Similarity, causality and argumentation

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Abstract

Similarity is a notion that is widely used both in cognitive science and in argumentation theory. These research programs have, however, developed in large part separately and in consequence rely on disparate notions of similarity. Only recently there has been a proposal for specifying how similarity actually plays a role in judging slippery slope arguments. We present here further theoretical discussion and empirical evidence in order to show how similarity can play a role in slippery slope arguments and in argumentation in general. In the experiment presented here, we manipulated the availability of causal information, and showed that people are sensitive to it when judging arguments' strength. We conclude that similarity between causal properties of the elements presented in arguments is crucial for arguments' strength assessments.

Keywords: Argumentation, similarity, causality, analogical reasoning.

Introduction

The degree of conviction that an argument generates depends on many elements. The effectiveness of some arguments seems to depend on the perceived similarity between the elements presented in the premises and the conclusions that might follow. For example, such is the case of the argument based on precedent, where the similarity between past events and the one under discussion is such as to warrant following the same course of action as with the precedent (Walton, 2010). Similarly, some arguments fail because the relation of similarity between premises and conclusion is weak. The fallacy of false analogy (Tindale, 2007) is one example, where there is a comparison between situations based on superficial similarities that do not support the conclusion. Walton, Reed & Macagno (2008) recognize that judgements of similarity between a class and an exemplar are key for the quality of arguments from verbal classification (from definition, vagueness, arbitrariness) (See also Macagno, 2009; Walton, 2009). The notion of similarity is thus central to explaining why people deem some arguments good or bad, and it is taken as a primitive element for explaining how people evaluate arguments.

Similarly, the typologies of arguments put forward by perspectives like the dialectical (Walton, 2010) and the pragma-dialectical (van Eemeren, Houtlosser, & Snoeck, 2007), rely on identification of similarity. In the pragma-dialectical perspective, for example, one of the three main types of arguments is the 'argumentation based on comparison" (van Eemeren, et al., 2007), where the argument and the standpoint argued for refer to different things but share a predicate. In the example "It is not at all necessary to give James a 10 dollar allowance, because his brother always got 10 dollars a week", the similarity between James and his brother regarding the money needed, is the justification that allows one to proceed from premise to conclusion (Hitchcock & Wagenmans, 2011). In fact, the questions proposed to identify this type of argumentation scheme presuppose the notion of similarity (e.g. "Are there enough *relevant similarities* in the things that are compared?")

Similarity thus plays a dual role in argumentation: not only is it proposed that similarity judgments are performed by people engaged in argumentation, but it is also suggested that argumentation schemes are to be identified by questions that imply similarity judgements. That is, similarity plays a role both in explaining what people do, and also as a tool that the argumentation scholar needs to identify arguments and evaluate its correctness.

Even though there has been vigorous research on the role of similarity in several psychological processes (Goldstone & Son, 2005), and despite argumentation research consistently using this construct as a tool to characterise several argumentation schemes (Walton et al, 2008), little work has been done to integrate the findings of cognitive science into our understanding of how people reason with arguments. In what follows, we will briefly examine the most common notions of similarity currently in use in cognitive science and consider the only work we are aware of that explicitly makes use of this idea to explain argument strength (Corner, Hahn & Oaksford, 2011). This will lead us to consider causality as one of the key ideas that is missing when using similarity as an explanatory principle. We will then present some empirical evidence to support our claims.

Similarity and cognitive science

It is difficult to overstate the importance of similarity as an explanatory tool in cognitive science. From categorisation to analogy, similarity judgements are advanced to explain very diverse phenomena. Links between rules and similarity as well as the very need of appealing to similarity in explaining cognition have been widely discussed (Sloman & Rips, 1998; Goldstone, Day & Son, 2010). It is more or less accepted that alternative ways of conceiving similarity capture different intuitions about our use of this notion, and that all have different weaknesses and strengths.

The multiplicity of contexts in which it is possible to use the notion of similarity is consistent with the diversity of ways in which people judge that objects are alike. One can distinguish three main models to conceive similarity: geometric models, featural models and alignment based

models.[1] While none of these models can possibly capture the flexibility of similarity, they offer important insights into how similarity can be possibly used in the context of argumentation.

Geometric models are based on multidimensional scaling of similarity and dissimilarity judgments provided by participants. People judge how alike two objects are, and their ratings are used to generate a set of points organised in a metric space. The similarity of two objects is an inverse function of the distance between points that represent the objects. The distances measured depend on the number of dimensions inferred (Goldstone el at., 2010). Certainly, a geometrical representation of similarity seems to be at play in the case of induction of blank properties, as proposed by the similarity-coverage model of induction (Osherson et al. 1990). Knowing that "bears require Biotin for haemoglobin synthesis" makes one more likely to believe that wolves require that substance when compared to whales. In this case, the induction is possibly supported by a similarity judgement along the dimensions of "animal with fur", and "lives in the woods".

Notice that this conception of similarity relies on the idea of objects represented by dimensions, which can be adequately captured by classification tasks. The problem with this idea is that it makes geometric models too heavily committed to the assumptions of minimality, symmetry and the triangle inequality, as pointed out by Tversky (1977). These assumptions make the model psychologically implausible for some similarity judgments (e.g. asymmetric judgments like "Korea is more similar to China than China is to Korea"). Featural models capitalise on some problems of geometric models to advance a notion of similarity based on weighted feature-matching. Here the objects are characterised as a set of features, and resemblance is established by some linear combination of shared and distinctive features, with their respective weights. Featural models have found success particularly in explaining categorisation tasks (Verguts et al, 2004). Typically, these tasks involve a learning phase where participants are presented several exemplars that belong to an artificial category (e.g. Flowers whose colour, number of petals and size can vary). Participants are then tested with new exemplars, whose characteristics may match the ones presented in the study phase.

Both geometric and featural representations of similarity have traditionally been used to analyse tasks with relatively unstructured inputs. The link between the inferred dimensions or features had traditionally been overlooked. In response to this problem, and inspired by research in analogy and metaphor, Gentner and Markman (1995) proposed the idea of having situations as the input of the comparison process, and thus starting with complex inputs. Similarity between objects is in this case derived from the role the object fulfils in the scene. This principle guides the selection of characteristics relevant for the comparison process. Alignment-based models assume that similarity comparisons involve a mechanism of structure-mapping, called structural alignment, that seeks maximal structurally consistent matches. When maximizing these matches, there is a set of matched characteristics and two sets of differences, alignable and non-alignable. The latter are key to establishing similarity and explaining the effects of asymmetry and minimality identified by Tversky.

While these approaches to similarity have met different degrees of success in explaining phenomena like categorisation and metaphor, little has been done to specify the particular approach at play when turning to the idea of similarity in the context of explaining argumentation. Thus we now consider the extant literature about argumentation.

Similarity in argumentation

To our knowledge, there are only two explicit proposals for using similarity as an explanatory tool in argumentation. The first one is attributed to Walton (2010, 2012), who presents an analysis showing how arguments from precedent are based on arguments from analogy and classification. The second one is attributed to Corner, Hahn and Oaksford (2011), who, in the framework of the Bayesian approach to argumentation (Hahn & Oaksford, 2007), claim that the mechanism underlying the slippery slope arguments (SSAs) consists of a category boundary re-appraisal process, which in turn depends on the perceived similarity between an exemplar and a category. We now consider each one in turn.

In law, arguments from precedents involve applying an earlier decision to a later case deemed to be the same. Of course, the issue at stake here is when two cases can be considered the "same" in light of the precedent. By the same token, in arguments from analogy a decision is suggested because the case is similar to another one, where "how similar" is the critical question. Walton (2010) is interested in finding an objective way "to identify, analyse and evaluate arguments from analogy" (p. 217), and proposes that arguments from precedent are a special case of arguments from analogy, which in turn are cases of arguments by classification or definition. Given Walton's interest in legal reasoning, the inputs of the process are "cases", complex situations that afford comparisons at multiple levels. Comparisons are only possible if there is a "plausible story" that connects the cases being compared.

The mechanism proposed to establish similarity is an abstract structure called a "story scheme" (Bex, 2009), which is a template that contains a connected sequence of events or actions represented by variables, so that different stories can be represented as instances of it (Walton, 2012). Once the right story scheme is selected, it is possible to establish if the case argued for is an instance of the story scheme. For example, the argument that selling unhealthy food is analogous to selling a malfunctioning car, and thus the same controls should be implemented for food, is only possible in a story scheme that can encompass both food

[1] These are not the only models that have been proposed to characterize similarity, but they are the most widely used. Alternatives such as simplicity and transformation models (see Goldstone et al, 2010), are not discussed for the sake of brevity.

and cars. In other words, to judge the quality of the argument, it is necessary to decide whether the coverage of the story scheme is to be extended to include the new case.

The methodology proposed by Walton is, ultimately, a combination of story schemes and the argumentation scheme from analogy. As such, it is a tool used by the argumentation analyst and it is not intended to have psychological reality. However, its use does imply a functioning cognitive system able to comprehend similarity. As such, the judgements of similarity from story schemes implicitly rely on an alignment-based approach.

The second case is the work of Corner et al. (2011), whose goal is to provide the objective basis for judging SSAs. SSAs are arguments where a proposal is put forward but its consequences are thought to be undesirable, so that if the proposal is allowed, the undesirable consequence will unavoidably follow (e.g. "if freedom of speech is refused to extremist groups, then there will be censorship to any kind of political expression") (Volokh, 2003). Corner et al. present evidence on how the strength of slippery slope arguments is related to the perceived similarity of the elements present in the premises of the argument. They propose that the mechanism underlying the judged strength of slippery slope arguments is the assessment of similarity between the exemplars presented in their premise and conclusion.

More specifically, Corner et al. claim that when assessing a SSA there is a process of category boundary re-appraisal (Corner et al., 2011), and thus the exemplar under discussion can be rightly considered within the scope of the category discussed. Consequently, people are more willing to accept arguments of this form when the similarity between the elements presented in the premises is high, and otherwise consider the argument fallacious. How good an SSA is, depends on extending the category boundaries to include the case under discussion. For example, the acceptability of the argument "If voluntary euthanasia is legalised, then in the future there will be more cases of 'medical murder" (Corner et al, 2011, p. 133), depends on being able to redraw the limits of the category 'medical murder' to include 'euthanasia'. Their claims are based on extensive findings from work on exemplars' effects on categorisation (Nosofsky, 1986).

This idea is certainly a step forward in integrating research in cognitive science and argumentation. However, the generality of Corner et al's proposal is lessened when considering the materials used in their experiments.

In their experiments 2, 2a and 3, they use numerically defined exemplars. They describe a situation where there is a discussion about the inclusion of a new territory in the category of places of outstanding beauty (PONB). Participants were presented with cases of areas that were either declared PONB or not, including the number of animal species in each place, as the decisive criterion. For example, they were told that location A (114 species) and location B (149 species) were not considered eligible as PONB, whereas location C (224 species) and D (259 species) were. In the testing phase, which corresponds with the SSA, a new pair of exemplars was presented in terms of two conditions: similar (194 and 179 species) and dissimilar (218 vs. 179 species). If the mechanism of SSA is an instance of category boundary re-appraisal, it would be expected that (1) an argument involving a comparison of items should be better evaluated when they are similar; and (2) that the results of a categorisation task would support this prediction. They did in fact find a good match between categorisation decisions and the strength of SSAs.

The similarity of the cases considered in Corner et al (2011) depends on numerical thresholds (e.g. number of species in a natural park necessary to declare it a PONB (exp. 2); number of years of imprisonment for knife/gun crime (exp. 3)), given by the fact of dealing with numerically defined categories with only one dimension. As such, their proposal suggests at least one question; namely, will the link between similarity and SSAs show up in cases where the similarity metric depends on more than one dimension (or no dimensions at all: features, stories, etc.)? The next logical step is then to examine the functioning of the hypothesized mechanism in the cases suggested.

The common theme in the work of Walton and Corner et al. is the idea of a more basic mechanism at work when dealing with arguments: Walton, at the level of the scholar of identifying and analysing argumentation schemes; Corner et al, at the cognitive level of individuals faced with arguments. We believe the latter is a particularly promising avenue of research since it relies on the accumulated knowledge of cognitive science about similarity and promotes the integration of cognitive science and argumentation theory (Hornikx & Hahn, 2012). However, as has been acknowledged, the evidence presented by Corner et al. is limited to cases where similarity judgments operate within a dimension, suffering, in consequence, from one of the main criticisms put forward against geometric approaches to similarity, that is, overlooking the connection between the judged dimension and other aspects of the objects under consideration.

Causality and similarity

We believe there is a complementary way of conceiving similarity in the context of argumentation that comes from the literature on causal categorisation. This literature offers a way of dealing with the dichotomy between dimensions and features, and also accounts for the fact that features are usually correlated in exemplars.

There is ample evidence of causal effects on similarity assessments in the categorisation literature (Rehder, 2003). According to the causal model of categorisation, the observed correlation between exemplars' features are understood as evidence of an underlying mechanism at work, resulting in those features (Rehder & Burnett, 2005). Whereas Rehder (2006) considers causality and similarity as two independent sources of information, it is possible to interpret categorisation as cases that depend on similarity judgments inspired by causality. Similarity is not a fixed

notion, as noted above, and proposing that causal information determines our perception of similarity amounts to saying that features and dimensions that enter comparisons are governed by a more general principle. In fact, causal-based models can actually provide a way to solve the apparent opposition of models based in either features or dimensions. Kemp, Shafto, Berke and Tenenbaum (2008) propose a causal model that integrates both kinds of knowledge, relations between objects and relation between features. The evidence accumulated recently in favour of the causal models of categorisation and induction gives good grounds for suggesting that the similarity assessment at work in the case of argumentation depends on the perceived *causal* similarity, in at least some relevant cases.

This would lead one to consider causal-based similarity judgements as the mechanism underlying some argumentation schemes, which can be characterised by the inclusion of a new exemplar under the scope of the category. Some of these argument types have been suggested above: analogy, precedent, classification, definition and slippery slope. Similarly, some forms of the SSA could be considered special cases of causal similarity-based argumentation, where how slippery a slope is, depends on the causal links shared by the exemplars presented in the premises of the argument, as the evidence of their features provide.[2]

Here we do not commit to a particular model of causal reasoning, only to the idea underlying causal-based models of categorisation. However, our proposal has the general appeal of using the logic of weighted feature-matching, where the weights are assigned following a psychological principle, viz. causal representation. In consequence, the strength of the arguments that depend on this mechanism can be predicted by establishing what the particular causal mechanism at work is.

The present experiment

As a first attempt to test this idea, we designed an experiment where the presence of the causal efficient feature was manipulated as well as the overall similarity (number of matched features), in the context of a slippery slope argument. This is a 3 (number of matched features) X 2 (presence/absence of a causally relevant feature), between-subjects design. We expect to see a main effect of the causally relevant feature, regardless of the overall similarity indicated by simple feature matching. In consequence, arguments based on causally matched information will be judged stronger.

[2] A popular classification (Walton, 1992) classifies slippery slope arguments into four types: Sorites, Causal, Precedent, and the Full. It is worth stressing that this classification does not aim to have psychological reality and it would not have any standing in the current proposal.

Experiment

Participants

132 university students (77 female) with ages between 18 and 34 (m=21.25, sd=3.36) took part in this study. The students came from several different undergraduate programs. Participants were randomly allocated to one of the six possible combinations, with 65 and 67 participants in the causal condition and non-causal condition, respectively, and 41, 42 and 39 for each one of the groups defined by the number of matched features.

Materials and procedure

Participants were tested in groups at the end of one of their classes. Each participant was provided with a four-page booklet containing, in the first page, some general instructions, in the following two pages the main task, and in the last page participants were requested to provide basic demographic information.

The main task involved making judgments relative to two scenarios (drugs and fertilizers). The first part of each scenario described a situation where a government agency had to decide whether to allow the use of a new substance (drug/fertilizer). The second part of the scenario included a table comparing the features of a banned substance and the corresponding characteristics of the new substance under consideration. Each table had four items, where the number of matched characteristics (1, 2 or 3) and the presence of the key causal feature (matched or not) were manipulated. For example, table 1 shows the information presented in the fertilizer scenario, with two matched features in the non-causal condition. Polenoy is the currently banned fertilizer, and Soilex the fertilizer the government is considering whether to allow. In this case, the "high concentration of nitric acid" was the key causal feature.

Causal features were selected from ratings provided by an independent group of 20 participants who selected what characteristic they considered more important for banning/allowing fertilizers and potentially addictive substances. Agreement on the most causal feature for the fertilizer scenario was 100%, and in the drugs scenario was 80%.

Table 1: Information presented in a sample item

	POLENOY	SOILEX
Doses lower than 50kg per hectare	YES	YES
Highly soluble in water	YES	NO
Delivered with sprinklers	YES	NO
High concentration of nitric acid	YES	YES

An argument was then presented claiming that the new substance should not be allowed, because allowing it would inevitably lead to removing the ban on the former substance too ("If we allow Soilex now, we are going to have to allow Polenoy. In consequence, we should not allow Soilex"). In both scenarios the arguments were uttered by fictitious characters in positions of power. Participants were asked to rate how convincing each argument was on a 10-point scale. All of the participants rated both scenarios, with the presentation order counterbalanced. Finally, participants rated how negative/positive (on a scale of 1 to 10) they

considered the consequence stated in the conclusion of each argument to be, as a measure of the perceived utility.

Results

Results of each scenario were submitted to a 2 (presence/absence of a causally relevant feature) X 3 (number of matched items: 1, or 3) between subjects Anova. Results for each scenario are considered separately because their respective utility ratings differed (paired $t(131)=4.56$, $p<0.001$), even though there was no significant difference between their acceptance ratings (paired $t(131)=0.6$, $p=.5$)

For both items, there was a main effect of causal information. People rated the argument with the matched relevant causal feature as more convincing than the case without the matched feature (5.8 vs. 3.7 for the drugs scenario and 5.3 vs. 4 for the fertilizer scenario)(see table 2). The differences are statistically significant in both cases, $F(2, 128) =19.95$, $p<0.01$, $\eta^2=0.03$; $F(2,128) =3.92$, $p<0.05$, $\eta^2=0.18$.

Table 2: Summary of argument strength ratings by causal information and number of matched items

Scenario	Causal Info	# of matched features	Mean (s.d)
Drugs	Yes	1	5.29 (3.15)
		2	6.14 (2.41)
		3	6.15 (3.26)
		Total	5.76 (2.91)
	No	1	3.03 (2.56)
		2	5.17 (2.71)
		3	3.40 (1.64)
		Total	3.69 (2.51)
Fertilizers	Yes	1	4.91 (3.11)
		2	5.72 (2.61)
		3	5.35 (1.98)
		Total	5.24 (2.69)
	No	1	4.50 (2.87)
		2	5.76 (3.10)
		3	2.15 (1.82)
		Total	4.14 (2.99)

There was also a main effect of the number of matched features ($F(2, 126)=3.99$, $p<0.05$, $\eta^2=0.05$; $F(2,126)=3.58$, $p<0.01$, $\eta^2=0.05$, for fertilizer and drugs, respectively). The degree of persuasion that an argument exerted changed with the number of matched features for both scenarios. Post hoc tests (Tukey) revealed that the mean acceptance rating was lower when having only one matched feature (the causal characteristic), compared to two or three matches. However, there is no consistent pattern of differences across scenarios when having more than one matched feature.

Interaction was significant for the fertilizer scenario ($F(2, 128)= 3.62$, $p<0.05$, $\eta^2=0.02$) but not for drugs item ($F=1.1$). In the fertilizers scenario, the difference between the causal and non-causal condition was larger when having only one feature matched. Maybe in this scenario having a single feature matched was more salient.

Utility ratings were significantly higher for fertilizer than for drugs (4.5 vs. 37, paired $t(131)=4.56$, $p<0.01$), which means people were more in agreement with fertilizer use. However, the utility ratings were not correlated with acceptance ratings in either scenario (0.04 and 0.002) and did not differ as a function of the inclusion of causal information or matched items (F's <1 for all anovas).

In short, both items were rated in the predicted direction, with the more convincing arguments being those that have a causally relevant matched feature to the sample item. However, the number of items does not have a clear effect. Increasing the number of matches is not linearly associated with higher argument acceptance ratings, but adding a matched feature does have an effect. The present experiment does not support a firm conclusion about this aspect.

Discussion

People are sensitive to causal information in the assessment of argument strength in SSA. In the case of the scenarios used in this experiment, people recognise the causal feature (e.g. concentration of nitric acid) as the key characteristic that produces the undesirable consequence and thus determines the acceptability of the SSA. This experiment adds support to Corner et al's proposal of category re-appraisal as the mechanism at work in SSA, and also sets it in the larger context of the use of causal information for categorisation. A potential problem with the interpretation of the data presented is that is not possible to discard that the other features presented were also interpreted as causal. This would explain why adding a matched feature was associated to higher acceptance ratings. Even in this case, it would still stand that matching the most causally efficient feature is related with a significant increase in the acceptability of the argument.

Summary and conclusions

Similarity clearly plays a role in argument evaluation. Here we have presented evidence of a particular way in which this can occur. The experiment presented shows that people are sensitive to causal information when judging how similar a new exemplar is to a known class. This finding complements Corner et al's (2011) work, by further specifying the mechanism at play, beyond the case of a geometrical notion of similarity. SSAs often imply an evaluation of how "inevitable" an undesirable consequence is once the proposed action has been effected, and in that sense, causal knowledge linking the elements in the argument is especially relevant.

Taking into account research in cognitive science on similarity has several benefits. First, it makes it possible to take further steps in the integration of dissimilar perspectives in the study of argumentation (Hornikx & Hahn, 2012). The different ways in which different evaluations of similarity can play a role in argumentation are still unexplored. Second, it can help predict cases where arguments may be considered bad or fallacious, by providing an understanding of similarity ratings of the

elements under discussion. The reverse is also true: by examining the way people assess arguments, it might be possible to examine the conceptual representation of the world, and the causal structure implied. The actual scope of the causal similarity mechanism is a matter of empirical research. For example, the perceived strength of ad hominem arguments, such as the *ad hitlerum* (Harris et al, 2012), where adopting policy X would lead to the adoption of other undesirable policies, might depend on the similarity of the causally relevant links that connect policy X with other undesirable policies. Third, the study of causal similarity from a cognitive perspective can potentially provide a unifying theme to the study of the argument typologies proposed in informal logic. The dialectical (Walton, 2010) and pragma dialectical (van Eemeren, Houtlosser, & Snoeck, 2007) approaches propose typologies that, useful as they are for the study of argumentation, might conceal important unifying psychologically themes in the evaluation of arguments. One of them, as suggested in this paper, is the use of categorical causal information.

There are several other questions that can be explored using judged causal similarity as a framework. For example, it is clear that complex situations require the rapid evaluation for alignable matches and mismatches (Gentner & Markman, 1995). Are alignable differences more important when they refer to causal characteristics? The way similarity is assessed, in the absence of specific characteristics to be matched (cf. geometrical models), will probably have a differential impact on argument strength, when compared to cases where the exemplars are fully specified by a set of characteristics. A causal-based model of categorisation offers a wealth of hypotheses to be investigated.

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