it appears that the left-right mapping of time is not just an alternative way of conceptualizing time; it may be the dominant spatial schema for time in English speakers' minds, at least for reasoning about sequences of events. Like English metaphors, spoken metaphors in Arabic also suggest that the future is ahead and the past is behind, but Moroccans' spontaneous gestures and their performance on temporal diagram tasks suggest that the poles of the sagittal space-time continuum are reversed in Moroccan Arabic speakers' minds.

Mental metaphors for time that assign the future to the front and the past to the back, which correspond to linguistic metaphors in many languages, are presumably grounded in the universal experience of moving the body forward

through space and time during locomotion (Clark 1973). Laterally-oriented mental metaphors for time, which correspond to conventions in graphic representations, are grounded in the experience of moving the eyes rightward or leftward through space and time during reading (Casasanto and Bottini 2013), and possibly in other activities like writing, using calendars, and perceiving culture-specific co-speech gestures. The mental metaphors for time discovered in Moroccans, which assign the past to the front and the future to the back of a sagittal continuum, cannot be based on experiences of locomotion or of interacting with cultural artifacts; rather, they appear to be grounded in people's attitudes toward time, and their tendencies (as individuals or as a culture) to focus attention on the past. The Temporal Focus Hypothesis (de la Fuente et al. 2014) provides a new mechanism by which culture-specific habits of conceptualizing time can arise.

The dissociations between temporal language and temporal thinking discussed here have implications both for theories of the mental representation of time and for the methods used to construct and test these theories. The left-right mapping of time in English speakers' minds could never have been discovered by analyzing patterns in language, alone, nor could the "backward" sagittal mapping of time in Moroccans. These space-time mappings are just two of the implicit mental metaphors that are evident in people's spontaneous gestures, and in their behavior in laboratory tests, but not in their speech (e.g., see also Casasanto 2009a, 2011; Casasanto and Henetz 2012; Casasanto and Jasmin 2010, for evidence of a "good is left" metaphor in left-handers' minds which contrasts with the "good is right" mapping found in linguistic expressions). Implicit mental metaphors do not always correspond to explicit linguistic expressions: People do not always think the way that language suggests they do – even when they are thinking metaphorically.

Space-time metaphors in language have inspired decades of fruitful research, and spoken metaphors often reveal implicit space-time mappings. In some cases, spoken space-time metaphors have been shown to shape mental metaphors, causing speakers of different languages to conceptualize time differently (e.g. see Boroditsky 2001; Casasanto 2008). But space and time are linked in the mind in more ways than linguistic analyses alone can reveal. This suggests that metaphors in language should be treated as a source of hypotheses about nonlinguistic mental representations, rather than a source of conclusions. Evaluating these hypotheses – determining when a linguistic metaphor reflects an implicit mental metaphor – requires both linguistic and extra-linguistic methods, and calls for cooperation across the linguistic and cognitive sciences.

Notes

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