Shaping Time: Conceptualizations of Time through Shape Metaphors

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Abstract

Previous research has shown that people represent the abstract concept of time by constructing metaphoric mappings from the more concrete domain of space. Earlier studies have revealed that different spatial metaphorical mapping systems are employed when people think about time (e.g., front/back, ego-moving/time-moving). However, it is possible that the abstract concept of time is also represented by means of shape metaphors. Two experiments investigated this possibility. The results extend previous findings and suggest that the use of shape metaphors in language influences participants' representations of the abstract concept of time.

Keywords: conceptual metaphors; time metaphors; language and thought; embodiment.

Spatial Metaphors and the Concept of Time

Recent research on the acquisition of abstract concepts has shown that people construct such concepts through metaphorical mappings from domains grounded in the individual's experience (Boroditsky, 2000; Gentner, 2001; Gentner & Grudin, 1985; Pecher & Zwaan, 2005; see also, Barsalou & Weimer-Hastings, 2005; Glenberg & Kaschak, 2002; Whitrow, 1972). A series of studies on the perception of the abstract domain of time has shown that the concept of time acquires its structure through metaphorical mappings in language from the domain of space. Gentner and Imai (1992), for example, investigated the psychological status of two putatively critical space → time metaphorical mapping systems, namely the *ego-moving* metaphor and the *time-moving* metaphor (see Lakoff & Johnson, 1980). In the first system the observer is perceived to move through time toward the future. In contrast, in the second system time is conceived as an array of events that the observer witnesses moving from the future to the past. Gentner and Imai explored the different aspects of spatial (e.g., front/back) metaphors that people employ to represent time within the two systems. Their experiments confirmed the psychological reality of these metaphors and suggested that spatial metaphoric language may provide a platform for situating the abstract concept of time.

In accordance with these findings, Boroditsky (2001) provided evidence that differences in space → time metaphors between different languages (e.g., the future lies *ahead* of us, we left the bad times *behind* us) reflect differences in the perception of time that depend on the type of language used. Specifically, English speakers conceive time as placed on a horizontal axis, whereas Mandarin speakers conceive time as placed on a vertical axis, a distinction that is evident in the words that members of each of the two linguistic communities use to talk about time concepts.

Furthermore, Gentner, Imai, and Boroditsky (2002) found that, consistent with the *ego-moving* versus *time-moving* metaphor distinction, people employ these two metaphors when making judgments about time, both in experimental and naturalistic settings (e.g., a busy airport). Boroditsky and Ramscar (2002; see also Matlock, Ramscar, & Boroditsky, 2005) extended those findings by showing that people's experience of space may alter the time metaphor that they employ and subsequently influence their judgments about abstract time questions. For instance, if people were waiting in a lunch line for several minutes (and, thus, moving through space toward a destination), they were more likely to employ the ego-moving time metaphor. When subsequently asked the ambiguous question "*Next Wednesday's meeting has been moved forward two days. What day is the meeting now that it has been rescheduled?*" they were more likely to say that the meeting had been moved to Friday than Monday. Conversely, people who were waiting for someone to arrive at the airport (and, thus, were standing still in space while someone was moving toward them) were more likely to employ the time-moving metaphor and respond Monday to the same question.

So far, research on the acquisition of the abstract concept of time has focused on the differences in representation dependent on the activation of either the ego-moving or the time-moving metaphorical mapping systems. If, as the earlier studies suggest, the hypothesis holds true that the abstract domain of time draws upon the more concrete domain of space, it could be the case that other types of visuo-spatial metaphorical systems that are situated in the individual's experience are involved in the representation of the abstract domain of time. Specifically, the present paper offers the possibility that certain aspects of the concept of time may be represented through shape metaphors. In particular, two experiments aimed to investigate whether the use of metaphorical language that employs shape-related

information to describe time concepts would influence participants' active representations of those concepts. It was hypothesized that, if the abstract concept of time is grounded on more concrete domains of experience, then different shape metaphors should bias participants' representation of time concepts toward the type of shape employed by a given metaphor. Furthermore, research focused on the grounding of cognition in action (e.g., Barsalou, 1999; Barsalou & Weimer-Hastings, 2005; Pecher & Zwaan, 2005; Zwaan, 1999a, 1999b; Zwaan, Stanfield, & Yaxley, 2002) suggests that when people represent concepts they perceptually simulate those concepts based on their experience. If time is indeed structured through the domain of shape, one would expect individuals to experience time by mentally simulating the shapes of objects dependent on the shape metaphors used in language.

Experiment 1

The aim of Experiment 1 was to investigate whether people conceptualize and spontaneously represent time by employing either linear or circular shapes, dependent on the use of linear or circular shape metaphors in language. It was hypothesized that participants who were primed with a linear metaphor to describe the time concept of a year would tend to depict this concept predominantly linearly in their pictorial representations, relative to participants who were primed with a circular metaphor to describe the same time concept and who were expected to depict this concept predominantly circularly.

Method

Participants Sixty (N = 60) Temple University undergraduates (17 males, mean age 20.87 yrs) participated in this study for course credit. Participants were randomly assigned in one of two experimental conditions: (1) Linear time metaphor (n = 31) and (2) Circular time metaphor (n = 29).

Materials A target task incorporated in a brief questionnaire among a variety of filler tasks was used. In the target task, participants are given a sentence referring to the duration of an event by using either a linear time metaphor or a circular time metaphor. In this task, participants are asked to describe the sentence to someone who does not speak English by drawing a picture (see Table 1). Participants are also asked to indicate which word of the sentence corresponds to which part of the picture that they will draw. The target task was randomly presented among four filler tasks: (a) an alternative uses generation task (modified from Christensen & Guilford, 1958; see Chrysikou, in press) in which participants were asked to provide three alternative uses for three items (*shoe*, *button*, *key*); (b) a variation of the Wason Selection Task (Griggs & Cox, 1982); (c) a free word association task (modified from Christensen & Guilford, 1958; see Chrysikou, in press); and (d) an analytical problem (the *Socks* problem, Weisberg, 1995). Given that the nature of the filler tasks was unrelated to that of the experimental task, none of the filler tasks was expected to impose any contextual effects on the performance of participants on the experimental task.

Table 1: Target task for Experiment 1 by condition

Condition	Sentence
1. Linear time metaphor	*Jack is playing tennis all year long.*
2. Circular time metaphor	*Jack is playing tennis all year round.*

Procedure The questionnaires, including consent forms and the target task – which was randomly presented among the four filler tasks – were distributed to participants during regular lecture time. Participants were asked to read the instructions carefully before they started working on the tasks. Participants were also asked to work on the tasks on their own and not to discuss information related to the tasks with their classmates during the experimental session. Once any questions were answered, participants had 15 minutes to complete the tasks. After the 15 minutes had elapsed the experimenter collected the questionnaires and debriefed the class regarding the purposes of the study.

Results and Discussion

Coding Participants' responses on the target task were collected and coded for the presence of prevailing linear or circular representations of the time concept of a year. The responses of two participants, both from the linear time metaphor condition, were excluded from any analyses as a result of participants' failure to comply with the experimental instructions; this resulted in a total of 58 participants (29 per condition). The pictures participants drew for the target task were scanned and converted in black-and-white JPEG format and any identifying features of each participant's condition (i.e., the presence of the words *long* or *round*) were eliminated to allow for blind coding. Two independent raters then coded all pictures on five measures intended to capture whether the participant used a prevailing linear or circular representation for the time concept of a year. Given that a year can be represented either in terms of months or in terms of seasons, the pictures were also coded for the presence of the calendar or for the presence of the four seasons. The measures were as follows:

1. Linear representation prevailing
2. Circular representation prevailing
3. Combined linear and circular representation prevailing
4. Presence of a calendar
5. Presence of the four seasons[1]

The representation of months in a calendar follows a predominantly linear pattern (e.g., the written names of the

[1] Measures 1, 2, and 3 are mutually exclusive and exhaustive categories.

months in a year follow the rules of written language from left to right). As a result, the presence of a calendar was considered as indicative of a linear representation of the concept of the year. However, the four seasons can be represented either linearly or circularly (e.g., a cycle of depicted seasons) or with a combination of linear and circular representations. Consequently, to be able to code participants' pictures as conveying a linear or circular patterns (for participants who represented the year by using the four seasons), responses were also coded on the following measures:

1. Circular representation of seasons
2. Z-shaped representation of seasons[2]
3. Linear representation of seasons

Inter-rater reliability (Pearson's r) ranged from $r = .70$ to $r = .85$. Any differences between the two raters were resolved in conference. The agreed combination of the coding of both raters was used for further statistical analysis.

Analysis A series of chi-square comparisons was employed to examine differences between the two groups. It was hypothesized that if people represent time through the concrete domain of shape participants in the linear time metaphor condition would be influenced by the sentence *all year long* and consequently represent the concept of a year by employing more linear than circular representations. In contrast, participants in the circular time metaphor condition were expected to be influenced by the sentence *all year round* and represent the concept of the year by employing more circular than linear representations in their designs.

According to the results of Experiment 1 (see Table 2) participants in the linear time metaphor condition used significantly more linear representations for the concept of a year relative to participants in the circular time metaphor condition ($\chi^2[1, N = 58] = 4.55$, $p = .03$, $\varphi = .28$). In contrast, participants in the circular time metaphor condition used more circular representations for the concept of a year relative to participants in the linear time metaphor condition, however, this difference was marginally significant ($\chi^2[1, N = 58] = 3.84$, $p = .05$, $\varphi = .26$). There was no difference between the two conditions regarding the number of participants who employed a combined linear and circular representation, ($\chi^2[1, N = 58] = .22$, $p = .64$, $\varphi = .06$). Finally, there was no difference between the two conditions regarding the presence of a calendar ($\chi^2[1, N = 58] = .32$, $p = .57$, $\varphi = .07$) or the presence of the four seasons ($\chi^2[1, N = 58] = .29$, $p = .59$, $\varphi = .07$) in participants' designs.

Table 2: Percent of participants' representations of the time concept of a year by condition for Experiment 1

Measures	Condition 1: Linear time metaphor	Condition 2: Circular time metaphor
Linear representation prevailing	.72	.45
Circular representation prevailing	.21	.45
Combined linear and circular representation	.07	.10
Presence of a calendar	.35	.28
Presence of the four seasons	.59	.66

Among participants who employed the four seasons in their responses to represent the concept of the year there were no differences with respect to the circular, Z-shaped, or linear representation of the seasons between the two conditions ($\chi^2[1, N = 35] < 2.50$, $p > .12$, $\varphi = .27$).

It should be noted that participants within the linear time metaphor condition were more likely to represent the year with linear relative to any other type of shape representations ($p = .02$, two-tailed binomial test) and less likely overall to employ circular representations in their designs ($p < .01$, two-tailed binomial test). In contrast, participants within the circular time metaphor condition were equally likely to employ circular or other types of shape representations ($p = .71$, two-tailed binomial test).

The results of Experiment 1 suggest that, in accordance with the experimental hypothesis, participants were indeed influenced by the type of shape metaphor used in language when thinking about the abstract concept of time. Specifically, between two sentences that are used similarly in language to refer to the duration of a year participants were more likely to represent the concept of the year linearly than circularly when primed with the linear time metaphor (i.e., *all year long*). Furthermore, even though the differences were marginally significant, the results suggest that participants tend to represent the concept of the year circularly than linearly when faced with the circular time metaphor (i.e., *all year round*). Finally, from the types of representations employed among participants within each condition, the results of Experiment 1 suggest that linear shape metaphors may have stronger effects with respect to influencing participants' representations of time, relative to circular shape metaphors.

Experiment 2

The aim of Experiment 2 was to extend the findings of Experiment 1 regarding the use of shape metaphors in the representation of time concepts. Specifically, Experiment 2

[2] The Z-shaped representation of seasons was considered as indicative of a linear pattern.

examined whether people conceptualize and spontaneously represent the time concept of a year by employing two different metaphors, namely either whole or partial shapes, dependent on the use of corresponding shape-related metaphors in language.

It was hypothesized that participants who were primed with a partial metaphor to describe the time concept of a year would depict this concept by dividing either linear or circular shapes in their pictorial representations; there was no reason to expect that participants would be biased toward either a linear or circular representation of time based on the type of metaphor used. In contrast, relative to participants who were primed with a partial metaphor, participants in the holistic metaphor condition were expected to be influenced in their representations toward circular shapes and depict the same time concept predominantly circularly. Furthermore, it was possible that participants in both conditions would employ mathematical symbols to depict half a year (e.g., *½*) or the whole year (e.g., *365*). Accordingly, Experiment 2 investigated the presence of any differences between the two conditions regarding the use of such abstract symbols to represent time, dependent on the type of metaphor used.

Method

Participants Seventy one (N = 71) Temple University undergraduates (18 males, mean age 22.57 yrs) participated in this study for course credit. Participants were randomly assigned in one of two experimental conditions: (1) Partial time metaphor (n = 36) and (2) Holistic time metaphor (n = 35).

Materials A target task incorporated in a brief questionnaire among a variety of filler tasks was used. The filler tasks were the same as in Experiment 1. In the target task, participants are given a sentence referring to the duration of an event using either a holistic shape metaphor or a partial shape metaphor. Participants are asked to describe the sentence to someone who does not speak English by drawing a picture (see Table 3). Participants are also asked to indicate which word of the sentence corresponds to which part of the picture that they will draw.

Table 3: Target task for Experiment 2 by condition

Condition	Sentence
1. Partial time metaphor	*Jack is playing tennis half of the year.*
2. Holistic time metaphor	*Jack is playing tennis the whole year.*

Procedure The procedure was the same as in Experiment 1.

Results and Discussion

Coding Similar to Experiment 1, participants' responses on the target task were collected and coded for the presence of prevailing linear or circular representations of the time concept of a year. The responses of five participants, two from the partial metaphor condition and three from the holistic metaphor condition were excluded from any analyses as a result of participants' failure to comply with the experimental instructions, resulting in a total of 66 participants (34 for condition 1 and 32 for condition 2). The pictures participants drew for the target task were scanned and converted in black-and-white JPEG format and any identifying features of each participant's condition (i.e., the presence of the words *half* or *whole*) were eliminated to allow for blind coding. Two independent raters then coded all pictures on six measures intended to capture whether the participant used a prevailing linear or circular representation for the time concept of a year, as well as to examine the use of mathematical symbols in the two conditions. The measures were as follows:

1. Linear representation prevailing
2. Circular representation prevailing
3. Combined linear and circular representation prevailing
4. Presence of a calendar
5. Presence of the four seasons
6. Presence of mathematical symbols[3]

Following the rationale of Experiment 1, for participants who represented the year by using the four seasons, responses were also coded on the following measures:

1. Circular representation of seasons
2. Z-shaped representation of seasons
3. Linear representation of seasons

Inter-rater reliability (Pearson's r) ranged from r = .76 to r = .82. Any differences between the two raters were resolved in conference. The agreed combination of the coding of both raters was used for further statistical analysis.

Analysis Chi-square comparisons were employed to examine differences between the two groups. It was hypothesized that participants in the partial shape metaphor condition would represent the concept of a year by employing either linear or circular representations. In contrast, participants in the holistic shape metaphor condition were expected to be influenced by the sentence *the whole year* and represent the concept of the year by employing more circular than linear representations.

According the results of Experiment 2 (see Table 4) participants in the partial time metaphor condition did not use significantly more linear than circular representations for the concept of the year relative to the holistic time metaphor condition ($\chi^2[1, N = 66] = .92$, $p = .34$, $\varphi = .12$). In contrast, participants in the holistic time metaphor condition employed significantly more circular than linear representations for the concept of the year relative to participants in the partial time metaphor condition ($\chi^2[1, N = 66] = 4.80$, $p = .03$, $\varphi = .27$). There was no difference between the two conditions regarding the number of

[3] Measures 1, 2, and 3 are mutually exclusive and exhaustive categories.

participants who employed a combined linear and circular representation, (χ^2[1, N = 66] = .34, p = .56, φ = .07). Similarly, there was no difference regarding the presence of a calendar in the responses of participants between the two conditions (χ^2[1, N = 66] = .56, p = .46, φ = .09). The difference between the two conditions with respect to the presence of the four seasons in participants' designs was only marginally significant (χ^2[1, N = 66] = 3.03, p = .08, φ = .21). Finally, with reference to the use of mathematical symbols, participants in the partial time metaphor condition employed significantly more mathematical symbols in their representations relative to participants in the holistic time metaphor condition (χ^2[1, N = 66] = 20.22, p < .001, φ = .55).

Table 4: Percent of participants' representations of the time concept of a year by condition for Experiment 2

Measures	Condition 1: Partial time metaphor	Condition 2: Holistic time metaphor
Linear representation prevailing	.65	.53
Circular representation prevailing	.18	.34
Combined linear and circular representation	.17	.13
Presence of a calendar	.53	.44
Presence of the four seasons	.24	.44
Presence of mathematical symbols	.71	.16

Similar to Experiment 1, among participants who employed the four seasons in their responses to represent the concept of the year there were no differences with respect to the circular, Z-shaped, or linear representation of the seasons between the two conditions (χ^2[1, N = 19] < 2.50, p > .13, φ = .27).

It should be noted that within the partial metaphor condition participants were less inclined to use circular representations relative to other shapes (p < .01, two-tailed binomial test), less inclined to employ the four seasons in their representations (p < .01, two-tailed binomial test), but more inclined to use mathematical symbols (p = .02, two-tailed binomial test). In contrast, within the holistic metaphor condition participants tended to employ more circular representations, but this difference was not significant (p = .11, two-tailed binomial test). They were less likely, however, to use mathematical symbols in their designs (p < .01, two-tailed binomial test).

In sum, the results of Experiment 2 showed that, in accordance with the experimental hypothesis, participants in the holistic shape metaphor condition were influenced by the holistic metaphor used and did employ circular shapes to represent time significantly more than participants in the partial shape metaphor condition. In addition, the results of Experiment 2 suggest that the partial metaphor increases the likelihood that participants will employ abstract mathematical symbols to represent time, whereas the holistic metaphor biases participants toward the use of shapes as opposed to mathematical symbols.

General Discussion

The present paper argued that metaphorical systems based on a linear domain of space may not be the only ones involved in the representation of the abstract concept of time. The results of the two experiments presented suggest that the abstract domain of time may be structured through the use of shape metaphors in language. In particular, Experiment 1 showed that the use of linear or circular metaphors influences participants' representations of the time concept of a year: The presence of a linear metaphor increases the likelihood that the year will be depicted more linearly than circularly, and vice versa. It should be noted that the linear metaphor seems to elicit stronger effects relative to the circular metaphor when people represent the time concept of a year. Finally, there seemed to be no difference regarding participants' use of a calendar or the four seasons in their representations between the two conditions.

Experiment 2 investigated the effects of partial and holistic shape-related metaphors on participants' representations of time. Similar to Experiment 1, the results are indicative of the implication of shape metaphors in the construction of the abstract domain of time. Specifically, participants in the holistic metaphor condition were more likely to employ circular metaphors relative to participants in the partial metaphor condition.

Overall, the results of both experiments complement and extend the findings of previous studies regarding the use of concrete domains of experience to represent the abstract concept of time (Boroditsky, 2000, 2001; Boroditsky & Ramscar, 2002; Gentner & Imai, 1992; Gentner et al., 2002) by suggesting that shape metaphors in language are implicated in the representation of time concepts. Further research should address whether the effects reported in the present paper would also be observed for other time concepts and whether there are differences in the use and significance of specific spatial or shape metaphors among the different units of the abstract concept of time (e.g. day, week, month).

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