

Are superficially dissimilar analogs better retrieved than superficially similar disanalog?

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Abstract

In the present study, we tested the assumption that structural similarity overcomes surface similarity in the retrieval of past events, by observing whether structural similarity alone is a better cue than surface similarity alone. To do so, in four story-recall experiments, we provided the participants with multiple source stories and then with a target cue story. This target cue only shared either surface or structural similarity with [the source stories](#). In Experiment 1A, a Superficially Similar Disanalog source story (SSD) and a Superficially Dissimilar Analog source story (SDA) were presented among Superficially Dissimilar Disanalog source stories (SDDs). A soundness rating task was used in Experiment 1B to control the absence of structural similarity among the SSDs presented in Experiment 1A. In Experiment 2, the number of SSDs was increased in the aim to reproduce more ecological conditions. In two further experiments, a five minutes (Experiment 3) [and a 45 minutes \(Experiment 4\) delay](#) was introduced, and supplementary source stories were presented, in order to make the study more similar to previous story-recall paradigms. The results of the [four](#) story-recall experiments support the dominance of structural over surface similarities in analogical retrieval. The role of a structurally-based access regarding the retrieval of Superficially Similar Analogs (SSAs) and SDAs is discussed, as well as the factors underlying the rare occurrence of SDAs retrievals in previous experiments.

Keywords: analogy, analogical retrieval, structural similarity, story-recall task, abstract encoding

1. Introduction

Analogies are crucial to take advantage of knowledge from our past experiences to make sense of new situations (Chalmers, French, & Hofstadter, 1992; Gentner, 1983; Gick & Holyoak, 1980). Determining the processes on which analogies rely and the conditions of their occurrence is of central importance to better understand the role that analogies have on our cognition. It has been proposed that the detection of abstract relational regularities across situations, at the heart of analogy-making, is made possible by a mapping process that is oriented rather toward abstract correspondence (termed structural similarity) than toward superficially close objects and their attributes (interchangeably termed surface or superficial similarity) (Goldstone, Medin, & Gentner, 1991; Gentner, Rattermann, & Forbus, 1993; Gick & Holyoak, 1980). **Imagine that** one is presented with a situation where a student has worked hard to get into a highly selective art school, but after her application was rejected, she claims to be relieved by the fact that she will not be joining such a narrow-minded school. Then, if one is asked to compare this situation with a Superficially Dissimilar Analog situation (SDA), predictions stemming from previous works about the mapping process would be that, he or she would notice structural overlap and bypass surface dissimilarities. For instance, this SDA could depict the story of a young man who has booked a table in a renowned restaurant. After running into a traffic jam, he arrives late and his reservation was given away; he finally says to his girlfriend that dining in such a soulless institution would **not have been** romantic. This situation does not have superficial matches with the first one since the objects are not taken from the same semantic domain: the surface features in the first situation are *a student, an art school, an application, the rejection of this application and the narrow-mindedness* of the school, whereas in the second one they are *a young man and his girlfriend, a restaurant, a*

reservation, the cancelation of this reservation and the soulless aspect of the restaurant. Still, correspondences are easily perceived: both situations exhibit common abstract relations since someone fails to achieve an intended goal and in consequence ends up denigrating it, just as in Aesope's *sour grapes* fable (Festinger, 1957).

However, two analog situations are hardly ever concurrently encountered in the real world. Thus, when facing a new situation, one must retrieve a familiar analog situation from Long Term Memory (LTM) in order to establish the mapping between the two situations. Studies focusing on the determinants of analogical retrieval have widely converged on a major effect of surface similarity, whereas the role played by structural similarity remains unclear (Gentner et al., 1993; Gick & Holyoak, 1980). In the present paper, we argue that studies which supposedly demonstrated the dominance of surface over structural similarity do not actually test the influence of surface similarity in the absence of structural similarity because [they include some](#) structural similarities among the Superficially Similar Disanalogues (SSDs). Following this proposal, the main purpose of this paper is to assess whether structural similarity overcomes surface similarity (the *structure dominance hypothesis*) when a fair competition is made possible by the isolation of the two types of similarities in different stimuli.

1. 1. The nature of encoding

[The kind of similarity driving retrieval is determined by the kind of features which are encoded during the presentation of the source and the target cue situations. Indeed, a representation containing the abstract features of a SDA has to be encoded so that these features can be used later as retrieval cues \(Hammond, Seifert, & Gray, 1991\). The critical role of encoding has been highlighted in analogical problem-solving experiments, where a solution has to be transferred from a source problem toward a target cue problem. In Gick and Holyoak's \(1980\) study, participants are presented with the source "General army problem",](#)

where a rebel general divides his army into small troops to attack a fortress surrounded by mines. Then, participants have to resolve the target cue “radiation problem” (Duncker, 1945), which involves a doctor who has to operate a stomach tumor with a powerful blast of radiation, but its use at high intensity would damage the healthy tissues in its way. In this condition, participants typically fail to notice the structural similarity (i.e. a force whose strength would suffice to achieve a goal would also harm elements that need to be preserved) to spontaneously transfer the convergence solution leading to realize that the doctor can point multiple low intensity rays at the tumor. Holyoak and Thagard (1995) pointed out that noticing the similarity between SDA situations would require to go beyond relational and object features which are specific to each situation, so as to encode the more abstract structure that they share. It was further demonstrated that one way that leads participants to detect abstract structures shared by a SDA source and a target cue problems is to invite them to map two SDA source problems (e.g. the "General army problem" and the “Fire chief problem”) before being presented with the target cue problem (e.g. the radiation problem) (Catrambone & Holyoak, 1989; Gick & Holyoak, 1983). The authors suggest that mapping two SDA source problems induces an abstract schema which will later mediate analogical retrieval.

Holyoak (2012) has suggested that schemas are often encoded throughout experience out of the experimental context. The influence of such schemas in the interpretation of abstract structures has been demonstrated by Bassok, Wu and Olseth (1995). They found that participants who have learned to use a formula to compute the probability that a subset of objects would be paired with a subset of people (e.g. some specific *computers* attributed to some specific *secretaries*) were dramatically better at applying this formula to SDA problems where objects were also assigned to people (e.g. *prizes* attributed to *students*) rather than where people were assigned to objects (e.g. *students* attributed to *prizes*). More specifically, participants kept on assigning objects to people even when the inverse had now to be done.

The authors suggested that participants interpreted the assignment of objects to people in the trained problem through the familiar *get* relation, in a way that led them to also link objects and people of the test problem to, respectively, the received and the receivers role. Hence, schemas stored in memory seem to be involved in the encoding of structural features. Other studies have shown that pre-experimental abstract knowledge can allow participants to encode abstract structures. According to Novick (1988), participants failure to transfer the solution when faced with the radiation problem may be due to their lack of expertise concerning the target domain. She demonstrated that experts in mathematics performed significantly better than novices in transferring solutions between SDA mathematical problems. The interpretation was that experts did not only encode surface information about the problems as did novices, but their representation also included abstract structural features. Similar interpretations were drawn by Chi, Feltovich and Glaser (1981), who demonstrated that experts in physics tend to categorize physics problems on the basis of abstract principles whereas novices mainly rely on surface criteria. The positive impact of expertise in producing structural analogies has been revealed in many studies (Christensen & Schunn, 2007; Dunbar & Blanchette, 2001; Kretz & Krawczyk, 2014). Thus, previous research suggests that pre-experimental knowledge is a key determinant in allowing participants to encode abstract structures, which is a pre-requisite for eliciting analogical retrieval.

Gentner has proposed that the dominance of surface similarity over structural similarity in the retrieval of past events is due to an encoding process which mainly focuses on surface features: "One explanation for the low degree of appropriate recall is that people often encode cases in a situation-specific manner, focusing mainly on their surface features" (Gentner, Loewenstein, & Thompson, 2003, p. 393). The beneficial role of expertise in analogical retrieval is viewed as being due to the relational terms experts have learned. Experts use of relational vocabularies referring to relational patterns would cause the

integration of relational features in their encoding (Forbus, Gentner, & Law, 1994; Gentner, 2010). Experimental support for this view comes from Jamrozik and Gentner (2013), who demonstrated that the presentation of a relational term (i.e. *reciprocity* or *inoculation*) to label SDA examples promotes analogical retrieval. However, encoding would be dominated by simple and local concepts in the absence of specific expertise, and this would explain the surface dominance in the retrieval of past events (Loewenstein, 2017).

The proponents of the surface superiority have developed a computational model, MAC/FAC, for *Many Are Called, Few Are Chosen*, which models retrieval as a two stages process (Forbus et al., 1994). In the first stage, MAC, a content vector is associated to all the source situations competing for retrieval, as well as to the target cue situation. Each content vector is computed by counting the number of occurrences of each concepts described in the situation. Then, the source situation which shares the highest number of concepts with the target cue situation, as well as the other 10% other best matches, are selected and submitted to the second stage, FAC. This subsequent stage applies a structural filter and preserves, among the previously selected source situations, those which have the highest structural evaluation score. Thus, one reason for the surface superiority, as implemented by this model, has to do with the content of the representations on which MAC works. As it is considered that most of the concepts in the description of a situation refer to concrete objects, it is likely that the situations sharing the highest percentage of word content are superficially similar situations. However, this view may neglect the inferences which are drawn so as to encode abstract relations involved in the situations (Hammond et al., 1991).

We propose that previous theories of analogical retrieval have greatly underestimated our ability to extract schemas from our experiences and to use them so as to encode the structure of the situations that we encounter in real-life (Hofstadter & Sander, 2013; Schank, 1999). Our view is that the use of abstract concepts to promote structural encoding is not

restricted to experts dealing with situations within their specific field of expertise (Forbus et al., 1994), nor to the specific cases where situations are conforming a relational label which is provided with them (Jamrozik & Gentner, 2013). Rather, abstract schemas may be sufficiently familiar to allow people to encode the structure of many situations that they encounter in daily-life, such as the ones presented in most reminding tasks (e.g. “making a deal to avoid a bad situation” (Gentner, et al., 1993), “closing the barn door after the horse has gotten out” (Wharton, Holyoak, & Lange (1996), “counting your chicken before they’ve hatched” (Johnson & Seifert, 1992)). We now turn to the experimental studies which have addressed the question of the role of surface and structural similarities in the retrieval of past events.

1. 2. The role of surface and structural similarities in retrieval

Studies have investigated the role of surface and structural similarities by assessing which kind of similarity must a target cue situation preserve so as to elicit the retrieval of a source situation. In story-recall tasks, participants are first presented with a set of source stories and later with a target cue story (or a set of target cue stories). Wharton et al. (1994) used a story-recall task in which some target cue stories shared surface similarity with two source stories and structural similarity with only one of these source stories (*competition paradigm*). They found that the Superficially Similar Analogs (SSAs) were more frequently retrieved than the SSDs, demonstrating that structural similarity plays a role in the retrieval of superficially similar situations. Using a similar competition paradigm, Wharton et al. (1996) showed that SDAs were better retrieved than Superficially Dissimilar Disanalogs (SDDs), suggesting that structural similarity may also have an influence on retrieval in the absence of surface similarity. Abstract features which are predictive of future events may be particularly important in driving these retrievals (Johnson & Seifert, 1992). Hence, it has been demonstrated that structural similarity has a beneficial role in access when only one of two

source stories shares structural similarity and both share the same amount of surface similarity.

The role of surface similarity was highlighted by studies showing that analog source situations are better retrieved when they share surface similarity with the target cue situation (Keane, 1987). However, Blanchette and Dunbar (2000) argued that this finding could be attributed to the shallow processing conditions of classical source-target paradigms (*reception paradigms*) which may prevent participants from encoding the analogs' structure. They found that participants predominantly retrieved SDAs over SSAs when they were instructed to generate their own analogies (*production paradigm*). More recently, Trench and Minervino (2015) pointed out that participants in Blanchette and Dunbar's (2000) experiments could have invented SDAs rather than retrieved them from memory. They provided evidence that SSAs outnumber SDAs in a production paradigm where only true instances of retrieval are considered. We will return to the question of the predominance of SSAs or SDAs in retrieval in the discussion. Studies demonstrating that structural similarity promotes the retrieval of superficially similar source situations (Wharton et al., 1994) as well as studies showing that surface similarity increases the likelihood of an analog retrieval (Keane, 1987; Trench & Minervino) cannot directly inform the question of whether surface or structural similarity prevails in driving retrieval. For now, we will thus focus on studies which have sought to compare the influence of surface and structural similarities by means of varying their level among the experimental stimuli.

Such variations of surface and structural similarities were performed in analogical problem-solving experiments. In this line, Holyoak and Koh (1987) varied the structural and surface overlap between the radiation problem and a source analog problem in which the filaments of a lightbulb had to be repaired. The authors found that the preservation of both surface and structural aspects had an influence on spontaneous transfer. Similarly, Ross

(1987) found that participants depended on both surface and structural similarities in noticing, among a pool of previously presented source problems, the one which is relevant to solve a target cue problem. Similar manipulations of the degree of surface and structural overlap, from relatively low to relatively high, were introduced in story-recall experiments (Catrambone, 2002). The results showed that retrieval performance was positively related to the number of structural similarities as well as to the number of surface similarities between the source and the target cue stories. The augmentation of surface similarities had about the same influence as the augmentation of structural similarities in eliciting retrieval.

For the purpose of determining if surface or structural similarity prevails in guiding the retrieval of past events, Gentner and colleagues tested whether a target cue story would be more likely to elicit the retrieval of a source story sharing the same structure but a different surface (SDA, or *analogy-match* in Gentner's terminology), or a similar surface but a structure that is claimed to be different (SSD, or *mere-appearance match* in Gentner's terminology) (Gentner & Landers, 1985; Gentner et al., 1993). The results supported the *surface dominance hypothesis* since SSDs were predominantly retrieved over SDAs. The higher frequency of SSD retrievals over SDA retrievals led to the widely shared view that even though structural similarity may play a certain role in retrieval of past events (Blanchette & Dunbar, 2000; Catrambone, 2002; Holyoak & Koh, 1987; Kretz & Krawczyk, 2014; Ross, 1987; Wharton et al., 1994, 1996), it may only be secondary compared to the influence of surface similarity (Gentner et al., 1993). This view can be summed up in Gentner and Colhoun's (2010) words: "Relational retrieval can be said to be the Achilles' heel of our relational capacity. There is considerable evidence that similarity-based retrieval, unlike the mapping process, is more influenced by surface similarity than structural similarity."(p. 11).

In this paper, we point out that the experimental stimuli used in studies showing the superiority of surface over structural similarity failed to afford a separation of the two kinds

of similarities. As noted by Hammond et al. (1991), when looking closer at the stimuli from the Karla the hawk set of stories (see Table 1), an important proportion of the SSD target cue stories preserves the structure of the source stories (e.g. “making a deal to avoid a bad situation”). Thus, the SSD target cue appears to be a literal match until the outcome of the stories differs (e.g. betrayal versus respect of this deal). This relational overlap between the stories could have been determinant in eliciting retrieval. It has to be noted that a residual relational overlap between situations that are supposed to be only superficially similar is also present in experiments using different materials than the Karla the hawk set of stories. For instance, the stories involving *three countries* as objects both involve a competition between two adjacent weak countries and the attempt of one of these countries to make a deal with a more powerful neighbor country, although the structure of the target cue differs at the end of the story (the more powerful country finally overruns both weak countries in the source story, whereas a hurricane bankrupts the three countries at the end of the target cue story) (Gentner et al., 1993, Experiment 3). Thus, it remains unclear whether surface similarity alone would still overrun structural similarity alone in driving retrieval.

Table 1: Example of Superficially Similar Disanalog (SSDs) Gentner et al., 1993, Experiment 1 and 2).

Source story
Karla, an old hawk, lived at the top of a tall oak tree. One afternoon, she saw a hunter on the ground with a bow and some crude arrows that had no feathers. The hunter took aim and shot at the hawk but missed. Karla knew the hunter wanted her feathers so she glided down to the hunter and offered to give him a few. The hunter was so grateful that he pledged never to shoot at a hawk again. He went off and shot deer instead.
Superficially Similar Disanalog target cue story (SSD)
Once there was an eagle named Zerdia who donated a few of her tailfeathers to a sportsman so he would promise never to attack eagles. One day Zerdia was nesting high on a rocky cliff when she saw the sportsman coming with a crossbow. Zerdia flew down to meet the man, but he attacked and felled her with a single bolt. As she fluttered to the ground Zerdia realized that the bolt had her own tailfeathers on it.

In the present study, we aim to assess the respective role of surface versus structural similarity by introducing them in different stimuli. In this line, we used a story-recall task

where surface and structural similarities were independently embedded in different source stories: a SSD and a SDA. Critically, the SSDs were designed so that structural overlap would be minimized in such a way that arguably their structures differ from the beginning of the stories.

2. Experiment 1A

The aim of Experiment 1A was to test the structure dominance hypothesis by assessing whether structurally similar situations are better retrieved than superficially similar situations. In this experiment, the SDA and the SSD were presented along with Superficially Dissimilar Disanalog source stories (SDDs) that hardly shared any of these features with the target cue story.

2. 1. Method

2. 1. 2. Participants

A total of 88 undergraduate students from the University Paris 8 (mean age = 21.3; females = 62) took part in the experiment during class.

2. 1. 3. Materials

Following Wharton et al. (1994, 1996), a competition was created between analog and disanalog source stories. Each participant received both types of source stories. Six stories were proposed before the target cue: four SDDs, one SSD and one SDA. [Structural similarity was varied by introducing a similar abstract relational structure versus a minimal abstract relational overlap between the stories, whereas surface similarity was manipulated through the presence of similar versus different characters in the stories.](#) The participants received one of the two versions (see Table 2) in which the SSD, the SDA and the target cue stories were different. This was done to show that the predicted structural retrievals could rely on different structural similarities and overcome different surface similarities as long as the two types of similarities are isolated. In one version, the target cue was Luigi and Lorenzo's story and the SDA was Julie and Victor's story, both situations embodying the structure "a competition

ends when a rival helps the other in improving his or her signature ability". The SSD was Alessandro and Fabio's story, *which shares surface similarity since the principal characters are also two pizzaioli*, but whose structure widely differs from the analogs' one from the beginning of the story (the story is about two colleagues adopting an Italian style to sell more pizzas). In the second version, the target cue was Elyse and Charles' story and the SDA was Paulo and Giorgio's story, both sharing the same structure "a circumstance compels someone to stay with a partner who has betrayed him or her". The SSD was Julie and Victor's story, *which shares surface similarity since the principal characters are also two lovers*, but whose structure (exposed above) differs from the beginning of the story.

2. 1. 3. Procedure & Design

After providing their informed consent, participants were given a booklet with the materials and the full instructions. The participants were first asked by the experimenter neither to turn the pages in advance nor to come back to a previous page (this was also indicated in the headline of the first page of the booklet). They were then invited to read the instructions presented on the first page of the booklet. The first two pages of the booklet presented the six source stories, then a blank page separated them from the last page containing the target cue story. The stories were listed in a semi-randomized order. Participants were asked to rate each source story for imageability (i.e. the ease with which they could imagine the scene while reading it) right after reading it on a five-points scale. This procedure was replicated from previous story-recall studies (Wharton et al., 1994; Wharton et al., 1996), including those which demonstrated the important role of surface similarity (Catrambone, 2002). The last page, which presented the target cue story, instructed the participant that they have to indicate whether the present situation remind them of one of the six previously read situations (in line with Gentner et al., 1993). If it was the case, they had to quote any element they could remember from this situation. The participants were told

that the task usually takes about 10 minutes to complete but that no time limitation was imposed. Participants were then verbally debriefed about the aim of the study.

Superficially Dissimilar Analog (SDA) source situations	Superficially Similar Disanalog (SSD) source situations	Target cue situations
Version 1		
Julie is in love with Victor, her classmate, and she is getting closer to him in order to seduce him. But Diane joins the class in the middle of the year and also has a crush on Victor. Julie notices that Diane is not very aware of her style and gives her some makeover advice, showing her fashion photos and taking her out for shopping. Diane now looks very cute and chic. Diane is so grateful that she tells Julie that she will stop flirting with Victor.	In a marketplace, a truck called « At Alessandro & Fabio's » has various choices of homemade pizzas. The important clientele that goes there is fond of the authentic atmosphere of the stand held by the two happy looking men in Italian traditional suits. However, once they leave from this marketplace, the two men will go to another one, but only after changing into German traditional clothes in order to sell special German sausages. The sign there displays « At Hans and Hendrich's ».	Luigi has a pizza truck in a very popular place. Lorenzo, another ambulant pizza chef, has placed his truck just beside Luigi's and is detrimental to his turnover. Luigi realizes that the dough of Lorenzo's pizzas is bland. Luigi spontaneously gives his personal recipe to Lorenzo so that he can improve the quality of his product. Since then, his pizza dough is amazingly tasty. The same evening, Lorenzo declares to Luigi that in order to show him how well-intended he found his act, he will move his truck in another sector, far from this one.
<i>Structure:</i> A competition ends when a rival helps the other in improving his or her signature ability <i>Surface:</i> two lovers	<i>Structure:</i> simulating an authenticity to take advantage of a situation <i>Surface:</i> two pizzaioli	<i>Structure:</i> A competition ends when a rival helps the other in improving his or her signature ability <i>Surface:</i> two pizzaioli
Version 2		
Paulo and Giorgio have had great success with their pizza truck. Now they intend to fulfil their dream of getting a real Italian restaurant. One day, while looking through their books, Paulo discovered that Giorgio has always hidden the real amount of their profits, and that he actually keeps much more than half of it. Infuriated, Paulo decides to put an end to their collaboration. But since his wages depend on the collaboration with Giorgio, he changes his mind and finally continues working with him.	Julie is in love with Victor, her classmate, and she is getting closer to him in order to seduce him. But Diane joins the class in the middle of the year and also has a crush on Victor. Julie notices that Diane is not very aware of her style and gives her some makeover advice, showing her fashion photos and taking her out for shopping. Diane now looks very cute and chic. Diane is so grateful that she tells Julie that she will stop flirting with Victor.	Elyse and Charles are very happy since they got married. They have many projects and, since the birth of their first son Antoine, are considering selling their apartment to buy a house with more space. However, while using Charles' phone, Elyse found out that he has been meeting with another woman. Shocked, Elyse rushes and fills a suitcase with her clothes and leaves the house. After reflecting, she finally realizes that she has no other choice than to stay and take care of her little Antoine.
<i>Structure:</i> a circumstance compels someone to stay with a partner who has betrayed him or her. <i>Surface:</i> two pizzaioli	<i>Structure:</i> a competition ends when a rival helps the other in improving his or her signature ability <i>Surface:</i> two lovers	<i>Structure:</i> a circumstance compels someone to stay with a partner who has betrayed him or her. <i>Surface:</i> two lovers

Table 2: Stimuli with surface versus structural similarity used in each version of Experiment 1A (translated from French).

2. 2. Results and discussion

For each participant, a score of 1 was attributed to the source story for which word content was recalled. Synonyms were accepted, for instance when the participants reported a "cooperation" between "two cooks" instead of a "collaboration" between "two pizzaiolos", as literally mentioned in the text. If no such word content could lead to a clear identification of the source recalled, or if no retrieval was reported by the participant, the response was classified as a non-retrieval. As responses reporting the retrieval of several source stories which share different types of similarity with the target cue could not help determining which similarity is preponderant for access, they were excluded from the analyses. Among the 85 participants which response could lead to a clear identification of at least one retrieved source story, four were excluded [for this reason](#) (all reported both the SDA and the SSD).

The analysis focused on the number of participants retrieving either the SSD, the SDA or one of the SDDs. As illustrated in Fig. 1, the analysis indicates that participants most often retrieved the SDAs (81.5%) and marginally retrieved the SSDs (18.5%). No SDD were retrieved. A Chi square test was performed on the number of retrievals of SSDs and SDAs and revealed a significant difference ($\chi^2 (1, N = 80) = 32.10, p < .01$)¹.

In accordance with the structure dominance hypothesis, the results demonstrate that structural similarity surpasses surface similarity in retrieval when the two types of similarity are presented in different source stories. They suggest that the structural similarity was itself sufficient so that participants focused on abstract features when retrieving a source story.

These results further comfort the idea that the preponderance of SSDs retrievals in previous story-recall studies (Gentner & Landers, 1985; Gentner et al., 1993) may have been due to the fact that an important proportion of the target cue story shares a structural similarity with the

¹ This difference was significant both in the version where the target cue situation is Luigi and Lorenzo's story ($\chi^2 (1, N = 43) = 7.36, p < .01$) and in the version where the target cue situation is Elyse and Charles' story ($\chi^2 (1, N = 36) = 29.43, p < .01$).

source story (e.g. making a deal to avoid a bad situation), before the stories come to different endings (e.g. respect or betrayal of this deal). In Experiment 1B, we provide a measure of the structural overlap between the SSDs which were used in previous story recall-studies demonstrating the superiority of surface similarity (Gentner & Landers, 1985; Gentner et al., 1993) and the SSDs used in the present study.

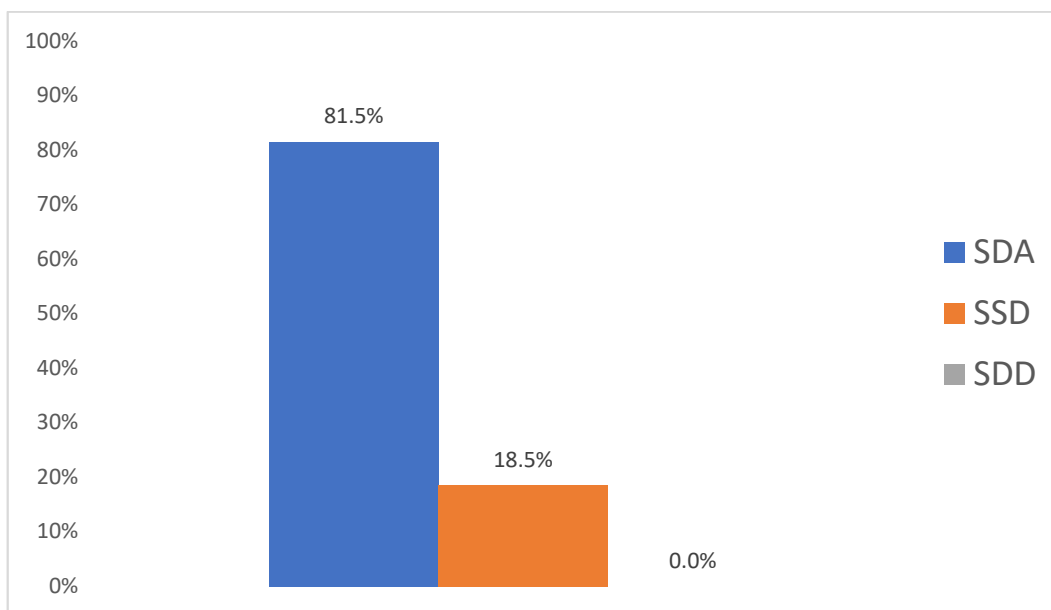


Figure 1: Proportion of retrievals of the source stories according to the type of similarity shared with the target cue story in Experiment 1A.

3. Experiment 1B

Previous research has shown that one way of assessing the structural overlap between two situations is to task participants with judging the *soundness* of the correspondence between them (Gentner & Landers, 1985; Gentner et al., 1993). More specifically, the soundness rating task is adequate to assess the presence of partial structural overlap between two stories (Johnson & Seifert, 1992). In this line, we adapted the soundness rating task to determine which proportion of the text depicting a SSD target cue story, if any, is judged by the participants as structurally similar to the corresponding source story. In order to better control the structural overlap between different SSDs, participants were asked to indicate if

and until where the correspondence was sound between different pairs of SSDs: the SSDs used in Gentner and Landers (1985) and Gentner et al. (1993) (Experiment 1 and 2), the SSDs used in Gentner et al. (1993) (Experiment 3), and the SSDs used in the present study. For the sake of clarity, the SSDs will be referred as with the terminology that was adopted in the original study where they were used (Mere Appearance (MA) matches, *Object-Only* (OO) matches for Gentner and collaborators' studies and SSDs for the current study).

3. 1. Method

3. 1. 1. Participants

27 undergraduate students (mean age = 30.1; females = 22) took part in the experiment during a class at the University of Cergy-Pontoise.

3. 1. 2. Materials

The materials were composed of two pairs of MA matches, two pairs of OO matches and two pairs of SSDs (Table 3). The two pairs of MA matches were taken from the materials presented in Gentner and Landers (1985) and Gentner et al. (1993). The two pairs of OO matches were the ones that are exposed in Gentner et al. (1993). The two pairs of SSDs were the ones used in the first experiment of the present study. Because one of the two stories of a pair (e.g. MA matches) could be used in another pair (e.g. OO matches), two versions of the task were elaborated where a story could only be presented in one pair. Thus, each version was composed of one pair of MA matches, one pair of OO matches and one pair of SSDs.

3. 1. 3. Procedure and Design

The participants first gave their informed consent before participating in the study and were debriefed about its aim at the end of the experiment. Fourteen participants received the first version of the task and 13 other participants received the second one. The first page of the booklet contained the instructions which started by the explanation of what a sound match

is, in an identical form as the one that was provided by Gentner and Landers (1985) and Johnson

Table 3: MA and OO matches (Gentner et al., 1993) used in experiment 1B

Source stories	Target cue stories
<i>Mere-Appearence (MA) matches</i>	
Version 1	
Percy the mockingbird spent the whole warm season chirping and twittering. When it began to get colder Percy visited a squirrel and sang a song for her, expecting to get some of the squirrel's sunflower seeds in return. However, the squirrel was very disappointed in him. "You are a terrible singer!" she yelled. "I'm not giving you any of my wheat." A tear rolled down Percy's cheek, and he vowed to give up singing for good.	A magpie named Sam sang all summer. When winter came he paid a visit to a chipmunk. However, the chipmunk was not at all pleased with Sam. "You have wasted the summer while I have been hard at work!" she said. Sam performed a ballad for her hoping she would give him some nuts in return. But she was still not pleased. "I will not give you any of my nuts!" she exclaimed.
Version 2	
Karla, an old hawk, lived at the top of a tall oak tree. One afternoon, she saw a hunter on the ground with a bow and some crude arrows that had no feathers. The hunter took aim and shot at the hawk but missed. Karla knew the hunter wanted her feathers so she glided down to the hunter and offered to give him a few. The hunter was so grateful that he pledged never to shoot at a hawk again. He went off and shot deer instead.	Once there was an eagle named Zerdia who donated a few of her tailfeathers to a sportsman so he would promise never to attack eagles. One day Zerdia was nesting high on a rocky cliff when she saw the sportsman coming with a crossbow. Zerdia flew down to meet the man, but he attacked and felled her with a single bolt. As she fluttered to the ground Zerdia realized that the bolt had her own tailfeathers on it.
<i>Object-Only (OO) matches</i>	
Version 1	
Two small countries, Bolon and Salam, were adjacent to a large, warlike country called Mayonia. Bolon decided to make the best of the situation by taking over Salam. Salam started looking for aid from other strong countries but soon Bolon succeeded in taking it over. Then victorious Bolon proposed to make a treaty with its warlike neighbor Mayonia. Bolon proposed to give Mayonia control over Salam in exchange for a guarantee that Bolon would remain independent. Mayonia responded by overrunning both Bolon and Salam. Bolon was so busy maintaining control of Salam, it could do nothing to stop Mayonia. Thereupon Mayonia installed puppet governments in both Bolon and Salam and took over the newspapers and radio stations.	Two weak nations, Lincoln and Moreland, bordered each other. Both countries relied heavily on the tourist trade to keep their economies afloat. They competed with each other over which one of them would get the most tourists. Meanwhile, another nearby nation, Chad, had a very strong economy with a thriving tourist trade. Tourist cruises flocked into its harbors and planes full of visitors were constantly landing in its airport. Because of this, Moreland tried to join forces with Chad in its new advertising campaign to entice still more tourists. Unfortunately a hurricane hit the coast and bankrupted all three nations.
Version 2	
Percy the mockingbird spent the whole warm season chirping and twittering. When it began to get colder Percy visited a squirrel and sang a song for her, expecting to get some of the squirrel's sunflower seeds in return. However, the squirrel was very disappointed in him. "You are a terrible singer!" she yelled. "I'm not giving you any of my wheat." A tear rolled down Percy's cheek, and he vowed to give up	One unusually warm spell in February Sam the magpie thought "This is my chance." He stood up on the edge of his nest and trilled proudly. His song was so loud and cheerful that it woke a nearby chipmunk. The chipmunk asked for another song. He was so moved by Sam's talents that he forgot it was still winter and decided to go looking for nuts to store.

Note: The stories were translated in French for the experiment. SSDs from Experiment

1A were also presented in Experiment 1B (see Table 2).

and Seifert (1992). The next paragraph indicated to the participants that they will have to draw a marker in the text of the second story, where what follows does not have a sound correspondence with the first story. They were told that the marker could be placed (i) before the first word of the second story if they thought that it does not have a sound match with the first story from the beginning, or (ii) between two words of the second story if they thought the match is sound before their marker but not sound anymore after it, or (iii) after the last word of the story if they thought that the second story has a sound match with the first one until the end. We first predicted that more participants would place the cursor before the first word of the target cue story in front of the SSDs than when they would be faced with the MA matches and the OO matches. Indeed, the SSD target cue stories should be considered as structurally different from the beginning of the text more often than the MA and the OO target cue stories, which should be considered as structurally similar (at least) at the beginning of the texts. A second prediction concerned the mean proportion of the target cue story texts that would precede the cursor placed by the participants. It was predicted that a more important proportion of the target cue story text should precede the cursor for MA and OO matches than for SSDs.

3. 2. Results and discussion

First, the number of words that preceded the cursor was coded for each response to each stories pair. We calculated the proportion of participants who placed the cursor before the first word of the target cue story for each type of stories pair. The proportion of each target cue story text that shares structural similarity with the source story was also computed. It was obtained by dividing the number of words that preceded the cursor by the total number of words of the target cue story. A mean proportion was calculated for each type of stories pair

(MA matches, OO matches and SSDs). When a participant did not provide any answer or drew more than one cursor in a stories pair, the protocol was excluded from the analysis. Two participants were excluded for these reasons.

As regards the proportion of participants who placed the cursor before the first word of the target cue story, 8.0% of the participants did so when faced with the MA matches, 24.0% of the participants did so when faced with the OO matches and 64.0% of the participants did so when faced with the SSDs. A chi square test was performed to compare the number of participants who placed the cursor before the first word of the target cue story between the MA match and SSD conditions, as well as between the OO match and the SSD conditions. It revealed that a significantly higher number of participants placed the cursor before the first word when they were faced with the SSDs rather than with the MA matches ($\chi^2(1, N = 24) = 10.88, p < .001$) or with the OO matches ($\chi^2(1, N = 24) = 4.55, p < .05$). Further, the results revealed that 65.4% of the MA target cue stories text was considered to have a sound correspondence with its corresponding source story. This was also the case of 43.7% of the OO target cue stories text. Conversely, only 8.6% of the SSD target cue stories text was judged as having a sound match with their source story. A paired-sample t-test was conducted to compare these mean proportions. The difference between MA and SSD target cue stories was significant ($t(24) = 7.51, p < .001$), as well as the one between OO and SSD target cue stories ($t(24) = 4.78, p < .001$).

Experiment 1B demonstrated that participants perceive that an important proportion of each type of target cue stories, which was constructed in previous experiments so as to share surface but not structural similarity (MA matches and OO matches), still preserves structural similarity with their corresponding source story. In contrast, it appears that the SSDs that were used in Experiment 1A are considered as structurally different since the beginning of the stories. Together with the results from Experiment 1A, the results from Experiment 1B

support the claim that some residual structural similarity may have been influential in the retrievals of the source situations which were considered to share only surface similarity in previous experiments.

As noted by Wharton et al. (1994), most experiments conducted on this topic, just like Experiment 1A, provided only one source story sharing surface features with each target cue situation (e.g. Catrambone, 2002; Gentner et al., 1993). However, in natural settings one has generally encountered more than a single situation that shares a surface similarity with a target cue situation. As an illustration, it is very likely that one has several memories involving *pizzaioli* when they go to a pizza restaurant. Experiment 2 was conducted in order to assure more ecological validity regarding the competition of source stories.

4. Experiment 2

As analogies with SDAs are known for being particularly useful when little is known about the target domain, it can be argued that the experimental condition where only one semantically similar source story is stored promotes the retrieval of the SDA. Following Hammond et al. (1991), "When there are few examples in memory that share content features, abstract similarities may be expected to play a larger role in reminding" (p. 127). In other words, the structural dominance could be attenuated in real-life conditions where one often has more knowledge (more exemplars of superficially similar source stories) about the domain of the target cue situation.

However, the structure dominance hypothesis predicts that SDAs are still predominantly retrieved when there is more than a single superficially similar situation in memory, as long as the latter do not preserve the structure of the target cue situation (i.e. as long as they are SSDs). In Experiment 2, several SSDs were put in competition with the SDA and with SDDs. We predicted that the SDA would still be retrieved more often than all the

SSDs taken together, since the former is the only one that preserves the structure of the target cue story.

4. 1. Method

4. 1. 1. Participants

A total of 76 undergraduate students (mean age = 22.1; females = 52) from the University Paris 5 and Paris 8 accepted to take part in the experiment in university libraries. All of them provided their informed consent prior to the experiment.

4. 1. 2. Materials

The target cue stories, the SSDs and the SDAs, were the same as the ones used in the two versions of Experiment 1A. In each version (see Table 4), the four SDDs were replaced by two SSDs (sharing surface features with the target cue story and the SSD from Experiment 1A) and two alternative SDDs (sharing surface features with the SDA in order to respect a symmetry with superficially similar ones, but not sharing its structure). In the version where

Table 4: Summary of all the stories used in Experiment 2

First version	Second version
Target cue stories	
Luigi and Lorenzo's story	Elyse and Charles' story
Source stories	
<i>Superficially Similar Disanalogs (SSDs)</i>	
Claudio and Franco's story	Arnaud and Zoe's story
Alessandro and Fabio's story	Claire and Quentin's story
Paulo and Giorgio's story	Julie and Victor's story
<i>Superficially Dissimilar Analogs (SDAs)</i>	
Julie and Victor's story	Paulo and Giorgio's story
<i>Superficially Dissimilar Disanalogs (SDDs)</i>	

Arnaud and Zoe's story	Claudio and Franco's story
Claire and Quentin's story	Alessandro and Fabio's story

the target cue is Luigi and Lorenzo's story and the SDA is Julie and Victor's story, the two SSDs that were introduced dealt with pizzaioli and the two alternative SDDs described lovers. The two new SSDs depicted lovers and the two alternative SDDs involved pizzaioli in the version presenting Elyse and Charles' story as the target cue and Paulo and Giorgio's story as the SDA. All in all, three SSDs and three superficially dissimilar source stories (one SDA and two SDDs) were presented before the target cue story.

4. 1. 3. Procedure and Design

The procedure and design were replicated from Experiment 1A.

4. 2. Results and discussion

Following the same coding procedure as in Experiment 1A, five of the 72 participants who mentioned a retrieval were excluded from the analyses for having reported both one of the SSDs and the SDA.

We compared the number of participants retrieving one of the SSDs, the SDA or one of the SDDs. As Fig. 2 illustrates, the analyses showed that a substantial majority of participants retrieved the SDA (79.1%), a marginal proportion retrieved one of the SSDs (13.4%) and few proposed one of the SDDs (7.5%). A chi square test was performed on the number of participants retrieving one of the SSDs and the number of participants retrieving the SDA. The difference was significant ($\chi^2 (1, N = 61) = 31.23, p < .01$)².

These results are in line with the ones obtained in Experiment 1A concerning the preponderance of structurally-based over superficially-based retrievals. They show that the

² This difference was significant both in the version where the target cue is Luigi and Lorenzo's story ($\chi^2 (1, N = 33) = 11.76, p < .01$) and in the version where the target cue is Elyse and Charles' story ($\chi^2 (1, N = 27) = 20.57, p < .01$).

structure dominance hypothesis still holds in settings where several SSD source stories are involved.

It could be objected that the structural dominance observed in Experiment 1A and Experiment 2 was due to the successive presentation of the source stories and the target cue story. In many experiments bearing on retrieval processes (e.g. Catrambone, 2002; Gentner et al., 1993; Gentner, Loewenstein, Thompson, & Forbus, 2009; Wharton et al., 1994, 1996), participants' attention is generally moved away from the source stories before the target cue story is presented (introducing a temporal delay or using a filler task). It could also be criticized that, contrary to experiments that present participants with a high number of source stories (Gentner et al., 1993), our first two experiments, presenting participants with six source stories, allowed them to engage in a mapping of the target cue story with each source story, instead of engaging in a retrieval process. Experiment 3 was designed in order to control for these parameters, by introducing a filler task and increasing the number of source stories.

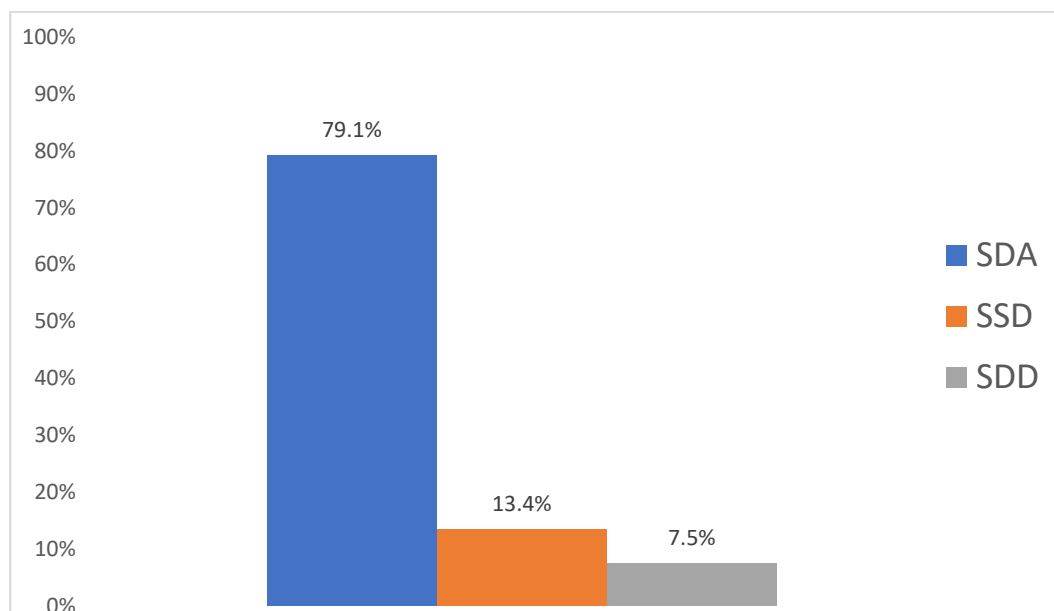


Figure 2: Proportion of retrievals of the source stories according to the type of similarity shared with the target cue story in Experiment 2

5. Experiment 3

5. 1. Method

5. 1. 1. Participants

Ninety-two participants (mean age = 22.4; females = 56) took part in the experiment at the libraries of University Paris 5 and Paris 8.

5. 1. 2. Materials

In line with Wharton et al. (1994), a five minutes filler task was introduced as a distractor between the encoding and the retrieval phases. For fulfilling this task, participants had to write down a maximum of alternative uses that could be made of different objects.

Given that previous studies pointed to a shallow processing induced by story-recall paradigms (Blanchette & Dunbar, 2000; Hammond et al., 1991), the presentation of an excessively high number of source stories may dissuade participants to get involved in a deep understanding of each story, and might induce a superficial encoding. Thus, besides the filler task, two SDDs were added to the source stories set from Experiment 1, so as to make the reactivation-mapping of each source story even less likely to be processed than in the two previous story-recall experiments, while not discouraging participants to pay attention to each story. In the present experiment, eight source stories were presented to the participants since the SSD and the SDA were presented along with six SDDs.

5. 1. 3. Procedure and Design

The procedure and design were replicated from Experiments 1A and 2.

5. 2. Results and discussion

Ninety participants reported at least one retrieval. Among them, responses of 14 participants were not analysed because they reported several retrievals (ten retrieved both the SSD and the SDA, two retrieved a SSD and a SDD, two retrieved a SDA and a SDD).

Again, we compared the number of participants retrieving the SSD, the SDA or one of the SDDs. The results are in accordance with Experiments 1A and 2 (Fig. 3). SDAs were predominantly retrieved (71.8%) whereas SSDs were marginally retrieved (26.9%). Only one participant retrieved a SDD (1.3%). A chi square test revealed that the difference between the number of retrievals of SDAs and SSDs was significant ($\chi^2 (1, N = 76) = 15.91, p < .01$)³.

Results from Experiment 3 support once again the structure dominance hypothesis. They also strengthen the conclusion that the greater amount of SDAs proposed in Experiment 1A and 2 was due to the predominant role of structural similarity in the retrieval process.

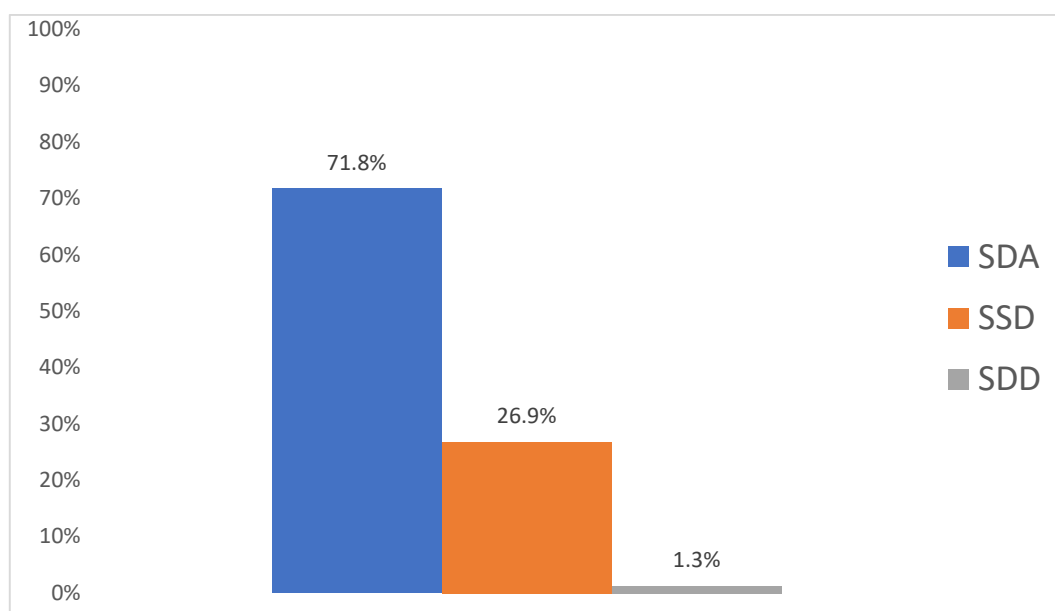


Figure 3: Proportion of retrievals of the source stories according to the type of similarity shared with the target cue story in Experiment 3

Experiments on analogical retrieval generally introduce a delay varying from a few minutes (Johnson & Seifert, 1992; Wharton et al., 1994) to several days (Catrambone, 2002; Gentner et al., 1993; Wharton et al., 1996) between the presentation of the source and the target cue situations. In this line, we designed Experiment 4 in order to provide a clearer assessment of access in LTM by introducing a longer delay between the presentation of the

³ This difference was significant both in the version where the target cue situation is Luigi and Lorenzo's story ($\chi^2 (1, N = 40) = 5.49, p < .05$) and in the version where the target cue situation is Elyse and Charles' story ($\chi^2 (1, N = 35) = 11.11, p < .01$).

source and the target cue situations. In the following experiment, a 45 minutes delay was introduced between the encoding and the retrieval phases.

6. Experiment 4

6. 1. Method

6. 1. 1. Participants

Eighty-three participants (mean age = 22.0; females = 37) took part in this experiment at the library of the University Paris 5.

6. 1. 2. Materials

The materials were replicated from Experiment 3, except that the five minutes filler task was replaced by a 45 minutes delay between the presentation of the source and the target cue stories.

6. 1. 3. Procedure & Design

The procedure and design were mostly replicated from Experiment 3, but this time participants were told that the experiment would be in two parts, separated by a 45 minutes delay. They were given a booklet with the materials and instructions for the first part of the experiment. Thus, the booklet presented the eight source situations with the imageability ratings but did not contain the target cue situation. After the participant had read the eight source situations, the booklet was removed from him or her. Forty-five minutes later, the experimenter came back to the participant with the second booklet which presented the target cue situation and the reminding instructions. The procedure and design were replicated from Experiment 3 on all other aspects.

6. 2. Results and discussion

Eighty-one participants reported at least one retrieval. Among them, responses of 15 participants were not included in the analysis because they reported several retrievals (ten participants retrieved both the SSD and the SDA, one participant retrieved the SSD, the SDA

and a SDD, one retrieved the SSD, the SDA and two SDDs, three participants retrieved the SSD, the SDA and three SDDs).

The number of participants retrieving the SSD, the SDA or one of the SDDs was compared. In line with the findings from Experiment 1A, 2 and 3, SDA retrievals (89.4%) outnumbered SSD retrievals (7.6%) and SDD retrievals (3.0%) (Fig. 4). A chi square was performed and showed that the number of retrievals of SDAs was significantly more important than the number of retrievals of SSDs ($\chi^2 (1, N = 63) = 45.56, p < .001$)⁴.

The results of this experiment demonstrate that a greater delay between the presentation of the source and the target cue situations did not affect the structural superiority in retrieval. Indeed, structural similarity still prevails over surface similarity when the target cue situation is presented 45 minutes after the source situations. These findings provide supportive evidence for the claim that structural similarity plays a predominant role in accessing past events in LTM.

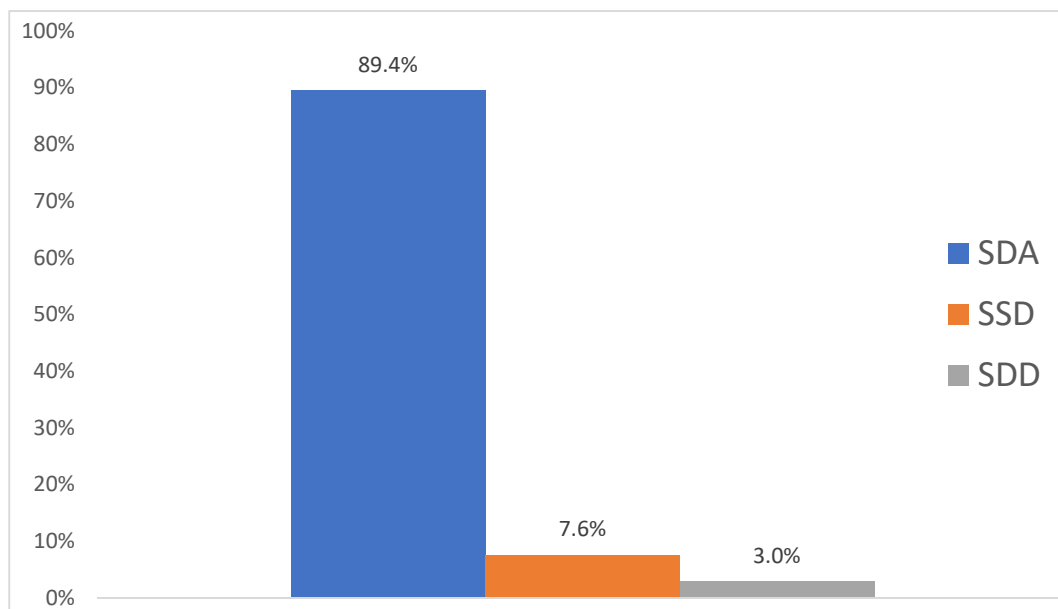


Figure 4: Proportion of retrievals of the source stories according to the type of similarity shared with the target cue story in Experiment 4.

⁴This difference was significant both in the version where the target cue situation is Luigi and Lorenzo's story ($\chi^2 (1, N = 30) = 14.2, p < .001$) and in the version where the target cue situation is Elyse and Charles' story ($\chi^2 (1, N = 32) = 33.0, p < .001$).

7. General Discussion

Previous experimental research led to the view that structural similarity may play a role in the retrieval of past events (Blanchette & Dunbar, 2000; Catrambone, 2002; Kretz & Krawczyk, 2014; Ross, 1987; Wharton et al., 1994, 1996), but more likely a secondary one compared to the influence of surface similarity, since SSDs would be more frequently retrieved than SDAs (Gentner & Landers, 1985; Gentner et al., 1993; Gentner et al., 2009). In the present study, we tested the structure dominance hypothesis by using story-recall tasks where the source stories sharing surface similarity did not share structural similarity, and where the source stories sharing structural similarity did not share surface similarity. In Experiment 1A, the competing SSD and SDA source stories were presented among four SDD source stories. The results demonstrated that surface features are only marginally used as retrieval cues, whereas structural similarity elicits near perfect retrievals. In Experiment 1B, a soundness rating task was used as a mean to assess the difference of structural overlap between the stories that were constructed so as to share surface but no structural similarity in previous studies and in our experiments. Participants rated a great proportion of the text of the MA and the OO target cue stories (Gentner & Landers, 1985; Gentner et al., 1993) as sharing structural similarity with their respective source story, whereas the SSDs used in the present experiments appeared from the beginning of the text as structurally different. Experiment 2 was aimed to assess whether the structure dominance hypothesis is also predictive of retrieval in the cases where one has encountered several exemplars sharing surface similarity with the target cue situation. Structurally-based retrievals remained preponderant when several SSDs were introduced in the pool of source stories. These data suggest that the retrieval of SDA source stories is preferred as long as the superficially similar source stories do not share a significant part of the target cue stories' structure, even when more exemplars sharing surface features compete. In order to rule out the possibility that our results were due to a reactivation

of all source stories one after another, and a mapping of each of them to the target cue story, a third experiment was conducted with the introduction of eight source stories and a five minutes filler task. The fourth experiment was led to provide a clearer assessment of access in LTM by testing whether the structural superiority still holds when a longer delay (45 minutes) separates the presentation of the source and the target cue situations. Structural dominance was still observed after these controls have been implemented. It could be argued that the implementation of a mapping process is still made possible by the presentation of a limited number of source stories (eight source stories) in the same experimental session as the presentation of the target cue story. However, it should be noted that the important influence of surface similarity was also shown in experiments where participants were presented with seven source stories (Gentner et al., 2009, Experiment 4), as well as when they were presented with the source and target cue stories during the same experimental session (Catrambone, 2002; Ross, 1987). Hence, the contrast between the results obtained in these studies and the present study appears to be better explained by the absence of structural similarity among the stories sharing surface similarity.

7. 1. Structural focus and surface erosion in analogical retrieval

Our results demonstrate that SDAs are better retrieved than SSDs. The literature provides ample evidence that SSAs are generally easier to retrieve than SDAs (Keane, 1987; Trench & Minervino, 2015). Together, these data suggest that structurally-based retrieval is preferentially oriented toward SSAs, but that when SSAs are lacking, surface similarity is put aside and leaves place to the retrieval of SDAs. The central role of structure in the situation's encoding may allow a situation sharing high, moderate or no surface similarity to be retrieved, as long as it remains structurally similar.

Some authors have claimed that the frequent retrievals of SSAs that have been reported in the literature (Bearman, Ball, & Ormerod., 2007; Dunbar, 1997; Trench &

Minervino, 2015) are due to the conjunction of a surface similarity-based access and the fact that a set of surface features generally correlates with some structural features (the *kind world hypothesis*; Gentner & Medina, 1998). In other words, the structural blindness in retrievals would be compensated by the kind nature of the world in which similar structures underlie similar surfaces. In contrast, our results suggest that the retrieval of structurally similar situations may not fully depend on probable but not systematic associations between surface similarity of two situations and their structural similarity. Conceiving retrieval as a process that is mainly based on structural similarity which is set at a moderate level of abstraction may provide a more accurate explanation for the reason why SSAs are more often retrieved than just any SSD.

One can still wonder why surface similarity seems to modulate the retrieval of an analog (Trench & Minervino, 2015) whereas it only marginally promotes the retrieval of a disanalog. As noted by Vosniadou (1989), two analogs belonging to a similar semantic domain can share an important structural similarity. It can be argued that the preponderance of retrievals of SSAs over the retrievals of SDAs is due to the fact that two analogs with surface similarity generally share a higher proportion of relevant abstract similarities than two SDAs. This explanation can be exemplified with the similarities existing between the target cue situation depicting someone who is consuming so much new food that he or she gets disgusted by it and the SSA or the SDA which retrieval was considered in Trench and Minervino (2015). The SSA may contain relevant abstract information, such as the fact that the character may have a sweet tooth or that he or she risks to put on weight or to get sick, which the SDA, such as playing too much of a video game with the consequence of getting fed up with it, may not preserve.

Also, the comparison of studies focusing on analogical retrieval, including ours, raises the issue of the kind of surface similarity which is introduced in the stimuli. It can be noted

that the surface features shared by superficially similar situations vary across experimental studies. Indeed, shared surface features range from a moderate number (e.g. *three countries* in Gentner et al., 1993, Experiment 3, *two pizzaioli* in our experiments) to a high number (e.g. *royal, war, troop, advisor, renovation and walkaway*, Catrambone, 2002). Moreover, surface similarity is introduced in terms of identical elements in some experiments (e.g. Catrambone, 2002), whereas it refers to semantically rather close elements in others (e.g. *mammoths/dinosaurs* and *glacier/mosquito fossil*, Trench & Minervino, 2015). In this line, it would be insightful to investigate more thinly how varying the kind of surface similarity may affect the retrieval of analog and disanalog source situations.

Our results raise an additional question on the type of analogies that are used when pursuing different goals, which is not circumscribed to the issue of retrieval processes. Even though participants may consider SSAs as more reliable while making predictions (Trench & Minervino, 2015), it may also be the case that alternative goals are better achieved through the use of a SDA (Blanchette & Dunbar, 2000). For instance, when pursuing the goal of illustrating and explaining a target cue situation, providing a SSA that shares many features with it may weaken the emphasis on the relevant ones, whereas a SDA restricts similarity to what is essential. In this line, observational studies suggest that experts frequently refer to SDAs while seeking to illustrate a concept (Christensen & Schunn, 2007; Kretz & Krawczyk, 2014; Richland, Holyoak, & Stigler, 2004). Further studies are needed to understand more precisely how contexts and purposes influence the use of an analog that shares or does not share surface similarity.

7. 2. Why were SDAs so rarely retrieved in previous experiments?

Previous studies have shown that SDAs retrievals are rare. Research in problem-solving has revealed that the solution from a source problem is rarely transferred to a SDA target cue problem. It has been highlighted that this difficulty may be due to the lack of knowledge of

participants about the situations, which does not allow them to encode their structure (Novick, 1988). When participants are familiar with the adequate schema, they become able to drive analogical retrievals (Catrambone & Holyoak, 1989). It was shown that pre-experimental knowledge is also involved in the encoding of structural features (Bassok et al., 1995; Chi et al., 1981). Our results support the possibility that participants are able to extract schemas from their experiences so as to use them to encode abstract structures and subsequently drive structurally-based retrievals.

However, findings from Trench and Minervino (2015) can appear to be in contradiction with the fact that familiar abstract schemas permit to encode the structure of our experiences. Indeed, they show that even SDAs from the participants' own experiences (e.g. the *Jurassic Park* movie) are rarely retrieved. The authors concluded from their results that even the structure of familiar events is rarely used alone to drive retrieval. However, the possibility to use a schema to encode a familiar situation may not imply that this situation will be retrieved when faced with a target cue situation sharing a structure at any level of abstraction. A schema may not systematically allow the participant to encode the situations at the most abstract level (at which the *Jurassic Park* movie and the Martian Storm scenario are similar). Indeed, the level of abstraction at which a structure is encoded may be determined by the abstraction of the schema which is used. It is possible that participants used a schema like "an attempt to recreate fascinating creatures" to encode the *Jurassic Park* movie. This schema category would not cover the Martian Storm scenario, although the category could contain other SDAs sharing a structural similarity at a less abstract level. Contrasting with the Martian Storm scenario, the Mammoths scenario would be a good fit of the category, which could explain why it elicits more frequent retrievals of *Jurassic Park*. It should be noted that the structure extracted from the *Jurassic Park* movie already requires a slight abstraction in order to be extended to the Mammoths scenario, since it necessitates to both detect common

structural features and to bypass a certain degree of surface dissimilarity (*mammoths* are not *dinosaurs*, *a frozen embryo* is not *a mosquito fossil*, etc). The sharp contrast in frequency of SDAs retrievals that lies between Trench and Minervino's (2015) results and the ones reported in the present study suggests that some SDAs may be harder to retrieve than others, due to the fact that they share a structural similarity at a higher level of abstraction. Whereas the present study provides evidence for the dominance of structural similarity in analogical retrieval, further studies are needed to determine at which level of abstraction the structural similarity which is set between the SDAs stops being the preponderant factor guiding retrieval.

Together, the findings obtained in the experiments reported in this study contribute to better understand the role of surface and structural similarities in the retrieval of past events. They demonstrate that the widely documented superiority of surface similarity over structural similarity is not reproduced when structural similarity is neutralized among superficially similar situations. The contrast between the present results and the failures to retrieve SDAs in previous experiments also suggests that the participants knowledge must be considered when assessing the ability to encode structural features and to subsequently use them as retrieval cues.

Appendix

SSDs used for the two versions of the task in Experiment 2 (translated from French)

First version	Second version
<p>Julie is in love with Victor, her classmate, and she is getting closer to him in order to seduce him. But Diane joins the class in the middle of the year and also has a crush on Victor. Julie notices that Diane is not very aware of her style and gives her some makeover advice, showing her fashion photos and taking her out for shopping. Diane now looks very cute and chic. Diane is so grateful that she tells Julie that she will stop flirting with Victor.</p>	<p>In a marketplace, a truck called « At Alessandro & Fabio's » has various choices of homemade pizzas. The important clientele that goes there is fond of the authentic atmosphere of the stand held by the two happy looking men in Italian traditional suits. However, once they leave from this marketplace, the two men will go to another one, but only after changing into German traditional clothes in order to sell special German sausages. The sign there displays « At Hans and Hendrich's ».</p>
<p>Today, Arnaud has invited Zoé to have a drink in a fancy bar downtown. Just yesterday, he was telling to his mate Pierre that he really likes her, while proudly claiming he was absolutely sure he would close with her tonight. At the end of their date, he came near and tried to kiss her, but Zoé, very surprised, pushed him away. On his way back, Arnaud meets Pierre, his friend, and tells him that anyway, he never meant to go further with that ugly and disgraceful girl he never pint his hope in.</p>	<p>Every day, Claudio and Franco wake up early to prepare pizzas in their food-truck. From sunset to sunrise, they run the streets restlessly in order to sell a maximum of pizzas a day. Exhausted, Claudio confesses to Franco that he cannot bear this routine anymore, which is as exhausting as gloomy. Franco tells he is fed up too. At this moment, a bright idea came to them : they would convert the truck into an RV with their savings and go abroad to see new horizons.</p>
<p>When she gets to the office, Claire sometimes meets Quentin whose company is set at the upper floor. She starts to charm him and to show interest in him by making eyes to him. Quentin, who had initially no hidden agenda, and who adopted a perfectly cordial attitude with her, progressively succumbs to her charm and credits her with an increasing attention. After she stated that Quentin was paying more and more attention to her, Claire finally ignored him and started seducing Gabriel, the server of the cafeteria.</p>	<p>Paulo and Giorgio have had great success with their pizza truck. Now they intend to fulfil their dream of getting a real Italian restaurant. One day, while looking through their books, Paulo discovered that Giorgio has always hidden the real amount of their profits, and that he actually keeps much more than half of it. Infuriated, Paulo decides to put an end to their collaboration. But since his wages depend on the collaboration with Giorgio, he changes his mind and finally continues working with him.</p>

Note : as in Experiment 1A, the target cue was Luigi and Lorenzo's story in the first version and Elyse and Charles' story in the second version.

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