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Brief article

Representation over time: The effects of temporal distance on similarity ☆

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Abstract

Similarity is central in human cognition, playing a role in a wide range of cognitive processes. In three studies, we demonstrate that subjective similarity may change as a function of temporal distance, with some events seeming more similar when considered in the near future, while others increase in similarity as temporal distance increases. Given the ubiquity of inter-temporal thought, and the fundamental role of similarity, these results have important implications for cognition in general.

Keywords: Similarity; Mental representation; Construal level theory; Inter-temporal choice

1. Introduction

Similarity is a foundational component of human cognition. For example, responses to new stimuli are a function of their similarity to prior examples (e.g., Shepard, 1987); similarity is a fundamental Gestalt grouping principle

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(Wertheimer, 1923/1958); similarity plays a vital role in memory (e.g., Hintzman, 1984), affecting everything from problem solving (Ross, 1984) to text comprehension (Myers & O'Brien, 1998); theories of categorization rely heavily on the concept of similarity (e.g., Medin & Schaffer, 1978); and similarity is proposed to be fundamental in inferencing, knowledge generalization, and knowledge transfer (e.g., Novick, 1988; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990; Ross, 1984). Yet similarity can be quite variable, across both people and situations. For instance, differences in domain knowledge can lead to important differences in perceived similarity (e.g., Chi, Feltovich, & Glaser, 1981; Gentner & Rattermann, 1991), as can changes in the comparison context (e.g., Medin, Goldstone, & Gentner, 1993).

But what about simply changing the distance in time – for instance, whether two things are considered in the near or distant future? Given how frequently and effortlessly we switch between thinking about the present, the past, and the future, it seems at first glance unlikely that such a minor difference could affect something as fundamental – and far-reaching – as similarity. When we look forward to skiing and ice skating next winter, could these events really seem more similar in May than in November?

One recent line of research suggests that distance in time may have a systematic influence on construal. Specifically, there is evidence that temporally distant events and entities are represented in a more abstract, less concrete way than those that are nearer in time (Trope & Liberman, 2003). For instance, when asked to describe an event such as "reading a book," individuals tend to use much more abstract descriptions when the event is considered in the distant future (e.g., "broadening my horizons") than the near future (e.g., "flipping pages"; Liberman & Trope, 1998). It is possible that these differences in representational content may indeed have an impact on perceived similarity. In the current studies, we explore this possibility.

1.1. Construal level theory

Construal level theory (Trope & Liberman, 2003; Liberman & Trope, 1998) proposes that events in the distant future are likely to be construed primarily in terms of their abstract, central, goal-related features. Conversely, representations of events that are closer to the present are likely to contain more concrete, contextual information. These are referred to as *high-level* and *low-level* construals, respectively.

A variety of research has provided evidence for this theory. For instance, one study (Liberman & Trope, 1998) asked participants to rate their likelihood of attending a particular lecture, which could vary both in terms of its topic (presumably a high-level attribute) and the convenience of its scheduling (a more contextual feature). Consistent with predictions, participants' responses gave relatively more weight to the abstract attribute of topic – and less weight to the low-level attribute of convenience – when the lecture was described as taking place in the distant future. Other research has found evidence for temporal

effects on construal in such diverse domains as monetary gambles (Sagristano, Trope, & Liberman, 2002) and behavior attribution (Nussbaum, Trope, & Liberman, 2003).

Trope, Liberman, and colleagues interpret these effects as reflecting changes in perceived "psychological distance". Consistent with this interpretation, more recent studies have reported similar effects from relative spatial distance (Henderson, Fujita, Trope, & Liberman, 2006), social distance (Bar-Anan, Liberman, & Trope, 2006), and even the metaphorical distance implied by probability (Wakslak, Trope, Liberman, & Alony, 2006).

2. Experiments

In three studies, we explore the possibility that the subjective similarity between two events may be influenced by the temporal distance at which they are considered. Specifically, we predict that similarity judgments for two events in the distant future will be driven primarily by their abstract commonalities and differences; for events in the nearer future, concrete features should receive more weight.

For instance, consider an individuals representation of visiting a dentist's office. This could include fairly high-level information pertaining to conscientiousness and long-term health benefits, as well as more concrete situational information about the particular setting and sensations involved. Now consider two different events to which this situation could be compared: the act of joining a health club, or the act of getting a tattoo. The first event seems to share important abstract characteristics with the dentist visit (the goal of health benefits, etc.), but appears quite different in terms of the situation-specific details. The tattoo, on the other hand, shares a surprising number of low-level, concrete features (reclining chair, needles, physical discomfort), but very few high-level commonalities. Now consider the effects that temporal distance would have on these commonalities and differences. By highlighting the more abstract information and de-emphasizing the concrete features, greater temporal distance should tend to increase the perceived similarity between the dentist and health club events, since the commonalities shared by those events are largely abstract. Conversely, the dentist and tattoo events should seem most similar in the very near future, where concrete and contextual information is highlighted and abstract features are given less weight.

The materials for the present studies all follow this basic structure, varying the abstractness or concreteness of the commonalities between two events, and varying the temporal distance at which they are described. The first study establishes the basic predicted effect. Study 2 replicates these results, and additionally explores any effects of the temporal distance *between* events. Study 3 extends these results by exploring similarity changes for events described in the past.

3. Study 1

This study assessed the effects of temporal distance on perceived similarity. Participants rated the similarity of events sharing either abstract or concrete attributes, which were described in either the near or the distant future.

3.1. Methods

3.1.1. Participants

Twenty-three undergraduate students participated in this study for partial course credit.

3.1.2. Materials and procedure

The materials for this experiment consisted of sentence pairs describing two events that a fictitious character was planning to undertake. Each test item included a *standard* sentence, and one of two *comparison* sentences. These comparison sentences were constructed to share either high-level or low-level commonalities with the standard, but not both. In addition to these test items, the material set included several filler sentence pairs, which were either *literally similar*, sharing both high- and low-level features, or *non-similar*, sharing neither.

Approximately half of the participants ($n = 12$) viewed events described as taking place in the near future (e.g., ''this week''); the other participants ($n = 11$) viewed temporally distant events (''next year''). Commonality level served as a repeated-measures factor: half of the standards were randomly paired with high-level comparison sentences, and half with low. Thus, the experiment was a 2 (temporal distance: Close vs. Distant future) $\times$ 2 (commonality level: High vs. Low pairing) mixed design.

Ten test items (five at each commonality level) and 13 filler items were presented in a completely randomized order, with the exception that all participants were given the same two initial items (fillers, one literally similar and one non-similar) to help ''anchor'' their similarity ratings and reduce variability. Additionally, sentence order was randomized for each pair. A typical test item might read as follows: ''Tomorrow, Karen will go to the dentist. Tomorrow she also will join a health club.'' Sample materials are given in Table 1.

The experiment was implemented as a computer-based task. After instructions, the first sentence pair appeared on the screen, followed by the prompt ''How similar do you think these activities are to each other?'' Beneath this prompt was a horizontal bar, with endpoints labeled ''very dissimilar'' and ''very similar''. Participants were instructed to click a location on this bar to indicate their perception of the similarity of the two events. This response was converted to a continuous value between 0 and 1, for the ''dissimilar'' and ''similar'' endpoints, respectively (reflecting the relative location of the click). To ensure that participants were attending to the task, response latencies of less than 3 s for any item resulted in the warning ''Too Fast'' appearing on the screen, followed by a delay of several seconds before proceeding to the subsequent item.

Table 1
Sample events

Event Standard	Low-level comparison	High-level comparison
Reading and coding completed research questionnaires	Doing taxes	Conducting telephone surveys
Going door-to-door distributing leaflets about the environment	Going trick-or-treating with daughter	Writing letters to congressmen and local council members
Going to the dentist	Getting a tattoo	Joining a health club
Buying diamond necklace for wife	Buying expensive watch for self	Taking wife out for gourmet meal
Calling colleges requesting information packets	Calling hotels to arrange summer trip to Mexico	Taking the SAT

Low-level comparison sentences were designed to share concrete features and procedures with the standard, while high-level comparisons share more abstract commonalities.

3.2. Results and discussion

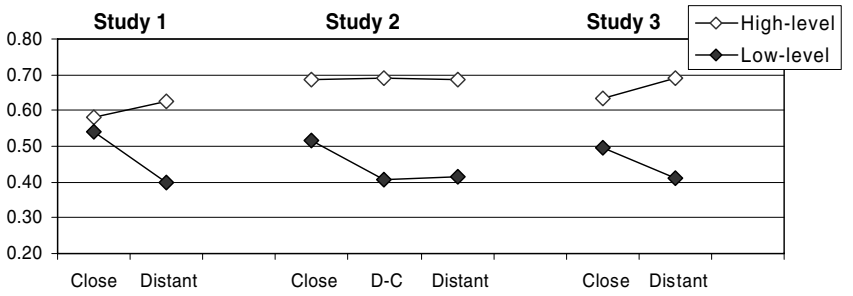
Consistent with predictions, a 2×2 ANOVA revealed an interaction between temporal distance and commonality level, $F(1,21) = 8.60$, $p < .01$. Participants rated high-level pairs as more similar in the distant condition ($M = 0.63$, $SD = 0.11$) than in the Close condition ($M = 0.58$, $SD = 0.10$). Conversely, low-level pairs were rated as more similar in the close condition ($M = 0.54$, $SD = 0.10$) than in the distant condition ($M = 0.40$, $SD = 0.09$). This interaction was also significant using items as a random factor ($F(1,18) = 7.77$, $p = .012$).

A main effect of commonality level was also observed. Participants rated high-level pairs as more similar ($M = 0.60, SD = 0.11$) than low-level pairs ($M = 0.47, SD = 0.12$) overall, $F(1,21) = 18.84$, $p < .001$, $\eta_p^2 = .48$[1]. Additionally, there was a marginal trend for participants to rate Close events as more similar than Distant events ($p = .092$). This last trend is attributable to the larger decrease in similarity for low-level comparisons over temporal distance than the corresponding increase for high-level pairs. In fact, post-hoc t-tests indicated that only the low-level comparisons changed significantly across temporal distances ($t(1,21) = 3.71$, $p < .01$, $\eta_p^2 = .40$).

The most relevant result is the interaction between temporal distance and the type of information that the events had in common. Participants judged event pairs sharing abstract, high-level commonalities to be more similar when described in the distant future than the near future, while pairs sharing more concrete and low-level commonalities showed the opposite pattern. Temporal distance appears to be affecting perceived similarity in a way consistent with the differential highlighting of concrete and abstract content. The two observed main effects, while not predicted, are consistent with prior research showing a preference for relational over "surface" similarity (e.g., Gentner, Rattermann, & Forbus, 1993).

[1] Partial eta-squared (η_p^2) approximates the proportion of variance explained by the contrast of interest. Cohen (1977) tentatively interprets η_p^2s of .02, .13, and .26 as small, medium, and large effects, respectively.

3.3. Results



4. Study 2

The results so far are consistent with the hypothesis that subjective similarity may be influenced by the temporal distance from the present. However, the first study has a potentially important confound: namely, two events that are both near to the present are also necessarily near to one another, while this is not the case for events in the distant future. It is therefore possible that the observed effects are being driven by the relative distance between the events themselves. For instance, consideration of events that are closer together may lead to a focus on how those activities would be coordinated with one another, which would only then lead to greater consideration of their more concrete, contextual details. Additionally, research has shown that participation in a common schema may increase similarity ratings (e.g., raising the similarity between "knife" and "peanut butter"; Jones & Love, in press; Wisniewski & Bassok, 1999). Considering activities that are near to one another in time may be having a related effect.

Study 2 explores this possibility by including a condition with distant future events that are explicitly temporally close to one another. If this condition's results mirror those for the near future condition, it would imply that the distance between events, rather than their distance from the present, is the critical factor behind these effects. If, on the other hand, the pattern of results resembles those observed for construals of distant events without explicit inter-event information, it would provide evidence for representational differences based on distance from the present, as predicted.

4.1. Methods

4.1.1. Participants

Fifty-nine undergraduate students participated in this study for partial course credit.

4.1.2. Materials and procedure

The materials and procedure for this study were identical to those of Study 1, but a third between-subjects condition was added to the design. In addition to the Close ($n = 20$) and Distant ($n = 20$) future conditions, Study 2 included a condition describing events that were temporally distant from the present, but explicitly close in time to each other. For example, participants might read "Next year, Karen plans to go to the dentist. That same day next year, she also plans to get a tattoo." This is referred to as the D–C (Distant–Close) condition ($n = 19$). As in the first two studies, participants rated the similarity of the described events, and were warned if a response was made too quickly.

4.2. Results and discussion

A 3×2 omnibus ANOVA revealed a marginally significant interaction between temporal distance and commonality level, $F(2, 56) = 2.82$, $p = .068$, $\eta_p^2 = .09$. As in prior research, a large main effect of commonality level was also observed, $F(1, 56) = 125.62$, $p < .01$, $\eta_p^2 = .69$.

The tests of primary interest in this study were the comparisons between the individual conditions. A difference score was calculated for each participant by subtracting average similarity ratings for low-level pairs from average ratings for high-level pairs. Independent sample t-tests performed on these scores therefore reflect the interaction between commonality level and temporal distance. A comparison between the Close and Distant conditions revealed a significant difference, replicating our previous findings, $t(1, 37) = 2.09$, $p < .05$, $\eta_p^2 = .10$ (across items, $F(1, 18) = 9.61$, $p < .01$). The novel question for this study was whether the D–C condition would more closely resemble the Distant or the Close condition. Tests showed the D–C condition to be significantly different from the Close condition (t $(1, 37) = 2.16$, $p < .05$, $\eta_p^2 = .11$), but not different from the Distant condition (t $(1, 37) < 1$) (this pattern also held across items). In fact, the pattern of results in the D–C and Distant conditions were nearly identical (.41 and .42 for low-level pairs, .69 and .69 for high-level), while the Close condition displayed a markedly different pattern (.52 for low-level pairs, .69 for high-level). This finding supports the suggestion that the effects observed in Study 1 were the result of the events' temporal distance from the present, not of their distance from one another. The results suggest that when events are described as taking place in the distant future – even when they are explicitly described as near to each other – participants tend to focus on their abstract rather than concrete attributes. As in Study 1, post-hoc tests showed that only the low-level comparisons changed reliably between temporal distances ($t(1, 39) = 2.46$, $p < .05$). In fact, ratings for the high-level pairs in Study 2 were identical in the near and distant future – in contrast to the first study, these items received uniformly high ratings. As noted, this is consistent with prior evidence showing a general preference for relational similarity; however, it remains unclear why this pattern differed from the identical conditions in Study 1.

5. Study 3

Finally, we explored whether similarity may be affected by distance in the past rather than future. Surprisingly, changes in the construal of prior events have received very little attention (though see Bar-Anan et al., 2006). Given that many of the cognitive phenomena that are influenced by similarity involve representations of prior experience (recall, categorization, knowledge generalization), this is a particularly interesting question for our purposes.

5.1. Methods

5.1.1. Participants

Forty-three undergraduate students participated in this study for partial course credit.

5.1.2. Materials and procedure

The materials and procedure were identical to those of Experiment 1, except each event was described as having taken place in the recent ($n = 21$) or distant ($n = 22$) past (e.g., "this week" or "last year"). For example, a typical test item might read "This week, Sara took the SAT. This week she also called several colleges to request information packets."

5.2. Results and discussion

A 2×2 ANOVA revealed an interaction between temporal distance and commonality level, $F(1,41) = 6.01$, $p < .05$, $\eta_p^2 = .13$ (across items, $F = 8.87$, $p < .01$). Consistent with predictions, participants rated high-level pairs as more similar in the Distant condition ($M = 0.69$, $SD = 0.09$) than in the Close condition ($M = 0.63$, $SD = 0.16$). Conversely, low-level pairs were rated as more similar in the Close condition ($M = 0.50$, $SD = 0.18$) than in the Distant condition ($M = 0.41$, $SD = 0.14$). (Although both high- and low-level pairs changed in the predicted direction, neither effect was significant on its own). Again, a main effect of commonality level was observed. Participants rated high-level pairs as more similar ($M = 0.66$, $SD = 0.13$) than low-level pairs ($M = 0.45$, $SD = 0.17$) overall, $F(1,41) = 53.06$, $p < .001$, $\eta_p^2 = .56$.

6. General discussion

Participants tend to judge event pairs with abstract, high-level commonalities to be more similar at greater temporal distances, but pairs sharing more concrete and low-level features show the opposite pattern. These results generalize to events occurring in the recent and distant past, and appear to depend specifically upon the events' distance from the present, rather than on the distance between events.

One interesting question involves the underlying reason for these temporal differences. Trope and Liberman (2003) argue that they represent a general heuristic, an association reflecting years of experience about what kinds of information are available or useful at different distances in time. Another possible interpretation involves a kind of "conservative generalization," in which people believe that closer events are more likely to be similar to recent experiences, and are therefore willing to make richer, more detailed inferences about them.

In addition to simply extending prior finding of temporal construal effects, the fact that similarity ratings necessarily involve the assessment of two representations simultaneously can lead to some interesting additional effects. For instance, although the predicted interactions were found in all cases, the differences only reached significance for the low-level pairs (Studies 1 and 2). Trends for the high-level pairs tended to be smaller, and in one case (Study 2), these ratings did not differ between conditions. Based on previous findings (e.g., Gentner et al., 1993), we believe that the comparison process itself may be preferentially highlighting these more abstract commonalities in all conditions, overshadowing some of the temporally based differences.

Another way in which multiple cases may affect processing is by inviting readers to construct a coherent narrative from the materials, through the generation of casual inferences (e.g., Trabasso & van den Broek, 1985) or integration into existing scripts (e.g., Shank & Abelson, 1977). Together with prior work on the role of temporal information on the comprehension of narrative text (e.g., Zwaan, 1996), this suggests an interesting link between the current research and the literature on text and discourse processing.

7. Conclusions

One of the hallmarks of human cognition is the ability to think outside of the current moment, and a large portion of mental life is devoted to considering and preparing for the future, and remembering and reconstructing the past. By altering the way that we gauge similarity, such differences in temporal framing may have a significant and far-reaching effect on cognition. For instance, episodes may be classified differently, influencing the inferences and attributions that we make. We are likely to make different kinds of generalizations from examples. There may be changes in which experiences from our past seem relevant and applicable to our current situation. Given the ubiquity of inter-temporal thought, even small changes in areas such as these are likely to have a profound impact.

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