Singular and General Causal Arguments

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Abstract

In two studies we examined arguments for singular and general causal claims. The first study, a content analysis of newspaper articles, revealed characteristic distributions for mechanistic, statistical, and counterfactual argumentations in singular and general problems. In a second experimental study, subjects formulated arguments from different perspectives on general and singular problems. The results show that subjects are sensitive to the singular-general distinction as well as to related argumentative roles and backgrounds of knowledge. This supports a rhetorical model of causal cognition.

Introduction

Causal arguments consist of causal claims or conclusions and premises which support the causal claims as reasons. The claims may be general (e.g. "smoking causes cancer") or singular (e.g. "John's cancer was caused by his smoking") in nature. Various reasons can be given for such claims: statistical data (e.g. "because smokers take a much higher risk of getting cancer"), counterfactuals (e.g. "because John would not suffer from cancer, if he had not smoked") and mechanistic explanations (e.g. "because the tobacco carcinogen BPDE damages the P53 gene which is critical in the development of lung cancer"). Statistical (Cheng 1993), counterfactual (Lipe, 1991), and mechanistic arguments (Ahn, Kalish, Medin, & Gelman, 1995) have been the mostly discussed justifications for causal claims, but there are other arguments in addition (Oestermeier & Hesse, 2000). Our main question here is: are there systematic relationships between the generality of the claim and the provided arguments?

Several researchers (e.g. Ahn & Kalish, 2000; Hilton, 1995) have stressed the difference between general and singular causal problems, i.e. cases where causal statements are in need of further justification. Unfortunately, the distinction between singular and general problems is not a clear cut one. In the literature on causal cognition this distinction is often illustrated by general phenomena that occur in all relevant contexts alike (e.g. physical laws) on the one hand and particular instances that only occur at specific points in time and place (e.g. a particular car accident) on the other hand. These are, however, only the extremes of a continuum because causal problems range from single events about limited series of occurences to universal general problems. In the following we count only those causal problems as singular where single (or very few events) at a specific point in time and place are involved, and we count all other as general. Several car accidents at different times at a specific junction, for instance, are considered as a general problem albeit a single property of the junction could be the cause of the multiple accidents. Thus our criterion roughly corresponds to the use of singular and plural in the formulation of the causal problem (e.g. "car accident" vs. "car accidents"). The question then is whether this distinction between the singular and general is indeed a crucial one and whether it shows up consistently in varieties of ordinary argumentative discourse. More specifically, we address the following questions: What are the characteristic arguments for general and singular problems? Do subjects expect different arguments from persons with specific argumentative roles and epistemic backgrounds (i.e. general or singular knowledge)?

Previous Research

Answers to these questions directly contribute to the research about causal attribution and argumentation (see Brem & Rips, 2000, for a recent overview). It is an often replicated finding (Kuhn, 1991; Ahn et al. 1995; Slusher & Anderson, 1996) that empirical evidence, i.e. covariation information and statistical data, plays a limited role in the justification of causal claims. Subjects seem to find information about explanatory mechanisms much more useful and convincing. Brem and Rips (2000), however, found that the formulation of empirical evidence increases if the subjects can cite evidence from whatever source they find appropriate. Under such an ideal condition they produce more empirical backings than in those cases were they rely on their own limited knowledge. Brem and Rips (2000) conclude that the neglect of empirical evidence may be largely due to pragmatic restrictions of the availability of appropriate data.

Table 1: A taxonomy of causal arguments

Argument type	Argument schema	Example
Circumstantial evidence	*A caused B, because*	*The poison killed him, because*
1. Spatio-temporal contiguity	B happened at A	a poison bottle was found near the corpse.
2. Co-occurrences	A often occurred together with B	several people taking this poison died.
3. Similarity of cause & effect	A is similar to B	the corpse smells like the poison.
Contrastive evidence		
3. Covariation	B changes with A	the more he took the more ill he became.
4. Statistical covariation	A increases the probability of B	this poison increases the risk to die.
5. Before-after-comparison	B exists after A but not before A	he became ill after taking it.
6. Experimental comparison	action A led to B, action ´A to ´B	poisoned rats died in the experiment.
7. Counterfactual	B would not have happened without A	he would not have died, if he had not taken it.
Causal evidence		
9. Mechanism/causal explanation	A led to C via the process/mechanism B	the poison impaired the metabolism.
10. No alternative	there is no better explanation for B	no other cause leads to such a painful death.
11. Typical effect	B happened and B is a typical effect of A	the colour of the skin is typical for this poison

The cited research remains indeterminate with respect to the relative impact of counterfactual, covariation, and statistical arguments in singular (e.g. a car accident and the death of a plant) and general (e.g. AIDS, unemployment) problems. There are, however, findings that can be taken as a starting point. Kuhn (1991) used general problems and found that subjects formulate mechanistic arguments much more often than covariation arguments, whereas counterfactuals formulations remained nearly non-existent. In singular problems, on the other hand, most subjects also ask for information about mechanism and not for covariation data (Ahn et al. 1995). Lipe (1991), however, found a preference for counterfactual over covariation information and alternative explanations if counterfactual information was available in particular cases.

These findings are compatible with the following hypotheses: Mechanistic arguments occur more often than statistical and counterfactual arguments in general (Kuhn, 1991) and singular cases (Ahn et al., 1995) alike because both kinds of problems are mainly solved on the basis of prior causal knowledge. Counterfactuals are restricted to singular cases because the relevant contrast cases are easier to imagine in concrete cases than in more diffuse global problems (Sherman & McConnell, 1996). Statistical arguments are inherently general and thus restricted to such problems (Ahn & Kalish, 2000, but see Cheng, 1993). With these hypotheses from the literature in mind we looked at newspaper corpora with a great diversity of causal problems.

Study 1: Singular and General Problems

Method

The content analysis of these newspaper articles was based on our taxonomy of causal arguments (see Oestermeier & Hesse, 2000). This taxonomy was developed from several sources: the general philosophical, rhetorical and psychological literature on causation, Kuhn's (1991) interview study, a content analysis of 42 newspaper articles and a pilot study of our own. Table 1 shows the core of our taxonomy, other parts are beyond the scope of this paper.

The first corpus for the taxonomic analysis was taken from the ECI/MCI CD-Rom (the Multilingual Corpus 1 of the European Corpus Initiative). All Frankfurter Rundschau articles were electronically scanned for the keyword "verursach*" (German for "to cause"). This scan of thousands of articles led to a sample of 1024 articles. From this collection a random subsample of 60 articles was drawn. These articles were classified by two independent raters. Cohen's kappa was calculated for the agreement on implicit and explicit causal claims (.81), the segmentation of causal arguments, i.e. whether the text provided complete claim-ground structures (.74), the classification of complete arguments according to our taxonomy (.66), the singular or general nature of the causal problem (.69). The rest of this corpus was analyzed by a single rater.

The method of electronic scanning for a keyword has serious limitations: synonyms, counterfactuals and implicit causal statements are ignored. Besides that all articles of this sample dated from 1992 to 1993. In order to overcome these restrictions two additional printed samples of other newspapers were read by a single rater. One sample of 10 newspaper was randomly drawn from the Schwaebisches Tagblatt (a local newspaper) of the year 1996, another sample of 30 newspapers randomly from the Koelnische Volkszeitung of the year 1903. The rater was instructed to read all articles for all causal arguments with singular and general conclusions and to omit only the parts without journalistic content (like obituary notices, tables etc.)

Results and Discussion

Table 2 shows the frequencies of the argument patterns across singular and general problems. Arguments from explanatory mechanisms were by far the most common ones (75.1%) in both conditions. They were followed by unspecific covariation arguments (4.3%)

and statistical covariations comparing multiple observations (3.5%). All other arguments for causal claims, including counterfactuals, remained below 3%.

72% of the described problems were singular in nature. This gives some support to the hypothesis that singular causal problems are more important for laypeople than general ones (Hilton, 1995). Besides that, singular and general causal problems seem to rely, at least in part, on different reasoning patterns. Explanations of mechanisms dominated singular and general problems alike, but spatio-temporal contiguity (argument 1), experimental comparisons (7) and no alternatives (10) were offered as arguments for causal claims nearly exclusively in single case problems, whereas statistical arguments (5) remained completely restricted to general problems. They occurred only once in the newspaper from 1903. This observation can be best explained by the relatively late penetration of life with statistics which took place after 1900. Argumentations in newspaper certainly reflect historical developments. We would, however, put not too much weight on this hypothesis from one isolated finding.

Some non-findings are also interesting. From the literature we expected that necessary and sufficient conditions should often be used as arguments for causal claims (e.g. Einhorn & Hogarth, 1985). Astonishingly this was not the case, we found no uses of arguments of the form "X caused Y, because all X are followed by Y" or "X caused Y, because Y never happens without X" in the corpora. Even arguments based on counterfactual necessity, although considered as essential for causal reasoning by many researchers (e.g. Lipe, 1991), were rare. The latter may be due to the fact that counterfactuals can be considered as implicit causal arguments that provide at the same time a ground and a claim, whereas our content analysis looked for causal arguments with distinct claims and grounds.

In sum, the data show that singular and general problems cannot be reduced to the same set of argument patterns. Mechanistic or causal explanations that infer causal claims from prior causal knowledge are abundant in both cases, but inductive and abductive arguments are dependent on the problem type. Especially covariation and statistical arguments seem to be restricted mainly to general problems.

Study 2: Roles and Epistemic Backgrounds

The distributions of arguments in the newspaper corpora can only in part be explained by chance and the question is whether subjects are sensitive to these characteristic distributions. Such a sensitivity would be very useful. Argumentation is a complex social activity in which subjects try to defend their interests and gain acceptance by others. The ability to anticipate different arguments from people with different backgrounds of knowledge would offer distinctive advantages in debates. By anticipating certain arguments, for instance, one can prepare the appropriate counter-arguments in advance and thus be in a better position to convince an audience from one's own perspective.

It is clear, however, that subjects can show this rhetorical competence only in settings were it is demanded. Law suits are especially demanding in this respect and therefore we used selected juridical causal problems with various argumentative points of view (plaintiff, defendant) and various backgrounds of knowledge (witnesses, experts).

Hypotheses

We assumed that participants should be able to take the epistemic backgrounds into account and thus expect more often arguments with a reference to concrete spatio-temporal relations from witnesses than from experts.

Table 2. Singular (S) and general (G) causal arguments in three newspaper corpora

Arguments	Volkszeitung (1903)	Rundschau (1992/3)	Tagblatt (1996)	Totals	
	S:G	S:G	S:G	S:G	S+G in %
Circumstantial evidence					
1. Spatio-temporal contiguity	3:0	2:0	5:0	10:0	1.7
2. Co-occurrences	1:1	2:3	0:1	3:5	1.3
3. Similarity of cause and effect		1:0		1:0	0.2
Contrastive evidence					
4. Covariation	5:7	2:4	2:6	9:17	4.3
5. Statistical covariation	0:1	0:10	0:10	0:21	3.5
6. Before-after-comparison	4:2			4:2	1.0
7. Experimental comparison	2:1	8:0	4:0	14:1	2.5
8. Counterfactual	5:4	1:0	1:0	7:4	1.8
Causal evidence					
9. Mechanism	67:26	183:40	94:45	344:111	75.1
10. No alternative	5:0	4:0	1:0	10:0	1.7
11. Typical effect	2:0		2:0	4:0	0.7
Other causal arguments	9:1	21:5	1:4	31:10	6.7
Total S:G	103:43	224:61	110:65	437:169	(100)

In general problems subjects should expect more statistical arguments from experts than from witnesses because it is unlikely that a witness shares the expert's knowledge about statistics. In other words, the participants' arguments should reflect their (perhaps tacit) knowledge that witnesses typically know only about the particular circumstances, whereas experts know about many different cases.

As a generalization of previous findings we expected that mechanistic arguments should dominate singular and general problems alike, because these arguments mirror directly the familiarity of subjects with everyday causal explanations and theories. But singular and general problems should be different with respect to statistical arguments, i.e. arguments that compare multiple observations. We expect more statistical arguments in general than in singular problems, because they abstract from particular circumstances and are inherently general. According to Sherman and McConnell (1996) counterfactual arguments should be occur more often in singular than in general problems.

Method

Participants. The participants were 40 paid volunteer students from various faculties of the University of Tuebingen (16 participants were male and 24 were female; ages varied between 18 and 44 years with a median of 24). Each subject was paid 30 DM. Participants were tested in groups from 3 up to 6 persons and required between 90 and 120 min to complete the paper and pencil tasks. One participant was removed from the data set because of difficulties to understand the instructions and questions in German.

Procedure. We used a mixed repeated measurement design. As a between subject factor 19 subjects had to work on general problems, 20 on corresponding singular ones. The subjects were randomly assigned to these two conditions. As within-subject variables every participant had to work on three different problem contents (food poisoning, allergic reactions, and car accidents) and several perspectives on the case at issue (plaintiff's, defendant's, witness', expert's view and the participant's own pros, cons and final justification). The problem contents and issues were based on real newspaper reports and reformulated for the sake of the experiment. The order of tasks was randomized.

Each participant read three problem descriptions and the related questions. The description of the singular food poisoning case, for instance, read as follows:

> "The organizer of the last year's public festival at the Rhine promenade was sued for compensation for personal suffering at the inferior court Duesseldorf. The plaintiff Oliver K. (36), a visitor of the festival, had suffered from a serious food poisoning. He had taken a snack at one of the snack stands. The vendor could be identified but went into hiding several month ago. An investigation of the case revealed that the vendor had no official license to sell food.
>
> In the last year, the organizer had granted numerous commercial licenses to vendors of snacks and peddlers without checking for the necessary official licenses and health certificates. This was not disputed by the organizer.
>
> At issue between the parties was the cause of the food poisoning. The question of guilt and responsibility was set aside for the moment, at issue was only the question, which cause lay behind this incident."

The first paragraph of the general food poisoning problem read as follows:

> "Several members of the spontaneously founded interest group 'Festival without Fear' brought an action against the municipality of Duesseldorf at the administrative tribunal Duesseldorf in order to lay the city under an obligation to choose another organizer for the traditional yearly public festival at the Rhine promenade. At the last festival numerous visitors had suffered from serious food poisonings. The investigation of these cases revealed that many vendors had no official license to sell food."

The other two paragraphs were identical with the former ones with the exception that plural constructions were used where appropriate.

After the description of the problem scenario the participants were asked for free formulations of causal claims and justifications from different point of views and juridical roles. Single and general case versions were identical except for number and gender:

> "What is the cause of the food poisoning in the plaintiff's [defendant's] point of view? Which justification do you expect from the plaintiff [defendant] for his position?"

In addition, the subject was asked for his own conjecture about the cause and possible pros and cons that would speak for or against his/her conjecture. Each question was followed by three empty lines to allow for free answers in complete sentences. The next sheet started with a causal claim from the plaintiff's view and asked for possible arguments from a witness' and expert's point of view:

> "The plaintiff argues, that the missing controls caused the food poisoning. He cites a witness and an expert.
>
> Which justification(s) do you expect from a witness, who worked at the festival, [an expert, who was procured by the court] for the claim that the missing controls caused the food poisonings?"

Finally, the subject was asked for his/her opinion about the cause and a final argument. The justifications that were freely formulated by the participants were classified in terms of our taxonomy by two independent raters. On a subset of five randomly chosen survey booklets, we calculated Cohen's kappa as a measure of rater agreement. When coding non-causal arguments as a default category (i.e. "other") the result was fair (.54). A second agreement measure was calculated solely for the categories within the taxonomy, i.e. those cases where both rater agreed that the argument in question

was causal in the sense of our taxonomy. This agreement was .76. Non-causal arguments (e.g. arguments from authority) were ignored later on. Differences in classification of arguments were resolved by discussion.

Results and Discussion

Table 3 gives a summary of the results. The overall number of causal arguments which were produced by the participants across all three tasks varied considerably from 5 to 33 with a median of 19.2. To compensate for this, we computed the relative percentages of each produced argument type per person. With the percentages of (a) statistical, (b) counterfactual, and (c) mechanistic arguments as dependent variables we calculated three 2x3x7 (type of task x content x perspective) mixed analyses of variance (ANOVA) with general and singular problems as a between factor and task content and perspective serving as repeated measures.

(a) Statistical arguments were less often formulated (in total 36 formulated arguments) than mechanistic arguments (in total 245) and especially rare under the singular condition (9 out of 36). In consequence there was a main effect of singular vs. general problems for statistical arguments, $F(1, 37) = 4.71$, $p < .05$. There was also a significant main effect of perspective, $F(6, 222) = 3.30$, $p < .01$, i.e. statistical arguments were more often formulated under the perspective of an expert (13) than under all other perspectives (0 for witnesses).

(b) Counterfactual arguments were more often formulated in singular (24) than in general problems (19) but in accordance with our first study and against the hypothesis of Sherman and McConnell (1996) this difference was not significant $F(1, 37) = .747$, $p = .39$. There was, however, a significant interaction between task type and content, $F(2, 74) = 10.894$, $p < .05$. In the car accident and allergic reaction tasks counterfactuals were more often produced under the singular condition than under the general one (14 vs. 5 respectively 5 vs. 1). In the food poisoning problem, this difference was reversed (5 vs. 13). We can offer no explanation for this interaction, but one can argue that our kinds of problems were perhaps not as general as necessary in order to gain a stable effect. Our problems involved multiple people and events but were far from universal because the described events occurred in restricted areas. The interactions show, however, again how content and context dependent causal argumentations are.

(c) Mechanistic arguments were the most common ones (245 in total) and produced by all participants alike across general (130) and singular (115) problems. We found, however, significant main effects of task content, $F(2, 74) = 19.32$, $p < .001$, and perspective, $F(6, 222) = 19.39$, $p < .001$. Nearly half (120) of all mechanistic arguments were formulated in the car accident problem. This may be due to the fact that the participants were more familiar with plausible car accident scenarios than with allergic reactions and food poisonings. In the latter two problem types the mechanisms behind the observable symptoms are less known and hidden to the unaided senses. Against the general trend of a dominance of mechanistic explanations, participants argued from the plaintiff's view equally often with observational before-after-comparisons as with mechanisms (both 20), whereas counter-arguments offering alternative explanations (28 out of 59) were especially frequent under the defendant's view. This shows a clear understanding of the addressed argumentative roles.

Table 3. Frequencies of singular (S) vs. general (G) arguments by perspective and contents

Arguments	**Total**	**Perspectives**					**Contents**		
		Plaintiff	*Defendant*	*Witness*	*Expert*	*Subject**	*Food poisoning*	*Car accident*	*Allergic reactions*
	S:G	S:G	S:G	S:G	S:G	S:G	S:G	S:G	S:G
Circumstantial evidence									
1. Spatio-temporal contiguity	37:25	9:8	4:1	8:5	2:2	14:9	6:3	7:1	24:21
2. Co-occurrences	23:30	0:4	0:2	10:7	4:5	9:12	9:8	1:7	13:15
3. Similarity of cause and effect	0:1	0:0	0:0	0:0	0:0	0:1	0:1	0:0	0:0
Contrastive evidence									
4. Covariation	6:33	1:3	1:3	0:3	1:5	3:19	2:9	2:12	2:12
5. Statistical covariation	9:27	0:5	1:2	0:0	3:10	5:10	5:7	4:13	0:7
6. Before-after-comparison	27:35	11:9	1:0	7:15	2:3	6:8	7:1	1:6	19:28
7. Experimental comparisor	10:7	1:0	1:1	0:1	2:1	6:4	2:1	0:0	8:6
8. Counterfactual	24:19	9:3	3:2	2:4	2:2	8:8	5:13	14:5	5:1
Causal evidence									
9. Mechanism	115:130	7:13	6:11	32:31	33:29	37:46	34:41	56:64	25:25
10. No alternative	6:10	1:2	0:0	1:1	1:3	3:4	4:2	0:4	2:4
11. Typical effect	20:6	3:0	2:1	6:2	6:0	3:3	3:0	4:1	13:5
Other arguments	72:82	6:5	25:21	1:0	2:2	35:33	29:24	16:17	27:18

Note: *This column contains the pros, cons and final arguments of the subject from his/her own perspective

General Discussion

Not all researchers define singular and general arguments in the same way as we do. Basically, we distinguished claims about one and many cases. In the literature a related but different distinction is often drawn in respect to episodic vs. semantic or conceptual knowledge. We decided to use a deviating one-many distinction for several reasons: Firstly, our criterion shows up relatively clearly at the language surface (singular vs. plural) whereas the distinction between episodic and semantic knowledge is much more implicit. Phenomena like unemployment and crime, for instance, can be viewed as local episodic or truly universal problems alike and it often not clear from the context whether causal claims about these problems are intended as propositions about the specific circumstances in a particular economy or society or as general law-like statements. Secondly, frequently cited examples for general claims like "smoking causes cancer" sound to be common but a closer look at non-scientific text corpora shows that such unrestricted causal statements are rare. They seem to be of limited importance in non-scientific contexts.

Thus it remains an open question whether the episodic vs. law-like distinction leads to similar characteristic argument sets. Up to now, relatively few studies looked directly at the verbalization of causal arguments (Brem & Rips, 2000; Kuhn, 1991; Thagard, 1999). A reason for this may be the implicitness and vagueness of ordinary language which makes utterances difficult to analyze. But this obstacle is unavoidable if one wants to understand how causal knowledge is established and communicated in modern societies. Taxonomic and rhetoric studies are indispensable in this respect and in our opinion they should become import guides for further research. The above mentioned studies show, for instance, that statistical (Cheng, 1993) and counterfactual (Lipe, 1991) theories of causal reasoning in psychology have no foundation in a prevalence of the corresponding argument patterns in ordinary discourses. The complex distributions of argument patterns that occur in ordinary language simply cannot be explained from theories that put their focus on a single central and normative causal argument pattern.

Differences in perspectives as well as differences along the singular-general-continuum pose especially difficult problems for reductionistic theories. If the supposed reasoning patterns are the same for all persons, perspectives, and problems alike, it is hard to see how differences can emerge at all. From a rhetorical perspective, however, differences in reasoning are fundamental and in many cases irreconcilable. Our data show that argumentative competencies of humans are highly sensitive to such rhetorical demands, i.e. specific contents and contexts, argumentative roles, different backgrounds of knowledge, restrictions in knowledge, etc. We do not claim, however, that by taking a rhetorical perspective alone, these competencies are already explained. But in our view, it is a progress if such a perspective shift leads to a more adequate description of the pragmatic aspects of causal reasoning and argumentation.

References

Ahn, W., Kalish, C. W., Medin, D. L., & Gelman, S. A. (1995). The role of covariation versus mechanism information in causal attribution. Cognition, 54, 299-352.

Ahn, W., & Kalish, C. W. (2000). The Role of Mechanism Beliefs in Causal Reasoning. In F. C. Keil & R. A. Wilson (Eds.), Explanation and Cognition. Cambridge, MA: MIT Press.

Brem, S. K. & Rips, L. J. (2000). Explanation and Evidence in Informal Argument, Cognitive Science, Vol 24 (4), 573-604.

Cheng, P. W. (1993). Separating Causal Laws from Casual Facts: Pressing the Limits of Statistical Relevance. In D. L. Medin (Ed.), The Psychology of Learning and Motivation Vol. 30, (pp. 215-264). San Diego: Academic Press.

Einhorn, H. J. & Hogarth, R. M. (1986) Judging Probable Cause. Psychological Bulletin, 99(1), 3-19.

European Corpus Initiative -- Multilingual Corpus 1 [CD-ROM] (1996). Edinburgh: Human Communication Research Centre [Distributor].

Hilton, D. J. (1995). Logic and language in causal explanation. In D. Sperber, D. Premack, & A. J. Premack (Eds.), Causal Cognition: A Multidisciplinary Debate, (pp. 495-529). Oxford: Clarendon Press.

Kuhn. D. (1991). The Skills of Argument. Cambridge: Cambridge University Press.

Lipe, M. G. (1991). Counterfactual Reasoning as a Framework for Attribution Theories. *Psychological Bulletin*, 109(3), 456-471.

Oestermeier, U. & Hesse, F. W. (2000). Verbal and visual causal arguments. Cognition, 75, 65-104.

Sherman, S. J., & McConnell, A. R. (1996). The Role of Counterfactual Thinking in Reasoning. Applied Cognitive Psychology, 10, 113-124.

Thagard, P. (1999). How Scientists Explain Disease. Princeton, NJ: Princeton University Press.

Walton, D. N. (1989). Informal Logic: A Handbook for Critical Argumentation. Cambridge: Cambridge University Press.