Comparing the Likelihood of Producing Distant Analogs Through Retrieval versus Invention

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Abstract

Research has long shown that retrieving semantically distant analogs from long-term memory is difficult, whereas retrieving near analogs is relatively easy, a limitation viewed as a major constraint on cross-domain transfer. An alternative route may lie in the invention of analogs. We report two experiments comparing the effects of surface similarity on analog retrieval and analog invention. In Experiment 1, using a production paradigm, participants were presented with simple events drawn from familiar schemas. In the retrieval condition, they recalled analogous events; in the invention condition, they generated them. Results showed that retrieving distant analogs was difficult, whereas inventing them was relatively easy. Experiment 2 replicated this pattern using materials with larger and more complex relational structures and a hybrid paradigm that controlled the availability of intra- and inter-domain analogs in memory, while enabling clearer discrimination between retrieved and invented analogs.

Keywords: analogy; invention; retrieval; similarity

Introduction

The capacity to draw analogies constitutes a central ability of human cognition (Hofstadter & Sander, 2013; Gentner & Maravilla, 2018; Holyoak, 2025) and underpins a wide range of cognitive activities (Gentner et al., 2001). Analogies are comparisons in which two situations (the *base* and the *target* analogs) share isomorphic systems of similar relations, regardless of whether the entities aligned in the comparison are similar (Gentner, 1983, 1989; Holyoak & Thagard, 1989, 1995).

There is broad consensus, supported by extensive empirical evidence (see Loewenstein, 2010; Trench & Minervino, 2020, for reviews), that retrieving interdomain base analogs from long-term memory (LTM) is very unlikely. This likelihood increases when the person has encoded the base and/or the target in terms of the same abstract schema, but this facilitation tends to disappear when near analogs are available and compete with distant ones (Gentner et al., 2009; Olguín et al., 2022; Raynal et al., 2026).

In contrast, analogs from the same domain are retrieved much more frequently and do not require the abstraction of the shared schema. While this retrieval bias does not pose a problem in cases where intradomain analogs are available and useful (e.g., when *predicting* an outcome for a target based on what happened in a similar situation), there are several tasks in which access to distant analogs becomes necessary. This may occur, for example, when the goal is to explain an unfamiliar concept by relating it to one that is more familiar to the audience (Gray & Holyoak, 2021; Olguín et al., 2017), or to support an argument by re-representing the target topic from a novel perspective drawn from a distant thematic field (Blanchette & Dunbar, 2001; Gentner & Wolff, 2000).

Fortunately, not all analogical tasks require retrieving interdomain analogs from LTM: in many cases, useful analogs can be constructed ad hoc. Gentner and Maravilla (2018) describe a distant analog in which someone compared forcing Microsoft to include Java in Windows as an antitrust remedy to requiring a Coke six-pack to include a Pepsi. Suppose now that the Coke episode had actually occurred and that a person knew about it. As noted above, retrieving such an episode would be highly unlikely. The central question of the present study is therefore whether inventing a distant analog, such as the Coke example, is more likely than retrieving it. We are not concerned with comparing the relative effort or complexity of retrieval and invention themselves. Rather, the relevant question is whether people produce more distant analogies through retrieval or invention. It is also important to note that this distinction does not involve "pure" processes: remembering includes reconstructive operations such as inference and completion, whereas invention depends partly on the recombination of episodic and semantic memories. Still, despite this overlap, the two processes appear to leave distinguishable linguistic traces, phenomenological features, and cognitive and neural signatures (Addis et al., 2009; Sap et al., 2020, 2022; Schacter et al., 2007; Johnson et al., 1993).

To address the paper's central question, we must consider the extra demands involved in constructing a distant analog compared with fabricating a near analog, and whether these demands may lead to fewer distant than near analogs being produced. To our knowledge, analog invention has not been studied within the analogical reasoning literature. Gentner (1989) characterized it as a case of "pure projection," whereby the relational structure of a base is projected onto a target domain in a manner analogous to inference generation: base relations are copied or replaced by similar ones, and entity slots are filled with appropriate target entities. Inventing an analog seems to require more than selecting a system of relations to project. It also requires preserving the semantic dependencies among the elements of that structure, since, for example, changing one entity often entails coordinated changes in other entities and relations (Minervino et al., 2025). Consider the Microsoft example again. Once its structural schema has been identified, the inventor must find a new company, a

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corresponding competitor, and a product of that competitor that can plausibly be incorporated into the company's own offering. A central difficulty in analog invention may lie in failing to detect or preserve some of them, thereby producing partial breakdowns of analogical relatedness (a retrieved analog must satisfy the same requisites, and the difficulty resides in finding it in the vast ocean of LTM).

Here's a near analog for the Microsoft target: Apple was obligated to include Google's Android compatibility layer within the iOS operating system. In terms of effort, at least, it seems less demanding to remain within the same domain than working in a distant one (as in the Microsoft-Coke case), since the relations and semantic dependencies will need to be changed to a lesser extent when entities are preserved. However, the fact that the invention of distant analogs may involve more effort than the fabrication of near ones does not necessarily imply that the goal is less likely to be achieved. Just to illustrate, Chesebrough et al. (2023) found that analogical reasoning can elicit insight moments when it requires individuals to expand their initial conceptual representation of a relation. In their experiments, participants were presented with verbal analogies in the form A:B :: C:D, followed by the addition of a third pair. When this third pair was conceptually close, the initial relational interpretation remained relatively stable. However, when the third pair was more distant, participants had to reformulate the concept underlying the analogy. This representational change led to more frequent reports of "aha!" experiences. This might lead us to think that inventing distant analogs is more difficult than inventing close ones. However, although expansive analogies were experienced as more difficult, this greater subjective difficulty was not accompanied by evidence of poorer objective performance. Thus, we might expect that inventing distant analogs need not be less likely than inventing close analogs. This idea is consistent with the well-established finding that generating adequate inferences is equally possible for distant and near target analogs (Holyoak et al., 1994). The question is whether this reasoning can be extended to cases in which the relevant structure to be projected is not a single base relation but a relational structure of varying complexity.

As noted above, the abstract schema instantiated by an analog is not typically generalized spontaneously, making distant analogs unlikely to be retrieved from memory (Raynal and Sander, 2025). However, findings from analogical problem solving suggest that inventing a second base or target analog can facilitate subsequent interdomain transfer (Bernardo, 2001; Minervino et al., 2017). This effect has been attributed to the fact that invention directs attention to the relational structure of the original analog, so that less attention is consequently paid to the specific entities that instantiate that structure (Gentner et al., 2009). In this way, invention may free the reasoner to generate content from a different domain.

So far, we have considered several reasons why the likelihood of inventing distant analogs might be expected to be higher than the likelihood of retrieving them. However, some findings from the cognitive approach to creativity may be discouraging in this regard. Those studies indicate that additional factors may constrain the tendency to depart from the original domain during analog invention. One such factor is the *conformity effect* (see Sifonis & Ward, 2017, for a review), whereby individuals rely on exemplars of a category when generating novel instances. Evidence for this effect has been documented across a wide range of creative tasks, including the generation of novel category members, problem-solving strategies, and new words (e.g., Binks et al., 1999; Landau & Lehr, 2004; Marsh et al., 1997; Smith et al., 1993; Ward, 1994). A central question, however, is whether similar constraints apply to the invention of analogical stories. Our hypothesis is that, whereas in the case of concepts there may be resistance to extending a category to instances that deviate from the category prototype, a story used as the basis for inventing another may not be interpreted as a prototype from which one should not depart. Instead, individuals may be able to identify the structural aspects that preserve analogical relatedness while allowing greater freedom to instantiate that structure with novel contents.

In the first experiment of this study, we sought to determine the relative difficulty of retrieving versus inventing interdomain analogs. To this end, participants were presented with simple everyday events that constitute cases of familiar schemas. In the retrieval condition, they were asked to recall analogous situations they had previously experienced, whereas in the invention condition, they were instructed to invent analogous situations.

Experiment 1

Method

Participants. A total of 132 undergraduate psychology students participated in the study (M = 24.78, SD = 8.14; 73.48% identified as female). Participants were randomly assigned to one of two conditions: invention (n = 54) or retrieval (n = 78). All participants provided informed consent.

Design. The experiment employed a between-subjects experimental design with one independent variable: task type (invention vs. retrieval). The dependent variables were (a) the proportion of analogs generated and (b) the domain of the generated analogs (intradomain vs. interdomain).

Materials and Procedure. Eight target analogs were constructed (see Table 1). These described simple everyday events and instantiated familiar schemas (e.g., temporary fix). For example, one described a person placing a piece of cardboard between the floor and a table leg in order to stabilize it.

The tasks were administered individually, online, via Google Forms. Two versions of the form were created: one for the retrieval group and one for the invention group. The first screen of each form presented the informed consent and sociodemographic questions. On the second screen,

participants were informed that an analogy is a comparison in which two situations share an abstract conceptual pattern, regardless of surface differences. Two examples of analogy were presented, matched in structural complexity to the target analogs: one intradomain and one interdomain.

In the retrieval condition, participants were told: "Below, you will be presented with a series of everyday events. For each one, you should try to recall an analogous situation you have experienced and describe it." They were emphatically told that their responses should correspond to real autobiographical episodes and to avoid inventing stories. Each target analog was presented on a separate screen, followed by a text box in which participants described the recalled episode. After each reported event, participants answered three follow-up questions probing episodic details: the location where the event occurred, the time at which it took place, and a more detailed description of the episode. Participants were informed that, after the study, the experimenters might further probe some episodes selected at random to verify the veracity of the reported events.

In the invention condition, participants were told "Below, you will be presented with a series of everyday events. For each one, you should try to invent an analogous situation and describe it." They were instructed to avoid, by all means, reporting real events experienced by themselves or others. Each target analog was presented on a separate screen, followed by a text box in which participants described the invented episode. Following the space for reporting each invented analog, participants answered the same follow-up questions as those in the retrieval condition, imagining that someone was asking them to provide further details about the invented event. In both conditions, participants were told that if they were unable to recall or invent (according to the condition) an analogous episode, they were to proceed to the next event. The order of presentation of the analogs was randomized for each participant. No time limits were imposed.

Table 1: Examples of materials used in Experiment 1

Familiar schema	Target analog
Distraction error	Marisa mistakenly put hair gel on her toothbrush.
Untimely bad luck	Magdalena's computer shut down just as she was about to finish her assignment

Data Coding. Two independent judges were presented with a list containing the reported events and another with the schemas of the targets. They were asked to evaluate whether each event belonged to one of those schemas or to none of them. For example, given the target analog associated with the temporary fix schema, a participant responded "I fixed the arm of my glasses with adhesive tape." Judges were asked to determine whether the response constituted a member of one of the schemas on the list. Agreement between judges was 93%. Disagreements were resolved through open discussion.

To code the dependent variable analog domain (intra- vs. interdomain), a list of all reported analogical situations was compiled. Two independent judges evaluated whether each reported analog belonged to the same domain as the target analog. There are several possible criteria for determining whether two events belong to the same domain, including the analysis of the similarity between their matched entities (e.g., Gentner et al., 1993). In the present experiment, we followed the criterion used by Blanchette and Dunbar (2000). Domain membership was defined a priori by the authors of the present study. For example, for responses corresponding to the temporary fix target analog, judges determined whether the reported event belonged to the domain of household furniture or appliances. Interjudge agreement was 91%, and disagreements were resolved through open discussion.

Results and Discussion

For each participant, we calculated the proportion of analogs generated by dividing the number of analogs produced by the total number of target analogs presented (eight).

To directly test whether the effect of analog domain differed by task type, we fitted a binomial logistic model with Task Type, Analog Domain, and their interaction as predictors. The Task Type × Analog Domain interaction was significant, $B = 2.04$, $SE = .35$, Wald $\chi^2(1) = 34.47$, $p < .001$, $OR = 7.67$.

The mean proportion of analogs generated was higher in the invention group ($M = .80$, $SD = .17$) than in the retrieval group ($M = .69$, $SD = .19$), $t(130) = 3.45$, $p = .001$, $d = .61$ (see Figure 1).

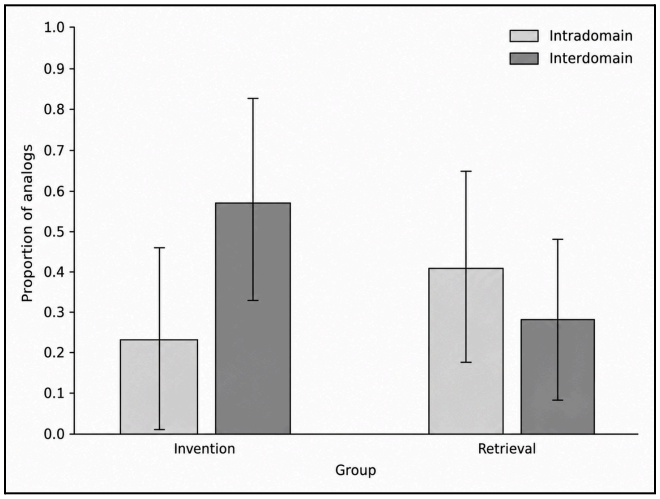

Figure 1: Proportion of analogs by semantic distance in each group

With respect to analog distance, for each participant, we calculated the proportion of intradomain and interdomain analogs relative to the total number of target analogs

presented (eight). In the invention group, the mean proportion of interdomain analogs (M = .57, SD = .25) was higher than the mean proportion of intradomain analogs (M = .23, SD = .22), $t(53) = 5.62$, $p < .001$, $d = 1.42$. In contrast, the retrieval group showed the opposite pattern: the mean proportion of intradomain analogs (M = .41, SD = .24) was higher than the mean proportion of interdomain analogs (M = .28, SD = .20), $t(77) = 2.85$, $p = .006$, $d = .58$, replicating the traditional pattern reported in studies of analogical retrieval.

As discussed in depth by Trench and Minervino (2015, 2020), the production paradigm used in this experiment has several methodological limitations. First, even if the data show that one type of retrieval, intra or interdomain, predominates over the other, this cannot be unambiguously attributed to a search bias in the cognitive system, since it may simply reflect the greater availability of one type of analog in memory. Second, despite the emphatic instructions participants received, it is never possible to determine whether a "retrieved" analog was largely invented, or whether an "invented" analog was largely retrieved.

The results obtained in Experiment 1 may also be partially explained by the relative simplicity of the events and schemas employed, which may have facilitated the invention of interdomain analogs. Just to exemplify with the temporary fix set, it is often sufficient to inspect the immediate environment to identify an object with a problem and imagine a provisional solution. For example, noticing that the hem of a pair of jeans is partially undone may prompt the idea of using a safety pin as a temporary fix. However, this kind of "random search" strategy cannot be applied to structures of substantial complexity. For instance, constructing a story analogous to the tumor problem and its convergent–divergent solution (Gick & Holyoak, 1980) cannot be achieved simply by looking at one's surroundings. In the second experiment, we aimed to determine whether the pattern of results observed in the first experiment generalizes to target analogs of substantially greater structural complexity, which do not correspond to events instantiating familiar schemas. To overcome the limitations of the production paradigm, we employed the hybrid paradigm (Trench & Minervino, 2015) applied to public events. We selected public events (e.g., the September 11 attacks and their consequences) that we assumed to be known to a large proportion of the population and derived for each of them one intradomain target analog and one interdomain target analog to be used in the retrieval condition. By presenting each participant with an equal number of intra and interdomain target analogs (two per condition), we assessed the influence of domain distance on retrieval. This method allows us to control for the initial equiprobability of retrieving intra and interdomain analog bases and to rule out invention in the retrieval group (if a person faithfully recounts the September 11 attacks, it is obvious that they retrieved it).

Experiment 2

Method

Participants. Initially, 237 undergraduate psychology students participated. They were randomly assigned to the retrieval group (n = 146) or the invention group (n = 91). To be included in the final sample, participants in the retrieval group were required to demonstrate sufficient knowledge of the four public base analogs whose retrieval was assessed. A large initial retrieval group sample was recruited in anticipation of substantial exclusions. The final sample consisted of 139 participants (M = 24.94, SD = 6.33, range = 19–49), with 65 in the retrieval group and 74 in the invention group. Of these, 58.3% identified as female. All participants provided informed consent.

Design. A between-subjects experimental design was used, with task type (retrieval vs. invention) as the independent variable. The dependent variables were: (a) number of analogs reported and (b) domain of the reported analogs (intradomain vs. interdomain).

Materials and Procedure. Six sets of materials were constructed, each consisting of one publicly known base analog and two constructed target analogs: one intradomain and one interdomain (see Table 2).

The target analogs shared the same abstract schema as the base event. However, the intradomain target pertains to the same or a very near domain as the base (e.g., behaviors during a pandemic), whereas the interdomain target concerns other domains (e.g., behaviors in the domain of species protection). As a consequence, the interdomain target differed in a large number of entities, which in many cases carry changes in the associated actions. Two distractor stories were constructed with structural complexity equivalent to that of the target analogs. They were only employed in the retrieval condition.

The experiment was administered online using Google Forms. The retrieval group form included four target analogs (two intradomain and two interdomain), along with two distractor stories for which no publicly known base analogs existed, presented in the second and third positions. Four out of the six target analogs were assigned to each participant in a counterbalanced manner, ensuring that all six were nearly equally represented across participants.

The invention group form was identical to the retrieval group form, except that it included only the six interdomain targets of the retrieval group. We selected these target analogs to avoid the highly probable retrieval of the public events themselves, which could have interfered with the invention task.

In both groups, the first screen presented the informed consent and sociodemographic questions. Participants then received the same explanation of the concept of analogy as in Experiment 1, accompanied by two examples matched in structural complexity to the target analogs: one intradomain and one interdomain.

In the retrieval condition, participants were told "Below, you will be presented with a series of simple, brief texts that you should read very carefully. After each one, you should

try to recall an analogous story that is publicly known." Each target analog was presented on a separate screen, followed by a space in which participants briefly reported the recalled event. Because a failure to retrieve an event can be interpreted as such only if the event was available in LTM, participants were asked after the experiment to indicate whether they were familiar with each public event. They then completed a five-item multiple-choice questionnaire for each base analog, including questions about both the event's abstract relational structure and its specific content details. Only participants who demonstrated adequate knowledge of all four public events whose retrieval was assessed were retained for analysis.

Table 2: Example of materials used in Experiment 2

Public base episode	Intradomain target analog	Interdomain target analog
During the COVID-19 pandemic, the Argentine president imposed a ban on social gatherings. Nevertheless, he celebrated his spouse's birthday and invited several people. Images of the event were later leaked on social media, generating public outrage and harming the president's public image.	Due to a chickenpox outbreak among children, the governor banned gatherings of children. However, she celebrated her child's first communion and brought together many classmates. Videos of the gathering later reached the press. This situation angered the public and damaged the governor's public image.	Due to the risk of extinction faced by beavers, the founder of an Animal Protection Association banned the hunting of these animals. However, the founder later participated in a forest expedition and hunted beavers. A journalistic article subsequently reported the hunting episode. This situation upset the public and damaged the founder's reputation.

The invention group form was identical to the retrieval group form in all respects except for task framing. Participants were told "Below, you will be presented with a series of simple, brief texts that you should read very carefully. After each one, your task will be to create an analogous story based on the one presented to you."

In both groups, participants were instructed to proceed to the next task if they were unable to recall or invent an analogous event. The order of task presentation was randomized for each participant (except for distractors in the retrieval group), and no time limits were imposed.

Data Coding. For the retrieval group, a story was considered previously known when the participant indicated familiarity with it and correctly answered at least four out of five questions for the corresponding base analog. As previously mentioned, only retrievals and non-retrievals from participants who met this criterion for all four base analogs whose retrieval was evaluated were included in the analyses (81 were excluded). Following the logic of the hybrid paradigm, reported events that were not the critical base analog selected by the experimenters were not counted.

For the invention group, participants who failed to respond to at least one task or showed clear evidence of misunderstanding the instructions were excluded from all analyses (17). For the remaining participants, a list was constructed containing: (a) the target analog presented by the experimenter along with its five structural features, and (b) the stories invented by participants for that target analog. Two independent judges awarded one point for each structural feature present in the invented story. A response was classified as analogical when it included four or more structural features. A feature was considered present only when both judges agreed. Initial interjudge agreement was 81%, with disagreements resolved through discussion.

The domain of the invented analogs (intradomain vs. interdomain) was coded by two different judges. They evaluated whether the invented analog belonged to a specific domain predefined by the experimenters as corresponding to the target (e.g., fauna and flora protection). Initial agreement was 92%, and disagreements were resolved through open discussion.

Results and Discussion

For each participant, we first calculated the overall proportion of generated analogs (retrieved or invented, depending on the condition) using the total number of target analogs presented as the denominator: four in the retrieval condition and six in the invention condition.

To directly test whether the effect of analog domain differed by task type, we fitted a binomial logistic model with Task Type, Analog Domain, and their interaction as predictors. The appropriate number of opportunities was used as the denominator for each domain and condition. The Task Type × Analog Domain interaction was significant, $B = 3.25$, $SE = .40$, Wald $\chi^2(1) = 66.45$, $p < .001$, $OR = 25.72$.

The mean proportion of analogs generated by the invention group ($M = .75$, $SD = .18$) was higher than that of the retrieval group ($M = .33$, $SD = .23$), $t(137) = 12.13$, $p < .001$, $d = 2.06$.

With respect to analog domain, proportions were computed according to the number of opportunities available for each domain. In the invention group, the mean proportion of interdomain analogs ($M = .55$, $SD = .25$) was higher than the mean proportion of intradomain analogs ($M = .20$, $SD = .26$), $t(73) = 6.46$, $p < .001$, $d = 1.40$. In contrast, in the retrieval group, where participants received two intradomain and two interdomain target analogs, the mean proportion of intradomain analogs ($M = .50$, $SD = .34$)

was higher than the mean proportion of interdomain analogs (M = .16, SD = .27), $t(64) = 6.72$, $p < .001$, $d = 1.10$, replicating the traditional superficial bias in analogical retrieval (see Figure 2).

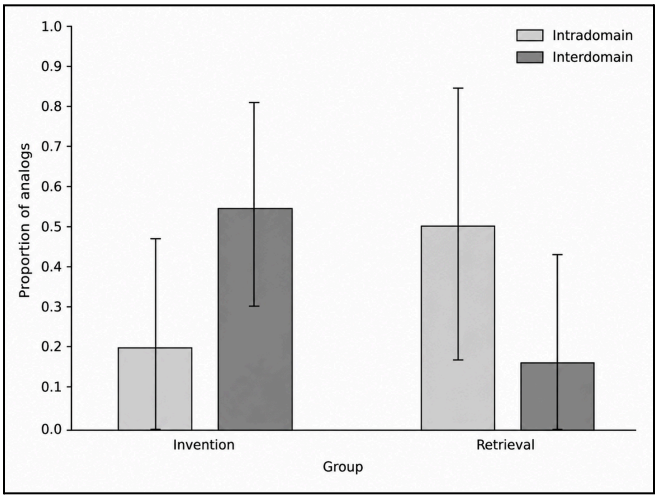

Figure 2: Proportion of analogs by semantic distance in each group

Overall, the pattern of results replicates that observed in Experiment 1: analog invention was associated with greater analog production and a higher proportion of interdomain analogs. In contrast, retrieval showed the traditional pattern, with a higher proportion of intradomain than interdomain analogs.

General Discussion

Across two experiments, we used the production paradigm (Experiment 1) and the hybrid paradigm (Experiment 2) to examine the number and type of retrieved and invented base analogs. The first experiment used simple events instantiating familiar schemas, whereas the second used more complex materials that did not instantiate familiar schemas. Both experiments yielded similar results: participants produced more invented analogs than retrieved analogs. On the other hand, in the invention groups, participants generated more distant than near analogs, while the retrieval groups showed the inverse pattern. While the first experiment assessed the retrieval of autobiographical events from episodic memory, the second replicated the finding with public events from collective memory.

The use of these naturalistic paradigms gives the study greater ecological validity than traditional reception paradigms, in which base analogs are provided by the experimenter and often lack the personal or real-world relevance of analogs acquired in everyday life (Dunbar, 2001; Hofstadter & Sander, 2013).

However, both naturalistic paradigms have some limitations. Although the hybrid paradigm overcomes some of the problems of the production paradigm (e.g., it allows one to determine that the cases reported in the retrieval condition were genuinely recalled rather than invented), it remains vulnerable to others. For example, in the hybrid paradigm, it is impossible to know which other analogs or surface matches compete with the base analog whose retrieval is being assessed. A marked-pool reception paradigm could address this limitation, but it would poorly capture retrieval as it occurs in natural contexts, where there is usually no episodic marking of a subset of LTM within which analogous situations must be searched, and where contextual change and temporal distance between the encoding of base and target analogs are the norm (Minervino & Trench, 2024).

Just as theoretical and computational models have been proposed to explain analog retrieval, the present study should be followed by research aimed at understanding the mechanisms involved in the invention of near and distant analogs. Such work should examine what kinds of memories are involved, what mechanisms organize retrieved information into newly constructed analogical events, the conditions under which analog invention becomes easier or harder, and how interventions might improve it. For example, in our experiments, participants were not instructed to invent one type of analog rather than another. As in prior work on retrieval (Trench et al., 2016), explicitly instructing participants to generate distant analogs could strengthen the natural tendency observed in the present experiments.

A further important question concerns when invented analogs, whether near or distant, are effective for different analogical tasks. Speculatively, for example, predicting the outcome of an economic plan may be best served by comparing it with a similar previous economic plan, whereas an invented distant analog may be especially useful for reductio ad absurdum arguments, as in the Coke example. The present findings offer encouraging news for the field of analogical thinking: in tasks for which distant analogs are useful, the difficult path of retrieving them from memory is not the only possible route.

Materials availability. The complete materials used in both experiments are available in: https://osf.io/ad6qf/overview?view_only=577c008990f14bd6b2ef0cd932fc86dc

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