Effects of information comprehensibility and argument type on lay recipients' readiness to defer to experts when deciding about scientific knowledge claims

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Abstract

The present study investigated whether laypersons are aware of their own knowledge limitations when having to decide about the acceptability of scientific knowledge claims. Specifically, we tested whether laypeople are more prone to discount their actual dependence on experts after having read simplified science depictions. Lay recipients read scientific arguments varying in comprehensibility and argument type and thus in apparent easiness. We assessed participants' inclination to rely on their own information evaluation rather than to seek out expert advice when deciding about claim acceptability. As expected, results showed lay recipients to be more confident in their own information evaluation and less inclined to turn to an expert for decision support after reading easy compared to difficult depictions.

Keywords: knowledge evaluation; expertise; argument comprehensibility; causal explanations; evidence

Introduction

Whether making up their mind about undergoing specific medical treatment or judging if certain behaviors are detrimental to the environment, laypeople frequently face situations where they need to decide about the acceptability of scientific knowledge claims. The ease of accessing information on the Web has eliminated problems with regards to the *availability* of science-related knowledge that might act as a basis for an informed judgment. However, a major challenge lies in the *evaluation* of this information, i.e. its acceptability, usefulness and sufficiency for solving a problem at hand (Bromme, Kienhues & Porsch, 2010).

The evaluation of scientific claims is particularly difficult due to the complexity and tentativeness of science knowledge, and it is therefore likely to be beyond laypersons' epistemic capabilities (Keil, 2008). Advances in science and technology have led to an enormous growth of knowledge. To manage this complexity, science knowledge is organized into different disciplines represented by specialized experts. Thus, throughout our whole lifetime we remain laypersons who depend on advice of pertinent experts regarding most topics. This uneven distribution of knowledge in modern societies will be conceived in the following as a 'division of cognitive labor' (Keil et al., 2008). However, for the division of cognitive labor to function successfully, laypeople must be *aware* of the incompleteness and limitations of their own knowledge. In other words, laypeople have to recognize that in certain situations they are unable to make an informed decision about the veracity of encountered information and instead need to defer to an expert for advice.

The present study addresses the question of whether laypeople are aware of the insufficiency of their own knowledge and thus the necessity to rely on the division of cognitive labor when having to come to an informed decision about scientific knowledge claims. Specifically, it was examined whether laypeople's awareness of their own limitations is decreased whenever scientific information is presented in a way that makes the subject matter appear fairly easy and uncomplicated.

Laypeople often encounter scientific information especially prepared for their consumption, i.e. presented in a simplified way to make the contents superficially comprehensible for non-experts (Zimmerman et al., 2001). However, if laypeople encounter such 'easy' texts, their understanding may mislead them to judge the subject matter as equally easy, and their mental representations of the described phenomena formed by reading the information as more complete and accurate than they actually are (cf. Goldman & Bisanz, 2002). Such an impression may manifest itself in the conviction that their knowledge and skill does not differ meaningfully from that of an expert. Consequentially, scientific messages that are easy to understand might create the impression that laypeople are

able to evaluate the viability of the provided information by themselves and that deferring to an expert is an unnecessary waste of time and energy.

The assumption that the ease of text understanding influences readers' confidence in their own evaluation is in line with research on fluency. Fluency is defined as the subjective experience of ease or difficulty when completing a mental task, and it has been shown that fluency experiences can serve as a basis for judgment of various information- or task-features (Schwarz, 2004). For instance, experienced fluency is generally connected with positive judgments of truth and confidence in one's own performance (e.g. Reber & Schwarz, 1999; Alter, Oppenheimer, Epley & Eyre, 2007). What we currently term 'text easiness' can actually be conceived as a type of processing fluency. However, the influence of experienced fluency on laypeople's assessment of their own epistemic capabilities in comparison to that of an expert has to our knowledge not been investigated by previous fluency research.

Perceived Easiness of Scientific Contents

Assuming that perceived easiness of information leads laypeople to neglect their dependence on the division of cognitive labor raises the question as to what characteristics make scientific contents appear easy. We presume perceived easiness to be influenced by at least two message attributes: information comprehensibility and type of argument in which information is presented to support a claim.

To date, the influence of comprehensibility and argument type on laypeople's readiness to evaluate science information themselves rather than to rely on an expert advisor has not been investigated directly. However, we base our assumption of the impact of both factors on previous theoretical considerations as well as empirical findings which show comprehensibility and argument type to affect the persuasiveness of arguments. Strong agreement to a claim or a positive evaluation of provided arguments should only occur if recipients feel that they are sufficiently informed and qualified to form an opinion about the subject matter. In contrast, if recipients do not feel competent to assess the quality of provided information, they should be more hesitant in their judgments and refrain from indicating strong agreement or evaluations. Thus, previously obtained effects of comprehensibility and argument type on persuasiveness might at least partly result from an influence of both factors on recipients' readiness to make an own decision about a claim or an argument.

Information Comprehensibility According to Chaiken and Eagly (1976), recipients are more apt to accept claims supported by comprehensible arguments for two reasons: First, if the argument is not well understood recipients receive lesser amounts of information in support of the claim. Second, failing to understand might create feelings of frustration among recipients, which then translate to the claim intended to be supported. The resulting negative affect makes it then less likely for recipients to accept the claim as valid. This assumption has been confirmed by previous research, which has shown comprehensible arguments to cause stronger claim agreement among recipients compared to arguments difficult or impossible to comprehend. This research was mainly focused on arguments supporting a moral claim and on arguments advertising the usefulness of consumer products (Bradley & Meeds, 2004; Chaiken & Eagly, 1976), but comparable findings have also been yielded for scientific claims (Eagly, 1974). However, it remains unclear whether the observed persuasive effect of comprehensibility also extends to laypeople's confidence in their own information evaluations and thus on their reliance on the division of cognitive labor.

Argument Type Previous research has differentiated between two types of arguments that can support a causal claim: 'Explanations' (also called 'causal arguments') describe the mechanism underlying a claimed causal connection (e.g. '*Cholesterol increases the risk of stroke because it blocks the blood vessels*'). In contrast, 'evidence' (also termed 'noncausal arguments') supports the claim by referring to statistical data (e.g. '*Cholesterol increases the risk of stroke because 74% of people suffering a stroke have above-average cholesterol levels*') (Brem & Rips, 2000; Sandoval & Cam, in press).

In spite of the prominent role evidence plays in empirical science, previous literature suggests that laypeople prefer causal arguments as epistemic justifications, possibly because their evaluation is perceived as easier. According to Keil (2010), individuals have a sophisticated sense for causal relations and structure and seek out explanations. These activities form the essence of individuals' folk science. Thus, laypeople may consider causal arguments as more traceable and easier to evaluate than noncausal arguments, since causal arguments more closely reflect the kinds of epistemic justifications they consider in everyday life. Consequentially, laypeople might be more prone to rely on their own evaluations of causal arguments, whereas they are more likely to appreciate the necessity of reverting to experts if confronted with noncausal evidence. Laypeople should then be more easily persuaded by causal than by noncausal arguments. Findings by Slusher and Anderson (1996) indeed confirm causal arguments to cause stronger claim agreement than noncausal arguments. However, other research comparing both argument types yielded different results, indicating that evidence is perceived as better argument support than explanations (Brem & Rips, 2000; Sandoval & Cam, in press).

Hence, although theoretical considerations suggest a persuasive advantage of causal over noncausal arguments from a layperson's point of view, previous research does not consistently provide support for the assumption of causal arguments being perceived as more traceable by laypeople and more manageable to evaluate by themselves. A possible explanation for the inconsistency of findings is that argument type and comprehensibility might have been

confounded in at least some studies. In cases where noncausal arguments had been more comprehensible than their causal counterparts, the perceived easiness of comprehensible arguments might have outweighed the easiness ascribed to causal arguments. In order to further investigate whether laypeople are indeed more strongly persuaded by causal arguments, it is necessary to assess the influence of argument type independently from the influence of argument comprehensibility. Moreover, and similar to the state of affairs regarding comprehensibility, it remains unclear whether argument type has an effect on recipients' confidence in their decision about information acceptability. Thus, further research is needed to assess whether and how argument type influences laypeople's readiness to rely on their own judgment rather than on the division of cognitive labor.

The Present Research

The present study was aimed to investigate how the way scientific information is presented influences laypeople's inclination to rely on their own evaluations of scientific claims rather than to defer to an expert. We assumed that if scientific information is presented in a way that makes it difficult for laypeople to process, they are more likely to realize that as non-experts they are in fact unable to confidently decide whether the information poses a sound argument to support a give claim.

In order to investigate this assumption, laypeople were confronted with argumentative texts which provided support for a causal claim and which were intended to vary in perceived easiness. Perceived easiness was manipulated in two ways. Firstly, the texts were either written to appear comprehensible or clearly incomprehensible. Secondly, the texts either supported the stated claim with an explanation of the underlying causal mechanism (thus with information tailored to laypersons' familiar way of reasoning in folk science) or with empirical evidence (thus with information that should be less compatible with laypersons' familiar way of thinking).

We expected lay recipients to evaluate comprehensible arguments as stronger (i.e. more supportive of the claim) than incomprehensible arguments (H1) and causal arguments as stronger than noncausal arguments (H2). We furthermore assumed that laypeople agree more strongly to a claim after reading comprehensible than incomprehensible arguments (H3) and after reading causal arguments compared to noncausal arguments (H4). With regards to laypeople's confidence in their own agreement decision, we assumed that comprehensible arguments cause higher trust in their own decision about the claim (H5) and conversely a weaker desire to consult an expert for further decision support than incomprehensible arguments (H6). Finally, causal arguments should lead lay recipients to trust more strongly in their own decision (H7) and to be less inclined to consult an expert than noncausal arguments (H8).

Method

The study was conducted with a 2x2 repeated measures design, the independent variables being argument comprehensibility (comprehensible vs. incomprehensible) and argument type (causal vs. noncausal). Each participant was assigned to all experimental conditions in a randomized order that varied between individuals. In each condition, participants were asked to read an argument about a medical topic. Thus, every recipient read four arguments in total: one comprehensible causal, one comprehensible noncausal, one incomprehensible causal and one incomprehensible noncausal argument.

Eighty-eight undergraduates (52 female, mean age = 25.66 years, *SD* = 5.13) of different subjects at a German university took part in the study and received 8 Euro for their participation. To ensure participants' lay status, students of medicine, biology or related subjects and students of empirical sciences, who can be assumed to be particularly familiar with noncausal arguments, were excluded from participation.

Materials

Expository texts about four medical issues were generated (mean length = 80.5 words, *SD* = 16.46). The texts contained concepts and relations that were derived from real-world concepts but were imaginary to ensure that readers were low in topic knowledge and had no strong prior opinion about the issues. Each text consisted of an argument that supported an issue-related causal claim (e.g. '*A side-effect of Rethoxat is that it brings about asthma attacks*'). The claim was always stated at the beginning of the argument, followed by information serving as claim support. For each text, four variations were created, analogous to the experimental conditions: In the causal argument conditions, the claim was supported by an explanation of the underlying mechanism and in the noncausal argument conditions by statistical data. Comprehensibility of both argument types was manipulated by use of technical terms, repetition of important information and inclusion/omission of unnecessary, distracting detail. For instance, the sentence '*After the intake of Rethoxat, the agent is absorbed from the stomach into the blood stream.*' from the comprehensible causal variation was transformed to '*After sublingual application of Rethoxat, the verum is resorbed via the Tunica mucosa gastrica into the sanguis*' in the incomprehensible causal variation. However, comprehensibility manipulations were only applied to the argument support, while the claim was stated in the same wording across conditions.

Before reading each argument, participants were confronted with a scenario in which a fictitious friend was described as having a medical problem. The fictitious friend was unsure whether a certain problem-related claim was true or false and asked the participant about their opinion. The arguments were presented as stemming from an online source and were described as being authored by a medical

expert in order to keep the social role ascribed to the source constant between conditions.

Dependent Measures

Manipulation Check To assess whether comprehensibility had been manipulated as intended, participants evaluated each argument for perceived comprehensibility on a 1 to 7 scale (1: *very incomprehensible*, 7: *very comprehensible*). Since comprehensibility might be interpreted differently by different readers (Wiley, Griffin & Thiede, 2005), participants were provided with a short definition of what the experimenters meant by comprehensibility to ensure that each participant judged the arguments by comparable standards. This definition described information as comprehensible when the contents are perceived as clear and when readers feel able to discriminate essential from less important parts and to evaluate information consistency.

Argument Strength Participants were furthermore asked to rate the strength of each argument on a 1 to 7 scale (1: *the argument provides no support for the claim*, 7: *the argument provides strong support for the claim*).

Claim Agreement To assess whether argument reception led to changes in participants' claim acceptance, agreement to each claim was assessed prior and subsequent to reading the claim-supporting argument. Participants were asked to indicate their agreement on a scale from 1 (*I don't agree at all*) to 7 (*I totally agree*).

Confidence in the Claim Agreement Decision Participants' readiness to decide about the claim was indicated by two measures, each of which was collected before and after participants read the argument.

(A) Trust in one's own judgment of the claim correctness: Before and after reading each argument, participants indicated on a 1 to 7 scale how strongly they agreed to the statement '*I am confident in my own decision about whether it is true that* [claim statement inserted]' (1: *don't agree*, 7: *strongly agree*).

(B) Desire to consult an expert for decision support: Similarly, before and after argument reception, participants were asked about their agreement to the statement '*Before I decide about whether it is true that* [claim statement inserted], *I would like to seek further advice from an expert*' on a 1 to 7 scale (1: *don't agree*, 7: *strongly agree*).

Procedure

Participants worked individually on a booklet which contained the arguments and scales for collecting the dependent measures. The booklet first presented participants with a scenario in which the fictitious friend's problem was described. Pre-measures of participants' claim agreement, trust in their own judgment and desire to consult an expert were collected. Participants then read the argument and provided their answers to the post-measures of the aforementioned variables. This was repeated four times, so that each participant read one argument of each experimental condition. After the described pre-and post-measured were collected for all arguments, readers were presented again with each argument and were asked to evaluate its strength and comprehensibility. Participants then completed a demographic questionnaire and were finally debriefed about the fictitious nature of the presented arguments.

Results

Table 1 shows the means and standard deviations of the dependent measures for the different experimental conditions. Medium to strong inter-correlations of the dependent variables claim agreement, trust in own decision and desire for expert advice show that all three measures are significantly related but nevertheless present separate constructs (Table 2).

Manipulation Check

A repeated measures ANOVA on comprehensibility ratings with the within-subject-factors comprehensibility (comprehensible vs. incomprehensible) and argument type (causal vs. noncausal) showed that as intended, arguments designed as comprehensible were considered more comprehensible than arguments designed to be incomprehensible, $F(1,87) = 744.05$, $p < .001$, part. $\eta^2 = .90$. Since neither the main effect of argument type nor the argument type*comprehensibility interaction was significant (both $F(1,87) < 1.90$, *ns*), the manipulation check confirmed comprehensibility to vary orthogonally to argument type.

Perceived Argument Strength

To test H1 (comprehensible arguments are perceived as stronger than incomprehensible arguments) and H2 (causal arguments are perceived as stronger than noncausal arguments) we conducted a repeated measures ANOVA on argument strength measures with comprehensibility and argument type as within-subject-factors. As expected, lay recipients judged comprehensible arguments as stronger than incomprehensible arguments, $F(1,87) = 11.41$, $p < .001$, part. $\eta^2 = .56$. Furthermore, according to our hypothesis, causal arguments were rated as stronger than noncausal arguments, $F(1,87) = 13.07$, $p = .001$, part. $\eta^2 = .13$.

Claim Agreement

H3 (comprehensible arguments cause stronger claim agreement than incomprehensible arguments) and H4 (causal arguments cause stronger claim agreement than noncausal arguments) were tested by subjecting difference-scores of pre-and post-measures of participants' claim agreement to a repeated measures ANOVA. Results showed that in line with H3, participants' agreement with the claim

Table 1: Means and standard deviations (in brackets) for the dependent measures as a function of comprehensibility and type of argument.

Argument condition	Compre-hensibility	Argument strength	Claim agreement		Trust in own decision		Desire for expert advice	
			pre	post	pre	post	pre	post
Compr. causal	6.07 (1.10)	5.85 (1.28)	3.99 (1.08)	5.14 (1.22)	1.24 (0.87)	4.22 (1.87)	6.65 (0.68)	5.72 (1.63)
Incompr. causal	2.14 (1.36)	3.93 (1.59)	3.94 (1.01)	4.93 (1.16)	1.18 (0.70)	3.63 (2.03)	6.55 (0.96)	6.16 (1.29)
Compr. noncausal	6.14 (1.14)	5.16 (1.56)	3.94 (0.99)	5.02 (1.15)	1.18 (0.56)	4.03 (1.85)	6.77 (0.58)	6.00 (1.36)
Incompr. noncausal	1.92 (1.24)	3.50 (1.67)	4.08 (0.91)	4.78 (1.26)	1.17 (0.55)	3.34 (1.93)	6.55 (0.91)	6.25 (1.25)

increased more strongly after reading comprehensible compared to incomprehensible arguments, $F(1,87) = 7.48$, $p = .008$, part. $\eta^2 = .08$. In contrast to our expectations (H4), the extent of agreement change did not differ between argument types, $F(1,87) = 2.624$, *ns*.

Confidence in the Claim Agreement Decision

We had hypothesized laypeople to rely more readily on their own decision about a claim after reading comprehensible compared to incomprehensible arguments, indicated by a higher trust in their own decision (H5) and a weaker desire to consult an expert (H6). Conversely, causal arguments should lead to higher levels of trust in one's own decision (H7) and to a weaker desire to consult an expert (H8) compared to noncausal arguments. To test our hypotheses, we conducted repeated measures ANOVAs on difference-scores of pre-and post-ratings of trust in own decision and desire to consult an expert.

(A) Trust in Own Agreement Decision Participants showed a stronger increase in trust in their own decision after they had read comprehensible compared to incomprehensible arguments, $F(1,87) = 13.271$, $p < .001$, part. $\eta^2 = .132$, providing support for H5. Contrary to H7, changes in trust did not differ between causal and noncausal arguments, $F(1,87) = 1.23$, *ns*.

(B) Desire to Consult an Expert Results indicated that laypeople's desire to seek out expert advice decreased significantly stronger after reading comprehensible arguments than after reading incomprehensible arguments, ($F(1,87) = 15.00$, $p < .001$, part. $\eta^2 = .15$), lending support to H6. H8 was not confirmed, since changes in desire for expert advice did not differ between argument types, $F(1, 87) = 1.08$, *ns*.

Discussion

By confronting recipients with texts of varying easiness, the present study investigated whether laypeople are aware of the limitations of their own epistemic capabilities when having to decide about scientific knowledge claims. We had expected that laypeople would rely less on the division of cognitive labor and thus agree more confidently and strongly with information they consider easy than with information that makes the subject matter appear difficult.

Results show that comprehensibility of scientific texts clearly influences laypeople's agreement to scientific arguments and their reliance on the division of cognitive labor. Participants perceived comprehensible arguments as stronger and were more inclined to agree to the argument claim when they received comprehensible compared to incomprehensible information. Moreover, as we had expected, laypeople were more confident in their agreement decision after reading comprehensible arguments. They showed higher levels of trust in their own decision about the claim and perceived themselves less in need of additional expert advice than after reading incomprehensible arguments.

Findings with regards to argument type only partly confirm our expectations: We found that recipients evaluated causal arguments as stronger than noncausal arguments. This is in line with previous research indicating that laypersons do not evaluate arguments in the same way as experts, who regard

Table 2: Intercorrelation (Pearson's *r*) of the pre/post difference-scores of claim agreement, trust in own decision and desire for expert advice. All correlations are significant at a .05 level.

Argument condition	Claim agreement & Trust in own decision	Claim agreement & Desire for expert advice	Trust in own decision & Desire for expert advice
Compr. causal	.496	-.225	-.460
Incompr. causal	.429	-.250	-.449
Compr. noncausal	.511	-.454	-.389
Incompr. noncausal	.355	-.241	-.373

empirical evidence as the preferable form of claim support and consider explanations unsubstantiated by data as generally weak (Kuhn, 1991; Slusher & Anderson, 1996). Furthermore, by holding comprehensibility constant between both argument types, our results show that laypeople's epistemic preference for causal over noncausal arguments is not due to a confounding with comprehensibility.

However, the influence of argument type on argument evaluation did not transmit to recipients' claim agreement or to their confidence in their claim agreement decision. We assume that stronger and more consistent effects of argument type might be found among a population outside of the academic context, who should be even less familiar with noncausal arguments than our present participants. While we were careful to exclude students from empirical sciences from our sample, their general academic background might have provided our participants at least with some experience in noncausal argumentation, exceeding that of the 'average layperson'.

The present results also indicate that laypeople are generally aware of the necessity to rely on the division of cognitive labor. Even when receiving easy texts, participants' ratings of their desire to ask an expert did not average below 5 on a scale from 1 to 7 (with 7 indicating a strong desire). However, the decreasing influence of information easiness on the perceived need for expert advice suggests that a too strong simplification of scientific contents might mislead lay recipients to underestimate their dependence on experts.

To summarize, our results confirm the assumption that laypeople are more inclined to rely on their own evaluations of scientific contents when they perceive the topic at hand as easy, than when they perceive the issue as beyond their own understanding. Moreover, it seems that whereas comprehensibility has a strong influence on lay recipients' impression of content easiness, the impact of argument type is comparatively small.

The present findings suggest that caution should be taken whenever scientific contents are communicated to laypeople. Popularized science reports, i.e. science depictions especially intended for public consumption, are usually characterized by simplification in order to facilitate the target audience's content understanding (Goldman & Bisanz, 2002; Zimmerman et al., 2001). However, our findings indicate that such simplifications comprise the risk of making scientific knowledge appear less complex and easier to evaluate than it actually is. Therefore, popularized science reports should not only inform laypeople about scientific contents itself but in addition make recipients aware of the fact that the content information presented is generally not sufficient to allow confident evaluations of related knowledge claims.

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