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The Continuity of Metaphor: Evidence From Temporal Gestures

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Abstract

Reasoning about bedrock abstract concepts such as time, number, and valence relies on spatial metaphor and often on multiple spatial metaphors for a single concept. Previous research has documented, for instance, both future-in-front and future-to-right metaphors for time in English speakers. It is often assumed that these metaphors, which appear to have distinct experiential bases, remain distinct in online temporal reasoning. In two studies we demonstrate that, contra this assumption, people systematically combine these metaphors. Evidence for this combination was found in both directly elicited (Study 1) and spontaneous co-speech (Study 2) gestures about time. These results provide first support for the hypothesis that the metaphorical representation of time, and perhaps other abstract domains as well, involves the continuous co-activation of multiple metaphors rather than the selection of only one.

Keywords: Metaphor; Time; Gesture; Communication

1. Introduction

Over the course of the last few decades, the view that metaphors are merely ornamental linguistic flourishes has been definitively turned on its head. Metaphors are now accepted as basic building blocks of everyday reasoning. In discourse across different domains—from talk about numbers and time, to discussions of political ideology and social status—metaphors are not only commonplace, they are inescapable. According to conceptual metaphor theory (CMT), metaphors are inescapable because human reasoning itself—not just language—is metaphorical (Lakoff & Johnson, 1980). In the framework of CMT, metaphors are conceptual mappings between a *target domain* concept—whatever it is we are actually

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talking or thinking about—and some *source domain* concept—whatever concept we draw on to understand the target. Consider, for example, Neil Armstrong's famous pronouncement that his first small steps on the moon constituted a "giant leap for mankind." In this case, the target concept is progress and the source concept he draws on is forward motion. Armstrong's pronouncement is hardly a one-off flourish. It is just one manifestation of a systematic and productive mapping between these domains, called a *conceptual metaphor*.

The PROGRESS IS FORWARD MOTION metaphor belongs to a large and much-studied subclass of metaphors, which Lakoff and Johnson (1980) termed "orientational metaphors." In an orientational metaphor, a spatial contrast is recruited to make sense of a contrast in a target domain that is not intrinsically spatial. In the example above, the contrast between forward and backward motion is recruited to construe the contrast between progress and regress. Interestingly, for many of our most foundational abstract concepts, such as time, number, and valence, there is more than one spatial source contrast available to construe the very same target contrast. In such cases, the competing metaphors involved appear to be cut from different cloth. Take the two predominant orientational metaphors for reasoning about past and future in English. On the one hand, there is evidence for a *sagittal metaphor* in which past times are mapped to the back and future times to the front. Such evidence comes primarily from everyday language use (Alverson, 1994; Clark, 1973). For example, people "think *back*" to past experiences and "look *forward*" to future ones. On the other hand, there is evidence for a *lateral metaphor* in which the past is mapped to the left and future to the right. This metaphor is not found in everyday language but reliably emerges in reaction time studies (Santiago et al., 2007) and in gesture (see Núñez & Cooperrider, 2013 for a review). Moreover, the sagittal and lateral temporal metaphors are often traced to different developmental sources, with the sagittal mapping most likely developing through linguistic experience and the lateral mapping through experience with graphical representations.

Given that these two temporal metaphors emerge in different kinds of behaviors and likely have different experiential sources, studies have endorsed the idea, at least implicitly, that they are distinct in online reasoning. Psychological studies have zoomed in on one metaphor at a time, for instance by having participants respond by pressing buttons on the left and right (Weger & Pratt, 2008) or front and back (Fuhrman et al., 2011; Sell & Kaschak, 2011), by having participants respond to stimuli that are displayed along the left-right axis (Torralbo, Santiago, & Lupiáñez, 2006), or by isolating only one axis to measure from a continuous, multi-dimensional response (Miles, Nind, & Macrae, 2010). In those studies whose designs have allowed both sagittal and lateral temporal metaphors to be glimpsed within the same paradigm, researchers have kept the metaphors analytically distinct (Casasanto & Jasmin, 2012; Cooperrider & Núñez, 2009; Walker, Bergen, & Núñez, 2014). In sum, the consensus in current research is that these orientational metaphors for time are distinct mappings and that speakers will "use only one in a situation that allows both of them" (Torralbo et al., 2006, p. 748).

In the present studies, we challenge this consensus view. The seed of this challenge lies in observations of a ubiquitous, spontaneous, and everyday behavior—*gesture*. Across a wide range of topics and contexts, gesture has been shown to provide a "window" into the mind (Goldin-Meadow, 2003; McNeill, 1992), reflecting both concrete spatial imagery and metaphorical conceptualization (Cienki, 1998). For our purposes, a critical property of gestures is that they are three-dimensional spatial representations that unfold in time. As such, they have a richness that other behaviors used to study metaphorical reasoning, such as language use or button presses, cannot match. In gesture, not only are the pure forward, backward, leftward, and rightward directions available; in principle the entire space in front of the body is available, in a continuous fashion. Interestingly, informal observation of gestures accompanying talk about time turns up examples in which a single gesture appears to be consistent with both sagittal and lateral metaphors for time. Such gestures suggest that these two metaphors are simultaneously active in the speaker's mind—in short, that they are *co-activated*. One way that this co-activation manifests is in the gesture's directionality. Consider an example from a television interview in which a speaker says "looking to the future" while moving his right hand simultaneously forward and to the right (see Fig. 1B). Another more subtle way that this co-activation manifests is in the selection of which hand to gesture with. For example, later in the interview, the same speaker uses his left hand to gesture backward while saying "where I had been," referring to his past (see Fig. 1A). Such examples from the wild are suggestive, but quantitative evidence is needed to distinguish what may be motor noise in gesture from the more interesting possibility of systematic co-activation of distinct temporal metaphors.

Here, we report two studies that test the possibility that English speakers systematically combine the sagittal and lateral metaphors for time in their gestures by looking for evidence of the two gestural signatures of co-activation described above: (a) gestural directionality and (b) hand selection. In a first study, we looked for these signatures of co-activation in people's directly elicited gestures about time concepts; in a second study, we looked for these same signatures in people's spontaneous temporal gestures. These two types of gesture data are complementary. Directly elicited gestures, though somewhat unnatural, allow more experimental control; spontaneous gestures, though more difficult to examine in a controlled way, are more naturalistic. What both types have in common is the critical property of gesture that makes it a useful window into the possible co-activation of metaphors: its three-dimensional, continuous character.

2. Study 1: Directly elicited temporal gestures

2.1. Methods

2.1.1. Participants

One hundred and four students (74 female; 10 left-handed) at the University of California, San Diego, participated in the study. All participants were native speakers of English.

2.1.2. Materials

To directly elicit temporal gestures, we used the same prompts developed by Casasanto and Jasmin (2012). The prompts consisted of four questions that explicitly asked participants how they would gesture about different temporal concepts. Two of the questions asked about

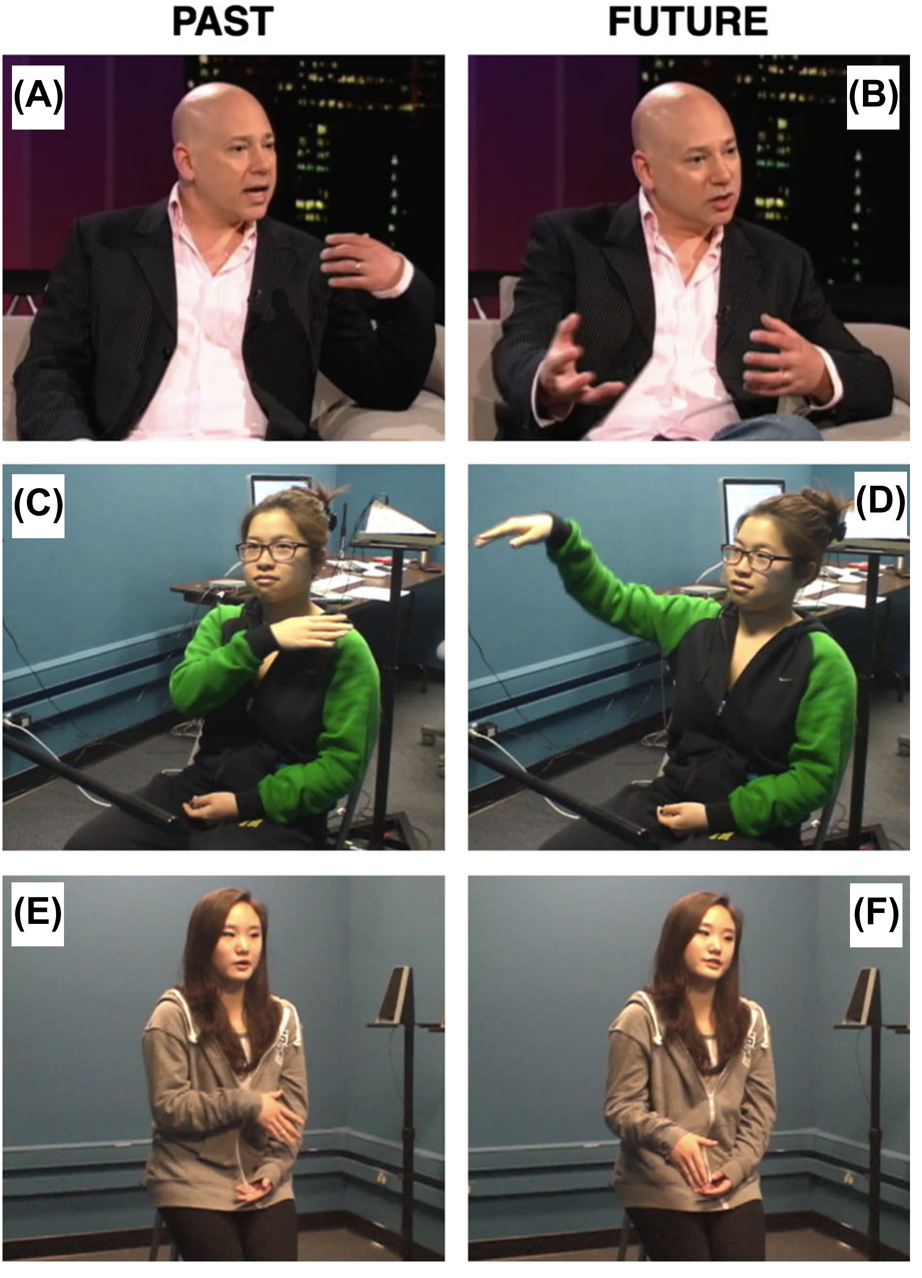

Fig. 1. Examples of gestures that combine sagittal (front-back) and lateral (left-right) metaphors for past and future. Gestures are taken from a television interview (A and B), from Study 1 (C and D), and from Study 2 (E and F).

deictic concepts (*past*, *future*), whereas the other two asked about sequential concepts (*before*, *after*). The order of the questions was counterbalanced across participants. The present analysis focuses only on gestures produced following the two deictic prompts (one past, one future, see Table 1) as the sequential prompts generated fewer gestures along the axes of interest. Some prompts used explicit directional language (e.g., *far ahead in the future*), whereas others used no directional language (e.g., *in the distant future*). This was counterbalanced across participants, but no differences across prompt types were found, consistent with Casasanto and Jasmin (2012).

2.1.3. Procedure

After having completed a separate task,[1] each participant was seated on a stool and was explicitly asked four questions about how they would gesture about time. Participants were told their responses would be video-recorded.

2.1.4. Coding

Separate clips for each question for each participant were created. Two coders coded only the video (without audio) of each clip. For each gesture, they recorded the handedness of the gesture (left hand, right hand, or both hands) and the directionality of the gesture stroke (leftward, rightward, backward, forward, forward-leftward, forward-rightward, backward-leftward, backward-rightward, or other). All statistics reported are based on the annotations of the second coder, who was completely naïve regarding the hypotheses. After the coding was complete, gestures were then analyzed for congruency.

Congruency of the gestures was determined as follows. For gestures produced along the lateral axis, leftward past gestures and rightward future gestures were coded as congruent, in line with previous research on English speakers (e.g., Casasanto & Jasmin, 2012). Along the sagittal axis, backwards past gestures and forwards future gestures were considered congruent. Finally, gestures that combined the two axes (combined-axis gestures) were coded as incongruent, singly congruent, or doubly congruent. Gestures were singly congruent if the gesture was only congruent along one of the two axes (forward-leftward or backward-rightward past gestures or forward-leftward or backward-rightward future gestures). They were considered doubly congruent if the gesture's directionality was congruent for both of the axes involved (backward-leftward past gestures or forward-rightward future gestures). All other cases were considered incongruent.

2.1.5. Reliability

For a conservative measure of reliability, we calculated the absolute agreement of the directionality of the gesture stroke (nine categories: leftward, rightward, forward, backward, forward-leftward, forward-rightward, backward-leftward, backward-rightward, and other). Good agreement was achieved between the two coders: 77.4% agreement, Cohen's $\kappa = .72$. To better compare our reliability rates with those of similar studies that have

Table 1
Prompts used to directly elicit gestures from participants in Study 1

How would you gesture about things that will happen a long time from now, far ahead in the/in the distant future?
How would you gesture about things that happened a long time ago, way back in the/in the distant past?

used fewer categories (e.g., Casasanto & Jasmin, 2012 coded four categories), we also adopted a more relaxed criterion according to which two codes were considered to be in agreement if they were within 45 degrees of each other (e.g., coder 1 coded the stroke as leftward, whereas coder 2 coded the stroke as forward-leftward). Under this scheme, reliability was very good: 92.3% agreement, Cohen's $\kappa = .91$.

2.1.6. *Analyses*

To test the hypothesis that people combine metaphors when gesturing about time, we looked for two signatures of co-activation. First, we analyzed whether combined-axis gestures were more likely to be doubly congruent than singly congruent, which would suggest that participants systematically combine the two axes. Second, we examined whether, for congruent gestures produced along the sagittal axis, the hand used to produce the gesture was related to whether the participant was gesturing about the past or the future. For example, when someone produces a backward gesture about the past, does she also smuggle in a leftward component by gesturing with her left hand as opposed to their right? If so, this would suggest activation of the past-to-left mapping even when the primary axis used is front-back.

2.2. *Results*

The total number of gesture strokes produced by each hand (left, right, or both hands) for each temporal category (past, future) along each axis (lateral, sagittal, combined) was recorded. Though 208 gestures were recorded, 30 of the gestures had no clearly codable direction along the axes of interest and were excluded from further analysis. Of the 178 remaining gestures, 30 (17%) were produced along the lateral axis (16 leftward, 14 rightward), 119 (67%) along the sagittal axis (60 forward, 59 backward), and 29 (16%) gestures combined the two axes (10 backward-leftward, 4 backward-rightward, 2 forward-leftward, 13 forward-rightward) (see Fig. 1C and D, for examples of combined-axis gestures). As for handedness, 39 of the 178 were produced with the left hand (22%), 124 with the right hand (70%), and 15 were produced bimanually (8%). The majority (96%) of gestures produced were congruent (26/30 lateral, 116/119 sagittal, and 29/29 combined-axis gestures were either singly or doubly congruent).

2.2.1. *Double and single congruency*

A binomial test revealed that gestures that combined axes were more likely to be doubly congruent (23 gestures, 79%) than singly congruent (6 gestures, 21%), $N = 29$, $p = .002$ (Fig. 2). The 29 combined-axis gestures were produced by 25 different individuals, with 19 of those individuals producing at least one doubly congruent gesture (range: 1–2 doubly congruent gestures). The complete data table is viewable in the online supplementary tables as Table S1.

2.2.2. *Hand selection and temporal category*

A chi-squared test on the 108 congruent, one-handed sagittal gestures (forward future gestures or backward past gestures) indicated that the use of the left or right hand was

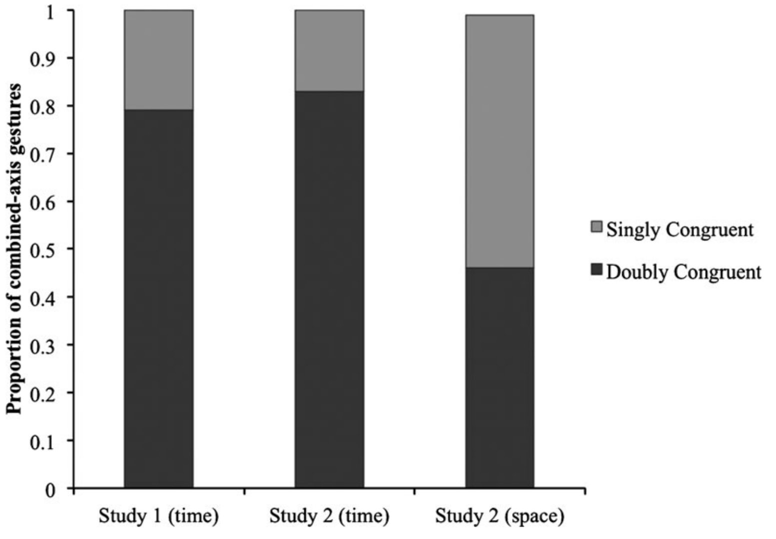

Fig. 2. Proportions of doubly and singly congruent combined-axis gestures produced in Study 1 (time) and Study 2 (time, space).

not independent of whether the participant was gesturing about the past or the future, $\chi^2(1, N = 108) = 12.15$, $p < .001$. There were only five instances of future gestures being produced with the left hand, whereas left-handed past gestures occurred 21 times. The right hand was used 50 times to produce future gestures compared to only 32 times to produce past gestures (Fig. 3).

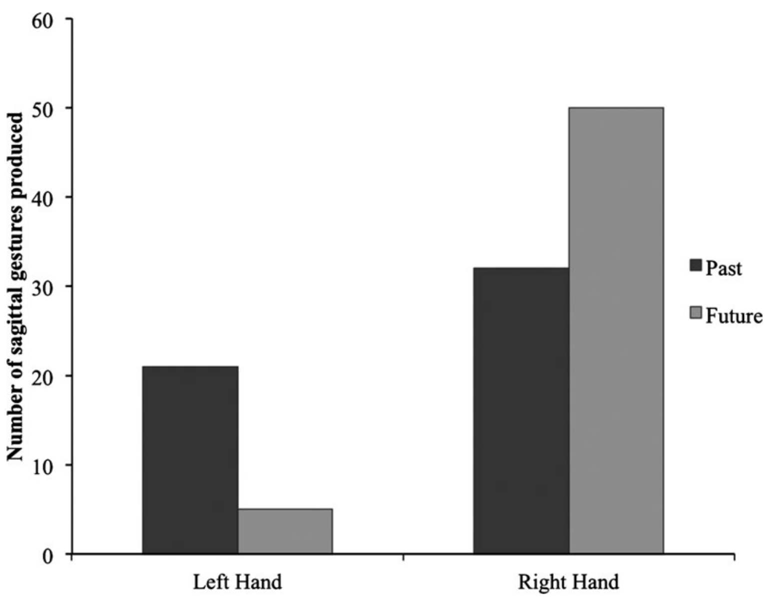

Fig. 3. Number of past and future gestures produced along the sagittal axis by each hand in Study 1.

2.3. Discussion

In Study 1, we found two kinds of evidence that people combine sagittal and lateral metaphors for time in their gestures: (a) people were more likely to produce combined-axis gestures congruent with both metaphors than congruent with one but not the other, and (b) people used their left hand more often to gesture directly backwards about the past than they did to gesture directly forward about the future, and vice versa for the right hand. These results demonstrate that people can activate both front-back and left-right temporal metaphors either simultaneously or else in extremely rapid succession. In a situation in which both temporal metaphors are available to be expressed, in this case through a continuous manual motor response, English speakers do not always choose one or the other.

Directly elicited gestures are, of course, somewhat unnatural. Under ordinary circumstances speakers do not attend closely to their gestural movements (McNeill, 1992). And, indeed, several studies have reported differences between participants directly elicited and spontaneous gestures (Casasanto & Jasmin, 2012; Goldin-Meadow, McNeill, & Singleton, 1996). Thus, an interesting additional question is whether speakers also combine metaphors in these same ways in their *spontaneous* co-speech gestures. If so, this would provide evidence that, not only *can* people co-activate distinct metaphors in gesture, they *do* in more naturalistic and everyday behaviors. To address this question, in a second study we had people explain time concepts, as well as other concepts, as a way of eliciting temporal reasoning and spontaneous gestures. The task also involved explanation of a handful of concrete spatial concepts to test whether mere biomechanical preferences—rather than the combining of metaphors—might explain the patterns observed in the first study. Specifically, we wanted to address the possibility that for some purely biomechanical reason gestures tend to follow those directions—forward-rightward and backward-leftward—that happen to be doubly congruent with the two time metaphors in English.

3. Study 2: Spontaneous temporal gestures

3.1. Methods

3.1.1. Participants

Twenty-four students at the University of California, San Diego, were recruited to participate in exchange for course credit. All were native speakers of English. Six participants did not produce any gestures during the task and were thus not included, leaving 18 participants for analysis (11 female, 7 male; 2 left-handed, 1 ambidextrous).

3.1.2. Materials

We generated a list of 32 English words (Table 2) comprising three categories: eight time-related (e.g., past, future), eight space-related (e.g., left, right), and sixteen filler words (e.g., beauty, courage). The list was split into two randomized lists that each

Table 2
List of stimuli included in Study 2

Time Words	Space Words	Filler Words	
Future	Below	Peace	Happiness
Now	Right	Cause	Success
Later	Back	Power	Hero
Earlier	Front	Remainder	Idea
Tomorrow	Far	Love	Summit
Today	Above	Courage	Anxiety
Past	Left	Beauty	Edge
Yesterday	Near	Fear	Faith

contained four time words, four space words, and eight filler words. Each participant received both lists and the order of the list presentation was counterbalanced.

3.1.3. Procedure

Participants were seated on a stool and instructed that their task would be to define a series of English words as clearly as possible so that someone with a beginning level of English would be able to watch the video and understand the words. They were told that they would have 30 seconds to define each word and were asked to continue speaking for the full time. Words to be defined were presented on a large computer monitor that was placed off to the participant's left side on a table. After 30 seconds, the current word was automatically replaced on the screen by the next. Once participants had finished the first list, they took a brief break and then the experimenter started the second list. Finally, participants completed a debriefing questionnaire that asked them what they thought the purpose of the experiment was, as well as whether they were familiar with all of the words they were asked to define.

3.1.4. Coding

For each participant, separate clips were created for each of the eight time words and for the four space words that corresponded to the temporal axes of interest (*front*, *back*, *right*, *left*). Audio-only and video-only versions of each clip were created for coding purposes. Coding then proceeded in three steps. First, using ELAN annotation software (Max Planck Institute for Psycholinguistics, Available at: http://www.mpi.nl/tools/elan.html), a coder listened to the audio-only version of each clip and created an annotation whenever the participant produced one of a pre-determined set of target words. In addition to the eight time words listed in Table 2, target temporal words also included *present*, *before*, *last/next* (*week*, *month*, *etc*.), *ago*, *after*, and *already*. Target spatial words included *front*, *back*, *left*, *right*, *forward*, *backward*, *leftward*, *rightward*, and *here*. The annotated words were then cleared for the next set of coders, leaving only empty annotations time-locked to the moment when they were produced. Then, two coders watched the video-only clips and coded whether a gesture occurred during each of the previously made annotations. If a gesture was present either within the annotation window or started within 500 ms before the start of that annotation, then the coders recorded the handedness of the gesture and the directionality of the gesture stroke, as in Study 1. Again, statistics reported are based on the annotations of the second coder, who was completely naïve regarding the hypotheses and naïve about whether participants were providing definitions of temporal or spatial words. Finally, the audio and video coding were brought together and the congruency of each gesture was determined in the same manner as in Study 1.

3.1.5. Reliability

In addition to conducting the absolute and "45 degree" reliability analyses on stroke directionality conducted in Study 1, we also determined how consistent the coders were in determining whether a gesture was present during a particular speech annotation (due to the nature of the direct elicitation, this analysis was not needed in Study 1). Reliability was calculated separately for gestures produced during the temporal and spatial clips.

The two coders had good agreement about the presence of a gesture (temporal gestures: 92.6%, Cohen's $\kappa = .77$; spatial gestures: 91%, Cohen's $\kappa = .77$). When coding for directionality, the two coders also had good agreement, both for the conservative absolute analysis (temporal gestures: 89.4%, $\kappa = .69$, spatial gestures: 85.3%, $\kappa = .67$) and the more relaxed "45 degree" analysis (temporal gestures: 91.9%, $\kappa = .77$, spatial gestures: 89.5%, $\kappa = .76$).

3.2. Results for temporal gestures

Two hundred and thirty-three temporal gestures exhibited a clearly codable direction along the axes of interest and were included in the analysis. Of these gestures, 167 (72%) were produced along the lateral axis (93 leftward, 74 rightward), 40 (17%) along the sagittal axis (18 backward, 22 forward), and 26 (11%) combined axes (9 backward-leftward, 1 backward-rightward, 3 forward-leftward, 13 forward-rightward) (see Fig. 1E and F, for examples of combined-axis gestures). As for handedness, 90 (39%) were produced with the left hand, 99 (42%) with the right hand, and 44 (19%) bimanually. The majority (86%) of gestures produced were congruent (148/167 lateral, 29/40 sagittal, and 24/26 combined-axis gestures were either singly or doubly congruent).

3.2.1. Double and single congruency

As in Study 1, a binomial test revealed that congruent combined-axis gestures were more likely to be doubly congruent (20 gestures, 83%) than singly congruent (4 gestures, 17%), $N = 24$, $p = .001$ (Fig. 2). Eleven of the 18 participants produced at least one combined-axis gesture, with nine producing at least one doubly congruent gesture (range: 1–4 doubly congruent gestures). The complete data table is viewable in the online supplementary tables as Table S2.

3.2.2. Hand selection and temporal category

There was a lower percentage of sagittal gestures produced in Study 2 (consistent with Casasanto & Jasmin, 2012 and discussed below) and fewer sagittal gestures overall (29 congruent sagittal gestures in Study 2, compared to 116 in Study 1). As a result, there are insufficient data to conclusively evaluate the relationship between hand selection and temporal category. While there were fewer left-handed future gestures (3) than for any other hand/temporal category combination (7 left-handed past; 6 right-handed future; 10 right-handed past), there is no strong evidence of an association between hand selection and temporal category.

3.3. *Results for spatial gestures*

One hundred and nineteen spatial gestures exhibited a clearly codable direction along the axes of interest and were included in the analysis. We observed 59 instances (50%) of lateral gestures (27 leftward, 32 rightward), 45 instances (38%) of sagittal gestures (21 backward, 24 forward), and 15 instances (13%) of combined-axis gestures (5 backward-leftward, 6 backward-rightward, 2 forward-leftward, 2 forward-rightward). Gestures were produced with the right hand 57 times, the left hand 48 times, and with both hands 14 times.

For spatial gestures, gestures were considered congruent if the gesture matched the speech content (e.g., a leftward gesture when saying "left," forward gesture when saying "front," etc.). Furthermore, to compare the patterns observed in the combined-axis temporal gestures to the combined-axis spatial gestures, we coded the spatial combined-axis gestures as "doubly congruent" if they were produced along the doubly congruent temporal axes (backward-leftward, forward-rightward) and "singly congruent" if they were produced along the singly congruent temporal axes (backward-rightward, forward-leftward). Overall, spatial gestures were congruent 75% of the time (38/59 lateral, 38/45 sagittal, and 13/15 combined-axis gestures were either singly or doubly congruent).

3.3.1. *Double and single congruency*

In contrast to the temporal gestures, congruent spatial combined-axis gestures were no more likely to be doubly congruent (six gestures) than singly congruent (seven gestures), as revealed by a binomial test, $N = 13$, $p = .46$ (Fig. 2).

3.3.2. *Hand selection and temporal category*

As in the temporal gestures, there were relatively few instances of purely sagittal spatial gestures (7 left-handed back gestures, 4 left-handed front gestures, 10 right-handed back gestures, 9 right-handed front gestures), but there is no strong evidence of an association between gesture directionality and hand selection.

3.4. *Discussion*

In their spontaneous temporal gestures participants in Study 2 were more likely to produce combined-axis gestures that were doubly congruent than combined-axis gestures that were singly congruent, mirroring the pattern found for directly elicited gestures in Study 1. Importantly, we found no evidence that the doubly congruent axes (backward-leftward and forward-rightward) are preferred in gesturing about concrete spatial concepts, suggesting the pattern is not driven by a quirk of biomechanics, but rather by the systematic combining of sagittal and lateral metaphors for time. Participants produced a lower percentage of sagittal gestures in their spontaneous gestures about time (17%) than in their directly elicited gestures (67%). Though perhaps striking, this overall pattern mirrors one found previously. In Casasanto and Jasmin (2012), English speakers produced a lower percentage of sagittal gestures in a spontaneous story-telling task (26%) than in a direct elicitation task (59%) (the same task used in our Study 1). The researchers note a likely source of this pattern: when directly asked to produce a gesture about the past or future, participants may consider how they would talk about these concepts. In English, linguistic metaphors for the past and future frequently involve front-back language but never left-right language (Casasanto & Jasmin, 2012). Thus, though our data are consistent with previous findings, the relative scarcity of sagittal gestures meant we had insufficient data in Study 2 to conclusively test for the presence of the other signature of metaphor combination, hand selection in front-back gestures.

4. General discussion

Across two studies we found evidence that people combine sagittal (past-behind, future-in-front) and lateral (past-to-left, future-to-right) metaphors for time in their hands, both in directly elicited (Study 1) and in spontaneous gestures (Study 2). Previous studies have reported that people spatialize time in gesture even when not explicitly using any spatial metaphor in speech (Cienki, 1998) and have highlighted that left-right temporal gestures are pervasive even though left-right temporal metaphors are entirely absent from language (Casasanto & Jasmin, 2012). In the present studies, we demonstrate yet another way that gesture sidesteps speech to provide distinctive insights into metaphorical reasoning: Though people may not combine metaphors for time in their words, they do so systematically in their hands.

It has been shown elsewhere that people "mix metaphors" in language more generally. How are our findings different? While it is clear that people sometimes switch between metaphors in discourse (e.g., Kimmel, 2010), it is less clear what we can infer about mental representation from such observations. For one, the presence of a metaphor in language is not necessarily evidence that a source domain is activated. Many linguistic metaphors may be frozen, conventional forms that are processed differently from novel forms (e.g., Bowdle & Gentner, 2005). Second, by virtue of its serial nature, language simply cannot express two metaphors at the same time—it can only express them one after the other, in sequential fashion. Gesture overcomes both of these limitations: In a single stroke it provides evidence, not only for source domain *activation* (e.g., Cienki, 1998), but also for the *co*-activation of two source domains within a very narrow time window. Our findings thus provide the strongest evidence yet that, counter to assumptions and occasional statements in the metaphor literature, people do not necessarily choose only one metaphor in a situation that allows more than one.

One reading of our data is that the phenomenon of combining metaphors in gesture is a somewhat marginal one, only exhibited in rare cases. This conclusion would be unwarranted. First, the rates of combined-axis gestures we observed were comparable to the rates of gestures produced along the less prominent of the two "pure" axes in each study (the lateral axis in Study 1, and the sagittal axis in Study 2). Furthermore, the rate of combined-axis gestures was not simply driven by one or two individuals. In Study 1, almost every instance of a combined-axis gesture was produced by a different individual, and, in Study 2, half of the participants produced at least one doubly congruent gesture. Second, our measures of combined metaphor use were relatively coarse-grained: Gestures were only coded as combining the front-back and left-right axes when they were closer to the 45 degree diagonal than to either of the "pure" lateral or sagittal axes. Many gestures were thus coded as purely lateral or purely sagittal when in fact they had subtle spatial properties not captured by our categorical measure. Future studies involving continuous measures of high-dimensional behaviors such as gestures or reaching movements will be required to shed further light on just how pervasive metaphor combination is in real-time behavior.

The above results provide initial empirical support for an emerging view that underscores the dynamic nature of metaphorical representation (Gibbs & Santa Cruz, 2012). According to this view, which we term the "continuity of metaphor" hypothesis, people do not have to choose one metaphor in a situation that allows more than one. Rather, in cases where more than one source domain is regularly mapped to a particular target domain, both sources may be activated in an apparently continuous fashion. Metaphorical representation, on this view, has the continuous character exhibited by other kinds of mental representation (Spivey, 2007), as seen, for example, in decision-making tasks involving motor responses (McKinstry, Dale, & Spivey, 2008; Song & Nakayama, 2009). Note that the continuity observed in temporal gestures might arise from different possible underlying processes. One possibility is that these metaphorical representations remain distinct but are sometimes activated in extremely rapid succession, for instance in the amount of time it takes to plan and execute a gesture. Another possibility is that these representations are not activated serially but rather are simultaneously active to different degrees whenever reasoning about time. Whether this co-activation is serial or simultaneous is an important question for further research, but answering it will require measures with fine-grained temporal resolution in addition to fine-grained spatial resolution.

Though the "continuity of metaphor" hypothesis is motivated by observations about the metaphorical construal of time, it extends straightforwardly to other bedrock abstract concepts. Reasoning about number and valence—like reasoning about time—has been shown to involve more than one orientational metaphor. Numerical magnitude can be either "higher" or further to the right on the mental number line (Núñez & Marghetis, 2015; Winter, Perlman, & Matlock, 2014), and the "continuity of metaphor" hypothesis predicts that these seemingly competing representations would in fact be co-active. Suggestive examples of this phenomenon have in fact already been described (Winter et al., 2015). Similarly, positive valence is mapped both with "up" (Meier & Robinson, 2011) and with the dominant hand side (Casasanto & Jasmin, 2010), and, again, the "continuity of metaphor" hypothesis predicts that these metaphors would be regularly combined in real-time behavior. Whether the continuity of metaphor extends beyond the orientational metaphors described here to other kinds of spatial metaphors, or even to metaphors that do not involve spatial source domains, is an important question. The use of mixed metaphors in formal writing is often considered a mark of muddy thinking and has long been reviled by English teachers and editors. But the use of mixed metaphors in everyday reasoning, much like the use of metaphor in the first place, may prove to be inescapable.

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Note

1. The first task was a reaction time experiment investigating spatial construals of time (Walker et al., 2014). No relationships were found between patterns of responses observed in the reaction time experiment and patterns observed in gesture.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Individual participant data for Study 1.

Table S2. Individual participant data for Study 2.