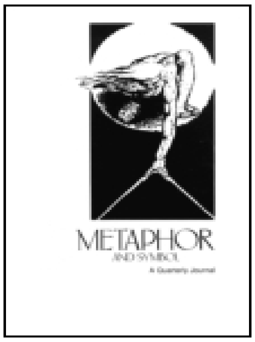

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Disentangling Spatial Metaphors for Time Using Non-spatial Responses and Auditory Stimuli

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While we often talk about time using spatial terms, experimental investigation of space-time associations has focused primarily on the space *in front of* the participant. This has had two consequences: the disregard of the space *behind* the participant (exploited in language and gesture) and the creation of potential task demands produced by spatialized manual button-presses. We introduce and test a new paradigm that uses auditory stimuli and vocal responses to address these issues. Participants made temporal judgments about deictic or sequential relationships presented *auditorily* along a body–centered sagittal or transversal axis. Results involving the transversal axis replicated previous work while sagittal axis results were surprising. Deictic judgments did not use the sagittal axis but sequential judgments did, in a previously undocumented way. Participants associated earlier judgments with the space *in front of them* and later judgments with the space *behind them.* These findings, using a new approach, provide evidence that different time concepts recruit space differently, mediated by meaning, stimulus modality and response mode.

Around the world, people talk about time using spatial terms (Clark, 1973; Haspelmath, 1997) as in the English expression *"I'm looking forward to tomorrow."* This spatialization of time also shows up in co-speech gesture, as when one points in front of the body when talking about the upcoming weekend (Núñez & Sweetser, 2006). These patterns have led to the proposal that our concrete experience of being embodied within and moving through space structures our understanding of abstract concepts including time (Lakoff & Johnson, 1980).

However, time is a multi-faceted concept. We can talk about the relationship between events in time and the present—such as whether an event happened in the *past* or will occur in the *future*. Or we can discuss the relative timing of events—whether the discovery of Mars happened *earlier* or *later* than the discovery of Jupiter. These examples capture two different types of temporal reasoning, deictic and sequential, a distinction that has been commented on by both philosophers (McTaggart, 1908) and linguists (Evans, 2003; Moore, 2006; Traugott, 1978). Deictic time describes past and future relationships relative to the present moment (e.g., *"The week ahead of us looks busy"*), while sequential time captures earlier and later relationships relative to another moment in time (e.g., *"The incumbent was in a strong position ahead of the elections"*). But this

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distinction has been largely overlooked by psychologists, and the particular methods that are often employed to investigate spatial construals of time also tend to mask this distinction. The present study introduces and evaluates a novel paradigm that uses auditory stimuli and vocal responses to investigate the psychological reality of these different spatial construals of time.

The paradigm we used is based on a common method that examines the psychological reality of space-time associations: measuring compatibility effects between the domains of space and time. If time and space share cognitive resources, then participants should be faster to respond when the time and spatial location of an event are presented in a manner that is consistent with patterns in language and gesture (e.g., the past *behind*). Such studies have examined compatibility effects along three different spatial axes: left-right (transversal), front-back (sagittal), and up-down (vertical). The present study will focus on the transversal and sagittal axes, as English was used as the language of study and it, like many other languages, does not use the vertical axis in a systematic way.

Past research using compatibility effects has demonstrated that even though English speakers do not talk about time using the transversal axis, this axis is associated with both deictic and sequential time in a manner consistent with cultural technologies, most notably, writing (e.g., Ouellet, Santiago, Israeli, & Gabay, 2010; Santiago, Lupiáñez, Perez, & Funes, 2007; Weger & Pratt, 2008). English speakers are faster to respond to past events on their left and future events on their right, but this pattern is reversed for speakers of languages such as Hebrew, which is written and read from right to left (Fuhrman & Boroditsky, 2010). In addition to associating past events with the left and future events with the right, English speakers also associate earlier events with the left and later events with the right (e.g., Weger & Pratt, 2008). Thus, if one only examines the patterns of space-time associations along the transversal axis, it may appear as though deictic and sequential time are spatialized in the same manner.

The sagittal axis, on the other hand, is used in both language and gesture. In English, linguistic and gestural data reveal that for deictic time, the future is often portrayed as lying in front of the speaker (*"The future <u>ahead</u> looks bright"*), the past behind the speaker (*"When I <u>look back</u> on my past . . ."*), and the present moment co-located with the speaker (*"The weekend is finally <u>here</u>"*). However, the same sagittal spatial terms can be used in different ways depending on whether one is talking about deictic or sequential time. For instance, the spatial term *ahead* used deictically refers to a time in the *future,* relative to the present (e.g., *"Sunny days lie <u>ahead</u>"*). For sequential time, however, the same term refers to a point *earlier* in time relative to another event (e.g., *"It is two minutes <u>ahead</u> of the hour"*; Moore, 2006, 2011). Thus, in contrast to the transversal axis, these two types of time appear to be spatially construed in different ways on the sagittal axis, at least in language.

While systematic associations between the sagittal axis and sequential time have not been observed experimentally (Casasanto & Jasmin, 2012; Fuhrman et al., 2011; Kranjec & McDonough, 2011), a variety of studies using different methods have found associations between deictic time and the sagittal axis, with future in front and the past behind (Eikmeier, Schröter, Maienborn, Alex-Ruf, & Ulrich, 2013; Hartmann & Mast, 2012; Koch, Glawe, & Holt; 2011; Kranjec & McDonough, 2011; Miles, Karpinska, Lumsden, & Macrae, 2010; Miles, Nind, & Macrae, 2010; Sell & Kashak, 2011; Sullivan & Barth, 2012; Ulrich et al., 2012). However, a closer look reveals that the space-time associations observed in these studies may depend on the particulars of the experimental paradigm used.

First, the majority of such studies require participants to produce manual spatial responses (Koch et al., 2011; Kranjec & McDonough, 2011; Sell & Kashak, 2011; Ulrich et al., 2012). This may serve to prime participants to behave in a way that is consistent with how they often gesture in space when talking about the past or the future, for example. Second, many paradigms include motion as part of the experimental design, either in the presentation of stimuli (e.g., Hartmann & Mast, 2012; Sullivan & Barth, 2012) or in the response (e.g., Koch et al., 2011; Miles, Nind, et al., 2010; Ulrich et al., 2012). This may not only make space particularly salient for the participants, but also confounds motion with spatial location, which makes it unclear whether the results are due to associations with particular locations or to movement (actual or imagined) to that location. Finally, many studies present participants with a sagittal axis that does not capture how sagittal space is used in language. That is, instead of using the space in front of and behind the body, experimenters often provide participants with responses that lie solely in the space in front of the body (e.g., Sell & Kashak, 2011; Ulrich et al., 2012).

While space-time associations for deictic judgments have been observed using a frontal sagittal axis, such a design requires participants to displace the deictic center from their body to an external location and thus may reflect a different construal than internal deictic time, which uses sagittal space that surrounds the body (Núñez & Cooperrider, 2013). Furthermore, in the case of sequential time, where a deictic center is not necessary and thus the body isn't necessarily yoked to the axis, the use of a sagittal axis that lies completely in front of the participant may lead to ambiguities in where the "front" and the "back" of the axis is located. Indeed, it has been shown that for objects that do not have a salient front/back distinction, people can interpret the front and the back of that object from different perspectives, and they can be primed to use one interpretation over another (e.g., Boroditsky, 2000). This may explain why Fuhrman et al. (2011), who had participants make judgments about sequential time using a button box placed sagittally in front of the participants, found no compatibility effects between sequential judgments and location on the sagittal axis.

The present paradigm aims to address these concerns and investigates, via compatibility effects, the link between body-centered sagittal and transversal space and deictic and sequential time. We use auditory stimuli and vocal responses, which allow for non-spatial responses and presentation of stimuli along a body-centered sagittal axis, which resolves any ambiguities regarding what is assumed to be the "front" and what is assumed to be the "back" of the sagittal axis. As a result, the use of this novel paradigm allows us to investigate the following three questions.

First, are the previously observed space-time compatibility effects the product of the particular constraints of experimental settings? Past research has often used a forced spatialization of responses (e.g., left and right response keys) and the salient visual presentation of stimuli in particular spatial locations on a computer screen. Such an experimental set-up may compel participants to respond in a manner consistent with learned external representations of time (e.g., timelines). In the present paradigm, responses are not spatialized and auditory stimuli are used and therefore it remains an open question whether the previously documented compatibility effects are still observed when responses are not overtly spatial and the stimuli are not visually presented.

Second, does the use of a body-centered sagittal axis lead to different patterns of space-time associations than an axis that lies completely in front of the body? As discussed above, for deictic judgments, a body-centered axis does not require the deictic center to be displaced away from the body and thus may capture different patterns of associations than a solely frontal axis, which may encourage a more allocentric construal (e.g., events as static positions on an external timeline). In the case of sequential judgments, a body-centered sagittal axis may remove any ambiguities as to what the front and back of the axis is, as the body's front-back asymmetry can serve as a particularly salient cue (e.g., Clark, 1973).

Third, what is the psychological reality of spatial construals of deictic and sequential time, particularly along the sagittal axis? Few studies have sought to tease apart these types of time (with two exceptions: Casasanto & Jasmin, 2012; and Kranjec & McDonough, 2011). The use of this novel paradigm, which separates deictic from sequential time, as well as the transversal from the sagittal axis, is particularly well-suited to shed some light on this question. If deictic and sequential time are not meaningfully different from one another, as is assumed in much of the psychological literature, then they should be associated with space in similar ways. Specifically, not only should deictic and sequential judgments use the transversal axis in the same ways, as is often observed, but they should also use the sagittal axis in a similar manner, with past and earlier judgments faster when presented behind the participant, and future and later judgments faster when presented in front of the participant. However, if they are spatialized in different ways, as reflected in linguistic patterns, then the associations observed between deictic and sequential time and the sagittal axis should reflect this difference.

METHODS

Participants were presented with a series of linguistic phrases referring to typical life events and performed one of two tasks. They were asked to vocally report either whether each event occurred in the past or will occur in the future (deictic judgment) or whether one event occurred earlier or later than another event (sequential judgment) by saying the appropriate word aloud into a microphone ("past" or "future" for deictic judgments, "earlier" or "later" for sequential judgments). The stimuli were presented from one of four speakers—in front of, behind, to the left, or to the right of the participant (see Figure 1).

Participants

Sixty-four participants from the University of California, San Diego received partial course credit for participating in the study. Thirty-two participants were randomly assigned to make deictic judgments, with the rest making sequential judgments. In the debriefing questionnaire, thirteen subjects reported that even though they were able to hear the stimuli, they were not able to localize sound from at least one of the four speakers and were thus excluded from analysis. This was largely due to front-back confusions, where participants perceived the sound presented from the back speaker as coming from the front speaker. This phenomenon is common in such laboratory set-ups, with front-back confusion rates as high as 50%, as in more natural environments, individuals often move their heads to localize sounds along this axis, but often are not encouraged to do so in the laboratory (Wightman & Kistler, 1999). Two other participants were excluded due to low levels of accuracy (< 80%). Additional participants were recruited to return the number of participants to 32 in each condition.

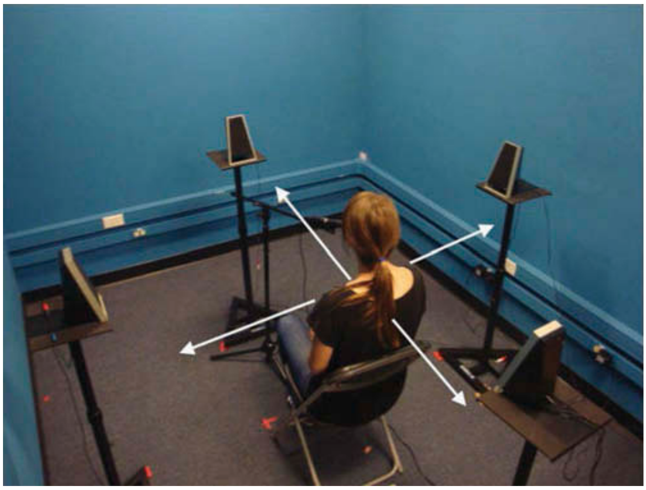

FIGURE 1 Experimental set-up to investigate deictic and sequential judgments along the sagittal (front–back) and transversal (left–right) axes.

Materials

For the deictic judgments, we generated 40 life events likely to have happened in the past (e.g., “your birth”) or the future (e.g., “your retirement”) for an undergraduate student in the United States (see Table 1). Past stimuli did not differ from future stimuli in word length (in syllables), $p = .35$, nor in auditory presentation length (in milliseconds), $p = .31$**.** The sequential stimuli were composed of 40 pairs of the life events used for the deictic judgments. Events in the sequential task were preceded with the pronoun “her” rather than “your” (e.g., “her high school graduation,” “her college graduation”).

TABLE 1
Deictic Stimuli Belonging to the Categories “Past” or “Future”

Past Events		*Future Events*	
Your birth	Speaking your first word	Your death	Your first mortgage
Your prom	Having your first crush	Your wedding	Starting your first career
Taking your SATs	Your first day in high school	Starting on Medicare	Having a child
Starting kindergarten	Your first time shaving	Your child’s baby shower	Getting your first gray hair
Getting your baby teeth	Your first part time job	Having a mid-life crisis	Paying off your loans
Getting your driver’s permit	Starting to crawl	Your high school reunion	Being middle-aged
Learning to walk	Getting chicken pox	Writing your will	Taking your last college exam
Learning to read	Starting elementary school	Having grandchildren	Being a senior citizen
Starting college	Being in sixth grade	Getting dentures	Your 45th birthday
Taking gym class	Your twelfth birthday	Your retirement	Getting promoted

Note. Sequential stimuli were composed of pairs of these events but included the pronoun “her” instead if “your.”

Design

The experiment was run using a Mac Pro computer and was programmed in MATLAB (2009) using Psychtoolbox (Brainard, 1997). Stimuli were presented via one of four computer speakers. Each participant only made one type of temporal judgment (either deictic or sequential), but all participants heard stimuli along both spatial axes (transversal and sagittal). Vocal response times were measured from the offset of the auditory stimulus**.**

Participants were each presented with 5 practice trials, followed by two blocks of 80 randomly presented experimental trials. Over the course of the experiment, each subject heard each stimulus once from each of the four speaker locations. In each block, subjects only made judgments along either the transversal or sagittal axis. Axis order (sagittal or transversal first) and type of judgment (deictic or sequential) were counterbalanced across participants. Each trial began with either a short tone (for deictic judgments) or another life event (for sequential judgments) that was simultaneously presented from both speakers along the axis being tested (e.g. from both the left and right speakers for the transversal axis). Participants then heard the critical stimulus from a single speaker along that axis (e.g., the left speaker) and made the corresponding judgment.

After the experiment, participants completed two questionnaires. The first questionnaire listed all of the life events stimuli and participants listed whether each event happened for them in the past or is likely to happen to them in the future. The data from this questionnaire was then used to calculate their accuracy on the deictic judgments. The second questionnaire asked participants what they thought the purpose of the experiment was and to report from which speakers they perceived sound played during the course of the experiment.

Analyses

All analyses were carried out in R (R Development Core Team, 2005). Trials that were not picked up by the microphone, that were spoiled (e.g., coughing, laughing), were incorrect based on questionnaire responses, or were 2.5 standard deviations from each subject's or item's mean were excluded from analysis (deictic: 5.7%; sequential: 6.8%). To compare deictic to sequential judgments along each axis, a separate ANOVA was conducted on vocal response times for each axis with type of time (deictic or sequential), location (left or right for the transversal axis, front or back for the sagittal axis) and temporal reference (earlier or past; later or future) included as independent variables. Furthermore, to examine how each temporal concept was associated with each spatial axis, planned by-subject and by-items ANOVAs were conducted separately along each axis for the deictic and sequential judgments with temporal reference (past/earlier or future/later) and location (left or right for the transversal axis, front or back for the sagittal axis) as the independent variables (see Table 2).

RESULTS

Sagittal Axis

Results are summarized in Figure 2. Overall, participants were faster to make deictic judgments (471 ms) than sequential judgments (588 ms) along the sagittal axis, $F(1, 62) = 4.32$, $p = .042$,

TABLE 2
Mean Reaction Times and Standard Deviations (in ms)

		Sagittal Axis		*Transversal Axis*	
		Front	*Back*	*Left*	*Right*
Deictic judgment	Past	421 (216)	422 (199)	395 (192)	413 (191)
	Future	521 (264)	534 (218)	506 (213)	488 (195)
Sequential judgment	Earlier	591 (241)	612 (260)	558 (207)	568 (213)
	Later	582 (229)	559 (208)	554 (209)	525 (177)

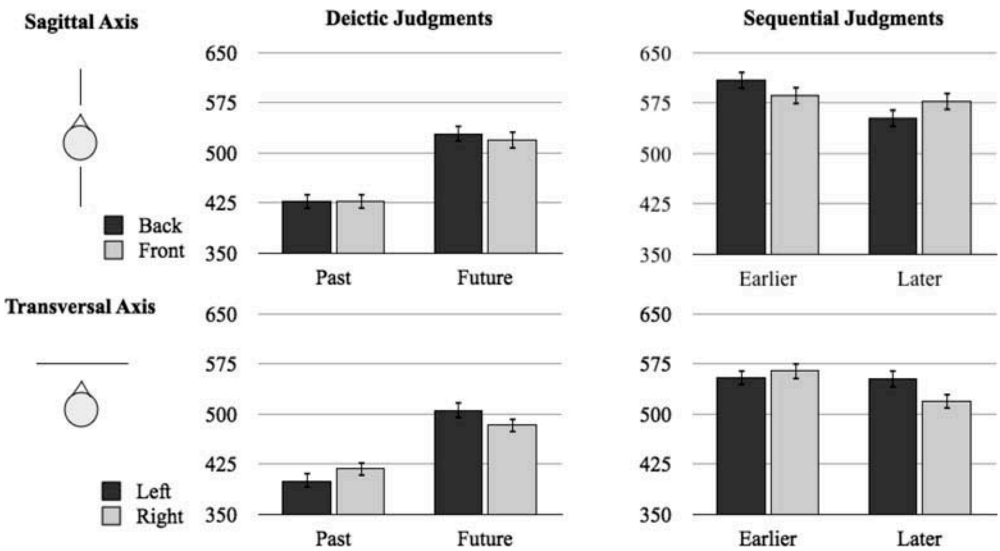

FIGURE 2 Reaction times to deictic and sequential judgments (columns) along the sagittal and transversal axes (rows). Error bars indicate standard error.

$\eta_p^2 = .07$. A two-way interaction between type of temporal judgment and temporal reference also emerged, $F(1, 62) = 60.72$, $p < .001$, $\eta_p^2 = .49$. While past judgments were faster than future judgments for deictic time, $p = .05$, $\eta^2 = .06$, earlier judgments were not significantly faster than later judgments for sequential time, $p = .60$, $\eta^2 = .004$. Critically, there was also a three-way interaction between type of temporal judgment, location, and temporal reference, $F(1, 62) = 4.45$, $p = .039$, $\eta_p^2 = .07$. This interaction was driven by different patterns of space-time compatibility effects for the two types of temporal judgments. For deictic time, contrary to predictions from language and gesture that there are systematic future-in-front and past-behind construals, our paradigm did not find an interaction between temporal reference and speaker location along the sagittal axis, $p_1 = .46$, $\eta_p^2 = .02$, $p_2 = .60$, $\eta_p^2 = .02$.There was a main effect of temporal reference, $F_1(1, 31) = 41.28$, $p < .001$, $\eta_p^2 = .68$; $F_2(1, 38) = 18.27$, $p < .001$, $\eta_p^2 = .34$, as participants were faster to make judgments about past events (421 ms) than future events (528 ms). No main effect of location was observed ($p_1 = .97$, $\eta_p^2 = .01$, $p_2 = .96$, $\eta_p^2 = 0$). Sequential judgments, however, revealed an unexpected interaction along the sagittal axis between temporal reference and location, $F_1(1, 31) = 5.42$, $p = .027$, $\eta_p^2 = .15$; $F_2(1, 38) = 5.32$, $p = .027$, $\eta_p^2 = .12$**.** Follow-up pairwise *t*-tests indicated that participants were faster to make later than earlier judgments presented behind them, $t_1(31) = 3.29$, $p_1 = .003$, $\eta_p^2 = .26$; $t_2(38) = 1.98$, $p_2 = .055$, $\eta_p^2 = .09$. There was no significant difference for stimuli presented in front of the participants, $p_1 = .53$, $\eta_p^2 = .01$, $p_2 = .70$, $\eta_p^2 = .004$.

Transversal Axis

Once again, participants were faster to make deictic (459 ms) than sequential judgments (556 ms) along the transversal axis, $F(1, 62) = 4.06$, $p = .048$, $\eta_p^2 = .06$. However, there was no three-way interaction between type of time, location, and temporal reference, $p = .64$, $\eta_p^2 = .004$. Participants produced similar space-time compatibility effects along the transversal axis for both deictic and sequential time. Planned comparisons for each type of time revealed that there was an interaction between temporal reference and location for deictic, $F_1(1, 31) = 4.28$, $p = .047$, $\eta_p^2 = .12$; $F_2(1, 38) = 6.77$, $p = .012$, $\eta_p^2 = .10$; as well as a marginal interaction for sequential judgments, $F_1(1, 31) = 3.51$, $p = .07$, $\eta_p^2 = .10$; $F_2(1, 38) = 4.72$, $p = .036$, $\eta_p^2 = .11$; replicating previous work.

DISCUSSION

We introduced and tested a new paradigm that uses auditory stimuli and vocal responses to investigate the psychological reality of different spatial construals of time. Along the transversal axis, we found the typically observed space-time associations for both deictic and sequential time, which squares with previous work (e.g., Santiago et al., 2007; Weger & Pratt, 2008). Importantly, the present results make the novel contribution of showing that these transversal effects are independent of stimulus modality and response mode, which points to the transversal axis as a stable and robust candidate for the spatialization of time. Furthermore, not only did we replicate previous work involving the transversal axis, but we also observed novel and interesting results using a body-centered sagittal axis. While no compatibility effects were observed for deictic judgments on the sagittal axis, there was a clear association between sequential judgments and location on this axis. To our knowledge, this is the first experimental evidence of such an association. Together, these results highlight the importance of separating deictic and sequential time in future work, as they appear to be two different types of temporal concept (Núñez & Cooperrider, 2013).

In the present study, the difference between deictic and sequential time was reflected in two distinct ways. First, participants were much faster to make deictic judgments than sequential judgments, which is likely due to a difference in difficulty in the two tasks, as participants found it more challenging to compare one event in time relative to another event in time than comparing one event to the present moment. This difference also highlights the very nature of the distinction we are making here—deictic and sequential time capture very different types of relationships, which is reflected in the time it takes people to reason about each of them. Second, deictic and sequential judgments recruited space in fundamentally different ways. While both temporal concepts recruited the transversal axis as expected—likely due to cultural conventions (Cooperrider & Núñez, 2009)—deictic and sequential time displayed different patterns along the sagittal axis. Compatibility effects were *not* observed for deictic judgments, but *were* observed for sequential judgments.

At first, the lack of a deictic space-time compatibility effect appears inconsistent with much of the literature investigating spatial construals of deictic time, as many studies have reported compatibility effects between past and future judgments and the sagittal axis (e.g., Hartmann & Mast, 2012; Koch et al., 2011; Sell & Kashak, 2011; Ulrich et al., 2012). For instance, using a similar set-up (auditory presentation and vocal responses) but a different type of task, Eikmeier et al. (2013) found a compatibility effect using tones presented in front of or behind the participant and whether they responded to that tone by saying "past" or "future". Thus, one possibility is that the present paradigm simply was not sensitive enough to capture such an effect. While this is possible, it seems unlikely given that compatibility effects were observed not only along the transversal axis for both types of time, but also along the sagittal axis for sequential judgments. Additionally, as Eikmeier et al. (2013) were mainly interested in measuring dimensional overlap between time and space, they only had participants make simple associations between the location of a tone and categorizing the tone's location as "past" or "future" whereas the present study required participants to actively construe a particular event as having happened in the past or in the future. As such, an alternative possibility is that the present paradigm, by removing spatialized responses, failed to highlight properties of spatial experience, such as motion, that are often involved in deictic construals.

When we talk about deictic time, we often use motion language, as in *"The weekend is fast approaching."* Interestingly, the majority of studies of the relationship between deictic time and the sagittal axis involve imagined or actual motion in space as part of their design (e.g., Sell & Kashak, 2011; Ulrich et al., 2012). For instance, Miles, Karpinska, et al. (2010) found that illusory forward self-motion through space induced more daydreams about the future while illusory backward self-motion induced more daydreams about the past. Thus, maybe *motion*—and not just location—is key to the representation of past/future relationships along the sagittal axis (Boroditsky & Ramscar, 2002; Sell & Kashak, 2011). Our results are consistent with this idea, as we found that non-spatialized responses failed to elicit a clear sagittal deictic association. Future work must carefully investigate this speculative hypothesis and examine to what extent and in what ways the motor system or other particular types of spatialized responses may be involved in bringing forth spatial construals of deictic time when using a body-centered sagittal axis. Whether this is due to patterns in language (e.g., is deictic time described more often using motion terms than static spatial locations?), contingencies in how we interact with the world (e.g., motion forward in space co-occurs with passing through time towards the future), or a combination of the two needs to be further explored.

While no deictic sagittal effect was observed, a space-time compatibility effect emerged for sequential judgments on the sagittal axis, with participants associating earlier events with the space in front of them and later events with the space behind them. This aspect of our results may appear surprising for a variety of reasons. For example, previous studies have failed to find evidence of an association between sequential time and the sagittal axis (Casasanto & Jasmin, 2012; Fuhrman et al., 2011; Kranjec & McDonough, 2011). A closer look at these studies, however, suggests that these studies may represent absence of evidence rather than evidence of an absence, as there are limitations to each. For example, in Kranjec and McDonough (2011), the sequential stimuli were not presented in a sequence, but were separated by other images, which may have prevented subjects from realizing they were part of a sequence. Furthermore, Casasanto and Jasmin (2012) found that individuals do not gesture along the sagittal axis when talking about sequential time. However, people may typically gesture along the transversal axis for sequential time for particular reasons. For instance, when comparing events in time, as is often the case with sequences, it may simply be easier to lay things out along the transversal axis, rather than use the space in front of and behind the body. This does not necessarily mean that individuals do not associate sequential time with sagittal space.

The pattern of associations we observed for sequential judgments on the sagittal axis might also appear counterintuitive: shouldn't *earlier* events be associated with the space *behind* the participant and *later* events associated with the space in *front*? However, that particular pattern describes the case for *deictic* time, where events that are earlier than the present, or past events, are behind and events that are later than the present, or future events, are ahead. Rather, the observed results are consistent with a deictically neutral field-based perspective of sequences in language (Moore, 2011), evidenced in expressions like *"The incumbent was in a strong position <u>ahead</u> of the elections,"* where earlier events are placed *in front* of later events. Given the use of a body-centered sagittal axis in this paradigm, participants may have used their body to anchor the first event they heard. Then, after aligning their fronts and backs with the metaphorically oriented sequence of events, they may have placed the second event either in front of them (earlier) or behind them (later). Future research may more closely examine the nature of this association and the differences between deictic and sequential time.

While the present paradigm proved to be a useful method of investigating spatial construals of deictic and sequential time along multiple spatial axes, it is important to consider its limitations. For instance, future implementations of a similar paradigm may want to consider further investigating the nature of the front-back sound confusions our participants experienced and how they may best be avoided. In addition, we explicitly sought to eliminate the use of spatial responding in the present study. Though compatibility effects were still observed along the transversal axis, no such effects were observed for deictic judgments along the sagittal axis, which conflicts with previous findings. However, it is unclear whether this is due to a lack of sensitivity of our paradigm or whether spatial construals of deictic time rely on particular aspects of space that weren't highlighted in the present paradigm. A potentially fruitful area of future research would be to more closely examine what particular aspects of space and spatial experience are important for bringing forth such spatial construals of time.

In sum, we developed a novel paradigm that can be used to tease apart the use of different spatial axes by different types of temporal concepts. The results obtained by this paradigm replicated previous work along the transversal axis, but also revealed previously unobserved findings along the sagittal axis. These results highlight the importance of disentangling the various elements involved in the realization of spatial construals of time and suggest that time is a multifarious concept that recruits spatial properties in nuanced, context-dependent ways.

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