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BRIEF REPORT

Moving Events in Time: Time-Referent Hand–Arm Movements Influence Perceived Temporal Distance to Past Events

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We examine and find support for the hypothesis that time-referent hand–arm movements influence temporal judgments. In line with the concept of “left is associated with earlier times, and right is associated with later times,” we show that performing left (right) hand–arm movements while thinking about a past event increases (decreases) the perceived temporal distance to the event. These findings show for the first time that hand–arm movements can influence the perceived temporal distance to events.

Keywords: temporal judgment, space, time, temporal gesture, embodied cognition

Sometimes past events can feel very close in time, and on other occasions recent events can feel as if they took place a long time ago. We report an experiment revealing that systematically controlled hand–arm movements on a horizontal plane can influence how past events are anchored in time. The argument driving this research was derived from conceptual metaphor theory (Lakoff & Johnson, 1999), which presents a framework to understand how concepts that we cannot touch or see are grounded and processed. The general idea behind conceptual metaphor theory is that we make sense of abstract concepts by grounding them on our knowledge and experience with more concrete experiences. Thus, abstract concepts are “mapped” onto concrete concepts. Such abstract–concrete mapping can be revealed in metaphors representing abstract concepts. For example, metaphors about time rely on spatial references, as in the case of “leaving one’s past *behind* oneself” or “looking *forward* to tomorrow’s party”. The spatial grounding of time facilitates our understanding and processing of time (e.g., Boroditsky, 2000; Casasanto, 2010). Notably, referring to leaving the past behind or looking forward to the future is accompanied by gestures, respectively pointing behind oneself or ahead (Cienki & Müller, 2008; Núñez & Sweetser, 2006). Aside from their communicative function, such gestures also facilitate the expression of thought (e.g., McNeill, 1992), and they influence cognition (e.g., Goldin-Meadow & Beilock, 2010). These considerations led to a novel line of inquiry connecting spatial hand–arm movements (HAMs) and the spatial grounding of time in order to examine the influence of systematically controlled HAMs upon the perceived temporal distance to events.

Although the spatial grounding of time (Lakoff & Johnson, 1999) can be noted in the everyday language we use when talking about time (Boroditsky, 2000; Boroditsky & Gaby, 2010; Boroditsky & Ramscar, 2002; Casasanto & Boroditsky, 2008; Matlock, Ramscar, & Boroditsky, 2005), its directionality seems to be influenced by writing direction (e.g., Boroditsky, 2001, 2011; Boroditsky, Fuhrman, & McCormick, 2011; Chan & Bergen, 2005). For example, whereas English speakers were faster in classifying events as having occurred “earlier” by pressing a left compared to a right response key, Hebrew speakers—writing from right to left—were faster in classifying earlier events with a right compared to a left response key (Fuhrman & Boroditsky, 2010). In line with these findings, a study on the relation between writing direction and classifying auditory presented time-related words found that responses of Spanish and English participants (left-to-right writing cultures) were faster to past (future) words with the left (right) hand, whereas the opposite held for Hebrew participants (Ouellet, Santiago, Israeli, & Gabay, 2010). Moreover, categorization of past and future words is faster when the key to be pressed and the position of the words on the screen are congruent with the left-to-right timeline (Santiago, Lupiáñez, Pérez, & Funes, 2007). Another study found that activating past or future words primes attention and motor responses to the left and right, respectively (Ouellet, Santiago, Funes, & Lupiáñez, 2010). HAMs may therefore both influence and reflect our spatial grounding of time.

In general, a spatial left-to-right mental timeline is thus commonly used in the West (Ouellet, Santiago, Israeli, & Gabay, 2010; Weger & Pratt, 2008), where “the left” is associated with earlier times and “the right” with later times. Hand–arm gestures accompanying speech about time reveal that this timeline is often used in one of two ways. One way is with the ego as a reference point, such that pointing to the left (right) refers to the past (future). Another manner to use the left-to-right timeline is without the ego as a reference point. The position of events in time are then expressed relative to one another, such that earlier (later) events

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are referred to by pointing more toward the left (right; Cooperrider & Núñez, 2009). In line with the use of the mental timeline with reference to the ego, Casasanto and Jasmin (in press) have observed that when participants were speaking about past events, they spontaneously gestured more to the left compared to when they were speaking about future events. Additionally, the influence of gestures on thinking, and the gestural expression of abstract as well as spatial concepts, are well documented (e.g., Alibali, 2005; Goldin-Meadow & Beilock, 2010; Kinsbourne, 2006).

HAMs Can Influence Perceived Temporal Distance

The research reviewed above leads cumulatively to the conclusion that if participants' HAMs were controlled such that if they were making left HAMs while thinking of an event from memory, then the event should feel temporally more distant compared to when they make right HAMs.¹

Although this general conclusion may be derived from the research cited above, there are three plausible accounts embedded in this general observation. The first is that it is not the movement per se but the *spatial position* of the movement relative to the body, namely with the ego as the reference point. So, it is possible that a movement on the left side of the body results in events being perceived as more distant and the reverse for performing HAMs on the right of the body. The second account is that it is HAMs with the left or right *hand* that may be responsible. Finally, the third possibility is that the *goal* of the movement is an important anchor for perceived temporal distance, such that movements with a left (right) directionality lead to events being perceived as more distant (close).

In order to be able to differentiate between these three alternatives, we designed an experiment whereby left HAMs and right HAMs were varied across three factors in order to disentangle the influence of (a) the spatial position, namely the side on which HAMs are performed (on the left vs. the right side of the participant); (b) the hand with which HAMs are performed (with the left vs. the right hand); and (c) the goal of movement of HAMs (toward the left vs. toward the right) on the perceived temporal distance to an event.

We conducted an experiment in which we experimentally controlled HAMs to examine whether they systematically influence the perceived temporal distance to an event. HAMs were manipulated by asking participants to manually move marbles from one box into a second box (cf. Casasanto & Dijkstra, 2010). Congruency with the concept of "left is an earlier moment in time, and right is a later moment in time" in spatial position, hand, and goal of movement was controlled for as between-subjects variables with two levels in each case. This resulted in an experiment with spatial position (left vs. right), hand (left vs. right), and goal (left vs. right) as the three between-subjects variables.

Participants were asked to retrieve an event from memory. After retrieving the event from memory, participants were asked to move the marbles manually from one box into a second box repeatedly for 3 min. They performed this marble-moving task while keeping the event in mind and were subsequently asked to indicate how temporally close or distant they felt to the event they had retrieved.

Method

Participants

One hundred ninety-two students (137 female, 55 male; $M_{\text{age}} = 21.33$, $SD = 2.96$) participated in this experiment. Five participants were excluded from analysis beforehand, as they failed to retrieve an event from memory with the specified temporal distance, and one participant was excluded, as he did not follow the instructions.

Independent Variables

Time of past event was controlled by asking the participants to retrieve an event from memory that had occurred a year ago. To induce HAMs, we asked participants to move marbles from one box to a second box. There were always three boxes present: one positioned to the left, one directly in front, and one to the right of the participant. Only two boxes were assigned in each condition, one containing marbles and the other being empty. Participants had to move one marble at a time from the box that contained marbles into the empty box. They heard a beep every 3 s, which was their signal to move a marble. The same movement was carried out during three 1-min rounds, resulting in a total of 60 HAMs per participant:

- Factor 1: Spatial position of movement: Participants had to move marbles either on their left side (moving marbles between the left and center box) or their right side (moving marbles between the center and right box).
- Factor 2: Hand used to produce the movement: Participants had to carry out the marble moving-task either with their left hand or with their right hand.
- Factor 3: Goal of movement: Participants had to move marbles either to the left (e.g., from the center box to the left box, or from the right box to the center box) or to the right (e.g., from the left box to the center box, or from the center box to the right box).

This resulted in a full factorial design with the above three factors as between-subjects variables.

Dependent Variable

The perceived temporal distance to the event was assessed by asking "How far in time do you feel the event that you described is?" (1 = *very close*, 9 = *very far*) and "How long ago does it feel that this event took place?" (1 = *shorter than in actuality*, 9 = *longer than in actuality*). These two measures were correlated ($r = .61$, $p < .001$), and were averaged to form one score for perceived temporal distance (1 = *very close*, 9 = *very distant*).

Procedure

After introducing the general background, participants were asked to retrieve an event from memory that was approximately a

¹ The judgment of perceived temporal distance to an event after producing HAMs should be classified as a retrospective temporal judgment (e.g., Block & Zakay, 1997) because participants were not aware that they had to make temporal judgments about the event prior to retrieving the event from memory and prior to engaging in left or right HAMs.

year old. They were also asked to write down the day, month, and year on which the retrieved event occurred. Subsequently, participants carried out the marble-moving task while keeping the event in mind. After completing this task, the two questions of perceived temporal distance were assessed. Participants then rated the event on five 9-point scales measuring various features of the event (*emotionality, importance, valence, vividness, and degree of rehearsal* of the event, adapted from Semin & Smith, 1999) to assess possible qualitative differences between the retrieved events.

Results

Manipulation Check

The event retrieval manipulation was successful. The retrieved events were approximately a year old ($M_{\text{days}} = 369.10$, $SD = 21.81$).

Perceived Temporal Distance

To check whether any of the qualitative features of events retrieved from memory revealed a systematic effect as a function of HAMS, we performed a multivariate analysis of variance with spatial position (left vs. right), hand (left vs. right), and goal (left vs. right) as the three between-subjects variables and emotionality, importance, valence, vividness, and degree of rehearsal as the dependent variables. This revealed that these features did not differ as a function of side, hand, and goal of movement (all $F_s < 2.06$). The main prediction that producing left (right) HAMS while keeping an event in mind would increase (decrease) the perceived temporal distance to the event was analyzed in a $2 \times 2 \times 2$ analysis of variance, with spatial position (left vs. right), hand (left vs. right), and goal of movement (left vs. right) as between-subjects factors. This analysis revealed a main effect for spatial position, $F(1, 184) = 7.84$, $p = .006$, $\eta_p^2 = .034$. In line with expectations, producing HAMS on the left side increased the felt distance to the retrieved event ($M = 5.51$, $SD = 1.98$) compared to producing HAMS on the right side ($M = 4.82$, $SD = 2.04$). A main effect of hand was also found, $F(1, 184) = 4.32$, $p = .04$, $\eta_p^2 = .023$, revealing that using the left hand to produce HAMS increased the felt distance to the retrieved event ($M = 5.52$, $SD = 2.10$) compared to using the right hand to produce HAMS ($M = 4.90$, $SD = 1.94$). There was no effect of goal of movement, nor were there any interactions.

This indicates that in line with the concept of “left is an earlier moment in time, and right is a later moment in time,” making HAMS on the left spatial position as well as making them with one’s left hand can make an event feel more distant compared to making HAMS on the right spatial position and with the right hand.

To further explore this effect, we carried out a linear trend analysis with spatial position and hand as factors. Because the reported three-way analysis of variance showed that spatial position had a somewhat stronger effect than hand, spatial position was chosen as the main factor in determining the congruency with “left is an earlier moment in time, and right is a later moment in time,” with hand being the additional factor. This leads to the following four combinations of the two factors: (a) both spatial position and hand are left (most congruent with “left is earlier”), (b) spatial position is left and hand is right (less congruent with “left is earlier”), (c) spatial position is right and hand is left (more congruent with “right is later”), and (d) both spatial position and hand are right (most congruent with “right is later”). The linear effect

was significant, $t(188) = 2.92$, $p = .004$, Cohen’s $d = 0.43$, whereas both the quadratic and cubic effect were not (both $t_s < 1$).

These findings reveal that when spatial position and hand used are congruent with each other in producing HAMS (i.e., left–left vs. right–right), then the highest difference reveals; participants in the left spatial position–left hand condition judged the event to feel the furthest in time ($M = 5.88$, $SD = 2.13$), and participants who produced HAMS in the right spatial position–right hand condition judged the event to feel the closest ($M = 4.50$, $SD = 2.03$), with the two other conditions—left spatial position–right hand ($M = 5.22$, $SD = 1.81$) and right spatial position–left hand ($M = 5.06$, $SD = 2.03$)—falling precisely in between.

Discussion

The experiment reported here was designed as a contribution to elucidate the relationship between the grounding of time, space, and gestures by examining the effect of time-referent HAMS on the retrospective memory judgments and temporal anchors for those judgments. The experiment revealed that time-referent HAMS influenced the perceived temporal distance to events. Producing HAMS on the left (right) spatial position with the left (right) hand while thinking about a past event increased (decreased) the perceived temporal distance to the event.

To our knowledge, this is the first time that a systematic analysis of the differential contribution of spatial position, hand, and movement goal on retrospective memory judgments and temporal anchors for those judgments has been examined. The present findings suggest that the left-to-right spatial representation of time in the West (Boroditsky, 2000, 2001, 2011; Boroditsky & Ramscar, 2002; Casasanto & Boroditsky, 2008; Matlock et al., 2005) is integrally represented and that the perceived temporal distance to events is influenced by left or right HAMS that map and prime corresponding temporal anchors and references.

Our findings are clearly in line with the idea of the left being associated with an earlier point in time and the right with a later point. The results support the argument that the mental timeline is constituted by the vertical body axis of left and right with the ego in the middle. The division of space to left and right with reference to the ego constitutes the constraint within which HAMS congruent with the spatial position influence the temporal anchoring of the same event. Thus, left HAMS to the left side of the vertical body axis move the felt temporal anchor of the event further to the past, whereas right HAMS to the right side of the vertical body axis move the felt temporal anchor of the event to a closer point in time.

Interestingly, the goal of the movement did not produce any systematic effects. This provides some support for the argument that the ego serves as a reference point of the mental timeline. If the goal of the HAMS was a driving factor, then one should have observed movements to the right (left) to induce a closer (more distant) perceived temporal distance to the event in time, irrespective of which hand was performing the movement and on which side of the body the movement was. This in fact turns out to be not the case. The goal of HAMS shows no main effect or higher order ones.

One may raise the argument that the valence implied by the spatial position involved in movements provides a possible alternative account for the results reported here. Research on the body specificity hypothesis has shown that right-handed people are more likely to associate the right horizontal space with positivity

and the left horizontal space with negativity (e.g., Casasanto, 2009). Independently, earlier research (e.g., Ross & Wilson, 2002; Semin & Smith, 1999; Wilson & Ross, 2001) has revealed that negative events retrieved from memory are anchored earlier in time than positive events.

If the left horizontal space is associated with negativity and the right horizontal space with positivity for right-handed people (e.g., Casasanto, 2009), as our participants were, then it is possible to argue that left HAMS induce negativity and thus shift the anchor of the event further away, whereas right HAMS induce positivity and shift the anchor of the event closer. However, our data show that there are no systematic differences in valence for the retrieved events. Moreover, the events were retrieved prior to HAMS. We therefore think that this account is implausible and that the present findings are best explained by conceptual metaphors about time that rely on spatial references and support the general view that the spatial grounding of time facilitates our understanding and processing of time.

Although time-referent gestures have been observed, experimentally controlled HAMS have never been shown to influence perceived temporal anchors of events. This contribution opens ways to examine which temporal anchors can be shifted in a variety of everyday contexts, as well as issues related to their generalizability across cultures where it is known that the timeline is the reverse or orthogonal to the Western left–right timeline.

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