A 'sweet spot' for creative ideation: Non-linear associations between semantic distance and creativity

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Abstract

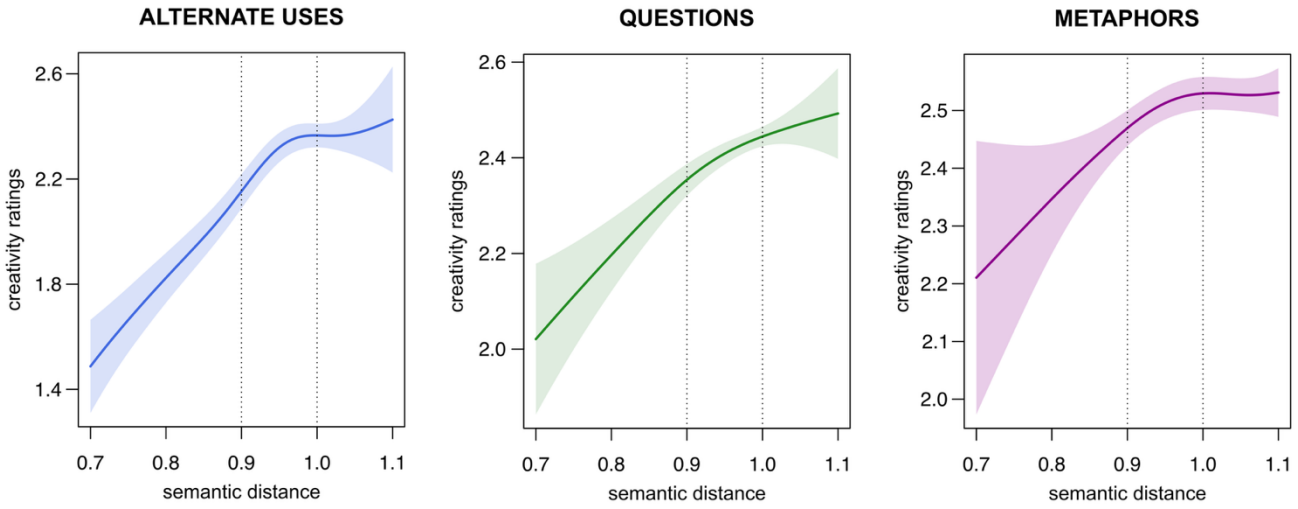
Creativity researchers have sought to standardize idea assessment via computational measures of semantic distance: the degree of conceptual dissimilarity between words. The relationship between semantic distance and creativity has traditionally been described using linear models, with the embedded assumption that as semantic distance increases, so does the creative quality of ideas. However, informal observations would suggest that distant associations may sometimes become too incoherent or nonsensical to be considered creative. Using generalized additive models (GAMs), we explored the non-linear nature of this relationship across three divergent thinking tasks: alternate uses, question asking, and metaphor generation. Our results revealed a consistent pattern: human ratings of creativity increased with semantic distance up to a certain threshold (between 0.9 – 1), after which point, additional semantic distance does not translate into more subjectively creative ideas. These findings provide a more nuanced understanding of the interplay between semantic distance and creativity, suggesting a potential "sweet spot" for semantic distance in creative ideation.

Keywords: Creativity; Divergent Thinking; Generalized Additive Models; Semantic Distance

Background

Creativity has been defined as the production of ideas that are both novel and useful within a given context (Amabile, 1983). A central aspect of creativity, particularly in creative idea generation, involves divergent thinking—the capacity to generate multiple ideas or solutions in response to an open-ended prompt. One of the core mechanisms thought to underlie divergent thinking is semantic distance, defined as the conceptual dissimilarity between a prompt (e.g., "generate original uses for a brick") and response (e.g., "flowerpot"). Greater semantic distance is typically associated with higher creativity, as it reflects the capacity to link more disparate domains. Semantic distance has been operationalized using computational models that quantify how conceptually similar or dissimilar two ideas are, often using word embeddings and other machine learning-based approaches (Beaty & Johnson, 2021). Empirical research has consistently found that semantic distance is a strong predictor of creativity across a range of divergent thinking tasks (Beaty et al., 2022; Orwig et al., 2024). Traditionally, this association has been described via linear models, which assume creativity monotonically increases as semantic distance goes up. Here, we suggest that the role of semantic distance in creative ideation may not be so straightforward, and by relaxing this assumption of linearity we may more accurately characterize the nuances of this relationship.

To characterize the relationship between semantic distance and creativity, the present study employed generalized additive models (GAMs). In the context of creativity research, GAMs provide a flexible approach for examining how semantic distance influences creativity across different divergent thinking tasks, without assuming a strictly linear relationship. By including spline functions, GAMs provide data-driven visualization of how creativity changes across varying levels of semantic distance. This approach allowed us to identify potential thresholds beyond which additional semantic distance no longer contributes positively to creative quality. The present study applies GAMs to examine non-linear relationships between semantic distance and creativity across three types of divergent thinking tasks to better understand the optimal conditions for creative ideation. This research has been previously published and can be read in full (Orwig et al., 2025).



Methods

Sample. In this study we analyzed data from published research, including three measures of divergent thinking: the alternate uses task, question asking task, metaphor generation task. The datasets contained prompt-response pairs with semantic distance scores and subjective creativity ratings (Beaty et al., 2022; DiStefano et al., 2024; Raz et al., 2023). Our final sample contained 3,448 responses for the alternate uses task, 2,430 responses for the question asking task, and 4,376 responses for the metaphor generation task.

Creativity Scoring. Responses to all three tasks were scored for their creativity according to the subjective scoring method (Silvia et al., 2008). Across all tasks, raters evaluated responses on a 5-point scale (ranging from 1 = "not at all creative" to 5 = "very creative"), which was then averaged across raters to provide an overall creativity score.

Semantic Distance. We followed the method first described by Beaty & Johnson (2021) to compute semantic distance scores. Semantic distance was calculated separately for each response by determining the inverse cosine similarity between the vector embeddings for the cue and response. Higher semantic distance values indicate more conceptual dissimilarity between the content of the cue and the response; lower values indicate semantic similarity.

Results

Across all three tasks, GAMs revealed significant non-linear relationships between semantic distance and creativity. This pattern suggests that greater semantic distance is beneficial, up to an optimal range that balances novelty and coherence. Specifically, we found that creativity ratings increased with semantic distance up to a threshold of 0.9–1; after this point more semantic distance didn't translate into more creative ideas. By modeling this relationship using GAMs, our study identifies a domain-general threshold beyond which increased semantic distance no longer enhances subjective creativity. Our findings indicate that while moderate semantic distance fosters novel and meaningful associations, extreme distance may hinder creativity by producing ideas that lack coherence or relevance.

Discussion

Our findings challenge the view that greater semantic distance always leads to higher creativity. This observation suggests that there is a 'sweet spot' for semantic distance in creative ideation: a range where associations are novel enough to be original but not so distant that they become incoherent. The present study adapts a data-driven modeling approach to characterize the relationship between semantic distance and creativity and highlights the need for creativity models to account for relative trade-offs between novelty and usefulness.

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