Down to the source! – Laypersons' processing and use of differences in relevant source information when confronted with conflicting scientific claims

Dissertation
der Mathematisch-Naturwissenschaftlichen Fakultät
der Eberhard Karls Universität Tübingen
zur Erlangung des Grades eines
Doktors der Naturwissenschaften
(Dr. rer. nat.)

vorgelegt von
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aus Reutlingen

Tübingen
2021

Gedruckt mit Genehmigung der Mathematisch-Naturwissenschaftlichen Fakultät der Eberhard Karls Universität Tübingen.

Tag der mündlichen Qualifikation:	12.03.2021
Stellvertretender Dekan:	Prof. Dr. József Fortágh
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2. Berichterstatter:	Prof. Dr. Marc Stadtler

Acknowledgements

An dieser Stelle möchte ich zuerst meinen Betreuern Prof. Dr. Yvonne Kammerer und Prof. Dr. Peter Gerjets für die ausgezeichnete Unterstützung während meiner Zeit als Doktorand bedanken. Sie haben es mir mit einer großartigen Balance aus konstruktivem Feedback und der Freiheit eigene Wege zu gehen ermöglicht, diesen Abschnitt meiner akademischen Entwicklung zu meistern.

Mein Dank geht auch an meine Kollegen am IWM, die mich in unterschiedlichster Form während meiner Promotion unterstützt haben: Die Mitglieder der AG 1, die mir seit meiner Zeit als studentische Hilfskraft das Gefühl gegeben haben, willkommen zu sein; Dr. Martina Bientzle, die mir mit ihrem Feedback zu verschiedenen Punkten der Promotion einen klareren Blick auf das Erreichte ermöglicht hat; und natürlich Caro, Georg, Lydia, Sergio, Jennifer, und all die anderen Doktoranden, die mir als Wegbegleiter und Freunde zur Seite standen.

Ich danke meinen Eltern, meiner Familie, und meinen Freunden für ihre unumstößliche Unterstützung durch ereignisreiche Zeiten und ich danke all den anderen Charakteren, die mich in diesem Abenteuer begleitet haben.

Ihr wisst, wer ihr seid!

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Abstract

When reading about scientific topics on the Internet it is common to encounter conflicting knowledge claims rooted in the tentative nature of science, the lacking quality control of online media, or even deliberate misinformation. For laypersons, this poses the challenge of evaluating these scientific claims without being able to draw form the necessary domain knowledge. The research presented in this dissertation aims to investigate source-based strategies of conflict evaluation that laypersons can use even without prior knowledge on the topic at hand. Four experiments with a total of 441 participants were conducted to test how aspects of source information that determine its usefulness in source-based conflict evaluation affect laypersons' attention to and use of source information when confronted with conflicting scientific claims. In all experiments, the participants were presented with two conflicting claims from different sources while source credibility (based on expertise and/or trustworthiness) was manipulated to either differ or be the same between the sources. It was assumed that differences in sources' credibility should affect subjective conflict explanation and agreement with the claims as parts of conflict evaluation, and that the underlying source-based evaluation processes can be detected via increased visual attention on source information when differences in sources' credibility are present. In line with these assumptions, differences in sources' expertise or trustworthiness led to increased subjective conflict explanation via sources' competence or motivation and affected agreement with the respective claims. In later experiments that used eye-tracking to measure moment-to-moment processing of source information, differences in sources' trustworthiness also led to increased visual attention to relevant source information. These findings are discussed in the context of theories from multiple documents comprehension and possible avenues of application, that could help to support laypersons in an informed and self-determined evaluation of scientific conflicts using sourcing, are proposed.

Zusammenfassung

Bei der Recherche zu wissenschaftlichen Themen im Internet stößt man häufig auf widersprüchliche Behauptungen, die aufgrund des fragilen und vorläufigen Charakters von Wissenschaft, fehlender Qualitätskontrolle von Online-Medien oder auch absichtlicher Fehlinformation entstanden sein können. Für Laien stellt dies die Herausforderung dar, die widersprüchlichen wissenschaftlichen Behauptungen zu bewerten, ohne auf notwendiges Vorwissen zurückgreifen zu können. Die in dieser Dissertation vorgestellte Forschung zielt darauf ab, quellenbasierte Strategien bei der Bewertung solcher Konflikte zu untersuchen, die Laien auch ohne Vorwissen über das jeweilige Thema nutzen können. In vier Experimenten mit insgesamt 441 Teilnehmern wurde untersucht, wie sich Aspekte von Quelleninformation, die deren Nützlichkeit bei der quellenbasierten Konfliktbewertung mitbestimmen, auf die Aufmerksamkeit und Nutzung von Quelleninformationen durch Laien auswirken, wenn letztere mit widersprüchlichen wissenschaftlichen Aussagen konfrontiert werden. In den Experimenten wurden den Teilnehmern zwei widersprüchliche Behauptungen aus verschiedenen Quellen präsentiert und dabei die Glaubwürdigkeit der Quellen (basierend auf Expertise und/oder Vertrauenswürdigkeit) so manipuliert, dass sie zwischen den Quellen entweder unterschiedlich oder vergleichbar war. Es wurde angenommen, dass Unterschiede in der Glaubwürdigkeit der Quellen die subjektive Konflikterklärung sowie die Zustimmung zu den Behauptungen als Teile von Konfliktbewertung beeinflussen sollten, und dass die zugrundeliegenden quellenbasierten Bewertungsprozesse über eine erhöhte visuelle Aufmerksamkeit auf die Quelleninformation messbar sind, wenn es Unterschiede in der Glaubwürdigkeit der Quellen gibt. In Übereinstimmung mit diesen Annahmen führten Unterschiede in der Expertise oder Vertrauenswürdigkeit der Quellen zu einer erhöhten subjektiven Konflikterklärung über die Kompetenz oder Motivation der Quellen und beeinflussten die Zustimmung zu den jeweiligen Behauptungen. In späteren Experimenten, die Eye-Tracking zur Messung der Verarbeitungsprozesse von Quelleninformationen einsetzten, führten Unterschiede in der Vertrauenswürdigkeit von Quellen zusätzlich zu einer erhöhten visuellen Aufmerksamkeit auf relevante Quelleninformationen. Diese Befunde werden im Kontext von Theorien zum Verstehen multipler Dokumente diskutiert und es werden mögliche Anwendungswege aufgezeigt, die helfen könnten, Laien bei einer informierten und selbstbestimmten Bewertung von wissenschaftlichen Konflikten mit Hilfe der verfügbaren Quelleninformationen zu unterstützen.

List of publications

Published manuscripts

Gottschling, S., Kammerer, Y., & Gerjets, P. (2019). Readers' processing and use of source information as a function of its usefulness to explain conflicting scientific claims. *Discourse Processes*, *56*(5–6), 429–446. https://doi.org/10.1080/0163853X.2019.1610305

Gottschling, S., Kammerer, Y., Thomm, E., & Gerjets, P. (2020). How laypersons consider differences in sources' trustworthiness and expertise in their regulation and resolution of scientific conflicts. *International Journal of Science Education, Part B, 10(*4), 35-354. https://doi.org/10.1080/21548455.2020.1849856

Submitted manuscripts

Gottschling, S., Kammerer, Y. (2021) Readers' regulation and resolution of a scientific conflict based on differences in source information: an eye-tracking study. *Submitted manuscript.*

Contributions

The contributions of the PhD student (and all co-authors) to the publications and manuscripts that are part of this cumulative dissertation can be found in the following tables:

Author	Author position	Scientific ideas %	Data generation %	Analysis & interpretation %	Paper writing %
Steffen Gottschling	1	50%	80%	60%	60%
Yvonne Kammerer	2	20%	20%	30%	30%
Eva Thomm	3	20%	0%	0%	10%
Peter Gerjets	4	10%	0%	10%	0%
Title of publication:		How laypersons consider differences in sources' trustworthiness and expertise in their regulation and resolution of scientific conflicts			
Status in publication process:		published			

Author	Author position	Scientific ideas %	Data generation %	Analysis & interpretation %	Paper writing %
Steffen Gottschling	1	60%	80%	70%	60%
Yvonne Kammerer	2	30%	20%	20%	30%
Peter Gerjets	3	10%	0%	10%	10%
Title of publication:		Readers' processing and use of source information as a function of its usefulness to explain conflicting scientific claims			
Status in publication process:		published			

Author	Author position	Scientific ideas %	Data generation %	Analysis & interpretation %	Paper writing %
Steffen Gottschling	1	70%	90%	80%	70%
Yvonne Kammerer	2	30%	10%	20%	30%
Title of publication:		Readers' regulation and resolution of a scientific conflict based on differences in source information: an eye-tracking study			
Status in publication process:		submitted			

Introduction

The spread of misinformation has been identified as a major educational and societal challenge over the last years (Scheufele & Krause, 2019; Sharon & Baram-Tsabari, 2020; Williamson, 2016). Especially on the Internet, we are continuously confronted with conflicting and potentially false information that may affect what we perceive to be true. If we are not able to identify false or unreliable claims within this often conflict-rich information environment, we might make decision based on such erroneous assumptions (Kobayashi, 2018). However, especially for laypersons, it can be difficult to evaluate scientific knowledge claims encountered in advertisement, on social media or during information gathering via search engines. That is because, in contrast to experts, laypersons commonly lack domain knowledge as well as knowledge on common conventions for the presentation and communication of information in the given domain (Bromme & Goldman, 2014; Hendriks et al., 2016). In light of these limitations, one frequently discussed strategy that laypersons can use to evaluate scientific conflicts and conflicting claims is sourcing (Braasch & Scharrer, 2020; Bråten et al., 2017; Britt & Rouet, 2012; Stadtler & Bromme, 2014). In this context, sourcing can be defined as "attending to, evaluating, and using available or accessible information about the sources of documents, such as who authored them" (Bråten et al., 2017, p. 141). Especially with the amount of misinformation and outright disinformation campaigns regarding socio-scientific issues that could be observed on the Internet over the last decade (Allgaier, 2019; Kata, 2010; Kouzy et al., 2020), effective sourcing is regarded as a skill of growing importance for scientific literacy (Britt et al., 2014; Halverson et al., 2010; Tabak, 2015; Wiley et al., 2009). Therefore, the work presented in this dissertation – four experimental studies published or submitted across three scientific papers – aims to further the understanding of underlying processes at play when laypersons use source information during the evaluation of conflicting scientific claims. Ultimately, the goal is to contribute to informing science communication and education on how to support laypersons in an informed and self-determined evaluation of scientific conflicts using sourcing.

In this introduction I will give a short overview regarding previous research conducted on sourcing in the context of conflicting information over the last decades, the theoretical models built on it, and how it informed the research questions pursued in this dissertation. Naturally, this overview will not be exhaustive, but will instead focus

on literature with the highest relevance for the aims and research questions of this dissertation.

The theoretical interplay of content and sources

Early systematic research on sourcing is rooted in the field of social psychology where the effects of source credibility on persuasion were investigated (for a review see Pornpitakpan, 2004). This research resulted in early theoretical frameworks that theorize on sourcing, like the Heuristic-Systematic Model (HSM; Chaiken, 1987) and the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986). Both the HSM and the ELM differentiate between low-effort elaboration, during which propositions are accepted (or declined) based on superficial cues and heuristics used by the recipient, and high-effort elaboration that requires motivation and the ability to evaluate the merit of the propositions. While the HSM identifies source information mainly as a cue that can be used during low-effort elaboration of a proposition, the ELM considers the different roles of source information during both low-effort and high-effort elaboration. On one hand, in the context of low-effort elaboration, source information (such as the perceived credibility of the source) can be used as a simple cue to accept (or decline) a proposition. On the other hand, it can also inform high-effort elaboration as an argument in itself or by increasing the recipients' confidence in their previous evaluation of a proposition given by the respective source (Wegener et al., 2018). Taken together, these frameworks from the domain of social psychology describe ways in which source information and especially the perceived credibility of sources can affect the persuasiveness of claims and are backed by an extensive body of evidence (e.g., Hovland & Weiss, 1951; McGinnies & Ward, 1980).

Two aspects of source information that are commonly identified to play an important role for the perceived credibility of sources are expertise and trustworthiness (Hovland & Weiss, 1951; Lombardi et al., 2014; Pornpitakpan, 2004; Rouet, Saux, et al., 2020; Werner da Rosa & Otero, 2018). In this context, expertise (or competence) can be defined as the perceived ability of the source to provide relevant and valid information while trustworthiness (or in some cases benevolence) is defined as the perceived willingness of the source to do so (Danielson, 2006; Sperber et al., 2010).

Source information as a link between multiple documents

Both the HSM and ELM, however, are rather restrictive in their applicability for the information environments that this dissertation is centered on: scientific conflicts. This is because, due to their focus on persuasion, they only give limited thought to processes and strategies through which readers build their comprehension of the available information. In this context, more recent frameworks from the area of multiple document literacy are more applicable since they take into account that information may come from different documents, while the majority of research on persuasion focuses on single documents or messages (Wegener et al., 2018).

The Documents Model Framework (DMF, Britt et al., 1999, 2013; Britt & Rouet, 2012; Perfetti et al., 1999) builds upon single text comprehension theories (e.g., Kintsch, 1988) to provide assumptions on how readers should build a global understanding across multiple (potentially conflicting) documents from different sources. According to the DMF, an adequate mental representation across multiple documents requires the integration of source information (e.g. document type, authors identity, or date of publication) and the content provided by the respective sources. Following this assumption, the Documents Model proposed in this framework encompasses two submodels: The Situations Model, containing constructed Situation Models for each document based on its content and the Intertext Model representing the relationship between the documents. For each available document, the Intertext Model contains a Document Node that can be filled with source information regarding the document (for an overview of the Documents Model see Figure 1). This source information can then be used to inform the relationships between documents and, if it is mapped to information within the Situations Model via source-content links, to potentially explain the existence of conflict between different elements of information across Situation Models. As an example, imagine a person searching for effective sunscreen on the Internet. If they find claims stating that sunscreen using nanoparticles as a UV filter is especially effective and safe, but also claims stating that nanoparticles used in sunscreen can enter the human body through the skin and may cause bodily harm, these claims stand in direct conflict to each other and cause incoherence within the Situations Model. In case these claims stem from different sources, for example a scientist from the field of nanosafety and a researcher working for a company producing sunscreen, this source information can be integrated in the Intertext Model, to then be used to explain that different perspectives exist. Furthermore, (under ideal

circumstances) the available source information can even be used to explain the emergence of the conflict via the source-link to a specific claim, namely in our example: potential bias of the researcher at company who may claim that a product is safe due to monetary incentives.

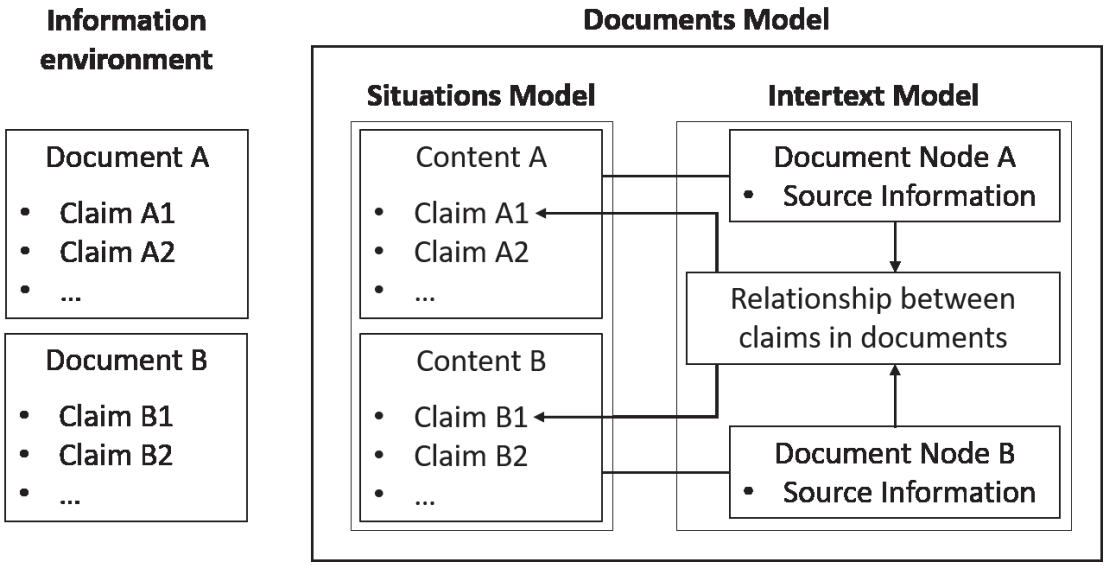

Figure 1. Reader's representation of contents and sources from multiple documents based on the Documents Model Framework by Perfetti et al. (1999).

The DMF was also later expanded to include the necessity of readers' attention to sources that are embedded within documents (e.g. in journalistic articles) in addition to the source of the document itself, to create a more accurate mental representation of the available information (Britt et al., 2013; Strømsø et al., 2013). An important restriction stated in all iterations of the DMF is that it refers to an ideal way of forming a mental representation over multiple documents providing information. Based on readers' deficits in prior knowledge, sourcing skills, general reading skills, and the information environment, the Situations and Intertext Model can remain incomplete resulting in limited understanding of a conflict (Britt et al., 1999, 2013; Perfetti et al., 1999).

Sourcing in the context of reading goals

Additional aspects that are expected to influence the completion level of Documents Models are the given task and readers' goals during the involvement with the documents. These aspects are more thoroughly explored in the Multiple-Document

Task-based Relevance Assessment and Content Extraction (MD-TRACE; Rouet & Britt, 2011) model and the REading as problem SOLVing (RESOLV; Britt et al., 2017; Rouet et al., 2017) model. The MD-TRACE model describes the use of multiple documents as “a cycle of processing steps and decisions” rooted in a subjective task model that is formed based on contextual cues and represents expected outcomes and goals of the specific multiple document use. One important decision in this case is if a document is relevant in the context of the task model. Based on this decision, the document or specific information within it is either processed further or may alternatively be ignored. In this context, source information can be either used to assess the reliability and therefore task-relevance of a document or can be task-relevant information in itself – for example if the reading goal is to gather a list of arguments including sources. In similar manner, the RESOLV model examines the formation of a task model based on physical and social context and identifies the question if specific information (e.g. source information) is relevant for the task as a central routine decision during the formation of a Documents Model. Based on the given task model and reading goals, the thresholds for decisions on when to attend and how to use source information can change due to benefit-cost analysis by the reader. In line with this, studies have shown increased use of source information based on requirements of given tasks (for a review see Wiley & Jaeger, 2018).

Specific reading goals that should emerge within task models when confronted with conflicting claims on a topic are expected to be the explanation and resolution of this conflict. Readers generally strive to construct a coherent representation of available information (Braasch & Scharrer, 2020; Kintsch, 1988). Disruptions of a reader’s coherence standards should therefore lead to strategic processes directed to re-establishing coherence (Graesser, 2007; Graesser et al., 1994; van den Broek et al., 2011).

Conflict-driven attention to sources

As already introduced in the context of the DMF (Perfetti et al., 1999), one way to re-establish coherence between multiple conflicting documents can be the use of source information. In the context of this reading goal, sources should therefore be regarded as relevant information (by competent readers) and, according to the MD-TRACE or RESOLVE model, should be processed as such. In line with this reasoning, the Discrepancy-Induced Source Comprehension (D-ISC; Braasch et al., 2012; Braasch &

Bråten, 2017) model specifically explores conflict between multiple sources as a trigger for increased processing of source information. The D-ISC model assumes that additional attention is directed towards source information when conflict within information available to the reader is detected. This additional attention is also attributed to strategic processing with the goal to re-establish coherence within the mental representation of the information. Support for the D-ISC model has been provided by multiple studies that showed increased attention to source information when conflicting information was presented within one (Braasch et al., 2012; Rouet et al., 2016; Saux et al., 2017, 2018, 2021) or between multiple documents (Kammerer et al., 2016), as compared to when only consistent information was presented. Another study by Stang Lund et al. (2017) also showed that memory for a conflict between claims within a text predicted the amount of source-content links in the mental representation of readers assessed with a matching task.

The specific case of laypersons and scientific conflicts

While the theoretical models presented up to this point illuminate the role of sourcing during the evaluation of conflicting information from multiple perspectives, they do not specifically differentiate between experts' and laypersons' evaluation of conflict and do not make specific statements on scientific conflicts. The Content-Source Integration (CSI; Stadtler & Bromme, 2014) model, however, focuses on situations in which laypersons need to evaluate conflicting scientific claims against each other and is therefore especially relevant for the subject of this dissertation. The CSI model proposes that laypersons' evaluation of scientific conflicts is comprised of three stages that build upon each other: conflict detection, conflict regulation, and conflict resolution.

Conflict detection

The first stage, conflict detection, is the key requirement for the latter processes and encompasses the detection of incoherence between propositions within one or multiple documents. Generally, readers show to be appropriately skilled in conflict detection within expository texts (e.g., Wiley & Myers, 2003). However, the probability with which conflicts are detected is still affected by variables like reading goals (Stadtler et al., 2011) and textual variables (Delgado et al., 2020; Stadtler et al., 2013; Wiley & Myers, 2003). Importantly, Stadtler et al. (2014) emphasize that conflict detection is not tantamount with the integration of the conflict into a mental representation or the

general interpretation of the conflict. These processes regarding the evaluation of the detected conflict are reserved for the following stages.

Conflict regulation

The second stage, conflict regulation, is driven by the previously introduced reading goal to restore coherence after a conflict is detected that impedes the building of a coherent mental representation of the available information. The CSI model identifies three ways in which this goal can be achieved. The first is to ignore the conflict entirely, which is only practical if the conflicting information is not relevant for the readers current task or reading goal. The second option is to reconcile the conflicting proposition by forming additional inferences that explain the conflict. The potential problem that laypersons face here is that, due to their limited prior knowledge, they might often form unwarranted inferences. However, the explanation of conflict using inferences based on source information can also be viewed as a first way of conflict regulation via sourcing. This form of conflict regulation was also investigated by Thomm and colleagues who identified source expertise and source benevolence as two source features that are used by laypersons in their subjective explanations of conflicting scientific claims (Thomm et al., 2015; Thomm & Bromme, 2016). The third option uses source information in a more general way to re-establish coherence, by accepting conflicting claims as due to different sources with distinct perspectives on the topic.

Conflict resolution

The third stage, conflict resolution, considers situations where conflict regulation and the formation of a coherent mental representation are not sufficient for the reader and reading goals include developing a personal stance on the conflict. In this case the conflicting claims within the conflict need to be evaluated and weighed against each other based on the available information. The CSI model differentiates between two pathways of evaluation and considers their availability for experts and laypersons. The first path is described as the direct (or first-hand) pathway of evaluation and encompasses evaluating the validity of claims based on prior domain knowledge (i.e. evaluating which claim is true or more accurate). The second, indirect (or second-hand) pathway of evaluation uses source information to evaluate the validity of claims via the credibility of their respective sources. Since, per definition, laypersons generally lack the domain knowledge to use the direct pathway reliably, the indirect pathway of

evaluation should be easier to use for laypersons (e.g. Bromme et al., 2015) as long as they can infer the credibility of sources based on available source information (i.e. sources' expertise or trustworthiness). A similar assumption is made by the two-step model of validation (Richter & Maier, 2017) in that strategic validation of claims (for example via source information) should be used especially when initial processes of knowledge activation (based on prior knowledge) regarding the claims fail to result in a satisfactorily coherent representation. In line with these assumptions, multiple studies have shown that available source information can influence the evaluation of claims in the context of scientific conflicts (Kammerer et al., 2016; Kobayashi, 2014; Paul et al., 2019).

It should be noted that conflict resolution gains in importance when readers want to decide on actions based on the conflicting information since the described validation processes of conflicting scientific claims might not only lead to changes in beliefs but also behavioral intent (Kobayashi, 2018), which in turn is a determinant of future behavior (Fishbein & Ajzen, 2011).

Laypersons (lacking) dependence on source information

One important point emphasized by the CSI model (Stadtler & Bromme, 2014) is that source information should be especially relevant for laypersons since they lack the domain knowledge to form correct content-based inferences for conflict regulation or to directly evaluate conflicting claims for conflict resolution. Source information therefore provides a more reliable pathway of evaluation in the absence of prior domain knowledge. However, studies have shown repeatedly that readers with low domain knowledge also show less use of source information compared to readers with higher domain when confronted with conflict across scientific domains like history (Barzilai et al., 2020; Wineburg, 1991), medicine (Bråten et al., 2015; Bromme et al., 2015), or psychology (Brand-Gruwel et al., 2017; von der Mühlen et al., 2016). Furthermore, many laypersons (most often samples of high school or undergraduate students) show generally low attention to and use of source information in the context of multiple documents on socio-scientific topics (Barzilai et al., 2015; Brem et al., 2001; Gerjets et al., 2011; Kammerer et al., 2016; Kiili et al., 2008).

This lack of sourcing might not necessarily be caused by a lack of skill concerning sourcing though. For instance, a study by Kobayashi (2014) in which undergraduate students read conflicting explanations regarding a (fictional)

relationship between blood type and personality with varying credibility between the sources, came to the conclusion that the students are capable of sourcing but do not use it to a satisfactory degree. This is an important point to consider since, for those laypersons that use sourcing in the context of conflicting information, it is found to be positively correlated with multiple desirable outcome variables connected to reading comprehension (for an overview see Bråten et al., 2017). These findings include increased argumentation quality (Anmarkrud et al., 2014; Barzilai et al., 2015; Barzilai & Eshet-Alkalai, 2015) and inclusion of relevant concepts (Goldman et al., 2012) in post reading essays. Furthermore, in a study by Bråten et al. (2009) attention to relevant source features positively predicted text comprehension independent of prior knowledge.

What is useful source information for laypersons?

The question arises, why source information is so regularly disregarded by laypersons even though its' integration into a mental representation of conflicting information is reported to enhance understanding and can potentially help to resolve conflicting information. Based on the previously presented literature there is a number of potential reasons for this. Possibly, the conflict might not be detected resulting in no subjective need for conflict regulation (Stadtler & Bromme, 2014) and no additional attention to source information (Braasch et al., 2012; Stang Lund et al., 2017). Or the laypersons lack the skills necessary to integrate available source information into a mental representation of the conflict (Perfetti et al., 1999) and/or to interpret it in a way that allows building the necessary inferences for conflict regulation and resolution. Another related explanation could be that laypersons in many cases may not regard the source information available as useful for the evaluation of the conflict and, following the argumentation of the MD-TRACE (Rouet & Britt, 2011) or RESOLV (Rouet et al., 2017) models, decide against strategic processing of source information. This latter explanation finds support in a study by Saux et al. (2018) that showed increased source memory in the presence of conflicting claims, selectively for source information that was relevant for the given task. Task-relevant source information in their study was related to the origin of the sources' knowledge while task-irrelevant source information related to the physical appearance of the sources. Saux and colleagues interpret this as evidence that these effects on source memory are linked to strategic reading goals. A more recent study by Rouet et al. (2020) expanded these results by showing that in

the context of a reading task focused on source knowledge, a more knowledgeable source was also preferred over a source with an irrelevant source feature, especially when the claims of the sources were discrepant.

Building on the assumption that the re-establishment of coherence during conflict regulation and the development of a personal stance during conflict resolution are central reading goals that arise when confronted with conflicting scientific claims, it can be assumed that characteristics of source information that can be used to achieve these goals will garner additional processing of the respective source information. This should lead to an additional increase in visual attention for source information that can be used to regulate and/or resolve the conflict over the initial effect in the context of the D-ISC assumption (Braasch et al., 2012; Braasch & Bråten, 2017). Based on the idea of indirect claim evaluation stated in the CSI model (Stadtler & Bromme, 2014), one characteristic of source information that should lead to this effect is the presence of differences in source information that lead to perceived differences in the credibility of the sources. Examples for characteristics of source information and how they can be used for reading goals during conflict evaluation are given in Table 1.

Table 1. Examples for different levels of available source information and their usefulness in the evaluation of a scientific conflict based on the CSI model (Stadtler & Bromme, 2014)

Available source information	Examples for source information		Possible ways to use the source information for conflict evaluation
	Source A	Source B	
No distinct sources	-	-	-
Distinct Sources; irrelevant source information	Person with brown eyes	Person with green eyes	General explanation of the conflict as due to different sources with different perspectives
Distinct Sources; relevant source information (without differences)	Scientist at a company	Scientist at a company	Specific conflict explanations with (limited) possible inferences based on sources
Distinct sources; differences in relevant source information	Scientist at a university	Scientist for a company	Specific conflict explanations with possible inferences based on differences between sources; Conflict resolution based on differences in source credibility

If in the presence of conflicting information we expect strategic processing of source information to be responsible for increased visual attention to source information, as stated by the D-ISC model (Braasch & Bråten, 2017), and if we expect especially high strategic processing for source information that can be used by

laypersons to regulate and resolve a scientific conflict, in accordance with the CSI model (Stadtler & Bromme, 2014), there should be especially high visual attention on source information indicating relevant differences between conflicting sources. In contrast, without differences in source information that can be used to explain the conflict and validate the claims strategical processing of source information should be more limited (Richter & Maier, 2017). To further scientific insight into these aspects of sourcing by laypersons, studies are needed that investigate if they differentiate in their attention to and their use of source information based on its usefulness to regulate and resolve a scientific conflict which would be in line with the CSI model and the other introduced models of multiple documents comprehension.

The current dissertation

To investigate this new assumption, four experiments with a total of 441 participants were conducted. All experiments used a design comparable to Thomm & Bromme (2016), in that participants were subsequently presented with two conflicting scientific claims, while source information was manipulated between participants to either provide differences in relevant source information (trustworthiness and/or expertise) or not. Scientific conflicts from the domain of nanosafety were used since we expected prior knowledge on these topics to be lower than in many other domains with socioscientific conflicts (Pillai & Bezbaruah, 2017), which should encourage the use of second-hand evaluation (Stadtler & Bromme, 2014). The claims were presented on separate pages that participants could navigate freely without a time limit. After the conflict presentation, subjective conflict explanation was assessed with the Explaining Conflicting Scientific Claims (ECSC, Thomm et al., 2015) questionnaire as a measure of conflict regulation. Claim agreement with both claims was assessed as a measure of conflict resolution. Additionally, source memory was measured as a dependent variable in all experiments and source evaluation was assessed as a manipulation check. For an overview of dependent variables and their operationalization across the experiments see Table 1.

Experiment 1

The first experiment (Gottschling et al., 2020) was implemented as an online-experiment and aimed at investigating general effects of differences in the trustworthiness and/or expertise of sources on laypersons' conflict regulation and

resolution. Two conflicting scientific claims regarding the safety of nanoparticles as UV blockers in sunscreen were presented to 144 participants while source information was manipulated so that scientists putting forward the claims differed in their trustworthiness and/or expertise. Importantly, other than in previous studies on the effects of the presence of differences in sources' trustworthiness and expertise (e.g., Thomm & Bromme, 2016), these differences were manipulated independent of each other resulting in four experimental conditions. One claim was consistently presented as stemming from a professor of nanotechnology working at a university as a baseline, while the other claim was said to stem from (a) either another professor of nanosafety at a university (control condition with no relevant differences), (b) a professor of nanotechnology working for a company (trustworthiness-differences condition), (c) a junior scientist of nanoscience working at a university (expertise-differences condition), or (d) a junior scientist working for a company (combined-differences condition). All source information was integrated into the claim texts. After self-paced reading of the conflict, participants' subjective conflict explanation, claim agreement, source memory, and source evaluation were assessed. Additionally, the time spent reading each of the two claims was measured. It was examined how differences in sources' trustworthiness and expertise affected these measures and whether respective effects were additive or interactive.

Experiment 2 and Experiment 3

The second and third experiment (Gottschling et al., 2019) were conducted as a combination of online survey and laboratory experiment. They expanded upon the first experiment by adding fixation time on relevant source information as a process measure, using eye-tracking. For these experiments, only the presence or absence of differences in sources' trustworthiness were manipulated, resulting in only a control condition and a trustworthiness-differences condition. A total of 79 (second experiment) and 76 (third experiment) participants were presented with the same conflicting claims as in the first experiment. In both experiments, participants were asked to answer questions regarding their prior knowledge and attitudes towards nanotechnology as well as their general explanation for scientific conflicts in an online questionnaire. One week later, the conflict presentation was conducted in a laboratory setting with eye-tracking and the same dependent variables as in the first experiment were assessed.

Experiment 4

The fourth experiment (Gottschling & Kammerer, 2021) was again conducted as a combination of online survey and laboratory experiment with eye-tracking. A total of 144 participants were recruited for this study. The aim was to replicate the previous findings with two changes in the experimental design. First, the conflicting claims used were changed in a way to be more equal in their persuasiveness (without arguments or source information). Now, each of the sources claimed one specific type of nanoparticle to be potentially dangerous when used as an UV-blocker in sunscreen while another was described as safe. To generate conflict between the claims, these types of nanoparticles where switched between the sources. Second, an additional control group in which both sources were of low trustworthiness due to potential biases (scientists working for a nanotechnology company) was used to ensure effects were indeed based on differences in source information and not due to the presence of (at least) one untrustworthy source. As an additional dependent variable compared to the previous experiments, participants were asked to rate their willingness to use sunscreen containing either of the two nanoparticles as a measure of behavioral intent.

Table 2. Overview over dependent variables and their operationalization across the experiments.

		Dependent variables					
Experiment	N	Source evaluation (manipulation check)	Subjective conflict explanation	Claim agreement	Behavioural intent	Source processing	Source memory
1	144	two 7-point-scales each for source trustworthiness and source expertise per source	ECSC dimensions	7-point-scale for agreement per claim	-	-	multiple choice question with four options for each claim
2	79	two 7-point-scales each for source trustworthiness and source expertise per source	ECSC dimensions	7-point-scale for agreement per claim	-	eye-tracking (total fixation duration on source information)	free recall task + multiple choice question with four options for each claim
3	76	two 7-point-scales each for source trustworthiness and source expertise per source	ECSC dimensions	7-point-scale for agreement per claim	-	eye-tracking (total first-/second-pass fixation duration on source information)	free recall task + cued recall task
4	144	two 7-point-scales each for source trustworthiness and source expertise per source	ECSC dimensions	7-point-scale for agreement per claim	7-point-scale for willingness to use per product endorsed by source	eye-tracking (total first-/second-pass fixation duration on source information)	free recall task + cued recall task

Objectives and expected outcomes of the doctoral research

Taken together, the aim of the four experiments within this dissertation was to investigate the processes of layperson's source use in the context of conflicting scientific claims and if they differentiate between situations in which source information can and cannot be used to regulate and resolve scientific conflicts.

Laypersons were expected to be able to identify source features that indicate differences in the expertise and/or trustworthiness between sources within a scientific conflict and to evaluate the sources accordingly. This should result in lower trustworthiness and/or competence evaluations for sources with lower trustworthiness and/or expertise indicated through available source information (manipulation check).

Based on these evaluations and their integration into a mental representation of the conflict (Perfetti et al., 1999), laypersons were expected to form inferences on the origins of the conflict (Stadtler & Bromme, 2014). This should result in increased subjective conflict explanations (a) via differences in researchers' competence when differences in sources' expertise are present and (b) via differences in researchers' motivations when differences in sources' trustworthiness are present.

Regarding conflict resolution, differences in relevant source information were expected to be used to indirectly evaluate the conflicting scientific claims and inform a preference for one of the claims (Stadtler & Bromme, 2014). This should result in stronger differences between the agreement scores of the claims when differences in relevant source information regarding credibility are present. Furthermore, this effect should result in higher agreement for the claim presented by the source with higher expertise or trustworthiness than for the source with lower expertise or trustworthiness when differences are present.

Most importantly, the strategic processes based on relevant differences in source information should lead to deeper processing and therefore to more visual attention on relevant source information. Thus, laypersons were expected to show longer total fixation durations on source information when relevant differences in relevant source information (that can be used in conflict regulation and/or resolution) are present compared to absent. This increased processing of source information should in turn lead to better source memory, as a measure of source-content links in the context of the DMF (Perfetti et al., 1999), when differences in relevant source information are present compared to absent.

Summary of results

In this section a summary of the experimental results of the doctoral research is given for all dependent variables. Furthermore, meta-analyses across experiments are reported to give a clearer picture of the data and more general effect sizes for the central findings of this dissertation.

Source evaluation (manipulation check)

Analyses of source evaluations conducted to ensure that the manipulation of differences in relevant source information affected perceived source expertise and trustworthiness in the intended manner, showed the following results: Sources with low indicated expertise were perceived as less competent than sources with high indicated expertise (Experiment 1), while sources with low indicated trustworthiness were perceived as less trustworthy than sources with high indicated trustworthiness (all experiments). This effect held true for sources within experimental conditions with differences in sources' trustworthiness present as well as between experimental conditions with two sources of low and two sources of high trustworthiness in the respective groups.

Subjective conflict explanation

In line with the expected outcomes of this thesis, increased explanation for the scientific conflict via differences in researchers' motivation was found when differences in sources' trustworthiness were indicated by source information compared to when sources did not differ in their indicated trustworthiness. This was the case in all experiments. Additionally, in Experiment 1, with differences in sources' expertise indicated by source information, readers showed increased subjective conflict explanation via differences in researchers' competence. In addition to these expected effects, there was also an increase in subjective conflict explanation via differences in researchers' competence when differences in sources' trustworthiness were indicated (Experiment 1) compared to when such differences were indicated. Another effect that was not part of the hypotheses in this research showed for subjective conflict explanation via differences in researchers' motivations in Experiment 4. Here, not only participants in the condition with differences in trustworthiness but also those in the condition with two sources of equally low trustworthiness showed increased conflict

explanation via differences in researchers' motivations compared to the condition with two source of equally high trustworthiness indicated by source information.

Although the focus of this doctoral research was on source-related conflict explanations, there have also been some effects on knowledge-related conflict explanation across the experiments. In Experiment 1 the absence of relevant differences in source information led to increased conflict explanation via differences in research process while in Experiment 3 – without differences in sources' trustworthiness – subjective conflict explanation via topic complexity were higher than with such differences.

Claim agreement

In similar manner to the effects on subjective conflict information, all experiments, except for Experiment 2, showed that differences in relevant source information regarding credibility led to increased differences in claim agreement for the claims of the respective sources. Agreement with the claim of the less trustworthy (or less expert) source was observed to be generally lower than with the claim of the source with high trustworthiness (or expertise) indicated by source information.

Behavioral intent

In Experiment 4, effects on willingness to use products based on the endorsement within the conflicting claims were examined as an additional measure of behavioral intent. Results showed that differences in sources' trustworthiness indicated by source information led to increased differences in the willingness to use the products endorsed by the respective sources.

Processing of relevant source information

As predicted, all three eye-tracking experiments presented within this thesis showed increased visual processing of relevant source information (operationalized with total fixation duration) when differences in sources' trustworthiness indicated by source information were present compared to when they were absent. While, in Experiment 2, this effect was shown for total fixation duration on relevant source information, Experiments 3 and 4 differentiated further between first-pass and second-pass fixation duration. In Experiment 3, both total first- and second-pass fixation duration on relevant source information were increased when differences in sources trustworthiness

indicated by source information were present compared to absent. In Experiment 4, this was only the case for total second-pass fixation duration.

Source memory

For source memory none of the conducted studies showed a significant positive effect of differences in relevant source information (trustworthiness or expertise) on readers' performance in recall tasks for source memory. However, for Experiment 4, an exploratory mediation analysis conducted for the effects of differences in sources' trustworthiness on source memory with second-pass fixation duration on relevant source information as the mediator showed a significant negative direct effect of differences in sources' trustworthiness, as well as a significant positive indirect effect via second-pass fixation duration on a cued and a free recall task of relevant source information.

Meta-analyses

In this section the results of meta-analyses conducted over all experiments are presented in order to give a clearer overview of the data and more precise effect sizes for the central findings of this dissertation. For all meta-analyses presented the effect of differences in sources' trustworthiness (vs. no differences in trustworthiness) are observed and the pooled effect size for the dependent variables conflict explanation via differences in researchers' motivations (*Figure 3*), differences in claim agreement (*Figure 4*), and fixation time on relevant source information (*Figure 5*) are calculated. To this end the means and standard deviations of the dependent variables are used for random effect meta-analyses using the R-package dmetar (Harrer et al., 2019). To make the effects comparable between experiments, only experimental groups with high source expertise for both sources were included since these groups were present in all experiments. While this leads to decreased statistical power for some of the comparisons concerned leading to more conservative estimate for the effects, it decreases the heterogeneity between the effects and thereby increases the quality of each metanalysis.

Also, an additional experiment that is not presented within this dissertation was included within the meta-analyses. The experiment was used as a pilot study for this doctoral research and included the same material as the first experiment but without the experimental group including both differences in expertise and trustworthiness

present. Since the relevant experimental groups for the meta-analyses are present in this pilot study and to reduce “publication bias” within the data, it was decided to include it in the following analyses.

Conflict explanation

For the meta-analysis on subjective conflict explanation via differences in researchers’ motivation, the respective ECSC scores for each group were used. The meta-analysis shows a medium significant effect of differences in trustworthiness of sources (see *Figure 2*), *SMD* = 0.53, 95%-CI = [0.09; 0.97], I^2 = 55%.

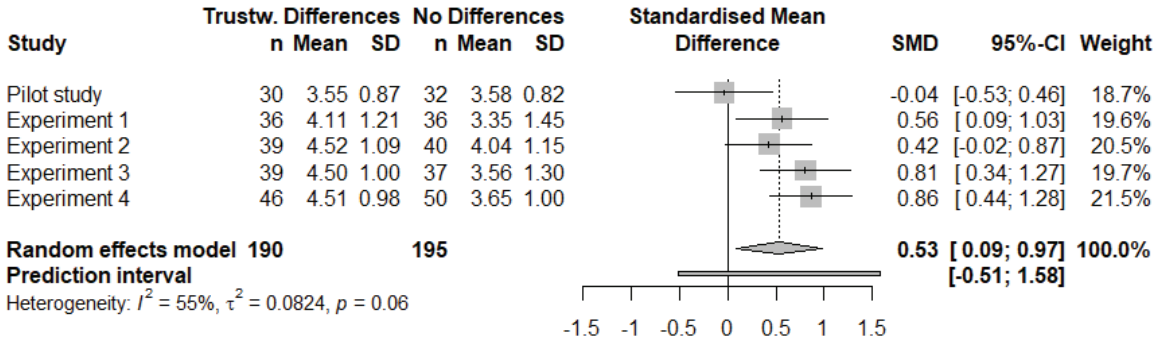

Figure 2. Forest plot showing the standardized mean difference (SMD or Cohens’ d) for the differences in *researchers’ motivations* scale of the Explaining Conflicting Scientific Claims (ECSC) questionnaire (Thomm et al., 2015) between experimental groups with differences in sources’ trustworthiness or no relevant source differences across all experiments that were part of this doctoral research.

Claim agreement

For the meta-analysis on differences in claim agreement, the absolute difference of claim agreement scores for each group was used. While this measure was only used in the fourth experiment of this dissertation, it was the only one with the best comparability between populations within the meta-analysis. It is also expected that this should be a more conservative measure than in the other experiments. The meta-analysis shows a medium effect of differences in trustworthiness of sources (see *Figure 3*), *SMD* = 0.45, 95%-CI = [0.07; 0.82], I^2 = 42%.

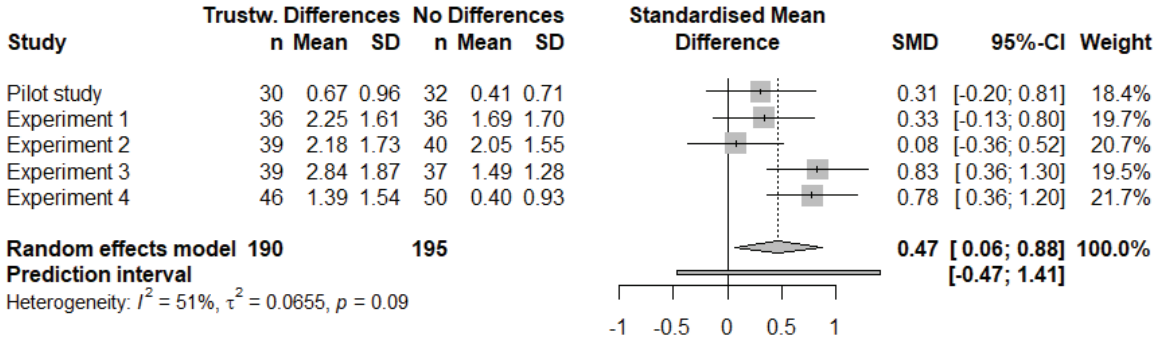

Figure 3. Forest plot showing the standardized mean difference (SMD or Cohens' d) for the absolute difference in claim agreement across experimental groups with differences in sources' trustworthiness or no relevant source differences across all experiments that were part of this doctoral research.

Processing of relevant source information

For the meta-analysis on total fixation duration on relevant source information, the respective the sum of second-pass fixation durations (or all fixation durations for Experiment 2) on relevant source information was used for each group. The meta-analysis shows a medium significant effect of differences in trustworthiness of sources (see *Figure 4*), *SMD* = 0.52, 95%-CI = [0.25; 0.80], I^2 = 0%.

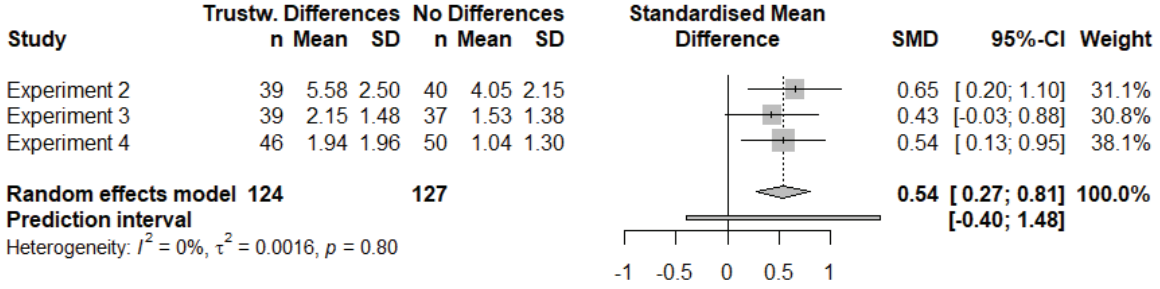

Figure 4. Forest plot showing the standardized mean difference (SMD or Cohens' d) for the total second-pass fixation duration (total overall fixation duration for Experiment 2) on relevant source information between experimental groups with differences in sources' trustworthiness or no relevant source differences across all eye-tracking experiments that were part of this doctoral research.

Discussion

Laypersons are continuously confronted with conflicting and, in part, false information when they try to inform themselves on scientific issues via the Internet. The goal of this dissertation was to investigate the processes in which laypersons use source information in their regulation and resolution of scientific conflicts since they cannot fall back on prior domain knowledge for validation. It was proposed that especially differences in relevant source information should, due to their potential usefulness in the explanation, regulation, and resolution of the conflicts, enjoy special prioritization during the strategic processing of source information. Therefore, these differences should not only affect conflict explanation and resolution but should also garner additional visual attention compared to source information without relevant differences in the context of scientific conflicts.

In this section the major findings of the experiments regarding source evaluation, subjective conflict explanation, claim agreement, and source processing as well as the meta analyses presented in this dissertation will be discussed in the context of prior findings and theories regarding multiple documents comprehension. Subsequently, limitations of the present research and possible applications of the findings will be addressed. Finally, a conclusion and outlook for future directions of similar research will be presented.

How source evaluations inform subjective conflict explanations

Regarding the source evaluations that were used in all experiments to ensure the source information was interpreted in the way intended by the experimental manipulation, the results indicate that laypersons paid attention to source information and were able to identify and interpret it in the intended manner. More specifically, the results show that a professor working at a university was perceived as more trustworthy than a professor working for a company and a professor working in the field for ten years was perceived as more competent than a junior researcher working in the field since one year. These effects were in line with studies by Thomm and Bromme (2016) who used a similar alteration of source information to manipulate aspects of source credibility. Importantly, based on these findings regarding source evaluation, it is reasonable to expect that the following effects of differences in relevant source

information are (at least in part) driven by the perception and evaluation of the sources based on these differences.

The first way in which these source evaluations seem to take effect, based on the theoretical considerations and results of this dissertation, are in laypersons subjective conflict explanation. These explanations were used as an operationalization of conflict regulation since they build upon additional inferences based on information that is not directly linked to the veracity of the claims. Throughout all experiments, differences in relevant source information affected subjective conflict explanations in the expected manner. Differences in sources' expertise led to increased subjective conflict explanation via differences in sources' competence, while differences in sources' trustworthiness led to increased subjective conflict explanation via differences in the sources' motivations. The results of the meta-analysis conducted over all experiments also support these findings (for trustworthiness) and suggest that it is a substantial effect with a medium effect size. This is not only in line with results of Thomm and Bromme (2016) but also can be interpreted as the use of source information to reestablish coherence within the mental representation of the conflict as expected in the DMF (Britt & Rouet, 2012; Perfetti et al., 1999). Here, it is important to note that in all experiments source information was no longer available for reading when participants made their judgments for conflict explanations. The fact that differences in source information affected subjective conflict explanation from memory gives further support for the assumption that source information is integrated in a mental intertext model when reading multiple documents or perspectives. In relation to the CSI model (Stadtler & Bromme, 2014), the results suggest that source information can be used in conflict regulation not only by accepting the conflict as due to different perspectives of multiple sources, but also by making inferences to explain the conflict based on source information. Another interesting finding in this regard was the increased conflict explanation via researchers' motivations when both sources had potential monetary interests in the fourth experiment. In this case source information affected conflict explanation (compared to the control group without any potential biases indicated by source information) even without differences in source information between the sources. Even though this effect was not hypothesized during the development of the experiment, it does make sense in the context of the underlying assumptions. When both sources have potential vested interest to make their knowledge claim, this allows the inference that the conflict resulted from one or both

sources acting based on this interest. Since this additional finding was not part of the hypotheses, however, it should only be interpreted with caution.

Conflict resolution and behavioral intent

In order to investigate effects on laypersons' conflict resolution, the experiments within this dissertation used differences in agreement with the knowledge claims of the respective sources. In the first, third, and fourth experiment, differences in sources' trustworthiness (and expertise in case of Experiment 1) indicated by source information led to increased differences in claim agreement compared to when no such differences were present. Following the argumentation of the CSI model (Stadtler & Bromme, 2014), this should be due to indirect evaluation of the conflicting knowledge claims based on the perceived credibility of the sources (see also Bromme et al., 2015; Bromme & Goldman, 2014). This is also in line with assumptions of the two-step model of validation by Richter and Maier (2017): When initial knowledge activation does not yield a clear validation of a claim, more strategic source-based validation processes might be used (e.g. Rouet, Ros, et al., 2020). These strategic processes based on available source information might also be reflected by the increased visual attention on relevant source information that will be discussed more detailed in the following section. The lack of an effect on claim agreement in Experiment 2 might be due to a free recall task for the content of the claim that was positioned between claim presentation and the retrieval of claim agreement. This might have made source information less salient compared to the content of the claims, shifting the focus to more content-based validation and reducing the effect of differences in sources' trustworthiness on claim agreement. Still, most of the findings as well as the conducted meta-analysis suggest that differences in sources' trustworthiness (and expertise in the case of Experiment 1) can affect conflict evaluation in a substantial way, which was expected since these aspects of source credibility have previously been shown to affect the agreement with respective claims (Kobayashi, 2014; Paul et al., 2019).

An important addition to these findings stems from Experiment 4, in which participants' willingness to use products endorsed through the knowledge claims was introduced as a measure of behavioral intent. As expected, and in parallel to the effect on claim agreement, differences in sources trustworthiness also affected this measure, indicating that the indirect evaluation of claims via source information is not only of theoretical interest but might also affect laypersons future behavior. While a study by

Kobayashi (2018) already showed that changes in beliefs through exposure to conflicting scientific claims can extend to behavioral intent, Experiment 4 of this dissertation indicates that behavioral intent can also be affected by differences in source information within a scientific conflict.

Strategic processing of source information

The eye-tracking data collected in the later experiments of this dissertation give some insight in how differences in relevant source information affect attentional processes during reading. Additional visual attention was allocated to source information that indicated differences in sources' trustworthiness and could therefore be used to explain and resolve the conflict. Again, this is in line with the theoretical considerations of the CSI model (Stadtler & Bromme, 2014), if we expect strategic processes during conflict regulation and conflict resolution to encourage increased processing of information that can be used for their successful completion. The results of the fourth experiment further accentuate these findings. Since the control group with two potentially biased sources did not show increased fixation time on source information while the group with differences in sources' trustworthiness did, these effects on visual attention cannot be explained by the mere presence of compromised trustworthiness of the sources. Instead, it seems that the effect on visual attention is driven by the differences in relevant source information. Taken together, these results indicate that in addition to the increased processing of source information in the context of conflicting information (D-ISC assumption; see Braasch et al., 2012; Kammerer et al., 2016; Rouet et al., 2016; Saux et al., 2017), attention to source information is especially high when it can be used to regulate and resolve the conflict. This in line with Saux et al. (2018), who showed that the presence of conflicting information increased memory performance especially for task-relevant source information but the present findings extend this by showing a distinct effect of differences in relevant source information and by using eye-tracking as a process measure of visual attention. Since the effects on visual attention where mainly observed for second-pass fixation duration, it can be assumed that they are indeed based on strategic validation processes of the textual information (Hyönä et al., 2003; Maier et al., 2018). This is especially important in light of the results on source memory that will be discussed next.

Compared to the previously discussed results of the experiments, the findings on source memory do not seem to fit the image provided by the rest of the available data. The lack of direct positive effects of differences in relevant source information on the performance in the different recall tasks across experiments not only contradicts prior findings of Thomm and Bromme (2016) but also seems perplexing in the context of the observed effects on second-pass fixation time. While plausible explanations have been proposed for minor disconnects between online and offline measures of text processing (Ferreira & Yang, 2019; Salmerón et al., 2018), the seemingly stark contrast between the results on visual attention to and memory of relevant source information imposes the question why differences in relevant source information increased visual attention to, but not memory of relevant source information. One possible explanation is that the generally high performance in the source memory tasks led to ceiling effects, weakening a possible effect due to the already high performance in the groups without differences in source information. While this might have been the case for the relatively easy multiple-choice task, from Experiment 2 onward a free recall task was used that seems to have been more difficult based on the observed performance of readers, reducing the chance of a ceiling effect. The most convincing explanation, therefore, is based on the exploratory mediation analysis in Experiment 4. For both the free and the cued recall task used in this experiment, the mediation analysis showed a direct negative effect of differences in sources' trustworthiness on source memory performance. This could be explained with an increase in task difficulty through the introduction of additional information that varied across the two sources. Readers had to remember a set of two source features instead of the same feature twice and could also mix up these features up during the recall task, which was not a risk without differences in sources' trustworthiness. Additionally, the mediation analysis showed an indirect positive effect of differences in sources' trustworthiness on performance with total second-pass fixation duration as the mediator for both recall tasks. This indirect effect is in line with the assumptions of the present research in that strategic processing of relevant source information is increased – based on its usefulness in the regulation and resolution of the scientific conflict – and mediates source memory as a measure of the integration of source information into the mental representation of the conflict (i.e. source-content links; Britt et al., 1999; Perfetti et al., 1999). The fact that the direct and indirect effect have contrary directions could explain the lack of an overall effect of differences in relevant source information on source

memory across the experiments within this dissertation. However, since this mediation analysis was exploratory, more experiments will be needed to further inform this assumption.

Possible avenues for application

Generally, the results of this dissertation show that that laypersons are able to use source information in meaningful ways during their regulation and resolution of scientific conflicts. One requirement for this kind of sourcing, seems to be the presence of differences in relevant source information between the sources of the conflicting claims. Based on these findings, science communication and science education can encourage more effective sourcing in two major ways. First, for science communication, by ensuring that useful source information is readily available for the recipients of communicated science. And second, for science education, by ensuring laypersons are aware of aspects of source information that are important in different context of scientific conflicts. Together this should encourage more self-determined evaluation of scientific conflict based on available source information.

A more specific way to apply the findings of this dissertation could lie in the use of source information within refutation texts. Refutation texts try to stimulate knowledge revision of scientific misconceptions within the public. To achieve this, refutation texts provide a given misconception together with an explanation of why it is false as well as correct information on the topic (Kendeou et al., 2016; Tippett, 2010). This resembles the information environment of the experimental design within this dissertation in that two (more or less scientific) knowledge claims stand in conflict with each other. Based on effects on claim evaluation within this research, providing additional source information for each claim could result in increased agreement with the correct information and therefore more successful knowledge revision. Of course, this should especially be the case for situations where misconceptions are based on claims of sources with low trustworthiness regarding the topic. There have been some studies regarding the role of source information in refutation texts, yet, these studies only investigated effects of differences in the credibility of the source of the whole refutation text (Butterfuss, 2020; Van Boekel et al., 2017). Nonetheless, it was shown that higher source credibility lead to increased knowledge revision compared to a source with lower credibility. Based on our findings and the assumptions regarding indirect claim evaluation within the CSI model (Stadtler & Bromme, 2014), useful source information

on the level of embedded sources for the knowledge claims could have the potential to further enhance knowledge revision.

Limitations and future research

Naturally, the research within this dissertation does not come without limitations. As discussed in the individual publications, a first important point that must be acknowledged is the limited generalizability of the findings.

A first factor in this regard are the samples used in the individual experiments. Participants consisted either predominantly or exclusively of university students and therefore represented a convenience sample that might differ from a more general population in the use of source information. While prior domain knowledge was controlled and generally low across all experiments, it can be argued that university students might have more experience in dealing with source information in scientific contexts or that they might have acquired more sourcing skills compared to the general population due to their above-average education (Bromme et al., 2015; von der Mühlen et al., 2016). They could also show distinct preferences in their explanations for scientific conflicts due to previous exposure (Johnson & Dieckmann, 2018). However, it can also be argued that the expected sourcing skills within this subpopulation make it a good candidate for first investigations on moment-to-moment processes during sourcing especially because there is a particularly high chance of sourcing to occur with this sample.

Another aspect of generalizability that can be viewed as a limitation is the fact that the effects have only be investigated regarding one content domain. The domain of nanosafety was chosen to ensure low prior domain knowledge (Pillai & Bezbaruah, 2017) which should encourage the indirect evaluation of claims via source information (Stadtler & Bromme, 2014) and therefore facilitate the observation of the related effects regarding the processing of source information. However, studies have shown that subjective conflict explanation for scientific conflicts can vary from one scientific domain to another (Dieckmann et al., 2017; Thomm & Bromme, 2016) and it stands to reason that, especially for conflict explanation, the contexts of the scientific domain could moderate the effects of sourcing. Additionally, for the domain of nanosafety, prior attitudes are expected to be relatively weak and balanced (Pillai & Bezbaruah, 2017) compared to other domains were effects like confirmation bias (Nickerson, 1998) or biased assimilation (Greitemeyer et al., 2009; Munro & Ditto, 1997) play major roles

during conflict regulation and resolution and might superimpose effects of differences in relevant source information.

A final issue regarding generalizability lies in the presentation of the conflict in the experiments within this dissertation. While the well-controlled and standardized material used is most definitely a strength of this research, it also limits external validity. Even though the material was designed in a way to be relatable to information environments on the Internet (with the information based on real online articles and claims given on separate html-sites), actual information found online is often more complex and source information more difficult to locate than references given directly in the text. For example, source information might only be available in a separate section like “about us” and more than two sources from multiple websites will often be involved. Additionally, different levels of source information (embedded sources vs. sources of the documents) as described in newer iterations of the DMF (Britt et al., 2013; Strømsø et al., 2013) can further complicate the formation of relations between sources within the intertext model.

Taken together, the conditions for the use of source information in the regulation and resolution of scientific conflicts in the presented experiments can be described as close to a best-case scenario. These ideal conditions regarding sample, content, and information environment allowed the investigation of underlying processes regarding the effects of useful source information in a controlled setting with little to no disruptive factors. Therefore, future studies should aim to replicate these effects with a more diverse sample of the population, within different content domains, and with more natural information environments to ensure that the observed effects hold true under these more complex conditions.

Another direction for future research regarding the effects of differences in relevant source information lies in the variation of different reading tasks. Depending on the task at hand when reading scientific information, the task-relevance of specific aspects of source information can vary and so can what differences of source information are useful for the reader in the context of the formed reading goals. While the different effects of source trustworthiness on conflict explanation and conflict resolution in Experiment 4 hint at how the same aspects of source information might affect some processes of conflict evaluation but not others based on their usefulness for the respective reading goals, this was not the focus of the present line of research and should only be interpreted with caution. Nonetheless, the variation of reading tasks

and with them what differences in source information are relevant (or useful) could be another way to investigate the assumption that the presence of differences in (task-) relevant source information is an important factor in how it is processed and used by readers. Additionally, such experiments could contextualize the observed effects of differences in source information within models that put more emphasis on tasks and reading goals like the MD-TRACE (Rouet & Britt, 2011) or RESOLV (Rouet et al., 2017) models.

Conclusion and outlook

To conclude, the research within this dissertation provides further evidence for laypersons' use of source information during the evaluation of scientific conflicts and identifies the usefulness of source information for conflict explanation and resolution as a possible moderator for these sourcing processes. The use of eye-tracking in the later experiments made it possible to investigate moment-to-moment attentional processes and showed how differences in relevant source information between sources can lead to deeper strategic processing of this information. Of course, more research on these processes in more natural contexts will be needed in the future but the present findings can already inform applications in science communication and science education. As a general rule, accurate and easily available source information that can be used for sourcing strategies should be provided wherever possible. At the same time, the importance of sourcing as a legitimate strategy to evaluate scientific information should conveyed in science education together with aspects of source information that can be used in this regard. In combination these steps give laypersons the best conditions to identify relevant source information and use it for self-determined evaluation of scientific conflicts. Misinformation on the Internet will continue to be a problem of great societal importance and supporting laypersons in their evaluation of scientific knowledge claims will therefore be an ongoing challenge of growing importance in the coming years and decades.

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Appendices

Appendix A: Manuscript 1 (Experiment 1)

Appendix B: Manuscript 2 (Experiment 2 and Experiment 3)

Appendix C: Manuscript 3 (Experiment 4)

Appendix A: Experiment 1

Please cite as:

Gottschling, S., Kammerer, Y., Thomm, E., & Gerjets, P. (2020). How Laypersons Consider Differences in Sources' Trustworthiness and Expertise in their Regulation and Resolution of Scientific Conflicts. *International Journal of Science Education, Part B 10*(4), 335-354. https://doi.org/10.1080/21548455.2020.1849856

The International Journal of Science Education, Part B is available online under:

https://www.tandfonline.com/toc/rsed20/current

How Laypersons Consider Differences in Sources' Trustworthiness and Expertise in their Regulation and Resolution of Scientific Conflicts

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How Laypersons Consider Differences in Sources' Trustworthiness and Expertise in their Regulation and Resolution of Scientific Conflicts

When reading scientific information on the Internet laypersons frequently encounter conflicting claims. However, they usually lack the ability to resolve these scientific conflicts based on their own prior knowledge. This study aims to investigate how differences in the trustworthiness and/or expertise of the sources putting forward the conflicting claims affect laypersons' explanation and resolution of the scientific conflict. We sequentially presented 144 participants with two conflicting scientific claims regarding the safety of nanoparticles in sunscreen and manipulated whether the scientists putting forward the claims differed in their trustworthiness and/or expertise. After having read the claims on a computer in a self-paced manner, participants rated their subjective explanations for the conflicting claims, assessed their personal claim agreement, and completed a source memory task. We examined how differences in source trustworthiness and source expertise affected these measures, and whether respective effects were additive or interactive. Results showed that trustworthiness differences resulted in higher attribution of the conflict to motivational explanations, and expertise differences in higher attribution of the conflict to competence explanations, than no respective differences. Furthermore, main effects of trustworthiness differences and of expertise differences on readers' claim agreement were shown, with participants agreeing more with claims from sources of higher trustworthiness or expertise. Finally, for both trustworthiness and expertise differences reading times of the claims were shorter than without respective differences.

Keywords: multiple document comprehension; source information; scientific conflicts; conflict explanation; conflict resolution

Introduction

Laypersons frequently need to find answers to complex and conflicting science-related questions that may affect their daily lives and personal decisions. ‘Is the sun helpful or harmful to my health?’, or ‘Is this ingredient in sunscreen safe?’ may serve as some examples. However, laypersons – per definition – do not have enough prior knowledge to adequately answer respective questions without the help of expert sources (Bromme & Goldman, 2014). The internet has simplified the access to scientific information; however, it often provides multiple perspectives and discrepant claims put forward by various sources. For example, one website may present the claim that sunscreen containing nanoparticles provides better protection from UV radiation and is safer than conventional products, while another website may point out potential negative consequences for our health by nanoparticles entering our body through the skin barrier. Thus, laypersons frequently need to decide not only whether to believe a scientific claim, but also *which* claim to believe in (if any at all), and the evaluation of multiple documents or perspectives becomes a central role in scientific literacy (Britt et al., 2014; Halverson et al., 2010; Lang et al., 2020; Sharon & Baram-Tsabari, 2020). This is a difficult task, since laypersons often lack prior knowledge and may rely on fragmentary understandings of complex scientific issues.

One potential way to overcome this challenge is to evaluate the sources providing the claims (Bromme et al., 2010, 2015; Stadtler & Bromme, 2014). In line with this, Kolstø (2001) identified the evaluation of information sources’ interests, neutrality, and competence as important strategies of students to resolve a socio-scientific conflict (i.e., “to decide who and what to trust”, p. 877). These strategies address aspects of source trustworthiness and source expertise, which are commonly identified as dimensions of source credibility (Hovland & Weiß, 1951; see also e.g., Bråten et al., 2010; Pornpitakpan, 2004; Rouet et al., 2020; Werner da Rosa & Otero, 2018). In this context, trustworthiness refers to the extent to

which a source is perceived to be willing to provide accurate and unbiased information, and expertise to the extent to which a source is perceived to be able, and thus competent, to provide accurate and valid information (Danielson, 2006; Sperber et al., 2010). That is, readers may perceive an expert in a field as more trustworthy if the expert works for a university rather than for a company, and therefore conceive the former source as more credible. Likewise, they may perceive a professor as having more expertise in his or her field of research than a junior scientist, and therefore to be a more credible source.

To our knowledge, previous studies that investigated the influence of these source features on conflict evaluation have varied either trustworthiness or expertise differences, while holding the other dimension of source credibility constant (e.g., Gottschling et al., 2019; Thomm & Bromme, 2016; Thomm et al., 2015). The goal of the present study was to examine how differences in both source trustworthiness and source expertise (as indicated by available source information) affect readers' subjective explanations for the conflicting claims, their personal agreement with the claims, and their source memory, as compared to situations in which sources do not differ in their trustworthiness and/or expertise.

With this study we thus aimed to contribute to the growing body of research on how laypersons reconcile discrepant scientific accounts based on source information. The results can be valuable and informative to further identify and detail skills on how to critically evaluate information and information sources. Such skills become increasingly relevant for laypersons within their everyday life and, thus, also need to be addressed as part of science education in schools (Sharon & Baram-Tsabari, 2020).

Processing of Conflicting Scientific Claims and the Use of Source Information

While a number of theoretical models on the use and representation of source information when reading multiple texts have been introduced in recent years (Braasch et al., 2012; Britt et al., 2013; List & Alexander, 2017; Perfetti et al., 1999; Rouet et al., 2017; Rouet & Britt,

2011), the present research is mainly based on the theoretical assumptions of the content-source integration (CSI) model proposed by Stadtler and Bromme (2014), which specifically addresses the use of source information to explain (or regulate) and resolve conflicting scientific claims. The CSI model proposes three stages of processing conflicting scientific claims readers can go through. The first stage, conflict detection, in which readers need to detect the lack of coherence between claims, is a prerequisite to engage in the subsequent stages. In the present research, however, we focus on the second stage, that is conflict regulation, and the third stage, that is conflict resolution, as source information plays an essential role in these stages.

Conflict Regulation

During the stage of conflict regulation readers try to re-establish coherence for themselves either (a) by ignoring the conflict or disputing its importance, (b) by reconciling the conflict by drawing additional inferences, or (c) by accepting and explaining it as due to different sources (Stadtler & Bromme, 2014). Ignoring a present conflict, while arguably the easiest option, will generally not lead to a resolution of the conflict and is therefore not regarded as a desirable option in this context. The second option, reconciling the conflicting claims by drawing additional inferences, refers to searching for explanations for the conflict provided in the document(s), generating one's own explanations, or explaining the conflict away, respectively (Otero & Campanario, 1990).

Finally, the third option, accepting the conflict as due to different sources, is a first way in which source information can affect conflict regulation. While this process does not necessarily encompass specific explanations for why the two sources might differ in their claims, it requires the understanding that different sources and perspectives can lead to conflicting claims (Bromme et al., 2015). Based on this understanding, the reader can integrate the conflicting information into a global, coherent mental representation, given that

contents are indexed onto the respective sources represented. This process is also described by the Documents Model framework (Britt & Rouet, 2012; Perfetti et al., 1999), on which the CSI model builds on, and specifically, by the documents-as-entities assumption of the Documents Model framework (Britt et al., 2013).

In addition, in some cases available source information cannot only be used to explain *that* a conflict emerged, but also to explain *why* it might have emerged (Braasch & Scharrer, 2020). As an example, two scientists might differ in their claims as to whether sunscreen containing nanoparticles is safe for use. If background information about the scientists (i.e., source information) indicates that one scientist is independent while the other scientist works for a company producing nano products, this information might be used as a subjective explanation for the conflict, in this case differences in the scientists' motivations (i.e., whether or not they have potential vested interests).

Prior studies have shown that differences in source trustworthiness (operationalized by potential vested interests) or source expertise (operationalized by the extent of professional experience) increased readers' attribution of the conflict to scientists' motivations or competence, respectively, as subjective explanations for the conflict, as compared to situations without such differences (Gottschling et al., 2019; Thomm & Bromme, 2016; Thomm et al., 2015). In these studies, readers were presented with two conflicting claims regarding scientific topics. While the source given for one claim was a scientist of high expertise and trustworthiness (i.e., a university professor), the source of the second claim was indicated to be either of the same standing (i.e., another university professor), or inferior in terms of expertise or trustworthiness (i.e., a professor working for a company or a junior scientist). Furthermore, Gottschling et al. (2019) recorded participants' eye movements while reading the conflicting claims and found increased attention to source information when the sources differed in their trustworthiness than when they did not differ in their trustworthiness.

As an indirect indication for increased processing of source information, Thomm and Bromme (2016) found that participants showed better memory for source information when differences in source trustworthiness and source expertise were present than when the sources were of equal trustworthiness and expertise (i.e., when both sources were university professors). In contrast, however, Gottschling et al. (2019) did not find an effect on source memory. Yet, as we will elaborate next, differences in source trustworthiness and source expertise may not only affect conflict regulation, but also readers' conflict resolution.

Conflict Resolution

To resolve a scientific conflict and, thus, to develop a personal stance toward it, readers need to not only explain the conflict but also judge the validity of the conflicting claims (cf. Braasch & Scharrer, 2020). According to Stadtler and Bromme (2014), there are two major pathways to resolve conflicting scientific claims: a first-hand approach and a second-hand approach. The first-hand approach implies that readers evaluate the validity of a claim based on their own knowledge and beliefs, and, hence, assess directly what appears to be true. Laypersons, however, may not be able to reliably judge claim validity directly due to their bounded understanding (Bromme & Goldman, 2014). Instead, they may engage in a second-hand approach and evaluate claim validity based on the perceived credibility of their sources. Consequently, they may assess whom to believe instead of what to believe.

In line with this reasoning, an interview study by Bromme and colleagues (2015) showed that laypersons focused mainly on second-hand evaluation strategies when asked to resolve and decide on conflicting scientific claims about a medical topic. Also, in a qualitative observational study by Halverson et al. (2010), source credibility was found to be one of the most prevalent criteria used by students when choosing and evaluating websites for a report on a controversial biotechnology subject. Further experimental research revealed that readers being confronted with conflicting claims agreed more with the position of sources

that appear to be more trustworthy (Gottschling et al., 2019; Paul et al., 2019) or more competent (Kobayashi, 2014), although it should be noted that one other study did not find such effects on claim agreement (Thomm & Bromme, 2016). Readers also have been shown to rate arguments of a source with potential vested interests as less convincing than those of a neutral source (Kammerer et al., 2016) or to cite sources they perceive as more trustworthy more often in their written argumentation about the conflicting scientific issue (Bråten et al., 2015; List et al., 2017). In contrast, if source information does not indicate any differences in source trustworthiness or source expertise, conflicts between scientific claims cannot be resolved by means of a second-hand approach (cf. Gottschling et al., 2019; for a similar argumentation, see Richter & Maier, 2017).

While previous research has varied either the presence of differences in source trustworthiness or source expertise when laypersons face conflicting scientific claims, the present study aims to examine whether respective effects on conflict regulation and conflict resolution are additive (i.e., main effects for both trustworthiness differences and expertise differences and no interaction) or interactive (e.g., over-additive, such that trustworthiness differences and expertise differences in combination would have an even stronger effect than alone).

Present Study

The main goal of the present study is to replicate and extend previous findings on the role of differences in source trustworthiness and source expertise on readers' conflict regulation and conflict resolution (Gottschling et al., 2019; Thomm & Bromme, 2016). This will help to better understand how laypersons use cues that point to the sources' credibility to explain unfamiliar conflicting scientific claims and to decide which claim to agree with more.

To this end, we varied differences (as compared to no differences) in the trustworthiness and expertise of two sources that put forward two conflicting scientific

claims. Specifically, other than in previous research, in the present study differences in source trustworthiness and source expertise were manipulated independently of each other, resulting in four experimental conditions. In each condition, one claim was said to stem from a university professor (baseline source) while the source information of the second claim was varied according to the condition (comparison source; cf. Gottschling et al., 2019; Thomm & Bromme, 2016). The scientific conflict used in our study addressed a topic from the domain of nanotechnology, specifically nanosafety, which dealt with the question as to whether nanoparticles in sunscreen are safe. We expected prior knowledge on this topic to be lower than on many other socioscientific issues (Pillai & Bezbaruah, 2017), which, in turn, should facilitate the examination of effects associated with the second-hand approach to evaluation (Stadtler & Bromme, 2014). Regarding our dependent variables we differentiated between conflict explanation as a part of conflict regulation and claim agreement as a part of conflict resolution.

While some previous studies presented both claims simultaneously (Braasch et al., 2012; Saux et al., 2017; Thomm & Bromme, 2016), we used a sequential presentation of the conflicting claims (Gottschling et al., 2019; Kobayashi, 2014), which is typical to situations on the Internet where opposing claims are often found on different websites. We ensured that source information was no longer present when participants were asked to provide explanations for the conflict and to judge their agreement with the claims. Effects of differences in source trustworthiness or source expertise on conflict explanation or claim agreement would therefore indicate readers' integration of source information into a mental representation, as also suggested by the Documents Model framework (Britt & Rouet, 2012; Perfetti et al., 1999).

Hypotheses

Based on our theoretical and empirical background analysis, we examined the following hypotheses: First, regarding conflict regulation, we assumed that perceived differences in source trustworthiness should lead readers to attribute the conflict more strongly to motivational explanations than when confronted with sources without differences in trustworthiness (H1a). Likewise, perceived differences in source expertise should lead readers to attribute the conflict more strongly to competence explanations than when confronted with sources without differences in expertise (H1b).

Second, regarding conflict resolution, we expected that perceived differences in source trustworthiness and source expertise should affect readers' agreement with the two claims as described in the CSI model, because these differences can be used for an indirect evaluation of the validity of the claims. Accordingly, there should be less agreement with the claim put forward by the less trustworthy source than with the claim of the more trustworthy source, whereas when confronted with sources without differences in trustworthiness, agreement to the claims put forward by the two sources should be comparable (H2a). Likewise, there should be less agreement with the claim put forward by the less expert source than with the claim of the more expert source, whereas when confronted with sources without differences in expertise, agreement to the claims put forward by the two sources should be comparable (H2b).

Third, we also expected better memory for source information in conditions with differences in source trustworthiness and/or source expertise compared to conditions without the respective differences, due to a deeper processing of source information to regulate and resolve the conflict in the former case. Accordingly, source memory should be higher with differences in source trustworthiness than without such differences (H3a). Likewise, source

memory should be higher with differences in source expertise than without such differences (H3b).

In addition to these hypotheses, we explored potential interactions between differences in source trustworthiness and differences in source expertise on conflict explanation, claim agreement, and source memory. However, we did not have directed hypotheses regarding such interaction effects. Furthermore, we explored how differences in source trustworthiness and source expertise affect process measures, such as, reading times of claims and revisits to the claims.

Materials and Methods

Participants

Participants were recruited via a local, web-based online recruitment system. Participants had the chance to win one of twenty 10€ Amazon-vouchers. The study was approved by the local ethics committee. Overall, data of $N = 178$ participants were collected. However, 22 datasets were excluded for the following reasons: (a) because participants studied psychology and might have participated in the pretest reported below ($n = 5$); (b) because they had finished the questionnaire in insufficient time to read all of the material (less than eight minutes; $n = 10$); or (c) because they interrupted their participation for at least 20 minutes ($n = 7$). Subsequently, we only included the first 36 participants by date of finishing the questionnaire for each experimental group (for details see Section 'Experimental Design') to ensure a completely counterbalanced design regarding the combination and sequence of claims and sources. Accordingly, the final sample consisted of $N = 144$ participants (68.75% female, 96.53% university students) from a variety of majors (42.36% from social sciences and humanities, 43.06% from natural sciences, 10.42% from psychology, and 4.17% unspecified), with an average age of 26.36 years ($SD = 9.52$). On average, participants reported moderate interest ($M = 3.13$, $SD = 1.07$) and low prior topic knowledge ($M = 1.97$,

247 *SD* = 1.10) concerning nanotechnology, as assessed in the beginning of the study with two
248 single self-report items with 5-point Likert scales from 1 (‘very low’) to 5 (‘very high’).

249 ***Material***

250 All materials were presented in German. The study was conducted as an online study using
251 the survey platform Qualtrics (Qualtrics, Provo, UT). The study was designed to be processed
252 in approximately fifteen minutes.

253 *Scenario and Claims*

254 Participants were presented with a conflict scenario from the field of nanosafety. We used a
255 topic that was expected to have personal relevance for a large proportion of participants, that
256 is, the use of nanoparticles in sunscreen. First, participants were given introductory
257 information on the use of nanoparticles as a UV-blocker in sunscreen and were informed
258 about the controversy on whether these nanoparticles can penetrate the human skin and
259 therefore might cause health risks. Participants, then, were informed that in the following
260 they would be presented with information from the websites of two scientists that put forward
261 opposing claims on this topic (Gottschling et al., 2019; Thomm & Bromme, 2016).
262 Participants were asked to carefully read the two opposing positions in order to answer
263 questions on the controversy afterwards. The two claims presented as part of the scenario
264 were that studies have shown nanoparticles to be unable to penetrate the human skin (Claim
265 A) or that studies have shown nanoparticles to be able to penetrate the human skin (Claim B).
266 These claims were based on authentic reports and adapted for use in this study. Both claims
267 were of similar length, structure, and readability (for detailed information on the claims see
268 Table 1 and for the translated claims Appendix A). The two claims were presented on
269 separate HTML pages.

270 The claims were pretested (without source information) in an independent sample
271 regarding perceived comprehensibility and convincingness. A total of 32 undergraduate

psychology students (M_{age} = 21.38, SD_{age} = 2.95, 27 female) assessed both variables on a seven-point Likert scale (1, 'very low' to 7, 'very high'). Paired t-tests showed no significant differences in the perceived comprehensibility of the claims ($t(31) = 1.09$, $p = .282$) while Claim B was perceived as somewhat more convincing ($t(31) = -2.33$, $p = .027$) than Claim A. To ensure that this possible difference in claim convincingness could not affect the results of this study, the combination of claims and source information was counterbalanced.

Table 1

Information on claim material (without source information)

	Claim A	Claim B
Number of words	56	56
Number of characters	355	346
Readability score[a]	61.9	63.7
Perceived comprehensibility[b]	5.78 (1.29)	5.62 (1.26)
Perceived convincingness[b]	3.38 (1.39)	4.00 (1.41)

[a]German readability score (Lesbarkeitsindex; LIX)
[b]Mean scores (and standard deviations) from the material pretest

Manipulation of Differences in Trustworthiness and Expertise

To manipulate differences in source trustworthiness and source expertise, source information was added to each of the two claims (23 additional words per claim). One claim was consistently said to stem from a professor of nanoscience working at a university, being publicly funded, and having 10 years of experience in the research field ('baseline source' in every experimental group, i.e., high trustworthiness and high expertise). The opposing claim (put forward by the 'comparison source') was said to stem from (a) a professor of nanoscience working for a company, being industrially funded, and having 10 years of experience in the research field (i.e., low trustworthiness, but high expertise; trustworthiness-difference group), (b) a junior scientist of nanoscience working at a university, being publicly funded, and having one year of experience in the research field (i.e., high trustworthiness, but low expertise; expertise-difference group), (c) a junior scientist of nanoscience working for a company, being industrially funded, and having one year of experience in the research field

(i.e., low trustworthiness and low expertise; combined-difference group), or (d) another professor of nanoscience working at a university, being publicly funded, and also having ten years of experience in the research field (i.e., high trustworthiness and high expertise; control group).

The used source information was pretested with an independent sample regarding perceived trustworthiness and expertise. A total of 17 undergraduate psychology students (M_{age} = 21.35, SD_{age} = 2.62, 15 female) assessed both variables on a seven-point Likert scale (1, 'very low' to 7, 'very high'). The results of this material test showed that scientists working at a university were rated as significantly more trustworthy than scientists working for a company, $F(1,48) = 14.95$, $p < .001$, and that professors were rated as significantly more competent than junior scientists, $F(1,48) = 22.20$, $p < .001$.

Measures

Prior Domain Knowledge and Attitudes (Control Variables)

To ascertain comparability across experimental conditions, we used adapted versions of the Public Knowledge in Nano Technology (PKNT) and the Public Attitudes towards Nano Technology (PANT) questionnaires (Lin et al., 2013) to measure participants' prior knowledge regarding nanotechnology and their attitudes towards risks of nanotechnology.

For prior domain knowledge, participants had to answer eight multiple-choice questions on nanotechnology (Cronbach's α = .63, correlation with self-reported prior knowledge r = .53). Each question was followed by four possible answers from which only one was correct. The sum of correct answers was used as a measure of prior domain knowledge.

For attitudes towards risks of nanotechnology, participants were asked to rate their agreement with four statements on possible risks of nanotechnology (sample item, 'The toxicity of nanoparticles may be even higher than that of large-size particles.') on a five-point Likert scale (1, 'very much disagree' to 5, 'very much agree'; Cronbach's α = .86).

Conflict Explanation

Conflict explanation was measured with the Explaining Conflicting Scientific Claims (ECSC) questionnaire (Thomm et al., 2015). The ECSC measures four different dimensions of explanations, capturing two knowledge-related explanations (i.e., *differences in research process* and *topic complexity*) and two source-related explanations (i.e., *differences in researchers' motivations* and *differences in researchers' competence)*. Each dimension is assessed by five to six explanatory statements (e.g., 'The scientists are qualified to varying degrees.' for the scale *differences in researchers' competence*), resulting in a total set of 23 items. In the present study, the 23 statements of the ECSC were presented to the participants as possible explanations for the previously read conflict. Participants were asked to rate the extent to which each explanatory statement may provide a potential reason for the specific conflict, from 1 ('very much disagree') to 6 ('very much agree'). Internal consistency (indicated by Cronbach's alpha) of the ECSC dimensions in the present study was $\alpha = .83$ for *differences in research process*, $\alpha = .72$ for *topic complexity*, $\alpha = .91$ for *differences in researchers' motivations*, and $\alpha = .75$ for *differences in researchers' competence*.

Claim Agreement

Participants were asked to rate their agreement with each of the two claims on a seven-point Likert scale (1, 'very much disagree' to 7, 'very much agree'), with the claims being presented without source information, and in the original presentation order.

Source Memory

To measure source memory participants were asked to answer one multiple choice question for each claim, in which they had to choose the correct source of the claim from four options. These were 'professor at a university', 'professor at a company', 'junior scientist at a university', and 'junior scientist at a company'. The original claim was presented together with these options, from which they had to choose one. Claims were presented in the original

presentation order but without source information. Source memory was only scored as correct, if the correct source was selected for both claims.

Ratings of Source Trustworthiness and Source Expertise (Manipulation Check)

Finally, as a manipulation check, the claims including source information (as displayed during the experimental part of the study) were presented again and had to be rated regarding the trustworthiness and the expertise of the source (with 2 items each). The questions for source trustworthiness were 'How trustworthy is this scientist in your opinion?' and 'How honest is this scientist in your opinion?' (Cronbach's α = .84 - .91). The questions for source expertise were 'How competent is this scientist in your opinion?' and 'How much domain knowledge has this scientist in your opinion?' (Cronbach's α = .90 - .92). Each question had to be answered on a seven-point Likert scale (from 1 = 'not at all' to 7 = 'very'). To compute one score for source trustworthiness or source expertise, respectively, we averaged the ratings across both trustworthiness and expertise items for each source separately.

Experimental Design

For the dependent variables of conflict explanation and source memory, the study was realized as a 2x2 between-subject design with the two factors *differences in trustworthiness* (differences vs. no differences) and *differences in expertise* (differences vs. no differences). For the dependent variables of claim agreement and trustworthiness and expertise ratings (manipulation check), which were all obtained separately for the two claims, the additional within-subject factor *source* (baseline source, comparison source) completed our 2x2x2 mixed design.

Procedure

After giving informed consent to participate in the experiment, participants reported their interest and prior knowledge concerning nanotechnology and completed the PKNT multiple-

choice knowledge test (Lin et al., 2013). Subsequently, participants received a short introduction into the topic and were instructed to read carefully the following material. Then, the claims were presented on two separate HTML pages and participants could navigate freely back and forth between them by clicking on respective navigation buttons. There was no restriction in reading time or navigation between the two claims. After participants decided to proceed, they were asked to complete the ECSC questionnaire (Thomm et al., 2015). Subsequently, they had to rate their personal agreement with the two claims, which were presented in the same order as in the experimental reading phase but without source information. Then, participants' source memory was assessed for both claims, also in the same order as originally presented. Finally, as a manipulation check, participants had to rate the perceived trustworthiness and expertise of the two scientists. To this end, they were again presented with the claims together with the source information in the same order as in the reading phase.

Analytic approach

H1a and H1b, analyses of variance (ANOVAs) were conducted to investigate the effects of differences in trustworthiness and differences in expertise on participants' conflict explanations. To test H2a and H2b, multilevel linear regression analyses with random intercepts were conducted to investigate the effects of differences in trustworthiness and differences in expertise on claim agreement depending on the source (baseline or comparison). To test H3a and H3b, a logistic regression model was conducted to investigate the effects of differences in trustworthiness and differences in expertise on the likelihood to correctly remember both sources. All analyses were conducted in R (R Core Team, 2016).

Results

Comparability of Experimental Conditions

Two-factorial ANOVAs with the factors differences in trustworthiness and differences in expertise were conducted to assess the comparability of the experimental groups in terms of age, self-reported topic interest, self-reported prior knowledge, prior domain knowledge (PKNT score), and attitudes towards perceived risks of nanotechnologies (PANT score). No significant differences were found for any of these measures, all $F(1, 140) < 1.09$, all $p > .298$. Means (and standard deviations) per group for these measures are shown in Table 2.

Table 2
Means (and *SD*) for control variables as a function of trustworthiness differences (differences, no differences) and expertise differences (differences, no differences).

	Trustworthiness differences			
	No differences		Differences	
Expertise differences	No differences	Differences	No differences	Differences
N	36	36	36	36
Age (in years)	26.31 (7.72)	27.44 (7.57)	25.75 (12.26)	25.94 (10.08)
Topic interest (self-reported)	3.03 (1.18)	3.08 (1.05)	3.31 (1.09)	3.11 (0.95)
Topic knowledge (self-reported)	1.94 (1.07)	1.89 (0.98)	2.14 (1.29)	1.92 (1.08)
PKNT[a]	4.67 (1.76)	4.58 (2.14)	4.56 (2.09)	4.00 (1.97)
PANT[b]	3.20 (0.97)	3.31 (0.97)	3.32 (0.74)	3.38 (0.82)

[a]Prior Knowledge on Nano Technology questionnaire (PKNT; Lin et al., 2013) with a maximum of 8 points and guessing probability of 25%
[b]Prior Attitudes towards Nano Technology questionnaire (PANT, Lin et al., 2013).

Table 3
Means (and *SD*) for ECSC dimensions and for source memory and revisiting claims as a function of trustworthiness differences (differences, no differences) and expertise differences (differences, no differences).

	Trustworthiness differences			
	No differences		Differences	
Expertise differences	No differences	Differences	No differences	Differences
N	36	36	36	36
ECSC *competence*	2.58 (0.81)	2.90 (0.86)	2.87 (0.96)	3.25 (0.78)
ECSC *motivations*	3.35 (1.45)	3.88 (1.19)	4.11 (1.21)	4.10 (1.04)
ECSC *research process*	4.49 (0.88)	3.99 (0.92)	4.06 (0.94)	4.21 (0.78)
ECSC *topic complexity*	4.18 (0.84)	3.97 (0.84)	3.91 (0.96)	4.00 (0.78)
Source memory (% participants)	77.78	72.22	69.44	83.33
Revisit claims (% participants)	25.00	25.00	19.44	13.88

Conflict Explanation (H1)

For the ECSC dimension *differences in researchers' motivations*, in line with H1a, the ANOVA showed a significant main effect of the factor differences in trustworthiness, $F(1, 140) = 5.67$, $p = .019$, $\eta_p^2 = .04$, in that participants agreed more strongly with motivations as an explanation for the conflict with differences in source trustworthiness ($M = 4.11$, $SD = 1.12$) than without such differences ($M = 3.61$, $SD = 1.34$). There was neither a significant main effect for differences in expertise, $F(1, 140) = 1.62$, $p = .206$, nor a significant interaction between the two factors, $F(1, 140) = 1.76$, $p = .190$. Means (and standard deviations) per group for all ECSC dimensions are shown in Table 3.

For the ECSC dimension *differences in researchers' competence*, in line with H1b, the ANOVA showed a significant main effect of the factor differences in expertise, $F(1, 140) = 6.18$, $p = .014$, $\eta_p^2 = .04$, with participants agreeing more strongly with competence explanations with differences in source expertise ($M = 3.07$, $SD = 0.83$) than without such differences ($M = 2.72$, $SD = 0.89$). There was also a significant main effect of the factor differences in trustworthiness, $F(1, 140) = 5.10$, $p = .025$, $\eta_p^2 = .03$, with participants agreeing more strongly with competence explanations with differences in trustworthiness ($M = 3.06$, $SD = 0.89$) than without such differences ($M = 2.74$, $SD = 0.84$). The interaction between the two factors was not significant, $F(1, 140) = 0.04$, $p = .833$.

For the ECSC dimension *differences in research process,* the ANOVA showed no significant main effects of differences in expertise, $F(1, 140) = 1.35$, $p = .247$, or differences in trustworthiness, $F(1, 140) = 0.48$, $p = .490$, but a significant interaction between these factors, $F(1, 140) = 4.84$, $p = .029$, $\eta_p^2 = .03$. While descriptively the data shows higher attribution to this explanation when neither differences in trustworthiness nor differences in expertise are present (i.e., the control group), further investigation of this interaction with Tukey-corrected pairwise comparisons, however, showed no significant effects, all $p > .08$.

Finally, for the ECSC dimension *topic complexity,* the ANOVA showed neither a significant main effect of differences in expertise, $F(1, 140) = 0.16$, $p = .686$, nor differences in trustworthiness, $F(1, 140) = 0.68$, $p = .410$, nor a significant interaction between the two factors, $F(1, 140) = 1.18$, $p = .279$.

Agreement with Claims (H2)

The multilevel linear regression model for claim agreement showed no significant variance in intercepts across participants, $\chi^2 = 0.00$, $p > .999$. Thus, random intercepts for participants were dropped from the model. Regarding fixed effects there were no significant main effects of differences in source trustworthiness, differences in source expertise, or source (baseline vs. comparison). However, there were significant interactions between differences in trustworthiness and source, $b = -1.00$ (95% CI: -1.94, -0.11), $t(140) = -2.13$, $p = .035$, as expected by H2a (see Figure 1), and between differences in expertise and source, $b = -1.02$ (95% CI: -1.91, -0.09), $t(140) = -2.19$, $p = .030$, as expected by H2b (see Figure 2). Tukey-corrected contrasts showed that with differences in trustworthiness, claim agreement was significantly higher for the baseline source than for the comparison source, $b = 0.611$ (95% CI, 0.00, 1.22), $t(140) = 2.61$, $p = .049$. In contrast, without differences in trustworthiness, claim agreement did not significantly differ between sources, $b = 0.26$ (95% CI, -0.35, 0.87), $t(140) = 1.13$, $p = .675$. Also, with differences in expertise, claim agreement was significantly higher for the baseline source than for the comparison source, $b = 0.625$ (95% CI, 0.02, 1.24), $t(140) = 2.66$, $p = .042$, whereas without differences in trustworthiness, claim agreement did not significantly differ between sources, $b = 0.25$ (95% CI, -0.36, 0.86), $t(140) = 1.07$, $p = .711$. The three-way-interaction between differences in trustworthiness, differences in expertise, and source, while pointing into the direction of a less than additive effect of the two source features, was not significant, $b = 1.31$ (95% CI: 0.01, 2.60), $t(140) = 1.97$, $p = .051$. Group means (and standard deviations) by source for claim agreement are shown in Table 4.

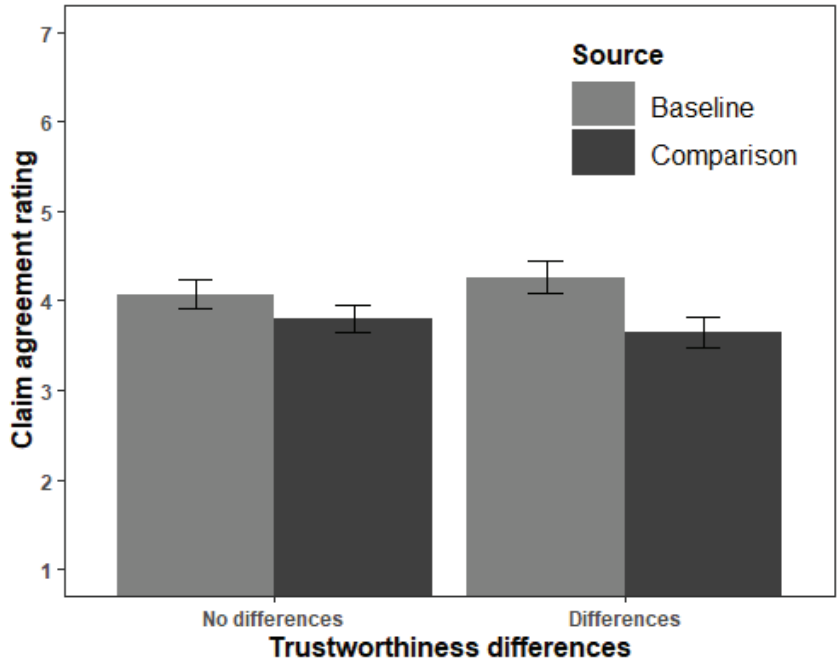

Figure 1. Agreement ratings for claims of baseline and comparison sources as a function of trustworthiness differences. Error bars represent the 95%-confidence intervals.

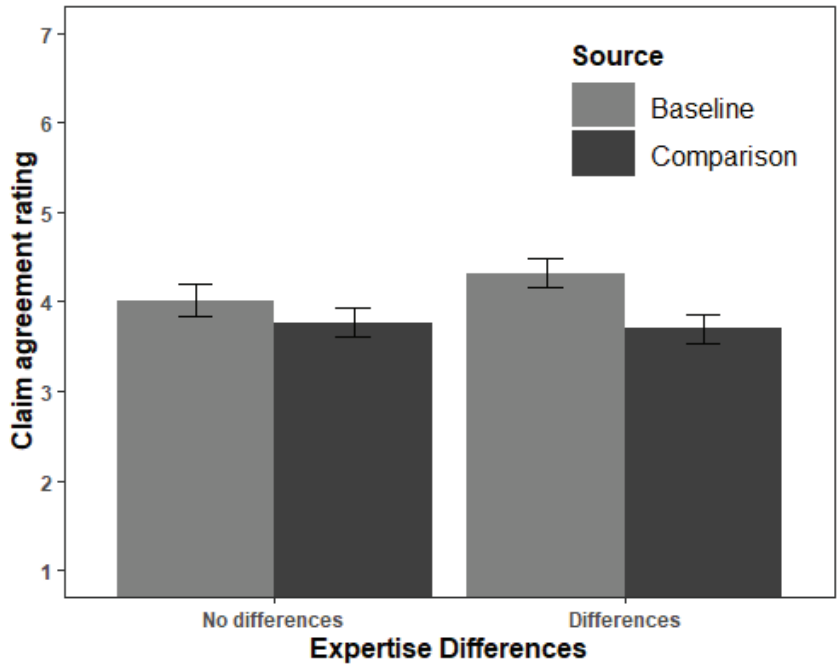

Figure 2. Agreement ratings for claims of baseline and comparison sources as a function of expertise differences. Error bars represent the 95%-confidence intervals.

Table 4

Mean scores (and *SD*) for reading time, claim agreement, and trustworthiness and expertise ratings for baseline and comparison source as a function of trustworthiness differences (differences, no differences) and expertise differences (differences, no differences).

	Trustworthiness differences							
	No differences				Differences			
Expertise differences	No differences		Differences		No differences		Differences	
Source	Baseline	Comparison	Baseline	Comparison	Baseline	Comparison	Baseline	Comparison
Measures								
Reading Time (log)	3.13 (0.68)	3.00 (0.43)	2.78 (0.59)	2.87 (0.65)	2.86 (0.59)	2.95 (0.57)	2.85 (0.48)	2.94 (0.56)
Claim agreement	3.78 (1.35)	4.03 (1.25)	4.36 (1.27)	3.58 (1.25)	4.25 (1.57)	3.50 (1.46)	4.28 (1.56)	3.81 (1.45)
Trustworthiness rating	5.44 (1.00)	5.29 (1.08)	5.07 (1.18)	5.06 (1.03)	5.35 (1.07)	3.89 (1.18)	5.49 (1.10)	3.85 (1.38)
Expertise rating	5.75 (0.91)	5.74 (1.06)	5.57 (0.92)	4.35 (1.11)	5.61 (0.90)	5.26 (1.05)	5.97 (0.86)	4.10 (1.42)

Source Memory (H3)

In total, 75.69% of the participants remembered both sources correctly. Contrary to H3a and H3b, the logistic regression model showed no significant main effects of the factors differences in source trustworthiness, Z = -0.54, p = .587, or differences in source expertise, Z = -0.80, p = .424, on the likelihood to correctly remember the two sources, nor a significant interaction between the two factors, Z = 1.37, p = .171. The mean percentages for source memory by group are shown in Table 3.

Trustworthiness and Expertise Ratings of the Sources (Manipulation Check)

The multilevel linear regression model for source trustworthiness ratings showed significant variance in intercepts across participants, SD = 0.68 (95% CI: 0.54, 0.86), χ^2 = 21.35, p < .001. Regarding the fixed effects of the model there were no significant main effects of differences in source trustworthiness, differences in source expertise, or source (baseline vs. comparison) on trustworthiness ratings. The only significant interaction shown by the model was the expected interaction between differences in trustworthiness and source (as expected in H1a), b = -1.31 (95% CI: -1.89, -0.72), t(140) = -4.36, p < .001. Tukey corrected pairwise comparisons showed that with differences in trustworthiness, the comparison source was rated significantly less trustworthy than the baseline source, b = 1.55 (95% CI, 1.16, 1.94), t(140) = 12.20, p < .001. In contrast, without differences in trustworthiness, trustworthiness ratings for the comparison and the baseline source did not differ significantly, b = 0.08 (95% CI, −0.30, 0.47), t(140) = 0.56, p = .945. Thus, the manipulation can be considered successful.

The multilevel linear regression model for source expertise ratings showed a significant variance in intercepts across participants, SD = 0.48 (95% CI: 0.33, 0.71), χ^2 = 7.29, p = .007. Again, there were no significant main effects of differences in trustworthiness, differences in expertise, or source on expertise ratings. The only significant interaction shown by the model

was the expected interaction between differences in expertise and source, b = -1.21 (95% CI: -1.81, -0.61), $t(140) = -3.94$, $p < .001$. Tukey corrected contrasts showed that in the condition with differences in trustworthiness being present, the comparison source was rated significantly less trustworthy than the baseline source, $b = -1.55$ (95% CI, 1.15, 1.95), $t(140) = 10.11$, $p < .001$. In contrast, without differences in trustworthiness, trustworthiness ratings for the comparison and the baseline source did not differ significantly, b = 0.18 (95% CI, −0.22, 0.58), $t(140) = 1.18$, $p = .641$. Thus, the manipulation can be considered successful. Group means (and standard deviations) by source for claim agreement are shown in Table 4.

Additional Exploratory Analyses

We explored reading times of the claims as a measure that could give insight into readers' degree of processing of the presented claims. We conducted a multilevel linear regression model for reading time (log-transformed) of each claim with the three predictors differences in trustworthiness, differences in expertise, and source. This exploratory analysis showed main effects for differences in trustworthiness, b = -0.28 (95% CI: -0.54, -0.01), $t(140) = -2.04$, $p = .043$, and differences in expertise, b = -0.35 (95% CI: -0.61, -0.08), $t(140) = -2.57$, $p = .011$, but no effects of source, b = -0.12 (95% CI: -0.28, 0.03), $t(140) = -1.48$, $p = .140$, nor any significant interaction effects (all $p > .103$). For both, differences in source trustworthiness and differences in source expertise, the reading time was shorter with differences than without. Additionally, we explored the use of the possibility to go back and forth between the claims. Only 20.83% of the participants made at least one revisit to the previously read claim. A logistic regression model showed no significant main effects of or interactions between factors for revisit likelihood (all $p > .50$). The revisit likelihood (in percent) by group is shown in Table 3.

Discussion

The goal of this study was to gain further insights into the effects of differences in perceived source trustworthiness and source expertise on laypersons' conflict regulation and resolution when facing scientific conflicts. To this end, we presented university students with two conflicting claims about an unfamiliar topic from the area of nanosafety, while varying information on the sources' workplace and work experience in the field. The results of our manipulation check suggest that participants in our sample were able to identify and interpret these source features as intended. That is, when the sources differed in their trustworthiness (university vs. company) and/or their expertise (professor vs. junior scientist), readers perceived the comparison source as less trustworthy or less expert, respectively, than the baseline source.

More importantly, we expected these differences in source trustworthiness and/or source expertise to affect conflict regulation as well as conflict resolution as predicted by the CSI model (Stadtler & Bromme, 2014). Participants' subjective conflict explanations were measured as indications for conflict regulation and participants' agreement with the two claims as an indication for conflict resolution.

Subjective conflict explanation based on source information

Regarding our hypotheses on readers' subjective explanations for the conflict, the present study corroborates prior research showing that source information affects readers' regulation of scientific conflicts (Gottschling et al., 2019). As expected, differences in source trustworthiness increased readers' attribution of the conflict to differences in scientists' motivations as a subjective explanation of the conflict and differences in source expertise respective attribution to differences in scientists' competence. This is in line with the assumption of the CSI model that one way to restore coherence is to accept the scientific conflict as due to different sources and to use source information to explain why the conflict

might have emerged. Additionally, we found an effect of differences in source trustworthiness on participants' endorsement of explanations through scientists' competence. Though we did not expect this effect, it appears to be plausible. The items of the ECSC questionnaire capturing competence explanations, in part, also consider competence as the appropriate usage of one's expertise as a scientist (e.g. being thorough in one's research work). Such facets could be interpreted as being connected to the willingness of scientists to provide accurate knowledge, and therefore might also be affected by source trustworthiness.

While the focus of this study is on source-related explanations of conflicting claims (i.e., differences in researchers' motivations and differences in researchers' competence), it is important to note that research-related explanations for the conflict (i.e., differences in the research process and topic complexity) also received high agreement by the readers. This could be explained through readers' low prior domain knowledge about nanotechnology and perception of the topic at stake. It is possible that they considered the topic to be highly complex and subject of advanced research. Interestingly, our results also indicate that, when sources were of equally high trustworthiness and expertise, participants allocated more time to reading. Thus, participants possibly spent additional time to search for and reason about explanations, when there was not an immediate explanation for the conflict at hand. However, so far, we can only speculate about this interpretation; more research is needed to clarify this observation.

Finally, it should be noted that the effects for conflict explanation were only small in size. Nonetheless, we believe that our results still have value for research on science education, since they point to laypersons' ability to explain a scientific conflict based on source information, which is a critical skill for scientific literacy (Aikenhead, 2003; Bos, 2000; Bromme & Goldman, 2014; Kolstø, 2001). Furthermore, following the rationale of the CSI model (also see Braasch & Scharrer, 2020; Stadtler & Bromme, 2014), the effects on

source-related conflict explanations lay the foundation for the more substantial effects of source differences on conflict resolution (as measured, e.g., by claim agreement), that we discuss in the following section.

Source credibility affecting claim agreement

In line with our expectations regarding claim agreement, both differences in source trustworthiness and differences in source expertise led to reduced agreement with the claim of the source that was perceived as less trustworthy or as less expert. This also corroborates previous findings regarding the influence of differences in source trustworthiness on claim agreement (Gottschling et al., 2019) and expands them by showing that the same effect can be triggered by differences in source expertise. Therefore, our quantitative results complement conclusions drawn from qualitative findings in science education (Kolstø, 2001). Also, in the present study, participants had to give their ratings for conflict explanation and claim agreement without source information again being presented to them. Thus, the observation that differences in source trustworthiness and/or source expertise still affected these dependent measures can be regarded as further evidence for the integration of source information into readers' mental representation as stated by the Documents Model framework (Britt & Rouet, 2012; Perfetti et al., 1999).

To conclude, our findings also have practical implications for science education. One potential application of our findings are refutation texts aimed to stimulate knowledge revision regarding common scientific misconceptions that are present in the public. Refutation texts try to accomplish this by providing the misconception along with an explanation why it is false, together with correct information on the topic (Kendeou et al., 2016; Tippett, 2010). Given that this resembles the information environment of our study with two conflicting positions, providing additional source information for both positions can be expected to further increase agreement with the correct information and therefore

574 respective knowledge revision. A first study regarding the role of source information in
575 refutation texts already showed that source information can have an effect on successful
576 knowledge revision (Van Boekel et al., 2017). In that study, however, only the source
577 credibility (i.e., professor vs. celebrity) of the whole refutation text was manipulated rather
578 than the sources for the positions within the text.

579 ***No effects of differences in source credibility on source memory***

580 It is important to note that even though differences in source trustworthiness and/or
581 differences in expertise affected readers' subjective conflict explanations as well as their
582 claim agreement, we did not find any effects on source memory. While this is in line with
583 previous findings by Gottschling et al. (2019), it contradicts the results by Thomm and
584 Bromme (2016). The absence of effects on source memory in the present study might be
585 explained by a ceiling effect, since source memory was high in all conditions, which may be
586 due to the relatively simple multiple-choice format used. Thus, future research could use free
587 or cued recall questions to assess source memory, in order to get deeper and more accurate
588 insights into what parts of source information are remembered by readers who are confronted
589 with conflicting scientific information.

590 ***Interactions of multiple dimensions of source credibility***

591 Finally, an additional goal of this study was to investigate possible interactions between
592 differences in source trustworthiness and source expertise on conflict regulation and conflict
593 resolution. While we did not find any significant interactions on our dependent variables,
594 there was one trend regarding claim agreement that should be considered for further research:
595 When both differences in trustworthiness and differences in expertise were present, effects on
596 claim agreement seemed to be less than additive. That is, the effect of the combined source
597 differences tended to be smaller than the sum of both main effects. This could indicate that as
598 soon as there is one reason to question the credibility of a source as compared to another

source with a conflicting claim (either because of differences in trustworthiness or differences in expertise being present), this is sufficient to resolve the conflict based on a second-hand approach to evaluation (Thomm et al., 2017). However, since this interaction effect did not reach significance, further research is needed to explore this possibility.

Limitations and outlook

This study does not come without limitations. First, because the sample consisted of undergraduate students, it is unclear how well the findings can be generalized to other samples. Undergraduate students might be more sensitive to source information than the general public because of their current education process as well as their high level of education. Yet, they may also represent a population that often searches for scientific information. Still, it would be desirable for future research to investigate whether the effects observed in the present study can also be found with other populations (e.g., younger students or individuals without academic education). This might be specifically relevant, when considering the current situation of the Covid19 pandemic that may drive individuals of all ages and educational backgrounds to search for scientific information.

A second limitation of this study is that we only used one scientific topic. Previous studies have shown that subjective explanations for scientific conflicts might vary across different topics or domains (Johnson & Dieckmann, 2018; Thomm & Bromme, 2016). Third, it is likely that the low prior knowledge about nanotechnology of our sample has resulted in a particularly high dependence on source information for claim evaluation. While this was intended, future studies could examine whether and how effects of differences in source trustworthiness and source expertise might be moderated by readers' prior domain knowledge.

Finally, while one strength of the present research is the well-controlled and standardized material, this comes at the cost of external validity. Although we took measures

to make the material comparable to natural information environments (e.g., by using information based on real online articles and a sequential presentation of information), situations on actual websites are generally more complex. In many cases source information would not be limited to references in text, but could also be related to the article type, the author, or the website's general reputation (Bråten et al., 2010), or would need to be actively sought out, for instance, by accessing 'about us' sections (Kammerer et al., 2016; Stadtler et al., 2015). Additionally, texts found during online inquiry are often longer than the ones used in this study and conflicting claims might not be as clear and easy to detect. Future research, thus, should gradually approach more realistic information materials in order to increase external validity and to inform educational interventions that can support laypersons in their assessment of scientific conflicts. Furthermore, by means of controlled experimental designs, such as the one used in the present study, interventions on the assessment of scientific conflicts then should also be evaluated regarding their effects on the use of source information in readers' conflict regulation and resolution.

In summary, the present study showed how laypersons can use source information in their explanation and resolution of a scientific knowledge for which they possessed low prior knowledge. Based on the vast amount of conflicting scientific information and plain misinformation that can be found on the Internet, this is a skill of growing importance for science literacy.

Funding Details

This research was in part funded by the Leibniz Research Alliance "Nanosafety".

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Appendix A

Introduction to the scientific conflict and the task, as presented to the study participants (translated from German).

Information about a controversy in the field of nanotechnology is presented below. Please read this information carefully.

Introduction to the topic "Nanoparticles in sunscreen"

Nanoparticles of zinc oxide and titanium dioxide have been used in the production of sunscreens for some time. The advantage of these particles is that they effectively reflect a broad UV spectrum. Thus, chemical UV filters can be avoided. Chemical UV filters convert UV radiation into heat on the skin and can trigger allergies or can have unwanted hormonal side effects. Such side effects are not known to occur with UV filters containing mineral nanoparticles that block and reflect UV radiation. Furthermore, particularly high sun protection factors can be achieved by using nanoparticles. However, it is controversial whether the tiny nanoparticles can enter the body through the skin, where they could have unknown and undesirable effects on our health.

In the following, statements by two scientists on this controversy are presented, which can be found on their respective websites. Please read both statements carefully and then answer some questions about the controversy.

Appendix B

Components of the claims presented in the study based on the manipulation of trustworthiness and expertise as well as the position concerning the scientific conflict (translated from German).

Component 1: First part of source information
a) A state-funded professor working in the field of nanoscience at a university assumes that …
b) An industry-funded professor working in a nanoscience company assumes that …
c) A state-funded junior scientist working in the field of nanoscience at a university assumes that …
b) An industry-funded junior scientist working in a nanoscience company assumes that …

Component 2: Position
1) nanoparticles do not penetrate the upper layers of the skin and therefore cannot have an undesirable effect on our health.
2) nanoparticles can penetrate deep into the skin and can have undesirable effects on our health.

Component 3: Second part of source information
a) This professor has been researching this topic at his university for about ten years and writes on his website: …
b) This professor has been researching this topic at his company for about ten years and writes on his website: …
c) This junior scientist has been researching this topic at his university for about a year and writes on his website: …
d) This junior scientist has been researching this topic at his company for about a year and writes on his website: …

Component 4: Quote
1) "The results of our study indicate that the used nanoparticles cannot penetrate the upper layers of skin and therefore cannot come into contact with living cells."
2) "The results of our study indicate that the used nanoparticles can penetrate deep into the skin layers and thus come into contact with living cells and the bloodstream."

The two conflicting claims presented to each participant were built from these blocks depending on the experimental condition regarding source expertise and trustworthiness with the following logic:

Source information
a) = high expertise / high trustworthiness
b) = high expertise / low trustworthiness
c) = low expertise / high trustworthiness
d) = low expertise / low trustworthiness

Position within the conflict
1) = in favour of nanoparticles in sunscreen
2) = against nanoparticles in sunscreen

Appendix C

Item used for the measurement of source memory with the instructions given to the participants of the study (translated from German).

Memory questions

In the following we are interested in how well you remember where the respective statements came from. For each of the two statements, please select the source you consider to be correct.

First claim

_____ assumes that nanoparticles do not penetrate the upper layers of the skin and therefore cannot have an undesirable effect on our health. He writes on his website: "The results of our study indicate that the nanoparticles used cannot penetrate the upper layers of skin and therefore cannot come into contact with living cells."

Who provided this statement? *(the four alternatives were presented in random order)*

- o an industry-funded junior scientist working in a nanoscience company for one year
- o a state-funded junior scientist working in the field of nanoscience at a university for one year
- o an industry-funded professor working in a nanoscience company for ten years
- o a state-funded professor working in the field of nanoscience at a university for ten years

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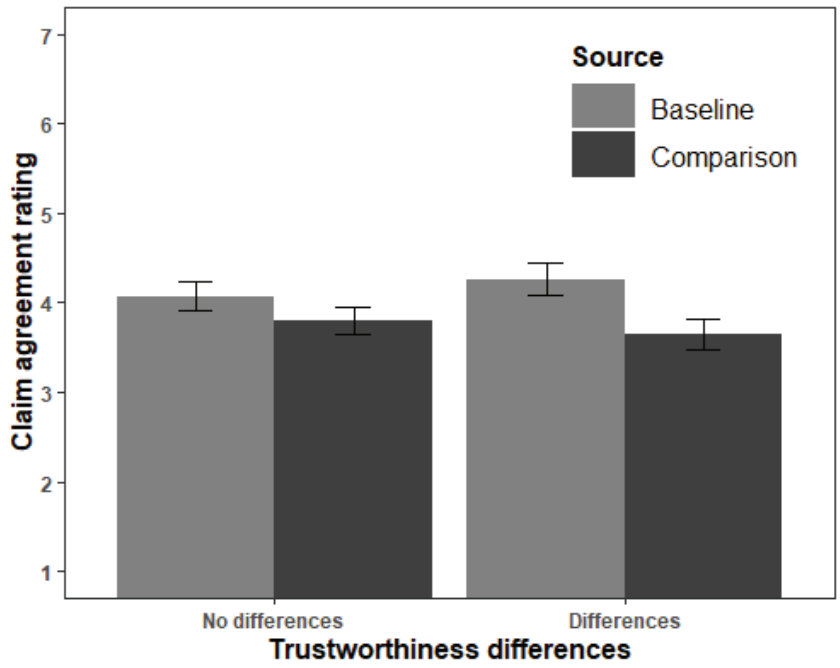

Figure 1. Agreement ratings for claims of baseline and comparison sources as a function of trustworthiness differences. Error bars represent the 95%-confidence intervals.

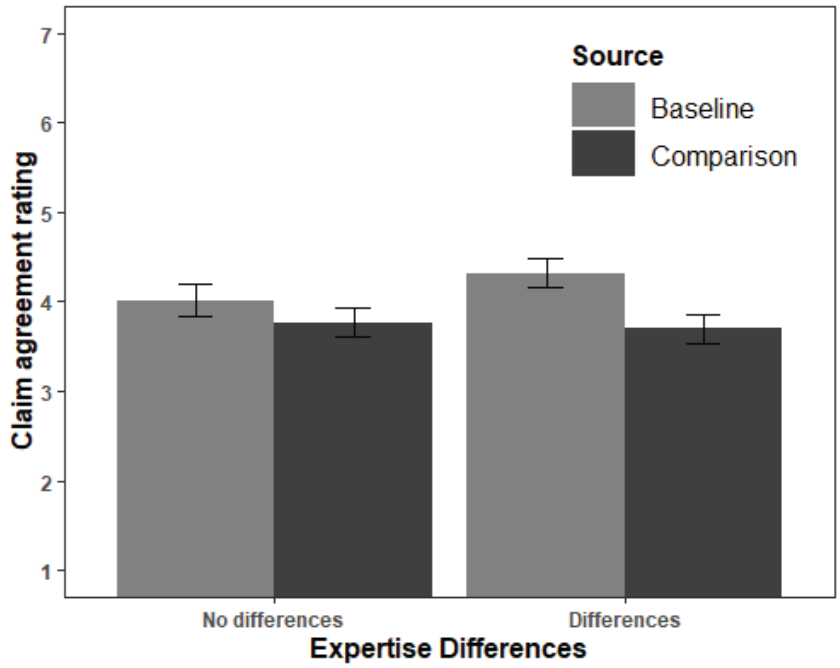

Figure 2. Agreement ratings for claims of baseline and comparison sources as a function of expertise differences. Error bars represent the 95%-confidence intervals.

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Table 1

Information on claim material (without source information)

	Claim A	Claim B
Number of words	56	56
Number of characters	355	346
Readability score[a]	61.9	63.7
Perceived comprehensibility[b]	5.78 (1.29)	5.62 (1.26)
Perceived convincingness[b]	3.38 (1.39)	4.00 (1.41)

[a]German readability score (Lesbarkeitsindex; LIX)

[b]Mean scores (and standard deviations) from the material pretest

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Table 2

Means (and *SD*) for control variables as a function of trustworthiness differences (differences, no differences) and expertise differences (differences, no differences).

	Trustworthiness differences			
	No differences		Differences	
Expertise differences	No differences	Differences	No differences	Differences
N	36	36	36	36
Age (in years)	26.31 (7.72)	27.44 (7.57)	25.75 (12.26)	25.94 (10.08)
Topic interest (self-reported)	3.03 (1.18)	3.08 (1.05)	3.31 (1.09)	3.11 (0.95)
Topic knowledge (self-reported)	1.94 (1.07)	1.89 (0.98)	2.14 (1.29)	1.92 (1.08)
PKNT[a]	4.67 (1.76)	4.58 (2.14)	4.56 (2.09)	4.00 (1.97)
PANT[b]	3.20 (0.97)	3.31 (0.97)	3.32 (0.74)	3.38 (0.82)

[a]Prior Knowledge on Nano Technology questionnaire (PKNT; Lin et al., 2013) with a maximum of 8 points and guessing probability of 25%

[b]Prior Attitudes towards Nano Technology questionnaire (PANT, Lin et al., 2013).

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Table 3

Means (and *SD*) for ECSC dimensions and for source memory and revisiting claims as a function of trustworthiness differences (differences, no differences) and expertise differences (differences, no differences).

	Trustworthiness differences			
	No differences		Differences	
Expertise differences	No differences	Differences	No differences	Differences
N	36	36	36	36
ECSC *competence*	2.58 (0.81)	2.90 (0.86)	2.87 (0.96)	3.25 (0.78)
ECSC *motivations*	3.35 (1.45)	3.88 (1.19)	4.11 (1.21)	4.10 (1.04)
ECSC *research process*	4.49 (0.88)	3.99 (0.92)	4.06 (0.94)	4.21 (0.78)
ECSC *topic complexity*	4.18 (0.84)	3.97 (0.84)	3.91 (0.96)	4.00 (0.78)
Source memory (% participants)	77.78	72.22	69.44	83.33
Revisit claims (% participants)	25.00	25.00	19.44	13.88

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Table 4
Mean scores (and *SD*) for reading time, claim agreement, and trustworthiness and expertise ratings for baseline and comparison source as a function of trustworthiness differences (differences, no differences) and expertise differences (differences, no differences).

	Trustworthiness differences							
	No differences				Differences			
Expertise differences	No differences		Differences		No differences		Differences	
Source	Baseline	Comparison	Baseline	Comparison	Baseline	Comparison	Baseline	Comparison
Measures								
Reading Time (log)	3.13 (0.68)	3.00 (0.43)	2.78 (0.59)	2.87 (0.65)	2.86 (0.59)	2.95 (0.57)	2.85 (0.48)	2.94 (0.56)
Claim agreement	3.78 (1.35)	4.03 (1.25)	4.36 (1.27)	3.58 (1.25)	4.25 (1.57)	3.50 (1.46)	4.28 (1.56)	3.81 (1.45)
Trustworthiness rating	5.44 (1.00)	5.29 (1.08)	5.07 (1.18)	5.06 (1.03)	5.35 (1.07)	3.89 (1.18)	5.49 (1.10)	3.85 (1.38)
Expertise rating	5.75 (0.91)	5.74 (1.06)	5.57 (0.92)	4.35 (1.11)	5.61 (0.90)	5.26 (1.05)	5.97 (0.86)	4.10 (1.42)

Appendix B: Experiment 2 and Experiment 3

Please cite as:

Gottschling, S., Kammerer, Y., & Gerjets, P. (2019). Readers' processing and use of source information as a function of its usefulness to explain conflicting scientific claims. *Discourse Processes*, *56*(5–6), 429–446.
https://doi.org/10.1080/0163853X.2019.1610305

The journal Discourse Processes is available online under:

https://www.tandfonline.com/toc/hdsp20/current

Readers' Processing and Use of Source Information as a Function of its Usefulness to Explain Conflicting Scientific Claims

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Readers' Processing and Use of Source Information as a Function of its Usefulness to Explain Conflicting Scientific Claims

Abstract. The present research examines how the usefulness of source information to explain conflicting scientific claims affects laypersons' processing of this information as they seek possible explanations for the conflicting scientific claims in the sources and during resolution of the conflict. In an eye-tracking experiment, we presented participants (N = 76) with two conflicting scientific claims (on a controversial nanotechnology issue) put forward by two scientists (sources) that did or did not differ in their implied trustworthiness. We expected differences in trustworthiness to be useful source information for claim evaluation and explanation of the conflict. This should lead to longer processing of the source information during reading, to a stronger explanation of the conflict through differences in the scientists' motivations, and to stronger agreement with the claim of the source which was more trustworthy. Our results show that differences in the sources' trustworthiness indeed led to increased visual attention to source information during reading. Moreover, the source information affected individuals' explanation of the conflict as well as their claim agreement: Individuals in the condition with differences in trustworthiness agreed more strongly with scientists' motivations as a potential explanation for the conflict, and they agreed more strongly with the claim of the more trustworthy source than the individuals in the control condition. These results are discussed in the context of the content-source integration (CSI) model.

Keywords: source information; scientific conflicts; conflict evaluation; eye-tracking; multiple documents literacy

Introduction

When searching for scientific information on the internet, laypersons are frequently confronted with multiple perspectives and conflicting claims. This holds true, for instance, when they are seeking information about current socioscientific topics such as the safety of nanotechnology (Brossard, 2013). Due to the nature of the internet, where anyone is free to publish information regardless of his or her personal expertise and motives, laypersons themselves need to evaluate the veracity of claims they encounter (Rouet & Potocki, 2018). However, because laypersons generally lack prior domain knowledge about current scientific topics such as nanotechnology (Pillai & Bezbaruah, 2017), it is often difficult for them to evaluate the veracity of claims directly (Bromme & Goldman, 2014). One possible alternative for laypersons to indirectly evaluate conflicting scientific claims is to assess the trustworthiness of the sources that provide the claims based on available source information (Braasch, Rouet, Vibert, & Britt, 2012; Stadtler & Bromme, 2014). Accordingly, in the present research we aimed to examine how the presence of differences in the sources' trustworthiness (as indicated by available source information) affects individuals' processing of source information while reading two conflicting claims and while trying to explain and resolve the scientific conflict.

Role of Source Information in the Evaluation of Conflicting Scientific Claims

In their content-source integration (CSI) model, Stadtler and Bromme (2014) proposed a theoretical model of how readers comprehend conflicting scientific information presented in single or between multiple texts. The CSI model is based on earlier models regarding multiple documents comprehension (Britt & Rouet, 2012; Perfetti, Rouet, & Britt, 1999) and focuses on cognitive processes as well as on the resources involved in the readers' evaluation of conflicting claims. The CSI model assumes three possible stages in readers' processing of scientific conflicts: First, conflict detection, second, conflict regulation, and third, conflict resolution. During the first stage (conflict detection) readers need to detect the lack of

coherence between conflicting claims within or between documents (Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013) in order to engage in the subsequent stages of conflict evaluation on which the present paper focuses.

Conflict regulation.

In the second stage of conflict regulation, readers try to restore coherence for themselves by either ignoring the conflict, reconciling the conflicting claims using additional inferences, or accepting the conflict as being due to different sources. While ignoring the conflict might not be desirable, the reconciliation of conflicting claims requires additional information from the texts and/or prior knowledge that can be used as an explanation for the conflict. The third option, to deal with conflicting claims by accepting them as being due to different sources, stems from the documents model framework (e.g., Britt & Rouet, 2012; Britt, Rouet, & Braasch, 2012; Perfetti, Rouet, & Britt, 1999). This framework assumes that when building a mental representation for the content of multiple documents, information on the sources of documents can be stored in so-called document nodes linked to the documents' content, to form a mental "intertext model" that can be used to explain conflict between the documents. There are several studies indicating that source information is used for conflict regulation through increased processing (Braasch et al., 2012; Kammerer, Kalbfell, & Gerjets, 2016) or memory and consideration of source information (Kammerer et al., 2016; Saux et al., 2017), when readers are confronted with conflicting compared to consistent claims from different sources within or between documents (for an overview see Braasch & Bråten, 2017). While some of these studies kept the perceived trustworthiness or expertise of sources constant across sources (e.g., Braasch et al, 2012; Saux et al., 2017), Kammerer et al. (2016) and Saux et al. (2018) used two sources that differed in terms of their trustworthiness (i.e., whether or not they had potential commercial intent) or their expertise (i.e. whether they were more or less

knowledgeable). Such differences in source information are assumed to also play a role in the third step of the CSI model, conflict resolution.

Conflict resolution.

The last step of conflict evaluation according to the CSI model is conflict resolution, which encompasses validity judgements of the claims in order to make a decision or form a personal stance on the conflict at hand. Based on Bromme, Kienhues, and Porsch (2010) there are a first-hand approach and a second-hand approach to evaluate which of two (or more) conflicting claims is (more) valid. The first-hand approach implies that readers directly evaluate the validity of a claim based on their own knowledge, with the central question, "Which claim is true?". Hence, this approach cannot be used reliably by laypersons, due to their lack of prior domain knowledge (Bromme & Goldman, 2014; Scharrer, Bromme, Britt, & Stadtler, 2012). In the second-hand approach, source information is used to decide which of the conflicting claims to adopt. Such judgements of source credibility could, for example, be based on the perceived expertise or trustworthiness of the source (Hovland, Jannis & Kelley, 1953; Hovland & Weiss, 1951). In this case, expertise and trustworthiness would be defined as the ability (or competence) and willingness (or motivation) of the source to provide accurate information (Danielson, 2006). Thus, when applying a second-hand approach, the central question is "Whom to believe?", which allows for an indirect evaluation of claim validity, which is more independent of one's prior domain knowledge. In line with this idea, multiple studies showed that when confronted with opposing claims, readers tend to align with the position of those sources perceived as more trustworthy (Paul, Stadtler, & Bromme, 2017) or more competent (Kobayashi, 2014). They also rate arguments of trustworthy sources to be more convincing than arguments put forward by sources with possible vested interests (Kammerer et al., 2016) and cite sources they rated as more trustworthy more often when asked to write an essay on the topic (List, Alexander, & Stephens, 2017). Moreover, Paul and

colleagues (2017) showed in a study with elementary school children that this effect of alignment with source perceived as more trustworthy is particularly strong when conflicting claims are mutually exclusive rather than only discrepant.

It is important to note that first-hand and second-hand evaluation may not be used exclusively of each other. However, it can be expected that individuals with less domain knowledge will rely more on source information rather than on the content itself to explain scientific conflict and evaluate conflicting claims increases (Bråten, Strømsø, & Britt, 2009; Bromme, Thomm & Wolf, 2015).

Source Information's Usefulness to Evaluate Conflicting Claims

With regard to the role that source information can play in the processes of conflict evaluation introduced above, it may be important to look at the specific characteristics of source information that may affect its role during conflict regulation as well as conflict resolution.

As argued by Saux and colleagues (2018), one major characteristic of source information that affects how it is used during conflict evaluation is its relevance. Building on previous findings that source information is processed especially in the presence of conflicting information than when claims are consistent, Saux and colleagues (2018) showed that readers' source memory was better for task-relevant source information when there was conflict between the claims compared to when claims where consistent, but not for task-irrelevant source information. Task-relevant source information used in their study was information on the origin of the sources' knowledge, while information on the sources' appearance was used as task-irrelevant source information, with the given task being the evaluation of sources' knowledgeability. These findings indicate prioritized processing of source information that is relevant to the task at hand.

Apart from its relevance, however, source information can also differ with respect to its usefulness to explain the conflict: While information regarding attributes like the

trustworthiness or expertise of sources might be relevant (compared to, for example, information concerning the physical appearance of sources), such information cannot necessarily be used to explain conflicting claims. If sources do not differ in their perceived trustworthiness or expertise, source information cannot be used to resolve contradictions between claims (Richter & Maier, 2017). This could be the case if the sources of both claims are experts of equal status (in the eyes of the reader), and no further source information is given. However, as soon as differences in relevant source information become apparent, for instance because of perceived vested interests of one of the sources, this information can be used as an explanation for the conflicting claims during conflict regulation and for conflict resolution according to the second-hand evaluation described in the CSI model (Stadtler & Bromme, 2014). Thus, we would assume deeper processing of source information to occur when it can be used for the explanation and resolution of the conflict (because one source is more trustworthy or knowledgeable than the other), than when it cannot be used for the explanation and resolution of the conflict (because the sources are comparable in terms of trustworthiness and expertise). To our knowledge, however, there is little research that specifically examines how the presence (as compared to the absence) of differences in sources' trustworthiness or expertise (as indicated by available source information) affects the explanation of the conflict and especially the processing of source information. One study by Thomm and Bromme (2016) indicates that laypersons indeed considered differences in the sources' trustworthiness or expertise as explanations for conflicting scientific claims (based on the explaining conflicting scientific claims questionnaire, ECSC; Thomm, Hentschke & Bromme, 2015). Specifically, when differences in the sources' trustworthiness were present (i.e., a professor from a public university vs. a researcher from industry), participants (university students) agreed more strongly with differences in researchers' motivations as an explanation for the conflict, while the presence of differences in the sources' expertise (i.e., a professor from a public university

vs. a junior researcher) led to higher agreement with differences in researchers' competence as an explanation for the conflict. Additionally, source information also affected participants' judgments of the sources' credibility, such that the researcher from industry was judged as being less credible than the professor from a public university. However, the junior researcher was not judged as being significantly less credible than the professor. Furthermore, in line with the idea that differences in source information receive deeper processing, participants showed better memory for source information when expertise or trustworthiness differences between the sources were present compared to when they were absent. However, no online measures of source processing were used in the study by Thomm and Bromme (2016). Thus, for the purpose of investigating whether there was increased processing of source information when differences in sources' trustworthiness that can be used to explain a scientific conflict were present, we used eye-tracking methodology as an objective indicator for individuals' moment-by-moment cognitive processing during reading (Rayner, 1998). This allowed us to discriminate between the processing of source information and the remaining text. Based on the eye-mind hypothesis (Just & Carpenter, 1980), it is assumed that the fixations of words are directly linked to their processing during reading. As recently argued by Salmerón, Gil, and Braten (2018), eye-tracking methodology can be a valid measure to examine attention to source information in multiple-text reading situations, at least when tied to experimental manipulations that are introduced to test specific hypotheses based on theoretical considerations regarding strategic processing of source information (cf. e.g., Braasch et al., 2012; Kammerer et al., 2016; Mason, Pluchino, & Ariasi, 2014).

Present Research

The main goal of our experiment was to examine how the presence of differences in source information on conflicting scientific claims, that is, the usefulness of this source information to explain the conflict, affected processes during conflict regulation and conflict

resolution (based on the CSI model; Stadtler & Bromme, 2014). In addition to the main experiment reported in this paper we will also shortly report on the results of a pilot experiment, on which the main experiment was based on.

In both the pilot experiment and the main experiment we focused on differences in the sources' perceived trustworthiness, as indicated by information regarding potential biases or vested interests of the sources (Metzger & Flanagin, 2013). To this end, participants were presented with two texts containing conflicting scientific claims. These claims were said to stem either from two sources that differed in terms of their trustworthiness (one high-trustworthy source and one low-trustworthy source) or were equally trustworthy (two high-trustworthy sources). The scientific conflict used in our experiments came from the domain of nanotechnology, specifically nanosafety, dealing with the question of whether or not nanoparticles in sunscreen (used as UV-blockers) can penetrate the human skin and therefore may have negative effects on humans' health. We expected there to be less prior knowledge on this topic than on many other socioscientific topics (Pillai & Bezbaruah, 2017), which in turn should lead to higher dependence on source information in the evaluation of the conflict (Stadler & Bromme, 2014). Furthermore, by telling the readers beforehand that they would be presented with conflicting claims, we tried to minimize the possible influence of conflict detection or non-detection, respectively, on conflict regulation and source processing.

In contrast to previous research (e.g., Thomm & Bromme, 2016; Paul et al., 2017; Saux et al., 2018), we used a sequential presentation of the claims, which is typical for situations on the internet, where opposing claims are often found on different websites. Individuals could go back and forth between the two texts, as would be the case if they were navigating between different websites. Furthermore, in contrast to earlier studies in this field (e.g., Thomm & Bromme, 2016), we made sure that source information was no longer present when participants were asked to provide reasons for the conflict and to evaluate the claims. Thus, any effects of

source information would be an indication of readers' integration of this information into a mental intertext model (Britt & Rouet, 2012; Perfetti et al., 1999) . Based on the theoretical considerations and empirical findings introduced above, we established the following four hypotheses:

(H1) Researchers' motivations should be rated as a more plausible explanation for the conflict when differences in the sources' trustworthiness are present compared to when differences are absent (cf. Thomm & Bromme, 2016 and the CSI model of Stadtler & Bromme, 2014).

(H2) With differences in trustworthiness present, there should be less agreement with the claim of the low-trustworthy source than with the claim of the high-trustworthy source (cf. Paul et al., 2017), whereas when differences are absent, claim agreement should be equal across sources based on the assumptions of second-hand evaluation during conflict resolution in the CSI model.

(H3) Source information should be fixated for a longer time when differences in trustworthiness are present, compared to when differences are absent under the assumption that source information that can be used for conflict regulation and resolution, receives deeper processing.

(H4) Due to deeper processing, there should be a better memory of source information when differences in trustworthiness are present compared to when differences are absent (cf. Thomm & Bromme, 2016).

Methods

Participants

Participants for both the main experiment and the pilot experiment were recruited via a local, web-based online recruitment system for university students (for details regarding the sample of the pilot experiment, see "Results" section). The main experiment was conducted

with a total of 79 participants who were compensated with 6€. Participants of the pilot experiment were not allowed to participate in the main experiment. Three participants had to be excluded due to problems in the experimental procedure, resulting in a final sample of N = 76 university students from a variety of majors (78.9% female, M = 24.63 years, SD = 7.52 years). The sample reported medium interest (M = 2.77, SD = 0.81) and low prior knowledge (M = 1.47, SD = 0.72) concerning nanotechnology, as measured by two self-report items with 5-point Likert scales from 1 (“very low”) to 5 (“very high”).

Material

Conflict scenario and claims.

Participants were presented with a conflict scenario from the field of nanotechnology, that is, the use of nanoparticles in sunscreen. They were introduced to the use of nanoparticles as a UV-blocker in sunscreen and were informed about the controversy on whether these nanoparticles can penetrate the human skin and could therefore cause health risks. Participants were informed that they would next be presented with information from the websites of two scientists that provided opposing claims on this topic. They were asked to carefully read these texts in order to answer questions on the controversy afterwards (cf. Thomm & Bromme, 2016). The two claims presented in the texts stated that studies have shown nanoparticles to be able (Claim A) or unable (Claim B) to penetrate the human skin. These claims were based on actual reports and adapted for use in this study. Both texts were of similar length, structure, and readability (see Table 1). In order to test the text materials, in a norming study the claims were presented (without source information) to 32 undergraduate students of psychology (M_{age} = 21.38, SD_{age} = 2.95, 27 female) who rated perceived readability and convincingness on seven-point Likert-scales (1, “very low” to 7, “very high”). Paired t-test showed no significant differences in the perceived readability of the claims, $t(31) = -1.09$, $p = .282$, while Claim A (M = 4.00, SD = 1.41) was perceived as significantly more convincing than Claim B (M = 3.38,

247 *SD* = 1.39), $t(31) = 2.33$, $p = .027$. This difference, however, was expected to have a constant
248 influence over our experimental groups, because the claims were identical for both the
249 conditions with and without differences in source information.

Table 1
Information on length and readability of the text material presented for each claim depending on experimental group

	Claim A	Claim B	
		Control	Trustw. differences
Sentences	2	2	2
Words	82	81	81
Syllables	176	174	174
Characters	605	606	608
Readability Score	78.8	77.5	77.5

Note. The readability score refers to the German readability score "Lesbarkeitsindex" (LIX), which indicates that both claim texts were of high difficulty comparable to scientific literature (Lenhard & Lenhard, 2014-2017).

250 **Source information.**

251 Each claim was said to stem from a scientist in the field of nanoscience. Claim A (i.e.,
252 nanoparticles are able to penetrate the skin) was said to stem from a professor of nanoscience
253 working at a university (baseline source in every experimental group) while Claim B (i.e.,
254 nanoparticles are unable to penetrate the skin) was said to stem from (a) a professor of
255 nanoscience working for a company (trustworthiness-difference group), or (b) another
256 professor of nanoscience working at a university (control group) as a comparison source (for
257 the translated claims with examples of source information from the trustworthiness difference
258 group, see Table 2). Claims and sources were not counterbalanced to avoid combinations in
259 which a source appeared to argue against its own personal interest, which could lead to an
260 evaluation of the source as more trustworthy (Harmon & Coney, 1982) which would have been
261 opposed to our intended manipulation. There were also names and countries of origin given for
262 each source (Mr. Peterson from Sweden or Mr. Hendricksen from Denmark) that were

263 counterbalanced across claims. The presentation order of the conflicting claims was also
264 counterbalanced.

Table 2
Claims presented to the participants (with the corresponding source information as presented for the trustworthiness differences group)

Claim A (baseline source)	Claim B (comparison source)
Mr. Peterson, a state-financed professor who works at a Swedish university in the field of nanosciences, thinks that nanoparticles can penetrate deep into the skin and therefore may pose a health risk. This professor works on this topic at his university for ten years and writes on his website: „The results of our study indicate that the used nanoparticles can penetrate deep into the skin where they can come in contact with living cells and also with the blood circulation.	Mr. Hendricksen, an industry-financed professor who works at a Danish company in the field of nanosciences, thinks that nanoparticles cannot penetrate the outer layers of the skin and therefore do not pose a health risk. This professor works on this topic at his company for ten years and writes on his website: „The results of our study indicate that the used nanoparticles cannot penetrate the outer layers of the skin and therefore cannot come in contact with living cells.

Note. The underlined parts represent relevant source information that can be used (in the trustworthiness differences group) to explain the conflict between the claims. Original material was presented in German.

265 **Measures**

266 **Prior domain knowledge.**

267 In addition to self-reported topic knowledge and topic interest (see Participants), we
268 used an adapted version of the Public Knowledge in Nano Technology (PKNT) questionnaire
269 (Lin, Lin & Wu, 2013) to gain an additional objective measure on prior domain knowledge.
270 Participants had to answer eight multiple-choice questions on nanotechnology ($\alpha = .58$) from
271 the PKNT, which were chosen and translated under consultation with researchers from the field
272 of nanosafety. Each question was followed by four possible answers from which only one was
273 correct resulting in a probability of 25 % to choose the correct answer by chance.

274 **Prior domain attitudes.**

275 We used an adapted version of the Public Attitudes towards Nano Technology (PANT)
276 questionnaire (Lin et al., 2013) to assess participants' prior attitudes towards potential risks of
277 nanotechnology for human health. Participants were asked to rate their agreement with each of
278 four statements on possible risks of nanotechnology from the PANT (e. g. "The toxicity of

nano-particles may be even higher than that of large-size particles.") on a five-point Likert scale (1, "very much disagree" to 5, "very much agree"; α = .78).

Explanation of the conflict.

The ECSC questionnaire by Thomm and colleagues (2015) is an instrument to measure individuals' causal assumptions regarding conflicts between scientific claims. The ECSC consists of four dimensions, each of which represents one of four explanations for conflicting scientific claims (5 items on *differences in researchers' motivations*, 6 items on *differences in researchers' competence*, 6 items on *differences in research process*, 6 items on *thematic complexity*). The 23 statements of the ECSC were presented to the participants as possible explanations for the conflict they had read before. Participants were tasked to rate their agreement with each explanation from 1 ("very much disagree") to 6 ("very much agree"). Internal consistencies (indicated by Cronbach's alpha) of the ECSC-dimensions in our experiment were α = .64 for *researchers' competence*, α = .71 for *thematic complexity*, α = .76 for *research process* and, α = .89 for *researchers' motivations*. A sample item from the dimension *researchers' motivations*, on which we focused in our experiment, was "External factors such as competitive pressure, rivalry, marketing, or advertising influence the scientists' work."

Claim agreement.

Participants were asked to rate their agreement with each of the two claims on a seven-point Likert scale (1, "very much disagree" to 7, "very much agree").

Source processing.

As a measure of source information processing (i.e., amount of visual attention devoted to sources) we measured the total f time (in ms) participants spent fixating on the source information of the two claims. For each text, three areas of interest (AOIs) were set

around critical source information, that is, “state-financed” vs. “industry-financed” and “company” vs. “university” (see Figure 1 for the comparison source in the trustworthiness difference group). Gaze points within a viewing angle of 2° over a minimum period of 80 ms were defined as fixations by the SMI BeGaze 3.7.59 eye-tracking software used for data processing). As the dependent variable, we used the sum of total fixation duration for all AOIs aggregated across both texts.

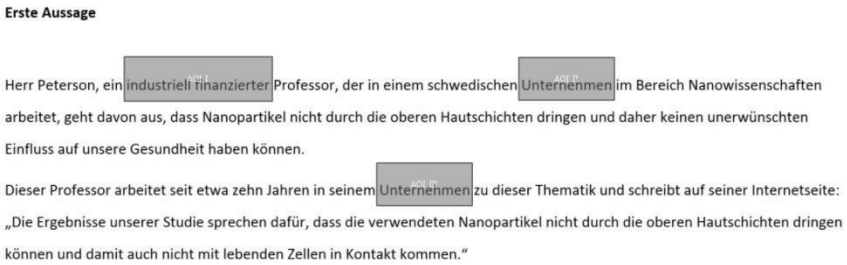

Figure 1. Example screenshot of the first claim with areas of interest (AOIs) around the text sections with relevant source information of the trustworthiness differences group (i.e., on the words “industry-financed” and “company”).

Additionally we computed the first-pass duration as the sum of all fixation durations on critical source information before exiting the respective AOI and the second-pass duration as the sum of all fixation durations for fixations that returned to an AOI after the first-pass (as described in Hyönä, Lorch, & Rinck, 2003). These measures also have been used in previous studies that measured attention to source information (e. g., Mason, Pluchino, & Ariasi, 2014; Salmerón et al., 2018). We analyzed these two measures separately for the baseline source and the comparison source.

Source memory.

Source memory was measured with a free recall task for each claim, in which participants were given the claim without source information and asked to write down all information they remembered about the source of the respective claim. Source memory for a claim was scored with 1 point, if correct information on relevant source information (workplace and/or funding of the source) was given. Otherwise it was scored with 0 points. The free recall

format for source information was followed by an additional cued recall format in which participants were directly asked to fill in the name, workplace, country, and financing for each of the two sources. Again, source memory for a claim was scored with 1 point, if a correct answer for workplace and/or funding of the source was given. Two independent raters scored all responses for the free ($\kappa = .90$) as well as the cued recall task ($\kappa = .97$). Disagreements were resolved through discussion.

Source trustworthiness rating (manipulation check).

At the end of the experiment, as a manipulation check, sources were again presented together with their respective claims, and had to be rated regarding the trustworthiness of the source. Specifically, participants were asked to answer the questions "How trustworthy is this scientist in your opinion?" and "How honest is this scientist in your opinion?" (cf. e.g. Clark & Evans, 2014) on seven-point Likert scales from 1 ("not at all") to 7 ("very"). The two responses were highly correlated and, thus, averaged for each source ($\alpha = .88$ - $.91$).

Experimental Design

For the dependent variables of total fixation duration, explanation of the conflict (ECSC-dimensions) and source memory, the study was realized as a one factorial between-subject design with the factor "differences in trustworthiness" (present, absent; for details see section 'Material'). For the dependent variable of claim agreement as well as for the source trustworthiness rating (manipulation check), the additional within-subject factor "source" (baseline source, comparison source) resulted in a 2x2 mixed design.

Procedure

All of the materials were presented in German. The study was conducted in two parts. The first part was sent to the participants as an online questionnaire using the survey platform Qualtrics (Qualtrics, Provo, UT), while the second part took place 24-48 hours later in a

laboratory environment. Informed consent for participation was given at the beginning of both parts of the experiment. In the online questionnaire, participants reported on their interest and prior knowledge concerning nanotechnology and completed the PKNT and the PANT questionnaires (Lin et al., 2013). In the second part of the study, participants were given a short instruction on the eye-tracking procedure and were then seated in front of a 15.6-inch monitor equipped with an SMI (Sensomotoric Instruments) RED250mobile eye-tracking device and ExperimentCenter 3.7 to record eye-tracking data. A chin rest ensured a constant distance of 60 cm between the monitor and the eyes of the participants. They were given a short on-screen introduction to the topic as well as the instructions to read carefully the following material that would follow. The two texts with claims were presented on two separate pages, and participants could navigate freely back and forth between them without any time constraints. Participants could choose for themselves when to end the claim presentation and therefore the eye-tracking part of the experiment. After the claim presentation, participants changed their seats to a different computer where they had to rate, in their opinion, what possible reasons there were for the conflict between the scientists' claims, based on the ECSC questionnaire (Thomm et al., 2015). Afterwards, participants had to rate their personal agreement with the two claims that were presented again in the same order as in the experimental task but without source information. Source memory was then tested with a free recall followed by a cued recall task, and finally, as a manipulation check, the participants had to rate their perceived trustworthiness of each of the two presented sources. To provide these ratings, they were again presented the claims together with the sources (cf. Thomm & Bromme, 2016), in the same order as in the claim presentation.

Analytic approach

For the two dependent variables total fixation duration on source information and differences in researchers' motivations as explanation of the conflict, one-sided Welch t-tests

(according to our directional hypotheses) were conducted to investigate the effects of the factor *differences in trustworthiness*. Additionally, for the first-pass and second-pass fixation durations these Welch t-tests were followed up by repeated measures ANOVAs, with the addition of the within factor *source*. For the dependent variable claim agreement as well as for source trustworthiness ratings (manipulation check), multilevel linear regressions with random intercept were used to investigate the effects of *differences in trustworthiness* on each of the two presented *sources* (baseline and comparison), accounting for the relation between ratings on sources or claims, respectively, presented to a participant. Finally, for the dependent variable source memory, χ^2-tests were used to compare the distribution of participants remembering either no source, one source, or both sources correctly. All analyses were conducted in R (R Core Team, 2016).

Pilot Experiment

The methods of the main experiment are based on improvements to a prior pilot experiment, with similar methods and the same hypotheses. The materials and measures of the pilot experiment differed from the main experiment only in the following ways: The material did not include information on the country of origin, and different names were used for the sources (“Mr. Müller” and “Mr. Maier”). Concerning the measures used in the pilot experiment, there was an additional free recall task on the content of the claims before responses on claim agreement were collected. Instead, no cued recall task on source memory was included after the free source recall task. Apart from these differences, the pilot experiment was identical to the main experiment outlined above.

Results

Results of the pilot Experiment

First, we will briefly present the central findings of the pilot experiment in order to give a more complete view of the data we collected to address our research questions. The sample of the pilot experiment consisted of $N = 79$ university students from a variety of majors (82.3% female; $M = 23.96$ years, $SD = 3.38$ years). It should be noted that participants of the pilot experiment were not allowed to participate in the main experiment. The sample reported medium interest ($M = 2.95$, $SD = 1.15$) and low prior knowledge ($M = 1.63$, $SD = 0.89$) concerning nanotechnology. Participants in the two experimental conditions did not differ in terms of age, self-reported topic interest, self-reported prior knowledge, the PKNT-score, or prior attitudes towards potential risks of nanotechnology (PANT-score). Results of the pilot experiment revealed significant effects of the presence of *trustworthiness differences* on (H1) the explanation of the conflict via researcher's motivation, $t(76.97) = -1.92$, $p = .030$, and (H3) the total fixation duration on source information, $t(71.70) = -2.62$, $p < .001$. However, we could not observe the expected effects of the presence of *trustworthiness differences* on (H2) claim agreement and (H4) source memory. For more detailed statistics on these findings see Table 3.

Table 3

Mean scores (and SD) for general measures and dependent variables in the pilot experiment separated by trustworthiness differences group and control group as well as (if applicable) by baseline and comparison source

	Control		Trustw. differences	
	Baseline	Comparison	Baseline	Comparison
n[a]	40		39	
General measures				
Age (in years)	23.58 (3.29)		25.09 (4.03)	
Topic interest (self-report, 1-5)	2.95 (0.83)		2.58 (0.76)	
Topic knowledge (self-report, 1-5)	1.59 (0.79)		1.34 (0.63)	
PKNT[b] (max. 8 points)	3.85 (1.84)		3.16 (1.69)	
PANT (risk, 1-5)[c]	3.49 (0.62)		3.27 (0.84)	
Dependent variables				
ECSC (*Motivations dimens., 1-6)*	4.04 (1.15)		4.52 (1.09)	
Total fixation time (in s)[d]	4.05 (2.15)		5.58 (2.50)	
Source trustw. rating (1-7)	5.55 (1.01)	5.06 (1.42)	5.63 (1.12)	3.28 (1.27)
Claim agreement (1-7)	4.83 (1.17)	3.38 (1.36)	5.05 (1.31)	3.33 (1.56)

[a]Because of dropouts due to low quality of eye-tracking data the sample sizes for total fixation time are *n* = 37 (Control) and *n* = 37 (Trustworthiness differences)
[b]Prior Knowledge on Nano Technology questionnaire (PKNT, Lin, Lin & Wu, 2013) with a maximum of 8 points and guessing probability of 25%
[c]Prior Attitudes towards Nano Technology questionnaire (PANT, Lin, Lin & Wu, 2013)
[d]Total fixation duration on AOIs (areas of interest) for relevant source information

Results of the main Experiment

Welch t-tests were conducted to check for differences in age, self-reported topic interest, self-reported prior knowledge, PKNT score, or prior attitudes towards potential risks of nanotechnology (PANT-score) between the control group and the trustworthiness difference group. No significant differences for any of these general measures were found (all $p > .389$). Both groups' mean scores for all general measures and dependent variables are shown in Table 3, and mean scores for dependent variables that could be additionally separated by the within factor *source* are shown in Table 4.

Table 4

Mean scores (and SD) for general measures and dependent variables in the main experiment separated by trustworthiness differences group

	Control	Trustw. differences
n[a]	37	39
General measures		
Age (in years)	24.68 (7.73)	24.59 (7.43)
Topic interest (self, 1-5)	2.95 (1.18)	2.95 (1.15)
Topic knowledge (self, 1-5)	1.65 (0.89)	1.62 (0.91)
PKNT[b] (max. 8 points)	3.51 (1.77)	3.62 (2.05)
PANT[c] (risk, 1-5)	3.36 (0.69)	3.51 (0.74)
Dependent variables		
ECSC (*motivations, 1-6*)	3.56 (1.30)	4.50 (1.00)
ECSC (*competence, 1-6*)	2.62 (0.77)	2.89 (0.76)
ECSC (*research process, 1-6*)	4.15 (0.96)	3.89 (0.69)
ECSC (*thematic complexity, 1-6*)	4.46 (0.73)	4.02 (0.83)
Total fixation duration (in s)[d]	3.21 (1.72)	4.74 (2.24)
First-pass duration (in s)	1.68 (0.91)	2.59 (1.37)
Second-pass duration (in s)	1.53 (1.38)	2.15 (1.48)

[a]Because of dropouts due to low quality of eye-tracking data the sample sizes for total fixation duration are $n = 32$ (Control) and $n = 38$ (Trustworthiness differences)
[b]Prior Knowledge on Nano Technology questionnaire (PKNT, Lin, Lin & Wu, 2013) with a maximum of 8 points and guessing probability of 25%
[c]Prior Attitudes towards Nano Technology questionnaire (PANT, Lin, Lin & Wu, 2013)
[d]Total fixation duration on AOIs (areas of interest) for relevant source information

Table 5

Mean scores (and SD) for dependent variables in the main experiment separated by trustworthiness differences and control group as well as by baseline and comparison source

	Control		Trustw. differences	
	Baseline	Comparison	Baseline	Comparison
First-pass duration (in s)	0.73 (0.56)	0.95 (0.60)	1.01 (0.69)	1.58 (1.16)
Second-pass duration (in s)	0.86 (0.88)	0.67 (0.75)	0.95 (0.95)	1.20 (1.01)
Source trustw. rating (1-7)	5.47 (0.82)	5.27 (0.90)	5.83 (0.88)	3.12 (1.26)
Claim agreement (1-7)	4.30 (1.75)	3.62 (1.01)	5.21 (1.74)	2.62 (1.27)

[a]Total fixation duration on AOIs (areas of interest) for relevant source information.

Explanation of the conflict (H1).

The one-sided Welch t-test used to examine the effects of differences in trustworthiness on the ECSC-dimension researchers' motivations showed a significant main effect of the factor differences in trustworthiness ($t(67.50) = -3.51$, $p < .001$), with researchers' motivations regarded as a stronger possible explanation for the conflict when differences in trustworthiness

were present (M = 4.50, SD = 1.00) than when they were absent (M = 3.56, SD = 1.30), confirming H1. Additionally, there was a significant effect of the factor *differences in trustworthiness* on the ECSC-dimension complexity of the topic, so that participants indicated more agreement with this dimension when differences in trustworthiness were absent (M = 4.46, SD = 0.73) compared to when they were present (M = 4.02, SD = 0.83), $t(73.54) = 2.47$, $p = .016$ (two-sided). For the ECSC-dimensions differences in competence, $t(73.76) = -1.54$, $p = .127$ (two-sided), and differences in research process, $t(64.78) = 1.39$, $p = .168$ (two-sided), there were no significant differences between the experimental groups.

Agreement with claims (H2).

The multilevel linear regression model for claim agreement showed no significant variance in intercepts across participants, $\chi^2(1) = 0.00$, $p > .999$, thus random intercepts for participants were dropped from the model. Regarding fixed effects, there was a significant main effect of *source*, b = -0.68 (95% CI: -1.21, -0.14), $t(74) = -2.50$, $p = .013$, and a significant main effect of *differences in trustworthiness*, b = 0.91 (95% CI: 0.38, 1.44), $t(74) = 3.40$, $p < .001$. Additionally, in line with H2, the interaction between *differences in trustworthiness* and *source* was also significant, b = -1.91 (95% CI: -2.66, -1.17), $t(74) = -5.07$, $p < .001$. Tukey-corrected contrasts showed that in the condition with differences in trustworthiness being present, claim agreement was significantly higher for the baseline source than for the comparison source, b = 2.59 (95% CI: 1.91, 3.27), $t(144) = 9.84$, $p < .001$. Instead, in the condition without differences in trustworthiness being present, claim agreement did not significantly differ between sources, b = 0.68 (95% CI: -0.03, 1.38), $t(144) = 3.40$, $p = .064$.

Source processing (H3).

Due to low quality of eye-tracking data, six participants (n = 5 in the trustworthiness difference condition, n = 1 in the control condition) had to be excluded from the sample for the analysis of the eye-tracking data. For the remaining sample, log-transformed values of total

fixation durations on source information were used to achieve a normal distribution of the models' residuals (as recommended e.g. by Field, Miles, & Field, 2012). A one-sided Welch t-test used to investigate the effect of *differences in trustworthiness* on the total fixation durations on relevant source information showed significantly longer fixation times with differences present (M = 4.74 s, SD = 2.24 s) than with differences absent (M = 3.21 s, SD = 1.72 s), $t(54.90) = -3.49$, $p < .001$, confirming H3. Additionally, a separate analysis showed both longer first-pass fixation durations, $t(68.00) = -3.36$, $p < .001$, and longer second-pass fixation durations on relevant source information, $t(65.07) = -1.90$, $p = .031$, with differences in trustworthiness present than with differences absent (see Table 4). To further explore these findings we conducted two repeated-measures ANOVAs for first-pass fixation durations and second-pass fixation durations with the factors *differences in trustworthiness* and *source*. For first-pass fixation durations we found significant main effects for *differences in trustworthiness,* $F(1,68) = 9.50$, $p = .003$, $\eta_p^2 = .12$, and *source,* $F(1,68) = 8.23$, $p = .005$, $\eta_p^2 = .11$, but no significant interaction between the two factors, $F(1,68) = 0.77$, $p = .382$, $\eta_p^2 = .01$, Participants fixated longer on relevant source information when differences in trustworthiness were present rather than absent, and they fixated longer on relevant source information of the comparison source than of the baseline source (see Table 5). For second-pass fixation durations there was neither a significant main effect of *differences in trustworthiness,* $F(1,68) = 3.49$, $p = .066$, $\eta_p^2 = .05$, nor of *source,* $F(1,68) = 0.13$, $p = .717$, $\eta_p^2 < .01$, but there was a significant interaction between the two factors, $F(1,68) = 4.74$, $p = .033$, $\eta_p^2 = .07$. We used Tukey-corrected pairwise comparisons to further investigate this interaction: Participants showed longer second-pass fixation durations on relevant source information of the comparison source when differences in trustworthiness were present than when they were absent, $t(68) = -2.77$, $p = .035$, whereas second-pass fixation durations did not differ for the baseline source between

the *trustworthiness difference* groups, $t(68) = -0.31$, $p > .990$. (for means and standard deviations see Table 5)

Source memory (H4).

There were no significant differences in the distribution of the number of sources (0-2) remembered correctly over experimental groups in the free recall task, $\chi^2(2) = 0.35$, $p = .841$, or the cued recall task, $\chi^2(2) = 1.45$, $p = .385$. For the free recall task, in the control group, 67.57% remembered both sources correctly, 10.81% one source, and 21.62% remembered neither of the two sources correctly. Similarly, in the trustworthiness-difference group, 64.10% remembered both sources correctly, 15.38% one source, and 20.52% no sources. For the cued recall task, in the control group, 81.08% remembered both sources correctly, 13.51% one source, and 5.41% remembered neither of the two sources correctly. Similarly, in the trustworthiness-difference group, 69.23% remembered both sources correctly, 23.08% one source, and 7.69% no sources.

Source trustworthiness ratings (manipulation check).

The multilevel linear regression model for source trustworthiness ratings showed no significant variance in intercepts across participants, $\chi^2(1) = 1.58$, $p = .209$, thus random intercepts for participants were dropped from the model. Regarding the fixed effects of the model, there were no significant main effects of *differences in trustworthiness*, $b = 0.36$ (95% CI: -0.09, 0.81), $t(74) = 1.60$, $p = .113$, or of *source*, $b = -0.20$ (95% CI: -0.65, 0.25), $t(74) = -0.89$, $p = .377$. The only significant interaction shown by the model was the expected interaction of *differences in trustworthiness* and *source*, $b = -2.52$ (95% CI: -3.15, -1.88), $t(74) = -7.88$, $p < .001$. Tukey-corrected contrasts showed that in the condition with differences in trustworthiness being present, the comparison source was rated significantly less trustworthy than the baseline source, $b = -2.72$ (95% CI: -3.30, -2.14), $t(148) = 12.20$, $p < .001$. Instead, in the condition without differences in trustworthiness being present, trustworthiness ratings for

the comparison and the baseline source did not differ significantly, $b = 0.36$ (95% CI: -0.23, 0.95), $t(148) = 1.60$, $p = .384$.

Discussion

With the increasing use of the internet as a resource for scientific information, laypersons frequently face situations in which they need to evaluate scientific conflicts. The CSI-model by Stadtler and Bromme (2014) assumes that in such cases, where laypersons often lack prior domain knowledge, source information plays important roles during conflict regulation and in the indirect (i.e., second-hand) evaluation of the validity of the encountered claims (i.e., asking "Whom to believe?", Stadtler & Bromme, 2014). Prior studies have provided some empirical evidence for this assumption, both in terms of increased attention to and memory of source information in the presence of conflicting claims in general (Braasch et al., 2012; Kammerer et al., 2016; Saux et al., 2017) and in terms of the use of source information for subjective explanations of scientific conflicts (Thomm & Bromme, 2016; Thomm et al., 2015).

The goal of the present research was to expand upon prior research by investigating how the presence of differences in sources' trustworthiness that can be used to explain the conflict, affects processing of source information during reading as well as the explanation of the conflict and which claim to agree with. Therefore, we presented laypersons with conflicting scientific claims together with the origins of these claims (i.e., source information), while experimentally varying whether differences in the sources' trustworthiness were present or not.

The Use of Source Information during Conflict Evaluation

In line with previous findings (Thomm & Bromme, 2016; Thomm et al., 2015) our results suggest that participants were indeed able to identify and interpret the indicated differences in trustworthiness that could be used to explain the conflicting scientific claims.

Differences in source information indicating possible vested interests of one source resulted in a reduction of perceived trustworthiness ratings of this source in comparison with a baseline source (as shown by results of the manipulation check). More importantly, the data obtained also showed that source information affected laypersons' subjective explanation of scientific conflicts. In line with our assumptions (H1), the presence of differences in source information (on trustworthiness) that could be used to explain the conflict led to increased subjective explanation of the conflict via differences in the experts' motivations, as indicated by the results of the ECSC. In relation to the CSI model (Stadtler & Bromme, 2014) this result indicates that source information can play an important role during conflict regulation not only as a way for readers to accept the presence of conflicts, but also to explain the conflict when differences in relevant source information are present. In such case, the explanation of the conflict via source information during conflict regulation might be a first step in the direction of second-hand evaluation of conflicting claims during conflict resolution.

In this regard, we also found the expected effect of differences in sources' trustworthiness on the readers' agreement with the respective claims in the main experiment. In line with H2, individuals agreed less with the claim of the source with lower perceived trustworthiness than with the claim put forward by the high-trustworthy source, when differences in source information were present. This supports the assumption that source information is not only used to build a subjective explanation for the conflicting claims, but is also considered in the evaluation of the claims, which is consistent with the assumption of the second-hand evaluation for conflict resolution in the CSI model (Stadtler & Bromme, 2014).

Another interesting observation in relation to this was that in the main experiment without differences in source information that could be used to explain the presence of a conflict, participants were more likely to explain the conflict with the complexity of the topic. While we had no hypothesis regarding this effect, and it should therefore not be overvalued, it

is in line with results from other experiments in which the absence of source information that could be used for an explanation of the conflict led to stronger agreement with alternative explanations such as the complexity of the topic or differences in research methods (Thomm & Bromme, 2016; Thomm et al., 2015). This could be an indication that people actively search for an explanation of conflict in order to reconcile the conflicting propositions (Bromme & Goldman, 2014).

As an important note, in the present research, source information was no longer available at the time the participants had to provide their ratings for explanation of the conflict and claim agreement. The fact that differences in source information still affected both of these measures can be regarded as further evidence for the integration of source information into a mental intertext model, from which source information can be used to explain conflicts and evaluate conflicting claims, as stated by the documents model framework (Britt & Rouet, 2012; Perfetti et al., 1999).

Processing of Source Information as a Function of its Usefulness for Conflict Evaluation

The eye-tracking data provided evidence for additional allocation of visual attention on source information when it can be used to explain conflicting scientific claims. In line with H3, relevant source information was fixated longer when differences in source information concerning the sources' trustworthiness were present. These findings are also in line with the CSI model's assumptions of second-hand evaluation (Stadtler & Bromme, 2014), since the use of source information to explain the conflict (conflict regulation) and evaluate the validity of the claims (conflict resolution) can be expected to be accompanied with increased visual attention on source information that can be used to explain the conflict. It seems reasonable that the observed increase in visual attention is driven by readers' attempts to explain and resolve content-related discrepancies by comparing the source information of both claims. Readers might cease these attempts when they realize that no differences in source information

suitable for resolving the conflict are present. Instead, source information seems to be even more deeply processed if differences in source information that can be used to explain the conflict are noticed.

An interesting addition to these findings on total fixation duration is the pattern we observed for the first- and second-pass fixation durations on source information. While we found increased overall fixation durations for first- and second-pass reading when regarding both sources together, when analyzing first-pass and second-pass fixation durations separately for the two sources (baseline vs. comparison) we found a more complex pattern. For the first-pass fixation duration, apart from the increased fixation durations on source information when differences in sources' trustworthiness were present, results indicated increased processing for the comparison source compared to the baseline source. This might be explained by the fact that the comparison source was always the source that claimed that nanoparticles cannot penetrate the skin, which was also perceived as the less convincing claim. Thus, participants might have processed that particular source information more critically. This is in line with findings from Bråten, Strømsø, and Andreassen (2016), who found better memory for source information when the source claimed that there were no health risks (of cellphone radiation or of artificial sweeteners, respectively) than when it claimed that there were health risks.

For the second-pass fixation durations our results revealed an interaction between *trustworthiness differences* and *source*, such that only the less trustworthy source received increased visual attention during second-pass reading when differences in trustworthiness were present. Since second-pass reading is generally regarded as an indication for more strategic processing (Hyönä et al., 2003), this finding might be additional evidence for our assumption that particularly source information that can be used to explain the conflict (in this case information on a source's possible commercial interest) is strategically processed during re-reading in order to explain and resolve the conflict. However, since the analyses on the

interaction of the factors *trustworthiness difference* and *source* were only explorative in nature and the factor source was confounded with the perceived convincingness of the respective claim, these findings should be interpreted with caution, and further studies will be needed to confirm them. Nonetheless, in addition to previous findings showing that the processing of (task-relevant) source information is increased when conflicting claims are present compared to when claims are consistent (Braasch et al., 2012; Kammerer et al., 2016; Saux et al., 2017), the results of our experiment suggest that not only increased task relevance of source information (Saux et al., 2018), but also the presence of differences in source information that can be used to explain a given conflict results in increased processing of this information. In short, the usefulness of source information to explain conflicting scientific claims put forward by different sources seems to lead to increased processing of this source information.

However, contrary to our expectations, for source memory (H4), no differences between the experimental groups for either the free or the cued recall were found. This might indicate that the presence (as compared to absence) of differences in source information to explain conflicting claims did not foster the integration of source information into the mental model of the conflict, despite the increased processing of source information during reading. However, the lack of an effect on source memory could also be explained with the presence of a ceiling effect due to generally high source memory in both conditions of our experiment. Therefore, future research should examine respective effects on source memory with more complex materials and source information that is more difficult to remember.

Limitations and Future Research

A limitation of the present research is that, because all participants were undergraduate students (although from a wide variety of majors), it is unclear how widely our results can be generalized. Undergraduate students might have a higher sensibility for source information than the general population due to their level of education. Therefore, it would be desirable for

future studies to investigate whether the observed effects can be generalized to other populations. Adding to this limitation regarding generalizability is the fact that only one scientific topic was used in our experiments, while research has shown that subjective explanation of scientific claims can vary in different domains (Johnson & Dieckmann, 2017; Thomm & Bromme, 2016). Another way in which our sample may have been different from the general population is the fact that they had to answer a prior knowledge test on nanosafety before the experiment. We cannot exclude that the experience of having problems answering the questionnaire might have reduced participants' self-perceived prior knowledge. This in turn could have led to higher reliance on source information and, thus, to an accentuation of our observed effects. However, since there was no feedback given for the prior knowledge test and since it was administered two days prior to the actual experiment we would not expect a major influence in this regard.

On a different note, the present research focused only on differences in the perceived trustworthiness of the sources (i.e., their presumed willingness to provide accurate information). In contrast, differences in sources' perceived expertise (i.e., their presumed ability to provide correct information), which is another important aspect of source credibility (Danielson, 2006) that can affect explanations for conflicting scientific claims (Thomm & Bromme, 2016), was held constant. According to the CSI-model (Stadtler & Bromme, 2014), differences in sources' expertise should affect conflict evaluation and source processing in similar ways as differences in sources' trustworthiness. This assumption should be investigated in future studies to examine whether our effects hold true for different aspects of source credibility, or whether they are limited to source information indicating trustworthiness (or a lack thereof).

One strength of the present research is the well-controlled and standardized material. However, in terms of external validity it should be kept in mind that although we tried to make

the material comparable to information that could be found in a natural information environment like the internet (e.g. information based on real online articles, sequential presentation of information), material embedded in actual websites is often more complex and source information is not limited to references embedded in the text. Instead, source information may have to be actively sought out elsewhere, for instance by accessing ”about us” sections and conflicts might not be as clear and easy to detect. Moreover, internet users often retrieve longer and more texts. Thus, to reach higher external validity, future studies should gradually try to approach the style and circumstances of information published online.

Summary and Conclusion

Notwithstanding these limitations, the present research provides further evidence for the assumption that laypersons use source information as an indirect means of evaluation to assess and, under certain conditions, even resolve conflicting scientific claims (Stadtler & Bromme, 2014; Thomm & Bromme, 2016). As indicated by the eye-tracking data, source information seems to receive increased processing, especially when it can be used to resolve a scientific conflict. More investigation of these processes will be needed to give better insight into how to design information environments that suit laypersons’ needs and habits, allowing them to make the best decision about the validity of knowledge claims they cannot easily evaluate with their own knowledge. Based on our results, one important step in this direction is to provide accurate and clear source information on scientific claims, particularly in the field of science communication. The more information from trustworthy and competent sources is available to laypersons and the easier it is for them to identify these sources, the better the strategy of second-hand evaluation can be used to successfully explain scientific conflicts and in turn to make informed decisions more likely.

Acknowledgements

We thank the two anonymous reviewers for their valuable comments on this paper.

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Appendix C: Experiment 4

The following is a preprint of a manuscript that is currently in preparation for resubmission after revision.

Please cite as:

Gottschling, S., Kammerer, Y. (2021) Readers' regulation and resolution of a scientific conflict based on differences in source information: an eye-tracking study. *Submitted manuscript*

Readers' regulation and resolution of a scientific conflict based on differences in source information: an eye-tracking study

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Source Information & Evaluation of Scientific Conflict

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Readers' regulation and resolution of a scientific conflict based on differences in source information: an eye-tracking study

Abstract

This eye-tracking study examines how differences in sources' trustworthiness are used by readers to regulate and resolve conflicting scientific claims. 144 university students were sequentially presented with two conflicting scientific claims (regarding nanotechnology) across two texts. The claims were indicated to stem either from two high-trustworthiness sources, two low-trustworthiness sources, or one high-trustworthiness source and one low-trustworthiness source. After having read the claims, participants rated their subjective explanations for the conflict, their personal claim agreement, and behavioral intent, and completed a source-memory task. In line with our predictions, trustworthiness differences resulted in increased visual attention to source information as compared to when both sources were of equal trustworthiness. Trustworthiness differences also affected subjective conflict explanations, claim agreement, and behavioral intent. We discuss these results in the context of the Content-Source Integration (CSI) model and propose an additional differentiation between readers' consideration of source information for conflict regulation and conflict resolution.

Keywords: multiple documents comprehension; source information; scientific conflicts; conflict regulation; conflict resolution; eye-tracking

Introduction

Today, in the age of information, we are regularly confronted with conflicting scientific claims on unfamiliar issues, for instance, when we inform ourselves about socio-scientific issues on the Internet. To illustrate this with an example, imagine that Olivia, a 22-year old Psychology student who enjoys spending time outdoors, is wondering whether or not to use sunscreen containing nanoparticles. On the Internet, she encounters websites presenting the claim that sunscreen containing nanoparticles is likely to have adverse health effects. However, she also encounters other websites claiming that such sunscreen provides better protection from UV radiation and is safer than conventional products. Thus, the important question arises as to how she (as a reader with low prior domain knowledge) will deal with these conflicting scientific claims presented across multiple documents. That is, how will she try to explain and resolve the scientific conflict, and which claim (if any) might she believe in?

As Olivia (like most individuals) does not have any background in nanoscience, she could not reliably evaluate the veracity of the conflicting scientific claims based on her own personal judgment (Bromme & Goldman, 2014). However, she might be able to overcome this challenge by paying attention to and evaluating the sources that put forward the claims ('i.e., where the information comes from', Rouet et al., 2020, p. 1), and asking herself 'whom to believe' (Braasch & Scharrer, 2020; Bromme et al., 2010, 2015; Stadtler & Bromme, 2014). Such strategies that involve 'attending to, evaluating, and using available or accessible information about the sources of documents, such as who authored them' (Bråten et al., 2017, p. 141) and that are referred to as *sourcing* in the research area of multiple document comprehension (e.g., Bråten et al., 2017), have been shown to be positively linked to readers' comprehension of information from multiple documents (e.g., Anmarkrud et al., 2014; Barzilai et al., 2015; Bråten et al., 2009; Goldman et al., 2012). While previous research has

repeatedly shown a low level of sourcing in readers with low domain knowledge when reading about complex issues (Barzilai et al., 2015, 2020; Brand-Gruwel et al., 2017; Bromme et al., 2015; Gerjets et al., 2011; List & Alexander, 2019; von der Mühlen et al., 2016; Wiley et al., 2009; Wineburg, 1991), the presence of conflicting claims has been identified as a crucial factor to increase sourcing, as proposed by the Discrepancy-Induced Source Comprehension (D-ISC) model (Braasch et al., 2012; Braasch & Bråten, 2017). Furthermore, when encountering conflicting claims put forward by different sources, sourcing "may be triggered when the reader perceives that one source is more trustworthy than another" (Rouet et al., 2020; p. 3; also see e.g., Kammerer et al., 2016; Gottschling et al., 2019).

The goal of the present research was to explore this latter assumption in greater depth by assessing the effects of differences (as compared to no differences) in sources' trustworthiness on readers' visual attention to source information (by means of fine-grained eye-tracking analyses) when reading two texts that present conflicting scientific claims, as well as their subjective explanations of the conflict, their agreement with the claims, and their resulting behavioral intents. Importantly, we aimed to not only compare a reading situation with differences in sources' trustworthiness to a situation with two trustworthy sources, but also to a situation with two untrustworthy sources, which has been widely overlooked in recent research on this topic.

Processes of conflict evaluation and possible roles of source information

The consideration of source information in understanding information from multiple texts is a central aspect in several theories and assumptions about multiple document comprehension, such as the Documents Model Framework (DMF, Britt et al., 1999), the REading as problem SOLVing (RESOLV) model (Rouet et al., 2017), the D-ISC model (Braasch et al., 2012; Braasch & Bråten, 2017), or the Content-Source-Integration (CSI) model (Stadtler & Bromme, 2014). While the D-ISC model contrasts reading situations with and without

conflicts between sources, the CSI model focuses especially on how readers react to scientific conflicts in texts, that is, how they detect, regulate, and (potentially) resolve the conflict, and which role source information can play in readers' conflict evaluation. Therefore, we will focus on this model as a theoretical underpinning for our further considerations. The CSI model proposes that readers process scientific conflicts in three separate stages that build upon each other: Conflict detection, conflict regulation, and conflict resolution. During the first stage (conflict detection) contradictions between text ideas (within or between documents) are detected by the reader, that is, a disruption in coherence formation is noticed. This stage is a prerequisite for engaging in the subsequent stages, on which the present paper will focus.

Conflict Regulation

In the second stage, conflict regulation, readers attempt to restore coherence in their understanding of the given information. According to Stadtler and Bromme (2014), this can be achieved (a) by ignoring the conflict, (b) by making additional (potentially unjustified) inferences, or (c) by acknowledging that the conflict exists due to distinct perspectives of different sources. The latter regulation strategy allows the reader to integrate the conflicting claims into a coherent mental model, as has also been proposed in the documents-as-entities assumption by Britt et al. (2013) and the D-ISC model (Braasch & Bråten, 2017). Furthermore, in some cases, source information can not only help to acknowledge the existence of a conflict, but also to explain why it might have emerged (Stadtler & Bromme, 2014). Thomm and Bromme (2016) proposed that this should be the case if sources putting forward conflicting claims differ in their credibility. While perception of source credibility might be affected by various characteristics of the source, there are two components that are considered in most conceptualizations of source credibility: expertise and trustworthiness (eg., Danielson, 2006; Hovland & Weiss, 1951; Lombardi et al., 2014; Pornpitakpan, 2004).

Expertise, in this context, is the extent to which a source is perceived to be able (i.e., competent) to provide accurate and valid information. Trustworthiness is the extent to which a source is perceived to be willing to provide accurate and valid (i.e., unbiased) information (Danielson, 2006). As proposed by Thomm and Bromme (2016), several studies indicate that when two sources that put forward conflicting scientific claims differ in these aspects of credibility, readers will be more likely to explain the conflict as being due to differences in sources' competence or sources' motivations than when both sources seem to be equally credible (Gottschling et al., 2019, 2020; Thomm et al., 2015; Thomm & Bromme, 2016). These studies used the Explaining Conflicting Scientific Claims (ECSC; Thomm et al., 2015) questionnaire to operationalize subjective conflict explanation via agreement to statements addressing different conflict explanations. Particularly relevant for the present research are the two ECSC dimensions addressing explanations that refer to differences in characteristics of the sources, specifically, differences in researchers' competence and researchers' motivations. Previous research has shown that indications that two researchers putting forward conflicting claims differed in their expertise, increased readers' subjective explanations that the conflict might be due to differences in researchers' competences (Gottschling et al., 2020; Thomm & Bromme, 2016). Likewise, indications that researchers putting forward conflicting claims differed in their trustworthiness, increased subjective explanations that the conflict might be due to differences in researchers' motivations (Gottschling et al., 2019, 2020; Thomm & Bromme, 2016).

Conflict Resolution

Finally, the third stage is conflict resolution, which may in part be affected by processes during the previous stage (Braasch & Scharrer, 2020). However, conflict resolution goes beyond mere explanation of a conflict. It involves the development of a personal stance towards the conflicting issue by evaluating the validity of the conflicting claims (Stadtler &

Bromme, 2014). Stadtler and Bromme (2014) described two different ways of evaluating claim validity: one is a direct (first-hand) approach, in which readers evaluate the validity of the claims based on their own domain knowledge (i.e., evaluating which claim is true or accurate). The other is an indirect (second-hand) approach, in which the validity of the claims is evaluated based on the perceived credibility of the sources putting forward the claims. While readers' limited knowledge about scientific issues hinders them to use the first-hand approach reliably (Bromme & Goldman, 2014), they can still use the second-hand approach (e. g., Bromme et al., 2015) if they are able to infer the credibility of sources based on the available source information (e.g. regarding trustworthiness or expertise). This is also in line with the two-step model of validation by Richter and Maier (2017) which assumes that readers engage in more strategic validation (for example via source information) when initial validation processes based on knowledge activation fail to result in a sufficiently coherent representation of the issue at hand (Rouet, Ros, et al., 2020).

Accordingly, in several studies, readers showed more agreement with claims from a source with high perceived trustworthiness than with claims from a source with low trustworthiness (Gottschling et al., 2019, 2020; Kammerer et al., 2016; Paul et al., 2019). Similar effects were found for claims from sources with high vs. low perceived expertise (Kobayashi, 2014). Additionally, effects on the mental representation of the conflict can be found in individuals' increased citation of sources of higher trustworthiness when writing essays about scientific topics (Bråten et al., 2015; List & Alexander, 2017). In contrast, if source information does not indicate any differences in the sources' trustworthiness or expertise, source information cannot be used to resolve contradictions between claims (Richter & Maier, 2017), which should affect the way source information is processed and used.

Strategic Processing of Source Information

The D-ISC model (Braasch et al., 2012; Braasch & Bråten, 2017) has proposed that source information receives increased attention in the context of conflicting as compared to consistent claims. Several studies have provided support for this assumption both in single document (Braasch et al., 2012; Rouet et al., 2016; Rouet, Saux, et al., 2020; Saux et al., 2017, 2018, 2021) and multiple document contexts (e.g., Kammerer et al., 2016). Since this increase in attention to source information is usually explained with strategic processing to re-establish coherence (Braasch & Bråten, 2017; Braasch & Scharrer, 2020), it can be argued that source information that can be used to regulate and resolve a conflict should receive especially high attention compared to less relevant or useful source information (Gottschling et al., 2019; Rouet, Saux, et al., 2020). In line with this assumption, Saux et al. (2018) observed increased memory for source information in the presence of conflicting claims (as compared to consistent claims) when the sources differed in their indicated knowledge, but not when they only differed in their described physical appearance. Further, Gottschling et al. (2019) found that differences in the trustworthiness of two sources putting forward conflicting scientific claims resulted in higher attention to source information as measured with eye-tracking (i.e., total fixation times) than when both sources were of high trustworthiness. Further, additional exploratory analyses of their eye-tracking data indicated that attention was particularly increased for the less trustworthy source when differences in source trustworthiness were present, but this was only the case for second-pass fixation durations and not for first-pass fixation durations. Second-pass fixations are generally regarded as an indication of more strategic processing, whereas first-pass fixations are considered as an indication for nonstrategic processing (Hyönä et al., 2003; Maier et al., 2018). Therefore, these findings might be additional evidence that differences in source information regarding sources' trustworthiness are strategically processed during re-reading to explain and resolve

an encountered conflict. However, as Gottschling et al. (2019) did not include a condition with two sources that both were of low trustworthiness, it cannot be excluded that increased attention to source information was actually due to the mere presence of an untrustworthy source rather than due to the presence of differences in sources' trustworthiness.

The Present Study

This study aimed to replicate and extend previous findings regarding readers' use of source information for the regulation and resolution of an unfamiliar scientific conflict that was addressed in two texts that presented conflicting claims put forward by two different sources. Specifically, based on the findings by Gottschling et al. (2019, 2020), the main goal of the present research was to examine how source information indicating differences in sources' trustworthiness affects readers' regulation and resolution of the scientific conflict as compared to situations in which source information indicates that the sources are of comparable trustworthiness.

To accomplish this, in an eye-tracking experiment, participants were asked to read two conflicting scientific claims regarding the safety of two different types of nanoparticles used as UV-blockers in sunscreen, with the trustworthiness of the respective sources being manipulated based on three experimental conditions. Participants were explicitly made aware of the conflict between the upcoming claims during a short introduction to the topic in order to minimize possible effects of failure to detect the conflict on sourcing (e. g., Stang Lund et al., 2017). In the trustworthiness-differences condition, one source was an independent expert of high trustworthiness while the opposing expert was potentially biased (working for a company with potential monetary interest) and therefore of lower trustworthiness. This condition was compared to two conditions, in which the sources did not differ in their trustworthiness: a no-differences high-trustworthiness condition, in which both sources were indicated to be of high trustworthiness and a no-differences low-trustworthiness condition, in

which both sources were indicated to be of low trustworthiness. Thus, the main contrast to previous studies lays in the addition of a control group with two untrustworthy sources. This addition ensures that effects on increased attention to source information observed in the trustworthiness-difference condition would not only be due to the presence of an untrustworthy source, but indeed due to the presence of differences in trustworthiness between the sources.

In addition to the analyses of participants' attention to source information during reading, after participants were presented with the claims, their subjective conflict explanations, claim agreement, behavioral intent, and source memory were measured. The measure of behavioral intent was considered as a second major addition to previous research, in order to also examine consequences of conflict resolution. Since behavioral intent is an important determinant of future behaviors (Fishbein & Ajzen, 2011) it should be incorporated more often in studies on the effects of exposure to scientific conflicts (Kobayashi, 2018) and respective sourcing processes. To this end, participants were asked about their willingness to use products containing either one or the other type of nanoparticles that the claims were in conflict about. Participants' prior knowledge on the issue of nanoparticles in sunscreen was expected to be low (Pillai & Bezbaruah, 2017), facilitating the investigation of effects associated with the second-hand approach to evaluation (Stadtler & Bromme, 2014).

Based on the theoretical considerations and previous empirical findings outlined above, we derived the following five hypotheses, which we preregistered via aspredicted.org:

Regarding conflict regulation, differences in sources' trustworthiness should lead readers to attribute the conflict more strongly to differences in researchers' motivations than when confronted with sources without any differences in trustworthiness (H1).

Regarding conflict resolution, differences in sources' trustworthiness should result in greater differences in agreement with the two claims (i.e., less agreement with the claim put

forward by the low-trustworthiness source than with the claim of the high-trustworthiness source) than when confronted with sources without any differences in trustworthiness (H2). Likewise, differences in sources' trustworthiness should also result in greater differences in the willingness to use the products advocated by the two sources than when confronted with sources without any differences in trustworthiness (H3).

In addition, regarding the strategic processing of source information during reading, differences in sources' trustworthiness should result in longer total fixation duration on relevant source information than when confronted with sources without any differences in trustworthiness (H4a). More specifically, we expected this effect for second-pass fixation duration (indicating strategic processing), but not for first-pass fixation duration. However, we also expected longer total second-pass fixation duration on relevant source information when being confronted with two low-trustworthiness sources than when being confronted with two high-trustworthiness sources, as in Gottschling et al. (2019) effects of differences in sources' trustworthiness were particularly shown for the low-trustworthiness source (H4b).

Finally, due to the increased strategic processing expected in H4a, differences in sources' trustworthiness should result in better memory for source information than when confronted with sources without any differences in trustworthiness (H5a). Furthermore, based on H4b, we also expected better source memory for the two low-trustworthiness sources than for the two high-trustworthiness sources (H5b).

Methods

Participants

Based on weighted standardized mean differences of previous studies that investigated similar effects (Gottschling et al., 2019, 2020), we expected medium effect sizes (Hedges' g around 0.5) for group comparisons regarding the effects of differences in sources' trustworthiness. A simulation-based a-priori power analysis indicated a sample size of 50 participants per group

to achieve a power of 80% for group comparisons, resulting in a sample size of 150 participants for our three-group design. A total of 151 students from a large German university were recruited for participation. Seven participants had to be excluded from the sample because of incomplete data sets. The final sample therefore consisted of 144 university students (110 females) from different majors with a mean age of 24.18 years (SD = 4.77). The sample reported medium interest (M = 2.91, SD = 1.02) and low prior knowledge (M = 1.53, SD = 0.78) on the topic of nanotechnology, as measured with two self-reported items on a 5-point scale (1 = *very low* to 5 = *very high*). All participants were compensated with 10 € for their participation in the study.

Material

Conflict scenario and claims

The two conflicting scientific claims presented to the participants were taken from the field of nanotechnology. One claim (Claim A) stated that titanium dioxide nanoparticles in sunscreen can penetrate the human skin and therefore may cause health risks, whereas zinc oxide nanoparticles are a safe alternative. For the opposing claim (Claim B), the two types of nanoparticles were switched. The two texts encompassing the claims were of similar length, structure, and readability (see Table 1). Before the two texts were presented, participants were given a short introduction to the topic in which they were told about the use of nanoparticles in sunscreen and the controversy about their ability to penetrate the human skin. They were told that they would subsequently be presented with two claims that were taken from the websites of two experts on the topic, and that they should read them carefully to answer questions on the controversy afterwards. The texts were then presented in Calibri font with 18-point font size and double line spacing on separate HTML pages, each spanning five lines, and participants could navigate back and forth between the pages. Participants terminated the reading phase in a self-paced manner.

Table 1

Information on claim material (without source information)

	Claim A	Claim B
Number of words	75	75
Number of syllables	155	151
Number of characters	465	462
Readability score[a]	58.3	58.3

[a] German readability score (Lesbarkeitsindex; LIX)

Source information

Depending on the experimental condition that the participants were randomly assigned to, different source information was added to each of the two claims. In the trustworthiness-differences condition one claim was said to stem from a professor of nanoscience working at a university who was publicly funded, whereas the other claim was said to stem from an industrially funded professor of nanoscience working for a company. In the two no-difference conditions, both sources were said to be either publicly funded professors of nanoscience working at a university (no-differences high-trustworthiness condition) or industrially funded professors of nanoscience working for a company (no-differences low-trustworthiness condition).

In the materials for the present study there were also names and countries of origin presented for both sources (Mr. Peterson from Sweden or Mr. Hendricksen from Denmark), which were identical in all conditions. For both sources it was stated that they have worked on the topic for ten years. All source information was presented in the same location in both texts to ensure the comparability of eye-tracking data. In total, the source information for each claim encompassed additional 28 words, with 64 to 66 syllables, and 195 to 197 characters, depending on the combination. The combination of sources and claims as well as the names

of the sources and the order of presentation for the claims were completely counterbalanced in this study.

Measures

Prior domain knowledge and attitudes (control variables)

In order to ascertain comparability among our experimental conditions, we used adapted versions of the Public Knowledge of Nano Technology (PKNT) questionnaire (Lin et al., 2013) and the Public Attitudes towards Nano Technology (PANT) questionnaire (Lin et al., 2013) to measure participants' prior knowledge on nanotechnology as well as their attitudes towards risks and benefits of its applications.

The adapted PKNT consisted of eight multiple-choice questions about different concepts in nanotechnology (such as, size and scale, structure of matter, or current applications of nanomaterials) with four response alternatives, of which only one was correct (also see Gottschling et al., 2019). The sum of correct answers was used as a measure of prior domain knowledge.

For the PANT, participants were asked to rate their agreement with five statements regarding possible risks of nanotechnology for human health (e.g., 'The toxicity of nano-particles may be even higher than that of large-size particles.'; Cronbach's $\alpha = .75$) and another five statements regarding possible benefits of nanotechnology (e.g., 'Nanotechnology can provide people with new and better ways to cure or examine their diseases.'; Cronbach's $\alpha = .80$) on 5-point scales (from 1 = *strongly disagree* to 5 = *strongly agree*).

Attention to relevant source information

Attention to source information during the reading phase was measured with eye-tracking methodology. Specifically, we measured the time (in ms) readers spent fixating on relevant source information indicating source trustworthiness ('publicly funded'/'industrially

financed' and 'company'/'university,' depending on the experimental group). To this end, areas of interest (AOIs) were defined around these words. Gaze points within a viewing angle of 2° over a minimum period of 80ms were defined as fixations by the SMI BeGaze 3.7.59 eye-tracking software used for data processing. Specifically, we computed first-pass fixation durations and second-pass fixation durations for each AOI. For the first pass, these were the sum of all fixation durations on an AOI before exiting the respective AOI, and for the second pass, the sum of all fixation durations for fixations that returned to an AOI after the first pass (Hyönä et al., 2003). As the dependent variable, we used the sum of second-pass fixation durations for all AOIs aggregated across both claims. All participants had a tracking ratio of at least 80%.

Explanation of the conflict

After having read the conflicting claims, participants were administered the Explaining Conflicting Scientific Claims (ECSC) questionnaire (Thomm et al., 2015) to assess their subjective explanations for the given scientific conflict. The ECSC questionnaire utilizes four explanations for why researchers might contradict each other in their claims. These explanations are differences in researchers' motivations (5 items; e.g., 'External factors such as competition, marketing, advertising, etc. influence the scientists in their work.'; Cronbach's $\alpha = .87$), differences in researchers' competence (6 items; e.g., 'The scientists are qualified to varying degrees.'; Cronbach's $\alpha = .67$), differences in the research process (6 items; e.g., 'The research methods of the scientists differ, e.g. with regard to the research design or the samples.'; Cronbach's $\alpha = .81$), and thematic complexity (6 items; e.g., 'The topic has not yet been researched enough to be able to classify the results.'; Cronbach's $\alpha = .71$). Participants were asked to rate the extent to which each of the 23 explanatory statements might provide a potential reason for the conflict on a 6-point scale (from 1 = *completely disagree* to 6 = *completely agree*).

Claim agreement

After having completed the ECSC questionnaire, participants were asked to rate their agreement with each of the two claims on a 7-point scale (from 1 = *completely disagree* to 7 = *completely agree*). For this purpose, the claims were presented again in the original presentation order, but without source information. As the dependent variable, a difference score between the two claim agreement ratings was calculated.

Behavioral intent

As a measure of behavioral intent, participants were asked how likely it was that they would use sunscreen containing titanium dioxide nanoparticles and sunscreen containing zinc oxide particles, each on a 7-point scale (1 = *not at all likely* to 6 = *very likely*). As the dependent variable, a difference score between the two ratings was calculated.

Source memory

Source memory was measured with both a free- and a cued-recall task for each claim. For the free-recall task, participants were given the claim and asked to give all the information they remembered regarding the source of the claim. For the cued-recall task, participants were asked directly for the name, workplace, country, and funding of the corresponding source. Separately for both tasks, source memory was scored as correct if a correct answer for the workplace (university or company) and/or funding (publicly funded or industrially funded) was given for both sources. Otherwise, it was scored as incorrect.

Source trustworthiness rating (manipulation check)

At the end of the study, as a manipulation check, sources were presented again together with their respective claims and had to be rated regarding the trustworthiness of the source. Specifically, participants were asked to answer the questions ‘How trustworthy is this scientist in your opinion?’ and ‘How honest is this scientist in your opinion?’ on 7-point scales (from 1

= *not at all* to 7 = *very*). The two items were highly correlated and thus were averaged for each source (Cronbach's α = .91).

Experimental design

The study was conducted as a one-factorial between-subjects design for all dependent variables (conflict explanation, claim agreement, behavioral intent, attention to source information, and source memory). As an independent variable, *differences in sources' trustworthiness* was varied between subjects with the following three conditions: a trustworthiness-differences condition, a no-differences high-trustworthiness condition, and a no-differences low-trustworthiness condition. Participants were randomly assigned to one of the three conditions, with 46 participants serving in the trustworthiness-differences condition, 50 participants in the no-differences high-trustworthiness condition, and 48 participants in the no-differences low-trustworthiness condition. To control for sequence effects of the sources in the trustworthiness-differences condition, we further divided this experimental condition into a group with the high-trustworthiness source presented first (high-low group, 25 participants) and a group with the low-trustworthiness source presented first (low-high group, 21 participants). Participants were randomly assigned to these groups.

Procedure

All of the materials were presented in German. The study was conducted in two parts. The first part was implemented as an online questionnaire and sent to the participants via the survey platform Qualtrics (Qualtrics, Provo, UT). The second part took place 24-48 hours later in the lab. Informed consent for participation was given at the beginning of both parts. With the online questionnaire, participants answered the items regarding prior interest and prior knowledge concerning nanotechnology, and completed the PKNT and the PANT questionnaires (Lin et al., 2013).

For the second part of the study in the lab, they were given brief instructions on the eye-tracking procedure and were then seated in front of a 24-inch monitor equipped with an SMI (Sensomotoric Instruments) RED250mobile eye-tracking device. A chin rest ensured a constant distance of 60 cm between the monitor and the eyes of the participants. After being calibrated to the eye-tracking system (using a 9-point calibration), participants were given a short on-screen introduction to the topic as well as instructions to carefully read the subsequent text materials in order to answer some questions about the texts afterwards. Then, the two texts with the conflicting claims were presented on two separate HTML pages. Participants could navigate freely back and forth between them by clicking on respective navigation buttons, without any time constraints. In order to terminate the reading phase (and the eye-tracking recordings), and to proceed with the questions, participants needed to click on a respective navigation button.

After having decided to terminate the reading phase, participants were no longer able to return to the text materials. First, they were asked to complete the ECSC questionnaire (Thomm et al., 2015). Next, they had to rate their personal agreement with the two claims, which were presented in the same order as in the experimental reading phase but without any source information. Then, they were asked to rate their willingness to use sunscreen containing titanium dioxide particles and sunscreen containing zinc oxide particles. Finally, participants' source memory was assessed separately for both claims, also in the same order as originally presented, followed by the manipulation check to assess the perceived trustworthiness of the two sources.

Analytic approach

For the dependent variables conflict explanation (H1), claim agreement (H2), behavioral intent (H3), and total second-pass fixation duration on relevant source information (H4) one-factorial ANOVAs with three planned contrasts were conducted. As the first contrast, we

compared the trustworthiness-differences condition with the two no-differences conditions. As the second contrast, we compared the no-differences high-trustworthiness condition and the no-differences low-trustworthiness condition. If there were significant differences between the two no-differences conditions, additional simple contrasts were conducted as a control. Additionally, as a third contrast we compared the two possible sequences of source trustworthiness (high-low vs. low-high) within the trustworthiness-differences condition to control for possible sequence effects. Finally, for source memory (H5), logistic regression analyses were used (separately for the free and cued recall task) with the same contrasts as outlined above to investigate effects on readers' probability to correctly recall both sources.

As additional exploratory analyses, linear mixed regression models with text position (first text vs. second text) as additional within-subjects predictor were conducted to further investigate effects on first-pass and second-pass fixation durations on relevant source information as well as the manipulation check. Also, mediation analyses were conducted to explore whether effects of differences in source's trustworthiness on source memory were mediated by total second-pass fixation duration on relevant source information.

Results

Comparability of experimental conditions on non-focal variables

As indicated by one-way ANOVAs with the factor *differences in sources' trustworthiness*, experimental conditions did not differ regarding participants' age, $F(2, 141) = 0.21$, $p = .808$, self-reported topic interest, $F(2, 141) = 1.25$, $p = .289$, self-reported prior knowledge, $F(2, 141) = 1.22$, $p = .298$, prior domain knowledge (PKNT score), $F(2, 141) = 0.33$, $p = .718$, perceived risks of nanotechnologies (PANT risks score), $F(2, 141) = 0.86$, $p = .426$, or perceived benefits of nanotechnology (PANT benefits score), $F(2, 141) = 1.44$, $p = .241$. Means (and standard deviations) per condition for all control variables are shown in Table 2.

Table 2

Means (and SD) for general measures and dependent variables as a function of differences in sources' trustworthiness and trustworthiness sequence.

	Trustworthiness differences		No differences (high)	No differences (low)
Trustworthiness sequence	high-low	low-high	high-high	low-low
N	25	21	50	48
General measures				
Age (in years)	25.32 (3.99)	23.29 (2.81)	24.34 (6.65)	23.81 (3.22)
Topic interest (self)	3.08 (1.08)	2.67 (0.91)	2.76 (1.08)	3.08 (0.94)
Topic knowledge (self)	1.68 (0.80)	1.38 (0.59)	1.40 (0.73)	1.64 (0.89)
PKNT	3.72 (1.99)	3.00 (1.70)	3.64 (1.64)	3.67 (1.89)
PANT (risks)	3.14 (0.79)	3.03 (0.62)	2.99 (0.57)	3.15 (0.57)
PANT (benefits)	3.31 (0.68)	3.44 (0.47)	3.27 (0.60)	3.49 (0.69)
Dependent variables				
ECSC researchers' competence	3.01 (0.83)	2.75 (0.67)	2.65 (0.87)	2.57 (0.71)
ECSC researchers' motivations	4.61 (1.11)	4.39 (0.81)	3.65 (1.00)	4.39 (1.02)
ECSC research process	4.06 (0.86)	4.09 (0.79)	4.02 (0.95)	3.97 (0.94)
ECSC topic complexity	4.11 (0.83)	3.77 (0.85)	4.17 (0.78)	4.13 (0.82)
Absolute differences in claim agreement	1.48 (1.53)	1.29 (1.59)	0.40 (0.93)	0.52 (1.13)
Absolute differences in willingness to use	1.12 (1.20)	0.76 (1.14)	0.44 (0.86)	0.58 (1.22)
Total first-pass fixation duration on relevant source information (s)	3.20 (1.28)	2.21 (1.36)	2.44 (1.46)	2.53 (1.15)
Total second-pass fixation duration on relevant source information (s)	2.13 (2.17)	1.72 (1.70)	1.04 (1.30)	1.19 (1.17)
Source memory (free)	48.00%	52.38%	64.00%	60.41%
Source memory (cued)	56.00%	61.90%	82.00%	79.17%

Conflict explanation (H1)

We first conducted a one-way MANOVA for the effect of differences in source information over all ECSC dimensions. The MANOVA showed a significant overall effect of differences in sources' trustworthiness on conflict explanations, $F(12, 278) = 2.63$, $p = .002$, Pillai's Trace = 0.211, and was therefore followed up with simple ANOVAs for the specific effects on each ECSC dimension. For the ECSC dimension 'differences in researchers' motivations', the ANOVA showed a significant effect of differences in sources' trustworthiness (see Figure 1), $F(3, 140) = 7.20$, $p < .001$, $\eta_p^2 = .13$. Planned contrasts revealed that in the trustworthiness-differences condition participants agreed more strongly with motivations as an explanation for the conflict ($M = 4.51$, $SD = 0.98$) than in the no-differences conditions ($M = 4.01$, $SD = 1.07$), $t(140) = 2.68$, $p = .008$, $d_{Cohen} = 0.48$. Furthermore, in the no-differences low-trustworthiness condition participants also agreed more strongly with motivations as an explanation for the conflict ($M = 4.39$, $SD = 1.02$) than in the no-differences high-trustworthiness condition ($M = 3.65$, $SD = 1.00$), $t(140) = 3.65$, $p < .001$, $d_{Cohen} = 0.73$. An additional direct comparison between the trustworthiness-differences condition and the no-differences low-trustworthiness condition showed no significant differences for agreement with differences in researchers' motivations as an explanation for the conflict, $t(141) = 0.59$, $p = .558$.

Furthermore, ANOVAs for the other dimension of the ECSC showed no significant effects of differences in sources' trustworthiness on the extent of attributing differences in researchers' competence, $F(3, 140) = 1.83$, $p = .144$, differences in the research process, $F(3, 140) = 0.11$, $p = .957$, or thematic complexity, $F(3, 140) = 1.23$, $p = .300$, as explanations for the conflict. Means (and standard deviations) per condition (and trustworthiness sequence) for all four ECSC dimensions are shown in Table 2.

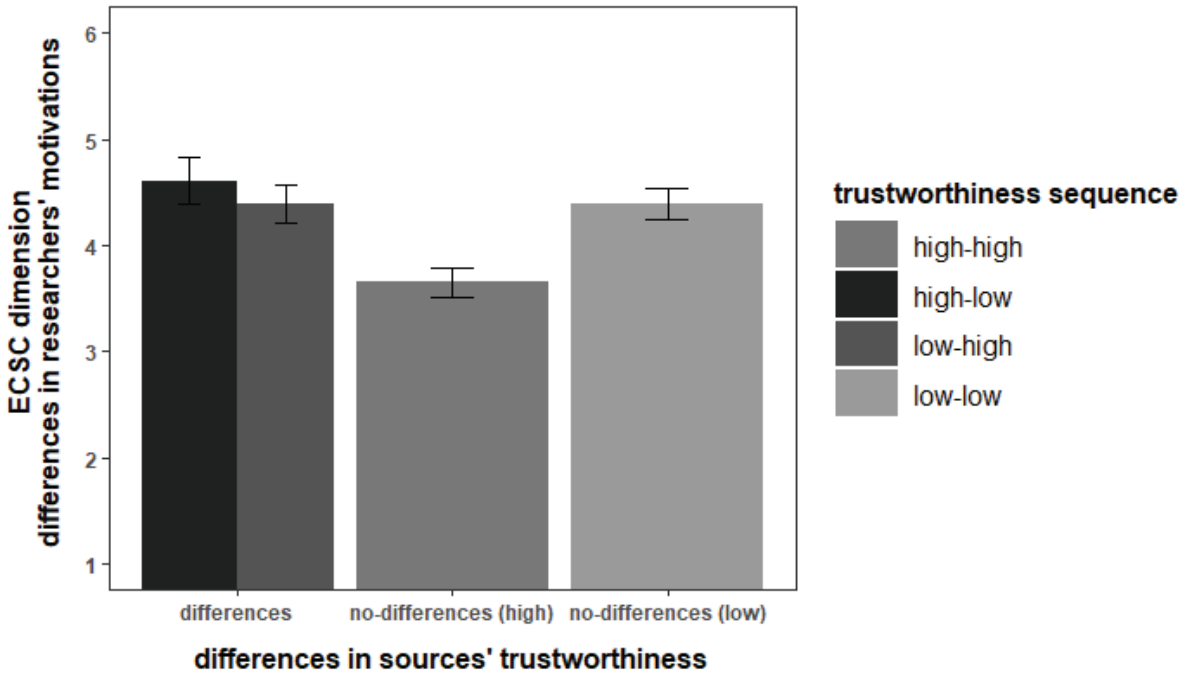

Figure 1. Means of the ECSC dimension 'differences in researchers' motivations' as a function of the variable differences in sources' trustworthiness (x-axis) or trustworthiness sequence (shading). Error bars represent standard errors.

Furthermore, ANOVAs for the other dimension of the ECSC showed no significant effects of differences in sources' trustworthiness on the extent of attributing differences in researchers' competence, $F(3, 140) = 1.83$, $p = .144$, differences in the research process, $F(3, 140) = 0.11$, $p = .957$, or thematic complexity, $F(3, 140) = 1.23$, $p = .300$, as explanations for the conflict. Means (and standard deviations) per condition (and trustworthiness sequence) for all four ECSC dimensions are shown in Table 2.

Claim agreement (H2)

For the dependent variable differences in claim agreement (i.e., the difference score between the claim agreement ratings for the two claims), the ANOVA showed a significant effect of differences in sources' trustworthiness (see Figure 2), $F(3, 140) = 6.26$, $p < .001$, $\eta_p^2 = .12$. Planned contrasts revealed that in the trustworthiness-differences condition, the difference in claim agreement ratings was greater ($M = 1.39$, $SD = 1.54$) than in the two no-differences conditions ($M = 0.46$, $SD = 1.03$), $t(140) = 4.22$, $p < .001$, $d_{Cohen} = 0.77$, whereas the two no-

differences conditions did not differ significantly, $t(140) = 0.46$, $p = .625$. The two trustworthiness sequences (high-low vs. low-high) within the trustworthiness-differences condition did also not differ significantly, $t(140) = 0.54$, $p = .592$. Means (and standard deviations) per condition (and trustworthiness sequence) for differences in claim agreement are shown in Table 2.

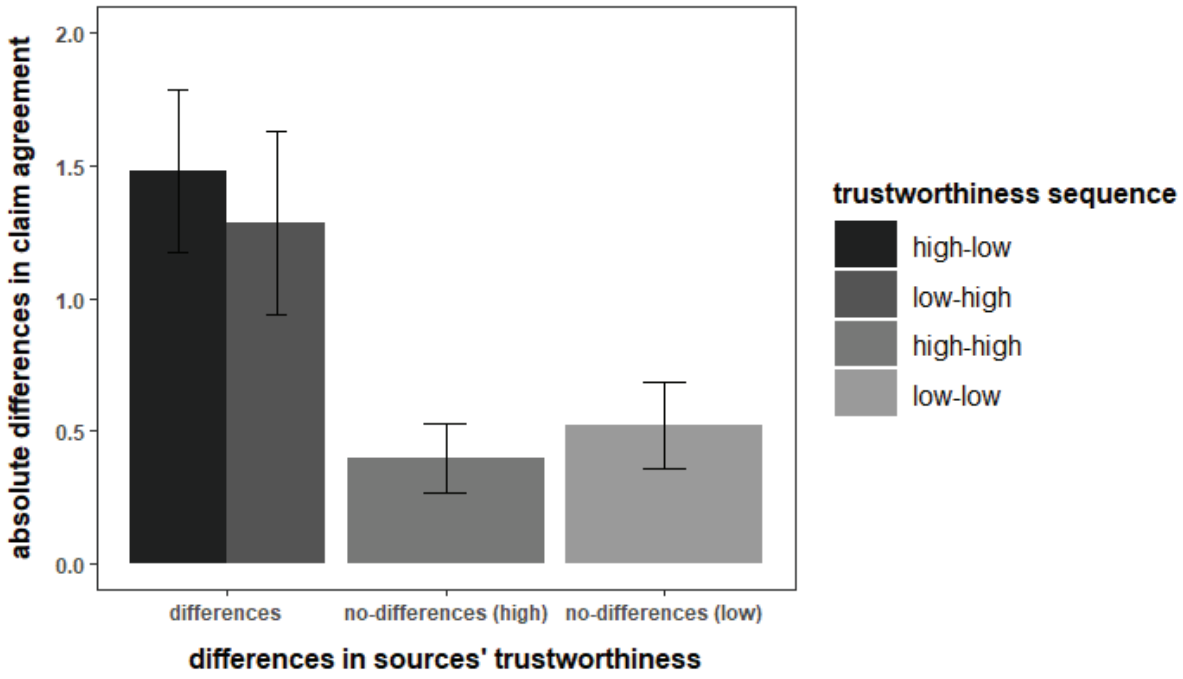

Figure 2. Absolute differences in claim agreement (mean) as a function of the variable differences in sources' trustworthiness (x-axis) or trustworthiness sequence (shading). Error bars represent standard errors.

Behavioral intent (H3)

For the dependent variable differences in willingness to use (i.e., the difference score between the willingness to use ratings for the two types of nanoparticles), the ANOVA showed that the effect of differences in sources' trustworthiness did not reach significance (see Figure 3), $F(3, 140) = 2.30$, $p = .080$, $\eta_p^2 = .05$. Still, planned contrasts revealed that in the trustworthiness-differences condition, the difference in participants' willingness to use ratings was greater ($M = 0.96$, $SD = 1.17$) than in the two no-differences conditions ($M = 0.51$, $SD = 1.05$), $t(140) = 2.20$, $p = .030$, $d_{Cohen} = 0.41$. The two no-differences conditions did not differ significantly,

$t(140) = 0.65$, $p = .516$, and the two trustworthiness sequences (high-low vs. low-high) within the trustworthiness-differences condition did also not differ significantly, $t(140) = 1.11$, $p = .270$. Means (and standard deviations) per condition (and trustworthiness sequence) for differences in willingness to use are shown in Table 2.

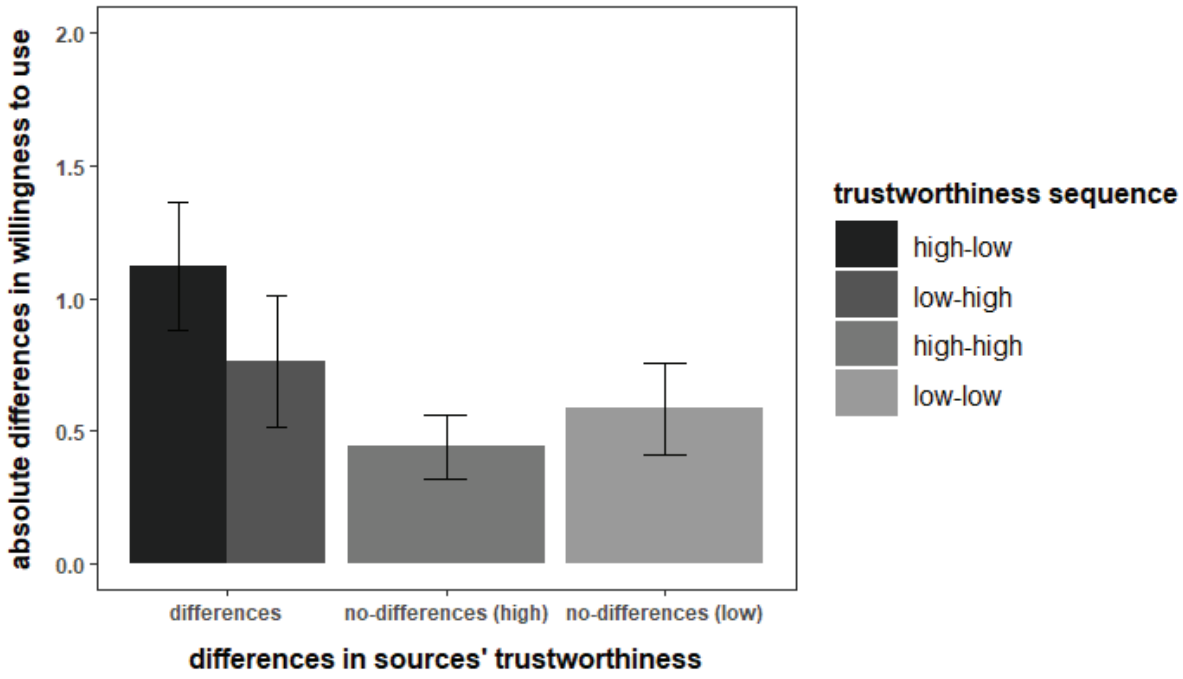

Figure 3. Absolute differences in willingness to use (mean) as a function of the variable differences in sources' trustworthiness (x-axis) or trustworthiness sequence (shading). Error bars represent standard errors.

Attention to source information (H4)

For total second-pass fixation duration on relevant source information, the ANOVA showed a significant effect of differences in sources' trustworthiness (see Figure 4), $F(3, 140) = 3.54$, $p = .016$, $\eta_p^2 = .07$. Planned contrasts revealed a longer total second-pass fixation duration in the trustworthiness-differences condition ($M = 1.94$, $SD = 1.96$) than in the two no-differences conditions ($M = 1.11$, $SD = 1.23$), $t(140) = 3.00$, $p = .003$, $d_{Cohen} = 0.55$. The two no-differences conditions did not differ significantly, $t(140) = 0.52$, $p = .604$, and the two trustworthiness sequences (high-low vs. low-high) within the trustworthiness-differences condition did also not differ significantly, $t(140) = 0.93$, $p = .356$.

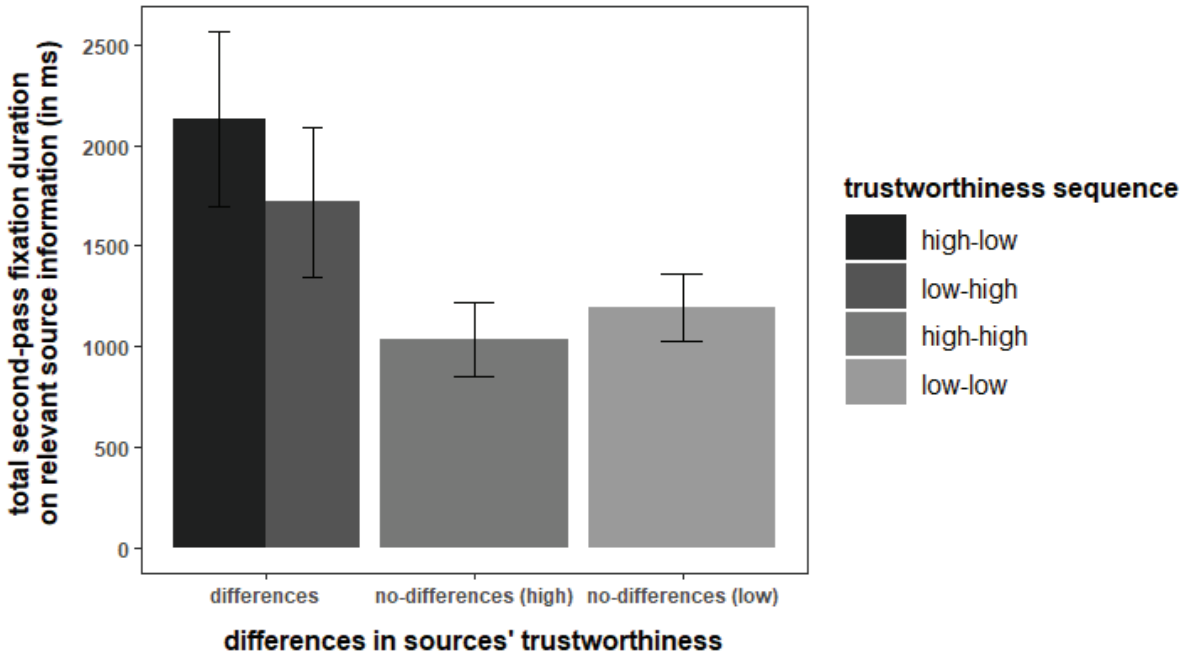

Figure 4. Total second-pass fixation duration on relevant source information (mean) as a function of the variable differences in sources' trustworthiness (x-axis) or trustworthiness sequence (shading). Error bars represent standard errors.

To further investigate the effect of trustworthiness differences, we also computed total second-pass fixation duration on relevant source information separately for the two claims (see Figure 5). In addition to the significant differences between the trustworthiness-differences conditions (high-low and low-high) and the no-trustworthiness conditions (low-low and high-high), $t(140) = 3.01$, $p = .003$, a significant main effect of text position was shown, $t(140) = 4.17$, $p < .001$, in that the total second-pass fixation duration on relevant source information was longer for the first text ($M = 0.88$, $SD = 1.06$) than for the second text ($M = 0.49$, $SD = 0.76$). There were no further significant main effects of our planned contrasts and no significant interactions, all $p > .355$. As part of our analyses on second-pass fixation duration we also checked readers' navigation pattern between the texts. Overall, 21.53% of readers revisited the first text after visiting the second text. This share was higher in the condition with differences in sources' trustworthiness (32.61%; 40.00% in the high-low sequence, 23.81% in the low-high sequence) than for the conditions without differences (16.00% for high-high, 16.67% for low-low). Since without these revisits there should be no

effect of differences in sources' trustworthiness for the second-pass fixation duration on relevant source information in the first text, we conducted an additional ANOVA with our planned contrasts for this measure. In line with our assumptions, this analysis showed no significant effects, $F(3,140) = 1.12$, $p = .342$.

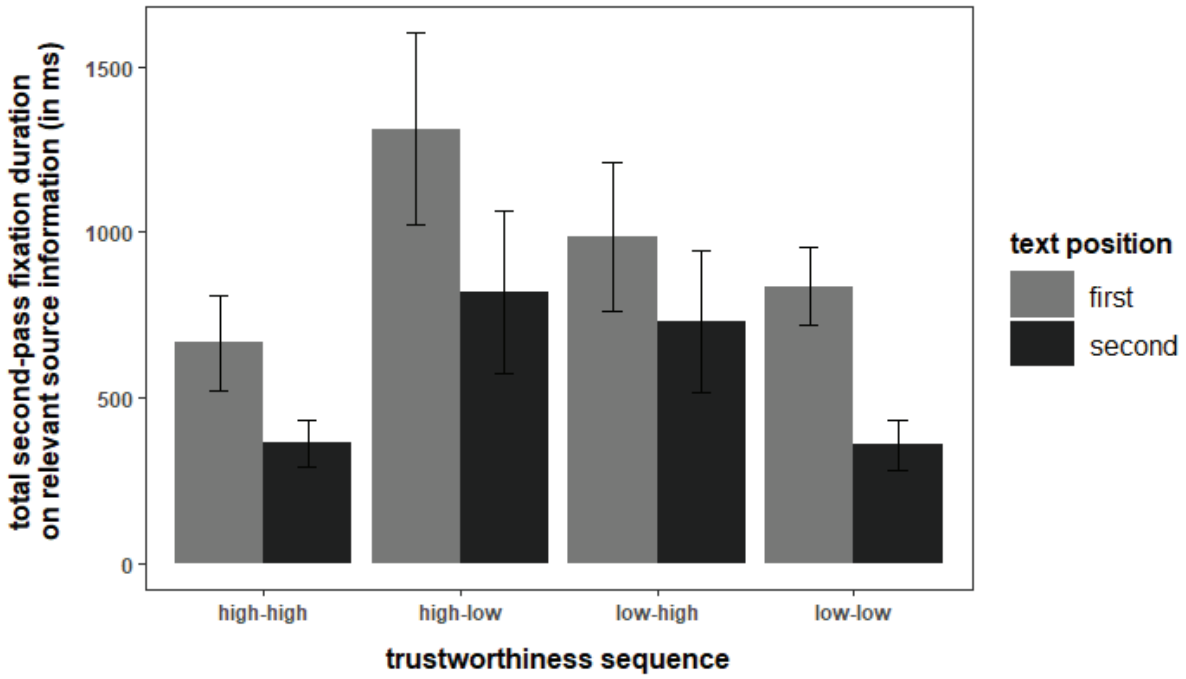

Figure 5. Total second-pass fixation duration on relevant source information (mean) as a function of trustworthiness sequence and text position. Error bars represent standard errors.

For total first-pass fixation duration on relevant source information the overall effect for the ANOVA with planned contrasts failed to reach significance, $F(3, 140) = 2.64$, $p = .052$, $\eta_p^2 = .05$. The planned contrasts showed no significance differences in total first-pass fixation duration between the trustworthiness-differences condition and the two no-differences conditions, $t(140) = 0.92$, $p = .362$, and no significant differences between the two no-differences conditions, $t(140) = 0.35$, $p = .731$. However, the two trustworthiness sequences (high-low vs. low-high) within the trustworthiness-differences condition differed significantly, $t(140) = 2.56$, $p = .012$, $d_{Cohen} = 0.75$. Readers showed longer total first-pass fixation duration in the high-low sequence ($M = 3.20$, $SD = 1.28$) than in the low-high sequence ($M = 2.21$, $SD = 1.36$). As for the total second-pass fixation duration, we further

explored this effect using linear mixed models (see Figure 6). This exploratory analysis showed that the effect was driven by an interaction of trustworthiness sequence and text position, in that in the high-low trustworthiness sequence the relevant source information of the second claim received significantly longer total first-pass fixation duration (M = 1.97, SD = 0.92) than in the high-low trustworthiness sequence (M = 1.23, SD = 0.65), $t(140) = 3.61$, $p < .001$.

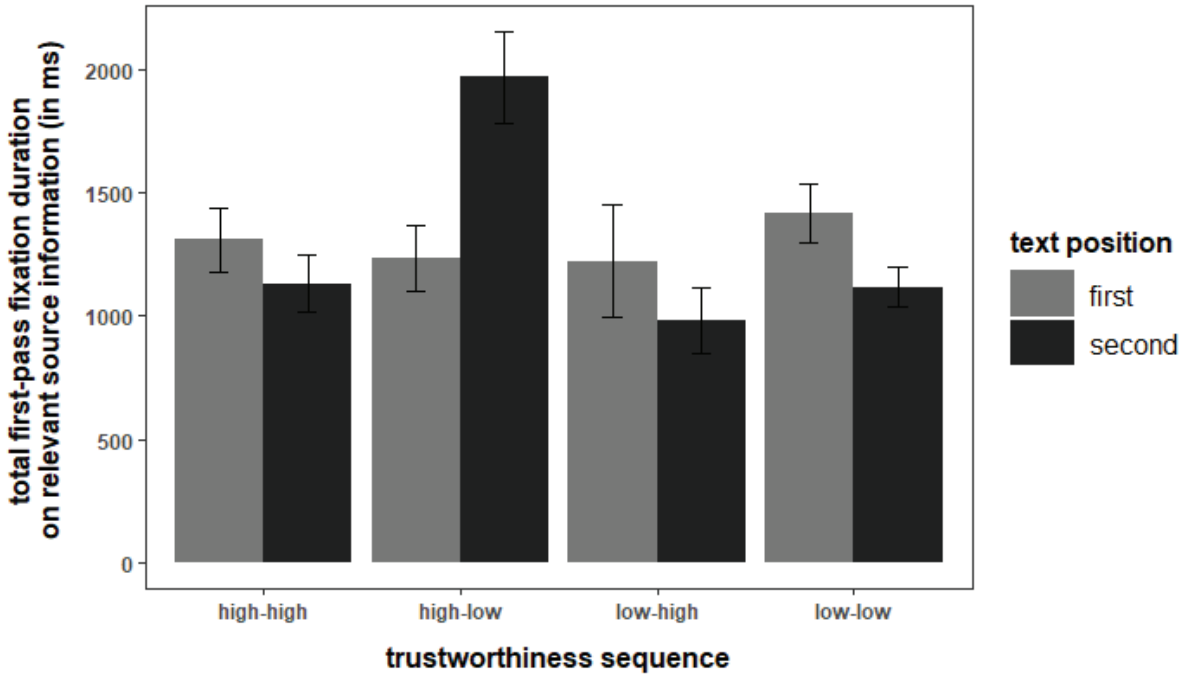

Figure 6. Total first-pass fixation duration on relevant source information (mean) as a function of trustworthiness sequence and text position. Error bars represent standard errors.

Table 3

Means (and SD) for source trustworthiness rating and total fixation durations on relevant source information as a function of differences in trustworthiness sequence and text position.

Experimental condition	Trustworthiness differences				No differences (high)		No differences (low)	
Trustworthiness sequence	high-low		low-high		high-high		low-low	
Text position	first	second	first	second	first	second	first	second
Source trustworthiness rating	5.74 (0.90)	3.56 (1.30)	3.29 (1.14)	5.21 (1.02)	5.39 (0.95)	5.36 (0.91)	3.77 (1.36)	3.75 (1.43)
Claim agreement	3.80 (1.38)	3.60 (1.32)	3.62 (1.16)	4.05 (1.28)	3.86 (1.18)	3.78 (1.17)	3.58 (1.25)	3.35 (1.23)
Willingness to use	3.16 (1.70)	2.60 (1.32)	3.19 (1.66)	3.19 (1.54)	3.30 (1.42)	3.14 (1.36)	3.40 (1.72)	3.27 (1.76)
Total first-pass fixation duration on relevant source information (s)	1.23 (0.65)	1.97 (0.92)	1.22 (1.04)	0.98 (0.61)	1.31 (0.90)	1.13 (0.84)	1.42 (0.83)	1.12 (0.54)
Total second-pass fixation duration on relevant source information (s)	1.31 (1.45)	0.82 (1.23)	0.99 (1.03)	0.73 (0.98)	0.67 (1.01)	0.36 (0.50)	0.84 (0.81)	0.36 (0.52)

Source memory (H5)

The logistic regression analyses for source memory showed the following results. For the free recall task, the planned contrasts showed no significance differences between the trustworthiness-differences condition and the two no-differences conditions in participants' likelihood to correctly recall both sources, $z(140) = -1.36$, $p = .175$. There were also no significant differences between the two no-differences conditions, $z(140) = 0.37$, $p = .715$, and the two trustworthiness sequences (high-low vs. low-high) within the trustworthiness-differences condition also did not differ, $z(140) = 0.30$, $p = .767$.

For the cued recall task, the planned contrasts showed a significant difference between the trustworthiness-differences condition and the two no-differences conditions in participants' likelihood to correctly recall both sources, $z(140) = -2.69$, $p = .007$. Contrary to our hypothesis, however, for participants in the trustworthiness-differences condition the likelihood to correctly recall both sources was lower (58.70% correct) than in the no-differences conditions (80.61% correct). There were again no significant differences between the two no-differences conditions, $z(140) = 0.35$, $p = .723$, and the two trustworthiness sequences (high-low vs. low-high) within the trustworthiness-differences condition also did not differ, $z(140) = 0.41$, $p = .686$.

For further explorative analyses, we additionally conducted a mediation analysis for the differences between the trustworthiness-differences condition and the two no-differences conditions (i.e., the first contrast used in the models above) on source memory (free and cued recall) with z-standardized total second-pass fixation duration on source information as the mediator (see Figure 7 and Figure 8). A probit link function was used for the regression models within this analysis. The analysis follows the idea that source memory should be affected by the visual attention allocated to source information. For the free recall task, the results showed a negative direct effect of the presence of differences in sources' trustworthiness on the odds to recall both sources correctly, $\beta = -0.21$, 95%-CI = [-0.36, -0.04], $p = .011$, while there was also

an indirect positive effect via total second-pass fixation duration on source information, β = 0.09, 95%-CI = [0.02, 0.17], p = .018, as tested using a bootstrapping procedure (with 1,000 bootstrapped samples). The same analysis for the cued recall task showed similar effects with a negative direct effect, β = -0.31, 95%-CI = [-0.45, -0.14], p < .001, and positive indirect effect, β = 0.09, 95%-CI = [0.02, 0.17], p = .018. This indicates that for both the free and cued recall task the presence of differences in sources' trustworthiness had a direct negative effect on source memory, but also an indirect positive effect on source memory with total second-pass fixation duration as the mediator.

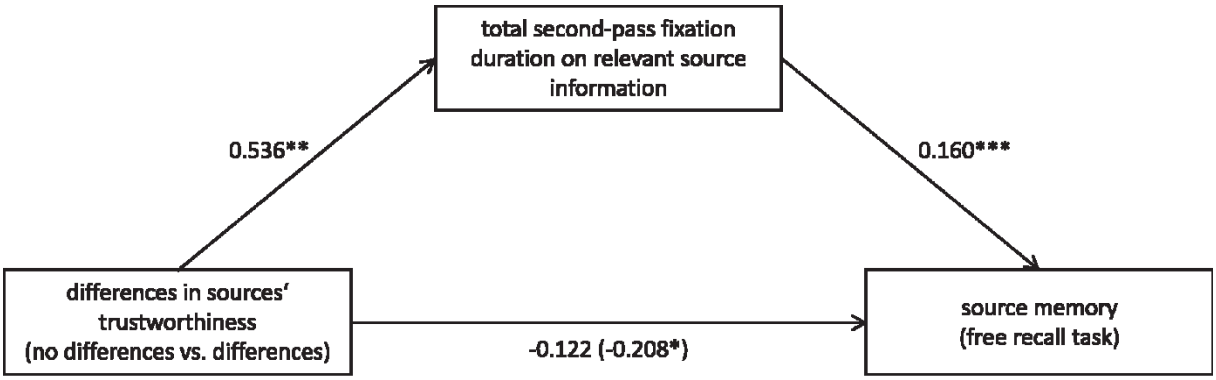

Figure 7. Path diagram for the indirect effect of differences in sources' trustworthiness on source memory (free recall task) through the mediator variable total second-pass fixation duration on relevant source information. The direct effect is provided in parenthesis behind the total effect.

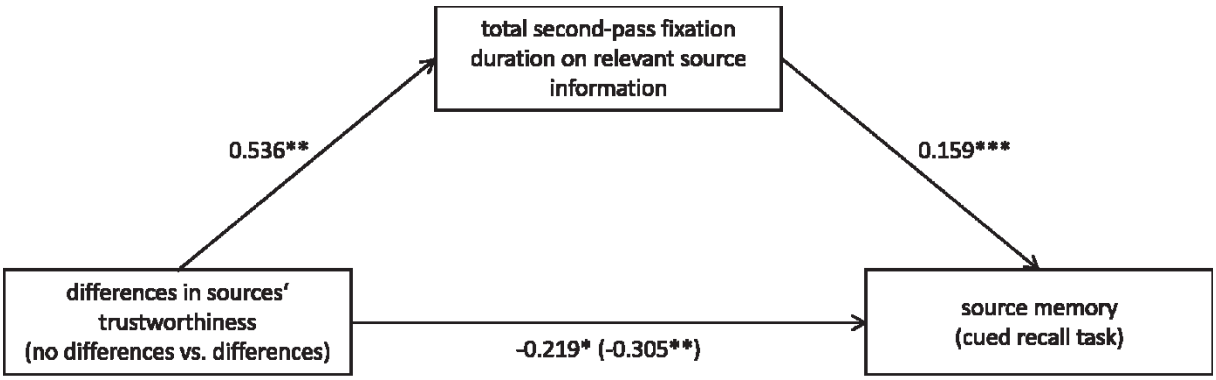

Figure 8. Path diagram for the indirect effect of differences in sources' trustworthiness on source memory (cued recall task) through the mediator variable total second-pass fixation duration on relevant source information. The direct effect is provided in parenthesis behind the total effect.

Source trustworthiness rating (manipulation check)

For the manipulation check we used a linear mixed model with our contrasts and text position (first text vs. second text) as additional within-subjects predictor, to verify if the source trustworthiness ratings were affected in the intended way by the manipulation of source information, see Figure 9. On the level of experimental conditions planned contrasts revealed significant differences between the no-differences high-trustworthiness condition and the no-differences low-trustworthiness conditions in that sources of the high-high group were rated as more trustworthy (M = 5.38, SD = 0.93) than the sources in the low-low group (M = 3.76, SD = 1.39), $t(140) = 7.53$, $p < .001$, $d_{Cohen} = 1.38$. On the level of trustworthiness sequence within the trustworthiness-differences condition, there was a significant interaction between trustworthiness sequence and text position in that the source of the first claim was rated more trustworthy (M = 5.74, SD = 0.90) than the source of the second claim (M = 3.56, SD = 1.30) in the high-low group, $t(140) = 9.43$, $p < .001$, $d_{Cohen} = 1.95$. On the contrary, the source of the second claim was rated as more trustworthy (M = 5.21, SD = 1.02) than the source of the first claim in the low-high group (M = 3.29, SD = 1.14), $t(140) = 8.09$, $p < .001$, $d_{Cohen} = 1.78$. Means (and standard deviations) per trustworthiness sequence and text position for the manipulation check are shown in Table 3.

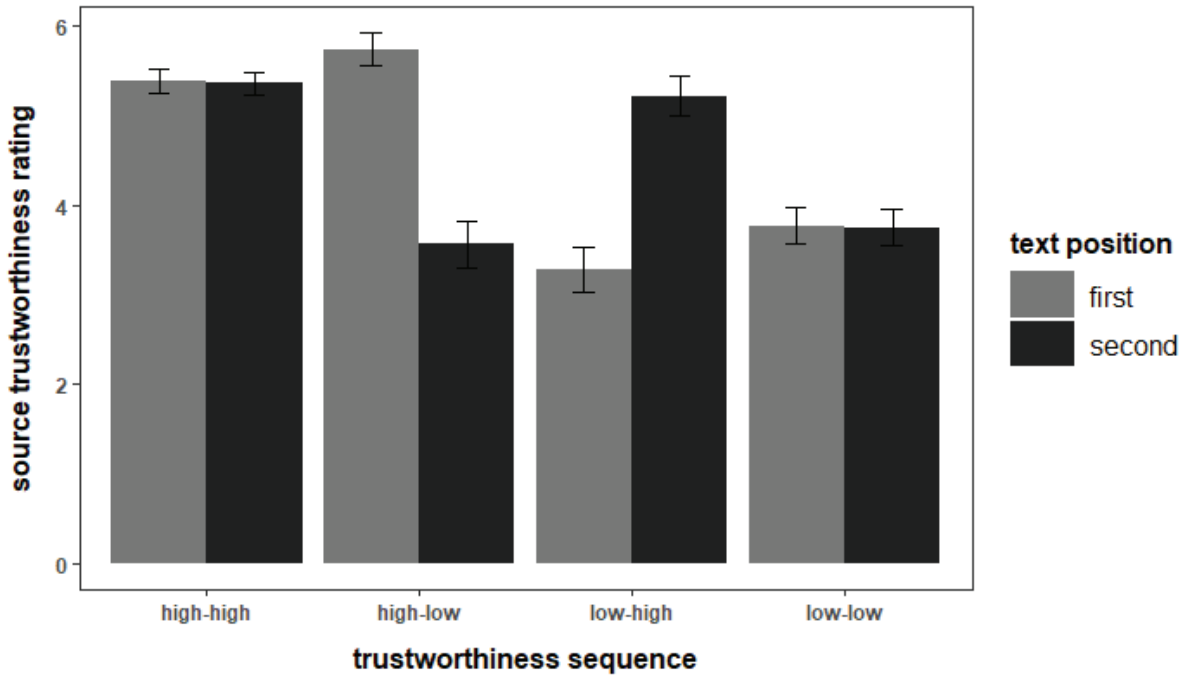

Figure 9. Source trustworthiness rating (mean) as a function of trustworthiness sequence and text position. Error bars represent standard errors.

Discussion

Readers are regularly confronted with conflicting scientific claims, for instance, when they inform themselves about socio-scientific issues on the Internet to make personal decisions. The CSI model by Stadtler and Bromme (2014) provides a framework for how readers choose to regulate and resolve such conflicts with the use of source information (e.g. through second-hand evaluation). The objective of this study was to expand upon prior research (Gottschling et al., 2019, 2020; Thomm & Bromme, 2016) by investigating how differences in sources' trustworthiness affect processes of conflict regulation and conflict resolution as compared to situations when sources of conflicting claims do not differ in their trustworthiness. Importantly, to the best of our knowledge, this is the first study that has compared a situation with differences in sources' trustworthiness to both a situation with two sources of high trustworthiness and a situation with two sources of low trustworthiness. This design allowed us to examine whether increased attention to source information when differences in sources'

trustworthiness were present as shown in prior experiments (Gottschling et al., 2019) were indeed due to these differences in source information and not due to the mere presence of an untrustworthy source.

Differences in sources' trustworthiness and conflict regulation

Regarding our first hypothesis about readers' conflict explanations, the present study corroborates prior research, showing that source information plays a role in the regulation of scientific conflicts (Gottschling et al., 2019, 2020; Thomm et al., 2015; Thomm & Bromme, 2016). As expected in H1a, differences in sources' trustworthiness increased participants' attribution of the conflict to scientists' motivations as an explanation of the conflict. This corroborates the assumption of the CSI model that one way to restore coherence is to acknowledge that the conflict is due to distinct perspectives of different sources (Stadtler & Bromme, 2014) and that source information is one potential explanation for why the conflict might have emerged (Gottschling et al., 2019; Thomm & Bromme, 2016). However, other than expected in H1b, readers' attribution of the conflict to scientists' motivations was higher when both sources were of low trustworthiness than when both sources were of high trustworthiness. Moreover, for those who were confronted with two low-trustworthiness sources the extent of readers' attribution of the conflict to scientists' motivation was as high as for those who were confronted with differences in sources' trustworthiness. Although we did not expect these findings, they are not surprising in hindsight: A situation with two sources of low trustworthiness might also explain the conflict, in that the claims of both sources might be biased towards their vested interests. This also indicates that differences in sources' trustworthiness are not a necessary precondition for the effect on subjective conflict explanation. We highly recommend future research to also include a condition with two low-trustworthiness sources to investigate this assumption further. Still, we would also like to point out that source information cannot be used to resolve the conflict, if both sources are of

equally low trustworthiness. In other words, differences in sources' trustworthiness might play a more essential role in conflict resolution, as we will illustrate in the following section.

Effects on conflict resolution

In line with our expectations regarding claim agreement, differences in sources' trustworthiness led to increased differences in readers' agreement with the conflicting claims, compared to when both sources were either of high or low trustworthiness, corroborating the results of earlier studies (Gottschling et al., 2019, 2020). Moreover, the same pattern of results was shown for differences in the willingness to use the products described in the claims as an indicator for readers' behavioral intent. We argue that differences in claim agreement (and the differences in behavioral intent based on them) are indicators for conflict resolution as described in the CSI model (Stadtler & Bromme, 2014) as these judgements are based on the validation of the claims. In the concrete case of this study, the effects of differences in sources' trustworthiness on claim agreement corroborate the assumption of indirect claim validation via the credibility of the respective sources. Since participants in this study had no (or only limited) prior knowledge that could be used to validate the claims directly, they turned to more strategic validation processes via the available source information (see also Bromme & Goldman, 2014; Richter & Maier, 2017). These strategic processes are also indicated by the following results regarding the attentional processes during reading.

Additional attention allocation on relevant source information due to differences in sources' trustworthiness

The eye-tracking data obtained in this study provides evidence for additional allocation of visual attention on relevant source information, when it indicates differences in sources' trustworthiness as opposed to no such differences, as predicted in H4a. Specifically, as expected, this effect showed especially for total second-pass fixation duration, which are assumed to reflect strategic processing (Hyönä et al., 2003). This corroborates results of

Gottschling et al. (2019), who, however, did not include a conflict situation with two low-trustworthiness sources. Other than expected in H4b, however, attention to relevant source information was not higher when the two sources were of low trustworthiness than when they were of high trustworthiness. This further supports the assumption that it is the presence of differences in sources' trustworthiness that drives the effect of increased attention allocation to source information (i.e., in order to resolve the conflict), rather than the mere presence of an untrustworthy source. It should also be noted that the pattern of results for the eye-tracking data is comparable to that regarding claim agreement and behavioral intent, as indicators of conflict resolution. To summarize, this study presents further evidence that in addition to increased attention allocation to relevant source information when being confronted with conflicting claims as compared to consistent claims (Braasch et al., 2012; Kammerer et al., 2016; Saux et al., 2021), particularly differences in source information that can be used to resolve a given conflict results in increased attention allocation to source information (Gottschling et al., 2019).

Finally, for source memory, the presence of differences in sources' trustworthiness had no effect on participants' performance in the free recall task (in line with Gottschling et al., 2019), while for the cued recall task differences in sources' trustworthiness even lead to impaired (instead of enhanced) source memory compared to a situation without trustworthiness differences, thus contradicting both H5a and H5b. Furthermore, these findings contradict those of Thomm and Bromme (2016) who found better source memory when differences in source information were present. Yet, the exploratory mediation analyses conducted in this study might provide some insight into these result patterns. First, there was a direct negative effect of differences in sources' trustworthiness on source memory for both tasks. This might be due to the fact that two different source features needed to be remembered instead of twice the same. This also carried the risk to mix up these relevant

source features during the recall task. In contrast, the positive indirect effects on recall performance via the attention to source information as a mediator is in line with our hypotheses. This also corroborates findings by Saux et al. (2018) showing increased source memory in the context of conflicting claims particularly for task-relevant source information. Furthermore, according to the D-ISC model (Braasch et al., 2012; Braasch & Bråten, 2017) and the CSI model (Stadtler & Bromme, 2014), this should especially apply to source information that can be used to regulate and resolve a given conflict, given that readers are inclined to achieve coherence in their mental representation of the scientific conflict. The fact that the direct and indirect effects of differences in sources' trustworthiness seem to work in opposite direction could explain the lack of a direct positive effect on source memory in the present study and similar experiments (Gottschling et al., 2019, 2020), despite the increased visual attention on relevant source information.

Conclusion

To conclude, results of the present study indicate that with differences in sources' trustworthiness present, strategic attention allocated to relevant source information increases, as compared to when both sources were of high or of low trustworthiness. Further, readers seem to take the differences in sources' trustworthiness into consideration when they rate their agreement with the two claims. Likewise, trustworthiness differences also affect readers' behavioral intent, such that they indicate that they are less willing to use the product that was promoted by the low-trustworthiness source than the product that was promoted by the high-trustworthiness source. All these findings point to conflict resolution based on perceived differences in sources' trustworthiness. In addition, our results suggest that readers also take source information into consideration in their conflict explanations, such that when at least one source is indicated to be of rather low trustworthiness, they attribute the conflict more to scientists' motivations than when both sources are indicated to be neutral and trustworthy. That

is, not only when the sources differ in their trustworthiness, but also when both sources are indicated to have potential vested interests (working for a nanotechnology company) do readers interpret differences in researchers' motivations as a potential reason for the conflict. In contrast to the effects related to conflict resolution, for conflict regulation differences in sources' trustworthiness do not seem to be a necessary precondition for source-related conflict explanation. Rather, indications that at least one source is of low trustworthiness (or biased in their motivation) seem to be sufficient. This suggests that conflict regulation and conflict resolution have different preconditions for source information to affect them. To further investigate and differentiate these preconditions seems to be promising topic for future research in order to understand the processes of sourcing in the evaluation of scientific conflicts. Additionally, the fact that differences in sources' trustworthiness seem to affect claim agreement and behavioral intent (as well as conflict explanation), is in line with the assumptions of the DMF (Britt et al., 1999) that source information is integrated into a mental representation of the conflict and, thus, can be used at a later stage to make judgements regarding the claims.

Limitations and outlook

We acknowledge that this study does not come without limitations. Two points can be brought up regarding the potentially limited generalizability of our findings. First, the sample examined in this study consisted exclusively of university students, who might be more used to handling source information because of their high level of education compared to the general population. At the same time, the topic of nanoparticles in sunscreen was highly unfamiliar to them, which might have encouraged the application of a second-hand approach to evaluation (Stadtler & Bromme, 2014). Second, regarding the material of this study, we only examined one specific scientific conflict in a highly controlled experimental setting. Previous literature found that especially conflict explanation can differ based on the topic of a scientific conflict (Johnson & Dieckmann, 2018; Thomm & Bromme, 2016).

Further, even though we tried to make the setting comparable to claims found on websites, actual information environments can be far more complex than the conflict presented in this study. Another limitation is that for the sake of experimental control in this study we explicitly pointed out the presence of the scientific conflict to our participants prior to reading. This factored out the process of conflict detection and the effects it might have on sourcing during a more natural contact with scientific conflicts. In such cases validation processes (e. g. Richter & Singer, 2017) might play an additional important role, especially when readers have more prior domain knowledge and pronounced beliefs regarding the topic. Based on these limitations, future research should aim to replicate our findings in more natural information environments, with a more diverse sample of the population and several different conflicting topics, to test whether the effects we observed under our controlled conditions can be generalized.

Nonetheless, we believe that the findings of the present study provide intriguing new results on how readers use source information indicating low source trustworthiness or differences in sources' trustworthiness, respectively, to regulate and resolve conflicting scientific claims about an unfamiliar socio-scientific issue. Due to the large amount of conflicting scientific information, and plain misinformation, that can be found on the Internet and through other sources, supporting readers with low prior domain knowledge in their evaluation of scientific claims will be a challenge of ever-growing importance for education in the upcoming years.

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Appendix A

Two versions of the claims used in the study (translated from German). Relevant source information that was encompassed by AOIs for eye-tracking analysis is highlighted.

1. Claim in favor of zinc oxide:

Mr. Hendricksen, a publicly funded professor working in nanoscience at a Danish university, believes that titanium dioxide nanoparticles in particular can be expected to penetrate the upper layers of the skin and therefore have an undesirable effect on our health.

The scientist has been working on this topic at his university for about ten years and writes on his website: "The results of our studies indicate that nanoparticles of titanium dioxide can penetrate the upper layers of the skin and thus also come into contact with living cells. This is not true for zinc oxide, which is why we consider it a safe ingredient for sunscreen".

2. Claim in favor of titanium dioxide:

Mr. Peterson, an industrially funded professor working in nanoscience in a Swedish company, believes that titanium dioxide nanoparticles in particular are expected to penetrate the upper layers of the skin and therefore may have an undesirable effect on our health.

The scientist has been working on this topic in his company for about ten years and writes on his website: "Our study results indicate that nanoparticles of titanium dioxide can penetrate the upper layers of the skin and thus also come into contact with living cells. This is not the case for zinc oxide and we therefore consider it a safe ingredient in sunscreen".