

# MEDIATED PUBLIC TRUST IN SCIENCE: TRACING TRUST CUES BETWEEN MEDIA CONTENT ABOUT SCIENCE AND ITS AUDIENCES

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Justin Tim Schröder

aus Hemer

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Vorsitzende: Prof. Dr. Katharina Kleinen-von Königslöw

Erstgutachter: Prof. Dr. Michael Brüggemann

Zweitgutachterin: Prof. Dr. Monika Taddicken

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## Vorwort und Danksagung

Niemals hätte ich mir ausmalen können, dass ich tatsächlich einmal eine Dissertation verfassen würde – und nun schreibe ich ihre einleitenden Worte. Die Arbeit an dieser Dissertation war für mich nicht nur ein wissenschaftliches Projekt, sondern auch eine intensive persönliche Reise, zu der ich zunächst einen Kontext liefern und ein paar Worte des Dankes aussprechen möchte.

Entstanden ist sie im Rahmen des DFG-geförderten Projekts *The Trust Relationship Between Science and Digitized Publics* (TruSDi; 456602133). Ziel des Projekts war es, die Vertrauensbeziehung zwischen Wissenschaft und (digitalisierten) Öffentlichkeiten besser zu verstehen. Dafür wurden verschiedene Forschungsmodule mit unterschiedlichen Schwerpunkten durchgeführt. Ein Modul hatte zum Ziel, mithilfe einer qualitativen Inhaltsanalyse sogenannte *Trust Cues* in Medieninhalten über Wissenschaft zu identifizieren, diese mittels quantitativer Inhaltsanalyse zwischen verschiedenen Medienarten zu vergleichen und schließlich eine Verknüpfung zwischen Inhaltsanalyse- und Umfragedaten zum Vertrauen in Wissenschaft in Deutschland herzustellen. Daraus resultierten drei der hier vorliegenden Publikationen. Neben meiner maßgeblichen Mitarbeit an Planung, Durchführung, Auswertung und Publikation habe ich das Forschungsvorhaben um eigene Schwerpunkte erweitert: Die Integration einer Gender-Perspektive führte zu einer weiteren, eigenständigen Publikation, die 2024 mit dem Genderpreis der Universität Hamburg ausgezeichnet wurde. Diese Erkenntnisse flossen auch in die quantitative Inhaltsanalyse ein und erweiterten das ursprüngliche Projektdesign. Zudem habe ich die Rezipient:innen-Perspektive gestärkt, indem ich Fokusgruppen konzipierte und durchführte – ermöglicht durch gemeinsam mit Lars Guenther eingeworbene Drittmittel aus dem Ideen- und Risikofonds der Universität Hamburg für das Projekt *Die Rezeption von Vertrauensindikatoren von Wissenschaftler:innen* (ReTruCues). Daraus entstand der fünfte, hier vorliegende Beitrag.

Zum Zeitpunkt der Einreichung umfasst die Dissertation somit drei in renommierten und peer-reviewten Fachzeitschriften erschienene Beiträge, einen Beitrag in einem peer-reviewten Sammelband sowie einen weiteren Artikel, der sich aktuell im Begutachtungsverfahren befindet. Zusätzlich sollte die wissenschaftliche Qualität der Arbeit erhöht werden, indem das Codebuch der quantitativen Inhaltsanalyse einem Peer-Review-Verfahren unterzogen und der Öffentlichkeit zugänglich gemacht wird. Inzwischen ist das Codebuch für die Publikation in einer peer-reviewten Datenbank angenommen. Darüber hinaus wurden die Studien bzw. verschiedene Teilaspekte auf zahlreichen nationalen und internationalen Konferenzen präsentiert. Sie haben sich damit der akademischen Debatte gestellt und den Austausch innerhalb der Fachcommunity gefördert.

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## Zusammenfassung

Wissenschaftliche Informationen dienen häufig als Grundlage für individuelle und kollektive Entscheidungen. Die meisten Menschen kommen nicht direkt, sondern vor allem indirekt – und dabei primär über Medien – mit Wissenschaft in Kontakt. Um sich aktiv mit wissenschaftlichen Informationen auseinanderzusetzen, ist Vertrauen in Wissenschaft eine zentrale Voraussetzung. Dieses Vertrauen wird durch Medien und ihre Inhalte vermittelt, wodurch Medien als Vertrauensintermediäre agieren, die die Beziehung zwischen den Vertrauenssubjektiven (hier: Öffentlichkeiten) und den Vertrauensobjekten (hier: Wissenschaft) ermöglichen. Um einen strukturierten Überblick über das Forschungsfeld zu schaffen, definiert diese Dissertation zunächst das Konzept des medienvermittelten öffentlichen Vertrauens in Wissenschaft und grenzt es konzeptionell von verwandten Begriffen wie Vertrauenswürdigkeit und Glaubwürdigkeit ab (Kapitel 2). Zur besseren Einordnung wird ein analytischer Bezugsrahmen entwickelt: das Modell der *Mediated Public Trust in Science Evaluation* (Kapitel 3). Dieses Modell zeigt eine zentrale Forschungslücke auf: Bislang gibt es keine systematische Untersuchung darüber, wie Vertrauen auf der Informationsebene in Medieninhalten vermittelt wird und wie diese Vermittlung von Rezipient:innen wahrgenommen wird. Daraus ergibt sich die leitende Forschungsfrage dieser Arbeit: *Wie wird öffentliches Vertrauen in Wissenschaft durch Inhalte über Wissenschaft und deren Rezeption vermittelt?*

Zur Beantwortung dieser Frage wird das Konzept der *Trust Cues* eingeführt, also sprachlicher Marker und Informationen, die Gründe für Vertrauen in Wissenschaft aufzeigen. Aufbauend auf diesem Konzept, dem theoretischen Rahmen und dem Modell werden fünf untergeordnete Forschungsfragen entwickelt (Kapitel 4). Diese befassen sich mit der Identifikation von Trust Cues, deren Vergleich über verschiedene Medientypen hinweg, geschlechtsspezifischen Unterschieden in der Darstellung männlicher und weiblicher Wissenschaftler:innen – als zentrale Akteure in Medienbeiträge über Wissenschaft –, den Effekten von Trust Cue Exposure sowie der Wahrnehmung und Bewertung dieser Trust Cues durch das Publikum. Zur Bearbeitung dieser Fragen wird eine Methodentriangulation angewendet, die qualitative und quantitative Verfahren kombiniert und sowohl aus der Perspektive der Medieninhalte als auch aus der der Rezipient:innen betrachtet, um ein umfassendes Verständnis für medienvermitteltes öffentliches Vertrauen in Wissenschaft durch Trust Cues zu ermöglichen. Die Ergebnisse (Kapitel 5) zeigen, dass Trust Cues unterschiedliche Aspekte bzgl. Expertise, Integrität, Wohlwollen, Transparenz und Dialogbereitschaft wissenschaftlicher Akteure vermitteln. Wissenschaftler:innen werden als die zentralen Vertrauensobjekte (im Vergleich zu Organisationen und Systemen) identifiziert, wobei sich signifikante Unterschiede in der geschlechtsspezifischen Darstellung zeigen. Darüber hinaus nutzen verschiedene Medientypen Trust Cues in unterschiedlicher Weise, was wiederum unterschiedlich starke

Effekte auf verschiedene Vertrauensgruppen innerhalb der Bevölkerung hat. Das Publikum erkennt Trust Cues und bezieht sie aktiv in seine Vertrauensurteile mit ein. Gleichzeitig wird jedoch ein Missverhältnis deutlich zwischen den medial genutzten Trust Cues und jenen, die vom Publikum als besonders vertrauensrelevant eingeschätzt werden.

Diese Dissertation leistet einen Beitrag zur Forschung im Bereich Wissenschaftskommunikation, indem sie eine vertiefte Auseinandersetzung mit dem Konzept des medienvermittelten öffentlichen Vertrauens in Wissenschaft ermöglicht (Kapitel 6). Sie trägt dazu bei, eine zentrale Forschungslücke zu schließen, indem sie aufzeigt, wie Vertrauen in Wissenschaft auf der Ebene medial vermittelter Informationen analysiert und verstanden werden kann.

## Abstract

Scientific information often serves as the basis for both individual and collective decision-making. In this sense, most people engage with science not directly, but indirectly – primarily through media. To engage with scientific information, trust in science is essential. This trust is mediated through media and its content, positioning the media as an intermediary of trust that facilitates trust relationships between subjects of trust (publics) and objects of trust (science). To provide a structured overview of the research landscape, this dissertation first defines mediated public trust in science and conceptually distinguishes it from related constructs such as trustworthiness and credibility (Chapter 2). For a better understanding, an analytical framework was developed: the Model of *Mediated Public Trust in Science Evaluation* (Chapter 3). This model reveals a significant research gap: There is currently no systematic research on how trust is conveyed on the information level in media content and how it is perceived by audiences. Consequently, the central research question guiding this work is: *How is public trust in science mediated in content about science and its audiences?*

To investigate this question, the concept of *trust cues* is introduced. Trust cues are defined as linguistic markers and information that signal reasons to trust in science. Based on this concept, the model, and the theoretical groundwork, five subordinate research questions have been developed (Chapter 4). These research questions focus on the identification of trust cues, their comparison across media types, gender-specific differences in trust cues referring to female and male scientists (as central actors in content about science), the effects of trust cue exposure, and the perception and evaluation of trust cues by audiences. These questions are addressed using a methodological triangulation, combining both qualitative and quantitative approaches and address this subject from two perspectives: the media content perspective and the audience perspective. In this way, a comprehensive understanding of mediated public trust in science via trust cues can be reached. The findings (Chapter 5) show that trust cues refer to different aspects of scientific actors, signaling expertise, integrity, benevolence, transparency, and dialogue. Scientists are identified as the most central objects of trust, with notable gender differences in how they are represented. Furthermore, the media uses trust cues in distinct ways, which have different effects on various trust groups within the general German population. Audiences recognize and actively use these trust cues as a basis for trust conclusions, yet a mismatch becomes evident between the cues that are most frequently used in media and those that audiences perceive as most relevant. This dissertation contributes to the field of science communication research by enabling an in-depth discussion of mediated public trust in science (Chapter 6). It helps close an important research gap by clarifying how trust in science can be analyzed at the level of information conveyed through media content.

## Overview of Publications

- Paper 1:** Schröder, J. T., Brück, J., & Guenther, L. (2025). Identifying trust cues: How trust in science is mediated in content about science. *Journal of Science Communication*, 24(01), A06. <https://doi.org/10.22323/2.24010206>
- Paper 2:** Schröder, Justin T. (2025). Trust cues in content about science: How the media presents female and male scientists differently. In: Antoinette Fage-Butler, Loni Ledderer, & Kristian Hvidtfelt Nielsen (eds.), *Science Communication and Trust* (pp. 385–406). Palgrave Macmillan.
- Paper 3:** Schröder, J. T., & Guenther, L. (2025). Mediating trust in content about science: Assessing trust cues in digital media environments. *Public Understanding of Science*, 0(0). <https://doi.org/10.1177/09636625251337709>
- Paper 4:** Guenther, L., Schröder, J. T., Reif, A., Brück, J., Taddicken, M., Weingart, P., & Jonas, E. (2024). Intermediaries in the limelight: How exposure to trust cues in content about science affects public trust in science. *Journal of Science Communication*, 23(09), A06. <https://doi.org/10.22323/2.23090206>
- Paper 5:** Schröder, J. T., Engel, M., Schröder, I., & Guenther, L. (2025). Public trust in scientists: Exploring the perception and relevance of trust cues in media content. *Journal of Science Education, Part B*. Under review.

## List of Abbreviations

e.g.	Exempli gratia
EC	European Commission
EU	European Union
GMMP	Global Media Monitoring Project
i.e.	Id est
TV	Television
WiD	Wissenschaft im Dialog

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# 1 Introduction

In many areas of life, scientific knowledge and associated information play an important role. This is even more the case in modern societies that are becoming increasingly complex, for instance, due to technological progress or societal developments. In these contexts, science can empower publics to make informed decisions through its findings and reliable information (e.g., Fischhoff & Scheufele, 2013; Goldenberg, 2023; Hendriks et al., 2015). This applies both to personal everyday choices as well as to decisions made collectively by societies. On a personal level, members of the public can use scientific information to make decisions about their own health, the use of technologies, climate- and environmentally conscious behavior, or to assess societal developments. On a collective level, for instance, politics can use science as a basis for action (e.g., Fischhoff & Scheufele, 2013; Schäfer, 2016; Taddicken & Krämer, 2021).<sup>1</sup> When political decision-making is guided by scientific findings, this can, in turn, be used by publics to make voting decisions – allowing for collective decision-making (e.g., Goldenberg, 2023; Huber et al., 2019; Intemann, 2023; Wintterlin et al., 2022). For publics<sup>2</sup> to engage with scientific information in the first place, trust in science is needed (e.g., Leiserowitz et al., 2013; Plohl & Musil, 2021; Saffran et al., 2020). In short, to have trust in science means to recognize science as a producer of valid knowledge that consequently includes the validity of scientific knowledge per se and science as a secure source of information (e.g., Origgi, 2012; Sperber et al., 2010; Wilholt, 2013).

Science communication serves as the hinge between science and its publics, enabling publics to encounter science and receive scientific information. Science communication, in the broadest sense, encompasses all forms of communication centered on scientific knowledge or scientific endeavors. This includes communication within and outside of the institutionalized scientific realm, encompassing its production, content, use, and implications (e.g., Schäfer et al., 2015). Consequently, science communication includes multiple actors (e.g., stakeholders within and outside of institutionalized science; e.g., Taddicken & Krämer, 2021). Media is considered the most important way for publics to receive scientific information and come into (indirect) contact with science and its representatives, i.e., the multiple actors within and outside of institutionalized science (e.g., Brossard, 2013; European Commission, 2021; Mede

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<sup>1</sup> This is a general observation; however, the precise relationship between politics and science as well as developments such as the politicization of science (e.g., Bolsen & Druckman, 2015; Hardy et al., 2019) and the epistemization of politics (e.g., Bogner, 2021), along with their consequences, are not addressed in this dissertation.

<sup>2</sup> Today's public sphere is shaped by the interplay of traditional journalistic media, its digital counterparts, online platforms, and social media. As a result, the notion of a singular public gives way to "a multitude of overlapping publics of different sizes, lifespans, visibility, and impact, across a variety of online and offline communicative channels and platforms" (Bruns, 2018: 339). Hence, the terms "publics" and "public audiences" are used throughout this text to refer to these multiple hybrid media environments.

et al., 2025; Schäfer, 2016; WiD, 2023). In this way, publics encounter a variety of scientific actors, such as the overall scientific system, scientific organizations, and individual scientists, who also differ in their characteristics, for instance, regarding gender, i.e., female and male scientists.

Furthermore, because of the diverse range of science communicators – from journalists to scientists as well as to fake experts (e.g., Weingart, 2017; Weingart & Guenther, 2016) – audiences need to assess not only if a source is credible but also if the scientific actors and information in the content can be trusted (e.g., Schäfer, 2016; Scheufele & Lewenstein, 2005). Because of this, public audiences evaluate information provided in media content to reach a trust conclusion (for related thoughts, see Metzger & Flanagin, 2013; Reif & Guenther, 2022). Personal experiences, familiarity with a scientific issue, and predispositions, for example, serve as so-called “trust heuristics” (e.g., Kahneman & Frederick, 2005; Tversky & Kahneman, 1974) that build the base for assessing various indicators that signal the credibility of a media source (such as media brands, metrics, or time stamps) and its message (e.g., consistency of a text; e.g., Metzger & Flanagin, 2013; Ross Arguedas et al., 2024). In addition, when the content of the sources is perceived, it potentially includes trust-evoking information and cues that provide reasons to trust in scientific actors and content that are part of the respective media content. After this assessment, a conclusion regarding trust in science is reached: the scientific actors and the information can or cannot be trusted; when in doubt, audiences collect more information to verify the information and cues provided (e.g., Flanagin & Metzger, 2007; Metzger & Flanagin, 2013). All in all, the evaluation of those indicators is a complex process. While there is already research about trust heuristics and media credibility, research about trust-evoking information and cues in content about science and how they present reasons for trust in science is scarce. Hence, to focus on this aspect, the overarching research question (RQ) of this dissertation asks: ***How is public trust in science mediated between content about science and its audiences?***

To investigate this overarching RQ, a triangulation of methods was employed, combining qualitative and quantitative research designs. The research begins with an open-ended and exploratory identification of how information and cues can present reasons of trust in content about science, using a qualitative content analysis (Paper 1: Schröder et al., 2025a). For this purpose, the concept of trust-evoking cues was developed. A re-analysis of this data with a specific focus on scientific actors and their genders (Paper 2: Schröder, 2025) follows. Subsequently, a quantitative content analysis is used to generalize findings from Papers 1 and 2, to make the use of trust-evoking cues comparable across different media types (Paper 3: Schröder & Guenther, 2025a). The next paper examines the effect of the exposure to trust-evoking cues on trust in science of public audiences by combining survey data with quantitative content-analytical insights (Paper 4: Guenther et al., 2024). Thus, the perspective on this issue

shifts from a content-analytical to an audience-centered viewpoint. Finally, a qualitative approach involving online focus groups actively involves public audiences by asking about the perception and relevance of the identified trust-evoking cues (Paper 5: Schröder et al., 2025b). Thus, this dissertation examines – across five individual studies – both media content and audience perspectives, to develop a comprehensive understanding of how trust in science is mediated in content about science via trust-evoking cues, thus addressing a significant research gap in research about mediated trust in science.

Chapter 2 will define the most important terms regarding the outlined research area. Furthermore, Chapter 3 introduces an analytical framework: the *Model of Mediated Public Trust in Science Evaluation*. Chapter 4 presents the state of research and derives the subsequent RQs that will be answered in the five consecutive studies included in this dissertation. Subsequently, Chapter 5 presents these studies with a focus on methods used and findings gained, by taking a holistic, overarching, and thus almost meta-perspective. The results will be presented from two perspectives: media content and audience. Finally, the results will be discussed in Chapter 6 from a superordinate point of view. This also includes the limitations, directions for future research, and the contribution of this dissertation to theory, methodology, and empirical evidence.

## 2 Definition of Terms

### 2.1 Trust

*Trust* is a complex concept that has been defined and studied by various research disciplines. Accordingly, numerous definitions exist in the scientific literature, often building upon one another (e.g., Grünberg, 2014) resulting in “conceptual confusion” (Lewis & Weingart, 1985: 975) about the term trust (e.g., Engdahl & Lidskog, 2014; McKnight & Chervany, 1996; Schäfer, 2016). This is also the case in communication science, where definitions draw on earlier concepts, mostly from sociology and psychology. Based on this, most definitions view trust as a mechanism to reduce complexity, especially in social contexts (Luhmann, 2014), because it enables coping with future uncertainties and bridging risks (e.g., Giddens, 1990), by allowing cooperation with other actors (e.g., Gambetta, 1988).

This description implicates that trust is a relational variable involving at least two actors: the subject of trust that places trust and the object of trust that receives trust (e.g., Giddens, 1990; Luhmann, 2014; Reif & Guenther, 2022; Resnick et al., 2015). The objects of trust do not exclusively have to be individuals but can be a variety of actors, such as groups, organizations, and even social systems – meaning the actors can be found at the micro, meso, and macro levels (e.g., Reif & Guenther, 2022; Schäfer, 2016). Regarding science, the object of trust can consequently be scientists (micro level), scientific organizations such as universities (meso level), and the system of science (macro level).

To trust means having confidence that an actor will fulfill a certain expectation by relying on their qualities. This expectation is positive or at least not harmful for the person placing such trust (e.g., Gambetta, 1988; Tsfati & Cappella). Since the expectation concerns a future action, trust is always future-oriented (e.g., Bentele, 1994; Kohring, 2001; Reif & Guenther, 2022; Schäfer, 2016). Moreover, there is always the risk that the expectation may not be met (e.g., Giddens, 1990; Grünberg, 2014; Kohring, 2016), which makes the subject of trust vulnerable (e.g., Mayer et al., 1995; Resnick et al., 2015; Schoorman et al., 2007). This signals a dependency of the subject of trust toward the object of trust to get the desired outcome, consequently leading to a conscious decision by the subject of trust to rely on the object of trust (e.g., Schäfer, 2016).

When individuals lack knowledge about complex issues, such as in scientific areas, they need to rely on the knowledge of others (e.g., Bentele, 1994; Kohring, 2016; Luhmann, 2014; Marques et al., 2015; Reif & Guenther, 2022). This aligns with the concept of epistemic trust, which means to trust in science as reliable source of information (e.g., Hendriks et al., 2015, 2016; Origgi, 2012; Sperber et al., 2010; Wilholt, 2013). This suggests that publics depend on scientific knowledge to make informed decisions, for instance related to their own health,

regarding the use of technology, or concerning the environment or climate friendly behavior (e.g., Reif & Guenther, 2022).

Epistemic trust in science is considered to be a multidimensional construct that consists of several components that are referred to as dimensions of trust in science. In the literature, three dimensions of trust in science are well established: expertise, integrity, and benevolence (e.g., Hendriks et al., 2015, 2016; Mayer et al., 1995). Based on the paradigm of public engagement with science,<sup>3</sup> these dimensions should be extended to pay tribute to the concept of dialogue behind this paradigm. Earlier suggestions include the dimensions of openness<sup>4</sup> (Besley et al., 2021), transparency, and dialogue (Reif & Guenther, 2022; Reif et al., 2024). To consider the reciprocity of science and its publics, the dimensions of transparency and dialogue were considered in this dissertation.

The dimension of expertise is defined as the function and ability of scientific actors to identify, analyze, and solve problems based on specific knowledge and experience, education, and qualification in a specific field of research. Integrity involves the assurance of objectivity and reliability by adhering to scientific standards and processes. This includes the appropriate use of methods, independence from external expectations or interests, and maintained quality assurance. Benevolence refers to scientific actors as serving the common good. This is accomplished by an orientation toward ethical norms and moral values as well as the social responsibility through which scientific knowledge aims to achieve a positive impact on the world and society. Transparency describes how scientific actors make research and corresponding information accessible to different publics in a clear and comprehensible way. Dialogue indicates that scientific actors participate in and enable interaction with, and engagement by, different publics, for instance, public lectures, discussions, or citizen science projects. For these definitions, see Reif et al., 2024.

There are multiple ways for public audiences to come into direct contact with science and receive scientific information (e.g., Bentele, 1994; Reif & Guenther, 2022; Schäfer, 2016), for example, by visiting a university, having conversations with scientists in science cafés, or attending public events where scientists participate. However, this direct contact is not the most common form of contact. Most people encounter science and receive scientific information indirectly, for example, through conversations with social agents: people talk to

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<sup>3</sup> The paradigm of public engagement with science emphasizes interaction with, and reciprocity between, science and its publics, with the goals of increasing citizen participation in science, informing and educating publics, raising interest in scientific issues, fostering trust in science – and, consequently, improving acceptance – as well as promoting innovation in science (e.g., Weingart et al., 2021).

<sup>4</sup> Besley et al. (2021) define openness as the willingness to listen. Consequently, this does not include an exchange between science and its audiences.

friends and family members about scientific topics. However, the second and most important way of indirect contact is through the media.

Public audiences use media to receive scientific information and, hence, come into indirect contact with science and its representatives (e.g., Brossard, 2013; European Commission, 2021; Mede et al., 2025; Schäfer, 2016; WiD, 2023). The *Theory of Public Trust* by Bentele (1994) acknowledges the importance of media for the trust relationship between science and its publics.

This theory conceptualizes public trust (i.e., trust placed by publics) as a communicative process involving various actors. In addition to the subject of trust (e.g., publics) and the object of trust (e.g., science), there are so-called intermediaries of trust, most notably media. Bentele (1994) acknowledges that public figures, institutions, and systems are rarely experienced directly; instead, they are primarily perceived through mediated information. In combination, direct personal experiences and mediated information form the basis of public trust in public actors, such as individuals, organizations, and systems – ranging from politicians, political parties, trade unions, the economy, sports, and entertainment to science. Media, therefore, serve as a key component in shaping public trust, which can evolve over time as new information and events emerge (see also Reif & Guenther, 2022; Schäfer, 2016). In this context, “trust factors” (Bentele, 1994: 144) play an important role:

Depending on how many of these trust factors are present or how strongly they are perceived by the subjects of trust, greater or lesser levels of trust or greater or lesser levels of distrust<sup>5</sup> will emerge. (Bentele, 1994: 144, own translation)

Bentele (1994) further differentiates between various kinds of trust depending on the object of trust: personal trust (micro level), institutional trust (meso level), and system trust (macro level). In addition, he describes a form of interpersonal (and non-public) basic trust that helps individuals manage everyday life. The Theory of Public Trust thus assigns a prominent role to the media and its content as key channels through which information is conveyed. Accordingly, public trust in science may be directed toward scientists, scientific organizations, and the scientific system as a whole. This thought aligns well with the current state of research. However, the Theory of Public Trust does not specify which specific trust factors are conveyed through media content in the context of science.

When this dissertation refers to public trust in science, it is grounded in the Theory of Public Trust (Bentele, 1994) and reflects an epistemic understanding that views science as a producer of valid knowledge (e.g., Hendriks et al., 2015, 2016; Origgi, 2012; Sperber et al., 2010; Wilholt,

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<sup>5</sup> Here, the focus lies on the issue of trust and not on a conceptual discussion about the similarities, differences, and the relationship between trust and distrust (e.g., Luhmann, 2014; McKnight & Chervany, 2001).

2013). Accordingly, public trust in science is conceptualized as a multidimensional construct, comprising the dimensions of expertise, integrity, benevolence, transparency, and dialogue (e.g., Reif & Guenther, 2022; Reif et al., 2024). At the same time, it is regarded as a relational variable that includes subjects of trust, objects of trust, and intermediaries of trust (e.g., Bentele, 1994, Reif & Guenther, 2022; Schäfer, 2016).

## 2.2 Trustworthiness and Credibility

When examining the concept of trust, it becomes evident that several related terms – such as *trustworthiness* and *credibility* – are frequently used in overlapping ways and are sometimes even treated as synonyms. Although conceptual distinctions between these terms exist, research on trust, trustworthiness, and credibility reveals notable similarities, and their interrelations remain insufficiently clarified in the broader literature (e.g., Hanimann et al., 2023). For instance, some studies conceptualize credibility as a two-dimensional construct consisting of expertise and trustworthiness (e.g., Hovland et al., 1953). However, expertise is also regarded as a dimension of both trust in science and trustworthiness of science (e.g., Hendriks et al., 2015, 2016; Reif & Guenther, 2022). Furthermore, this understanding of credibility implies that it functions as an overarching concept, with trustworthiness as a subordinate component. In contrast, credibility can also be defined as a feature of trustworthiness (e.g., Boothby et al., 2021). Interpretations across the literature also diverge regarding the relation of trust and credibility. Some scholars view trust as a precursor to credibility (e.g., Grünberg, 2014; Hong, 2006); others see it as the outcome of a broader evaluation process in which credibility plays only a partial role (e.g., Rowley et al., 2015), and, finally, some even use the two terms synonymously (see Hanimann et al., 2023).

Given that the concepts of credibility and trustworthiness are relevant to media perception, which plays a critical role in shaping public trust in science (e.g., Bentele, 1994; Schäfer, 2016), this dissertation aims to concisely untangle and examine their relationship systematically. To establish a conceptual framework, the terms must first be clearly defined, and their understanding in this research must be established before they can be connected to trust in science.

In communication research, trustworthiness is often used synonymously with trust. Especially in the context of science, the term “trust” is used to define trustworthiness and vice versa. The descriptions make it clear that the perception of certain characteristics leads to an evaluation of someone or something as trustworthy, which then forms the basis for trust. In the context of science, trustworthiness refers to how science is perceived, while trust describes the behavior of a subject of trust based on this perceived trustworthiness (e.g., Hautea et al., 2024; Mayer et al., 1995). The relevant aspects that inform the judgment of trustworthiness correspond to

the dimensions of trust in science (e.g., Hendriks et al., 2015, 2016; Meyer et al., 1995; Reif & Guenther, 2022; Reif et al., 2024). Hence, in this dissertation, trust is considered as the overarching concept that incorporates perceptions of trustworthiness based on the dimensions of trust in science.

Credibility is also a central concept in communication research (e.g., Hanimann et al., 2023) and is commonly understood as the extent to which an audience perceives individuals, organizations, or their communicative output as believable (e.g., Bentele & Seidenglanz, 2008; Metzger & Flanagin, 2013; Simons, 2020). This conceptualization highlights the importance of the audience perspective and reveals three core areas of focus within credibility research: source credibility, media credibility, and message credibility (for an overview, see Hanimann et al., 2023).

Source credibility refers to the perceived trustworthiness and expertise of a source (see Hovland et al., 1953). In this sense, trustworthiness is defined as the honesty attributed to the source, and expertise means the ability of a source to provide accurate and valid information. Over time, additional aspects, such as dynamism, attractiveness, and goodwill, have been suggested – with no consensus reached (e.g., Hanimann et al., 2023). However, source credibility does refer to specific individuals and organizations as sources.

In contrast, media credibility refers to entire media outlets or platforms (e.g., newspapers, TV, internet, or Facebook and Instagram). To judge the credibility of media, key criteria were identified: fairness, accuracy, lack of bias, completeness, and trustworthiness (e.g., Meyer, 1988; West, 1994). However, due to the conceptual ambiguity and limited significance (e.g., What exactly is meant when the credibility of the internet is assessed?), some researchers argue that it is more appropriate to focus on source credibility rather than media credibility (e.g., Hanimann et al., 2023).

Lastly, message credibility refers to the content of the message itself (independent of its source) and if it is perceived as accurate, authentic, and believable (e.g., Appelman & Sundar, 2016). Message and source credibility are interrelated (e.g., Schweiger, 2010), but message credibility becomes especially important when no clear information about the source is available, leading individuals to assess credibility based solely on the message's characteristics (e.g., Rosenthal, 1971). In addition, message credibility and trustworthiness can also be easily confused, which is why it is worthwhile to compare the two concepts directly. In the context of mediated trust in science, message relates to the media, which is evaluated based on structural aspects of the media content. Trustworthiness, by contrast, relates to scientific actors presented in this media content and is conveyed through the information presented. In this sense, these are two distinct concepts that will be examined in relation to one another in the following chapters.

Based on these definitions and the definition of trust in science (see Chapter 2.1), an analytical framework will be developed in Chapter 3 that outlines how mediated public trust in science is placed und thus understood in this dissertation.

### 3 Model of Mediated Public Trust in Science Evaluation

Trust is not granted arbitrarily but is, according to the understanding presented here, the result of a complex evaluation processes (see also Bentele, 1994; Luhmann, 2014; Mayer et al., 1995; Reif & Guenther, 2022; Schäfer, 2016). Based on the Theory of Public Trust (Bentele, 1994), these processes include a subject of trust (e.g., publics), an object of trust (such as scientific actors<sup>6</sup> at the micro, meso, and macro levels), and intermediaries of trust (see also Schäfer, 2016; Reif & Guenther, 2022). Here, the intermediaries of trust are exclusively the media and, furthermore, include a variety of components connected to media and its contents (e.g., Bentele, 1994; Metzger & Flanagin, 2015; Schäfer, 2016). Based on this, the *Model of Mediated Public Trust in Science Evaluation* (MPTSE) designed here will include both the media and the audience perspectives based on the outlined trust relationship between a subject, an intermediary, and an object of trust in science (see Bentele, 1994; Reif & Guenther, 2022). The primary aim of this model is to illustrate the interrelations among the previously discussed concepts, thereby facilitating the localization of this dissertation's focus. Moreover, the model represents a preliminary attempt to impose structure on the current state of research, which, as outlined above, is marked by numerous conceptual overlaps and ambiguities (e.g., Lewis & Weingart, 1985; McKnight & Chervany, 2001). It is thus to be understood as an invitation to further scholarly discourse, with the goal of developing a coherent framework for understanding the existing body of research.

The model describes how public audiences as subjects of trust use (1) trust heuristics, i.e., cognitive shortcuts, as a basis for evaluations when they encounter media and its content that refers to scientific actors as objects of trust (e.g., Kahneman & Frederick, 2005; Metzger & Flanagin, 2015; Tversky & Kahneman, 1974). By doing so, subjects of trust are exposed to a whole (2) environment of evaluation indicators that provide (2.1) context for media content, signal (2.2) source credibility and (2.3) message credibility that are all connected to media. Furthermore, they receive (2.4) trust cues that refer to scientific actors at the micro, meso, and macro levels in media content about science (e.g., Bentele, 1994; Boothby et al., 2021; Choi & Stvilia, 2015; Fogg et al., 2003; Intemann, 2023; Metzger & Flanagin, 2013; Ross Arguedas et al., 2024). An overall evaluation finally results in (3) a trust conclusion regarding the object of trust (e.g., Flanagin & Metzger, 2000; Rosenthal, 1971), ranging from a positive to a neutral or even negative outcome. When the overall assessment is neither positive nor negative but remains unclear, audiences can become engaged and use further actions to verify information to reach an agreement (e.g., Metzger & Flanagin, 2013). This could be, for instance, further research about an issue or person.

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<sup>6</sup> When this study refers to “scientific actors,” it always includes actors operating at the micro, meso, and macro levels, i.e., scientists, scientific organizations, and the system of science.

By describing this model of MPTSE, it becomes evident that trust is seen here as an overarching construct that encompasses a diverse range of aspects, such as credibility (see Grünberg, 2014). To date, a model like MPTSE has not been developed in previous research; however, initial thoughts in this direction (that only address single aspects of this model) can be found across research on trust, trustworthiness, and credibility (see Bentele, 1994; Metzger & Flanagin, 2013; Origi, 2012; Reif & Guenther, 2022). In addition, the MPTSE can be applied to hybrid media environments including both digital and non-digital media. This allows the model to be used in investigations of mediated public trust in science across a variety of media types – including legacy media, such as print newspapers, modern forms of journalistic media (e.g., via social media), as well as digital, non-journalistic media, such as blogs or user-generated content about science in social media. The MPTSE is visualized in Figure 1 and its components will be described in more detail below.

(1) *Trust heuristics.* People employ various trust heuristics to assess information provided in media content. Simply said, trust heuristics are the lens through which media content is viewed. These heuristics can be, among other aspects, (ideological) predispositions, familiarity with a topic, and probability judgments (e.g., Kahneman & Frederick, 2005; Tversky & Kahneman, 1974). They are diverse and individual (e.g., Metzger & Flanagin, 2015). In the context of science, for instance, audiences need to navigate highly complex issues that they do not have the capacity in terms of time and/or cognition to truly assess. Hence, arguments from scientific actors are, in this case, the basis of decisions. This means that the assessments of scientific actors potentially lead to the acceptance or rejection of scientific information (e.g., Cummings, 2014).

(2) *Environment of evaluation indicators.* Subjects of trust (unconsciously) use trust heuristics to assess a variety of indicators that provide contexts for media content, signal source and message credibility, and may evoke trust in an object of trust (see 2.1–2.4) that together build the environment of evaluation indicators. This environment is a “black box” to some extent. Even though there is already research on different aspects and their (potential) effects on source and message credibility as well as on trust in science, their interaction remains unclear. It is not known (and probably highly individual) how they influence each other, both positively and negatively, and how, in the end, a trust conclusion is reached. All elements of this environment will be described in the following; they are organized according to the level of analysis, i.e., context, media, content, and information.

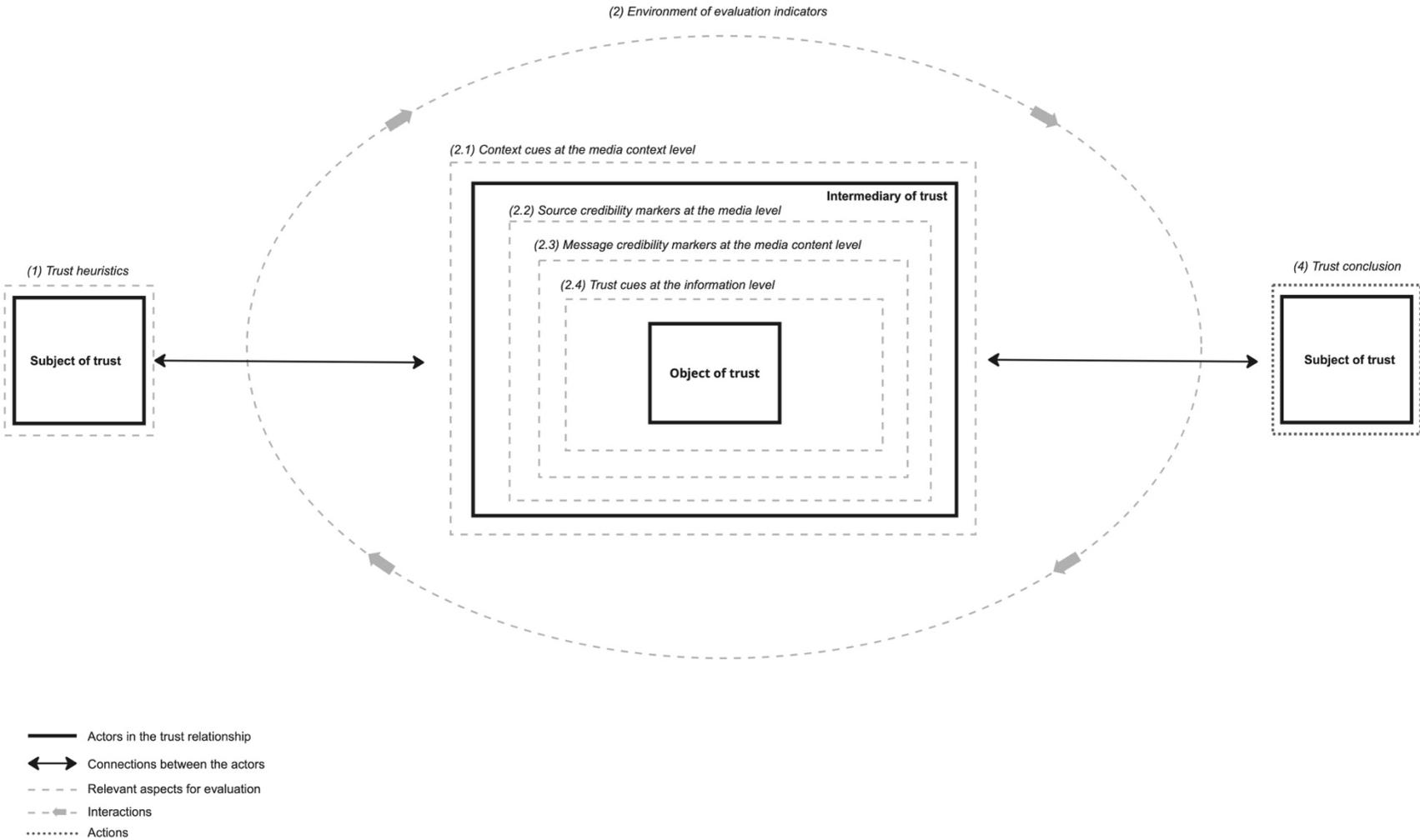


Figure 1. Model of Mediated Public Trust in Science Evaluation.

(2.1) *Context*. Whereas the use of legacy media, such as traditional journalistic reporting in print newspapers, allows public audiences to receive information directly from media outlets, this is no longer the case in many online contexts. Especially in social media, audiences not only follow media outlets directly (e.g., Newman, 2020) but are also exposed to media content indirectly and incidentally (e.g., Boczkowski et al., 2018), and its content can be reframed by anyone (e.g., Carlson, 2018; Casero-Ripollés, 2018). Media content can be endorsed or recommended by users and so-called opinion leaders (e.g., Turcotte et al., 2015; see also Lazarsfeld et al., 1948) but the content can also be reshaped in a negative light by adding critical commentary or reinterpretation (e.g., Bos et al., 2023). Context cues are decisive, because the person sharing media content highly influences how users engage with this content (e.g., Sterrett et al., 2019), and criticism of shared media content often receives more attention than the information provided in it (e.g., Anspach & Carlson, 2020). This, consequently, impacts the evaluation of source and message credibility. Cues at the context level need to be considered in the overall investigation of evaluations of mediated public trust in science. However, this is primarily the case in digital online contexts but less for non-digital and/or offline media. Since the MPTSE is applicable to hybrid media environments, cues at the context level need to be considered in the overall investigation of evaluations of mediated public trust in science.

(2.2) *Source and (2.3) message credibility*. Here, credibility is defined as the believability of a media source or a message (e.g., Metzger & Flanagin, 2013). Since audiences, especially online, encounter a variety of unfamiliar sources (e.g., Ross Arguedas et al., 2024), the question arises as to which of these sources and contents are considered credible. Consequently, at this point, media are the reference point of credibility evaluations, not scientific actors as the object of trust.<sup>7</sup> Just as it is true for trust heuristics, the judgement of credibility is an individual process (e.g., Metzger & Flanagin, 2015).

To assess the credibility of media sources and of their content, various credibility markers are considered. Credibility markers have been studied extensively, especially in online environments with a variety of markers that have been identified (e.g., Boothby et al., 2021; Choi & Stvilia, 2015; Fogg et al., 2003; Metzger & Flanagin, 2013; Ross Arguedas et al., 2024). Aligning with the duality of source and message credibility (e.g., Hanimann et al., 2023), markers referring to sites/sources and authors as well as messages have been identified (Metzger & Flanagin, 2015).<sup>8</sup> Markers that signal source credibility can be found at the level of

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<sup>7</sup> It is also possible for media itself to become an object of trust. However, this dissertation focuses on trust in science, not on trust in news media. Due to conceptual ambiguity, credibility is at times examined when the actual object of trust is news media, or trust is analyzed while the investigation concerns credibility. Regarding trust in journalistic news media, trust is defined as confidence in journalistic selection (e.g., Kohring, 2004).

<sup>8</sup> In the study of Metzger and Flanagin (2015), a fourth category of credibility markers considers “receiver

media itself but not at the level of its content. For instance, a professional page design, visuals, metrics, easy navigation, presence of security policies, and absence of errors can support the source credibility by referring to sites/sources (e.g., Choi & Stvilia, 2015; Metzger & Flanagin, 2015). In addition, contact information, name recognition, or absence of commercial motives are also considered to be markers for source credibility by referring to authors (e.g., Choi & Stvilia, 2015; Metzger & Flanagin, 2015). These two types of source credibility markers serve as the initial evaluation criteria when encountering media content.

These evaluation criteria are followed by markers that signal message credibility that are located at the media content level. They relate to the format and structure of a media piece, such as a text. In this regard, for instance, the presence of a date stamp showing that the information/content is current, as well as clear writing, general plausibility, lack of bias, and sufficient depth of information, is relevant (e.g., Fogg et al., 2003; Metzger & Flanagin, 2015; Ross Arguedas et al., 2024). Consequently, these message-related markers focus on the style of media content and do not take the specific information provided into consideration.

(2.4) *Trust-evoking cues.* At the level of information in media content about science, the information provided includes elements that may function as cues that evoke trust in scientific actors. As previously outlined, this aligns with the trust factors suggested by Bentele (1994), which can trigger trust in relation to an object of trust (here: science). So far, these trust-evoking cues have not been systematically examined. However, it is reasonable to assume that they are closely related to the dimensions of trust as they convey reasons to trust in science (e.g., Reif & Guenther, 2022). In addition, these trust-evoking cues must always refer to an object of trust and may, therefore, vary both qualitatively (e.g., in terms of the aspects addressed) and quantitatively (e.g., in terms of the frequency with which trust-evoking cues are used) depending on the specific object of trust. For instance, the use of trust-evoking cues may differ between scientific actors at different levels – but also within one level, such as in the case of differences between female and male scientists at the micro level.

The concept of trust-evoking cues thus represents a key research gap within the MPTSE and requires further investigation to enhance our understanding about this model and its processes. Since the overarching RQ of this dissertation asks how public trust in science is mediated between content about science and its publics, it places particular emphasis on the idea of trust-evoking cues. Hence, the main research interest is located in the heart of the

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characteristics.” However, these share similarities with trust heuristics; therefore, they will not be addressed at this point.

MPTSE. In the following, the idea of trust-evoking cues will be referred to in its shortened form, “trust cues.”<sup>9</sup>

(3) *Trust conclusion.* After audiences have assessed the credibility of the source and the message, engaged with the media content, evaluated scientific actors based on trust cues, and possibly taken further steps to seek or verify information, they reach a conclusion about their trust in science (for trust as a decision, see Schäfer, 2016; Reif & Guenther, 2022). The degree to which trust is granted or withheld is highly subjective and varies individually. It may result in a positive, neutral, or negative outcome regarding one’s trust in science. Hence, public audiences may place trust in science to some extent (positive), confirm their current state of trust in science or experience no change in trust (neutral), reduce trust in science to some degree, stay or become skeptical, or even dismiss it (negative). Audiences can also remain undecided after the assessments and, hence, try to verify information (e.g., Rosenthal, 1971) by, for instance, checking if information provided is current and complete or searching for other sources to validate information. Additionally, audiences can also verify qualifications and credentials of scientists (e.g., Flanigan & Metzger, 2000). Audiences will continue to seek information until they reach an individual saturation and, hence, reach a conclusion regarding their trust in science.

However, when trust in science is granted, this links back to the subject of trust because trust itself can become a heuristic for forming opinions about science and related issues such as risks (e.g., Hmielowski et al., 2013; Lewicki & Brinsfield, 2011) as well as a heuristic for making decisions about complex issues (e.g., Bruhn, 2019; Sintov & Hurst, 2023).

As previously outlined, the MPTSE aims to provide a bigger picture connected to trust cues in content about science that are the focus of this dissertation. In this regard, research about trust cues is scarce. The following section describes the state of research that addresses this gap and considers various related and relevant aspects.

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<sup>9</sup> Regarding the short form, the question why the term “trust” and not “trustworthiness” was used seems worth noting. Even though trust refers to the behavior and trustworthiness relates to the perception (see Chapter 2), the distinction between these terms becomes blurred when the focus shifts away from the subject or object of trust and instead centers on the information conveyed by intermediaries. Content-analytical approaches on trust in science are needed to investigate the issue of trust cues, but these approaches do not consider the perception of scientific actors (i.e., trustworthiness) nor do they include the resulting action (i.e., trust). As a result, the content-analytical perspective on trust in science operates in an intermediate space between trustworthiness and trust. For this reason, there is no single correct way to label trust-evoking information in content about science. However, the rationale behind referring to this information as “trust cues” is rooted in the aim of discussing the broader framework (the MPTSE) in which this concept is embedded and results in a trust conclusion.

## 4 State of Research

Existing research covers, for instance, trust heuristics as well as source and message credibility markers, but not trust cues. This highlights a significant research gap in the MPTSE that this dissertation seeks to address. Therefore, this thesis aims to answer the overarching RQ “*How is public trust in science mediated between content about science and its publics?*” To do so, a set of subordinate RQs will be developed based on the current state of research that serve as an operationalization of the overarching research interest.

In Germany, trust in science has, according to representative quantitative surveys, remained consistently high, with 55% of the population indicating that they fully or somewhat trust in science in 2024. In contrast, only 9% reported somewhat not or no trust at all in science (WiD, 2024; for other countries see also Cologna et al., 2025; Funk, 2017). Beyond individual experiences and attitudes, mediated information about science constitutes a significant factor in the formation of trust judgments (e.g., Wintterlin et al., 2022). As established, the most important way to encounter science and to receive scientific information is through the media (e.g., Brossard, 2013; EC, 2021; Mede et al., 2025; Schäfer, 2016; WiD, 2023). Across the EU, the most commonly used medium to become informed about science is the TV, followed by social media, newspapers, and radio (EC, 2021). For Germany in particular, online channels have become increasingly important for obtaining scientific information (WiD, 2023). These differentiations do not provide information about what kind of sources are used but as research suggests, journalistic media might be the most important source for receiving scientific information (e.g., Brossard & Nisbet, 2007; Dunwoody, 2008; Nelkin, 1995). Hence, when investigating mediated trust in science from a content perspective, it is important to include a variety of sources, such as media types and media brands, for a holistic and complete picture (e.g., Schröder & Guenther, 2024). Even though journalistic media should be representatively the most prominent source in this investigation, it should not be examined exclusively because this would not pay tribute to the diversity of media content public audiences encounter when obtaining information about science.

Media provides information about scientific actors in its content that might be trust-evoking (e.g., Bentele, 1994; Schäfer, 2016). However, as previously outlined in the description of the MPTSE (see Chapter 3), it is not clear which trust cues occur. However, it can be assumed that they in some way relate to the dimensions of trust in science and provide reasons for this trust, as they reveal a conceptual connection (see Chapter 1.1): expertise, integrity, benevolence, transparency, and dialogue (e.g., Reif et al., 2024). Theoretically, trust cues could refer to diverse aspects that signal these dimensions of trust in science. Based on this, **RQ1** asks: **(a) *What trust cues can be identified in content about science mediating trust***

***between science and publics, and (b) how do they link to the established dimensions of trust in science?***<sup>10</sup>

The preceding theoretical section has already highlighted that various scientific actors play a key role in content about science, such as scientists, scientific organizations, and the scientific system (e.g., Mayer et al., 1995; Reif & Guenther, 2022). Consequently, trust relevant information and trust cues, respectively, refer to these actors and can thus evoke trust in relation to them (e.g., Bentele, 1994). Scientists (i.e., micro-level actors) are, particularly in science journalism, the central actors of science media coverage (e.g., Guenther, 2019). Science journalism often seeks a personal angle (e.g., Amend & Secko, 2012; Guenther, 2019) to make its reporting more accessible and engaging. However, when it comes to the representation of scientists in the media, there is a significant imbalance regarding their gender. Women are not only underrepresented in quantitative terms but are also frequently portrayed in stereotypical ways (e.g., Araújo et al., 2022; Fletcher et al., 2021; Joubert et al., 2023; Kitzinger et al., 2008; Mitchell & McKinnon, 2019; Niemi & Pitkänen, 2017). A pattern known as the Matilda effect refers to the systematic undervaluing of female scientists' achievements (e.g., Knobloch-Westerwick & Glynn, 2013; Rossiter, 1993).

Male scientists are cited more frequently and more prominently than their female counterparts, who are often quoted only as secondary sources (e.g., GMMP, 2020; Kitzinger et al., 2008). Moreover, portrayals of female scientists often involve gendered stereotypes, emphasizing personal and domestic aspects such as motherhood, childcare, and household roles, as well as physical appearance and femininity, rather than scientific competence (e.g., Chimba & Kitzinger, 2009; Mitchell & McKinnon, 2019; see also GMMP, 2020; Joubert et al., 2022; Klaus, 1998; Lünenborg & Maier, 2012). In contrast, attributes, such as intelligence, motivation, communication skills, and social conscience, tend to be represented in a more balanced way across genders (e.g., Mitchell & McKinnon, 2019).

Given the focus on micro-level actors in content about science – with gender biases being clearly evident in current research – **RQ2** investigates gender representations in the context of mediated public trust in science by asking: ***How is trust in female and male scientists mediated differently in content about science?***

When considering the media use regarding science of public audiences, a diverse range of different media types and sources need to be considered (e.g., Schröder & Guenther, 2024): Journalistic media, ranging from print and online newspapers to TV news and social media posts, can communicate about science. These media are already diverse in the sense that they can be categorized into different types, such as quality journalism and tabloid journalism.

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<sup>10</sup> The five RQs presented here represent the overarching research questions of Papers 1 to 5. In most of the papers, they are further specified and translated into more concrete RQs.

Furthermore, online platforms provide access to public arenas for a wide range of (non-journalistic) actors (see Hilgartner & Bosk, 1988), allowing them to independently share content (e.g., Brüggemann et al., 2020; Bruns, 2018; Hermida, 2020; Schäfer, 2015; Schröder & Guenther, 2024). Hence, lay people can address scientific issues, particularly on social media, but populist media can also publish scientific content (e.g., Taddicken & Krämer, 2021; Weingart, 2017; Weingart & Guenther, 2016). Such populist media (also called alternative or fringe media) exists across both the right and left political spectrum. Overall, in the online context, there is evidence that social media and right-wing populist media, in particular, pose a risk of encountering mis- and disinformation (i.e., unintentionally and intentionally wrong information; Frischlich et al., 2022). Furthermore, scientists themselves have a diverse range of possibilities to communicate scientific findings more directly, such as via social media, online blogs – and more traditionally through interviews with journalists (e.g., Lörcher et al., 2024; Taddicken & Krämer, 2021; Weingart, 2017).

As a result, public audiences encounter a diverse range of different sources for scientific information that pursue different intentions (e.g., Weingart, 2017; Weingart & Guenther, 2016). Therefore, they also publish a variety of different contents (i.e., in the sense of how content is presented and what information is provided; e.g., Brossard & Scheufele, 2022; Huber et al., 2019; Schäfer, 2016). For this reason, it is possible that different media sources use trust cues to a different extent and in different ways; this also applies to science as the object of trust. Trust cues may be used differently in reference to scientific actors at different levels. However, since scientists at the micro level are likely the most prominent actors (e.g., Guenther, 2019), further differences may emerge, for example in relation to scientists' gender, with female and male scientists being referred to in different ways as previously mentioned. That is why **RQ3** asks: ***How does the use of trust cues in content about science vary across different (digital) media and genders of the scientists represented?***

The differentiated and complex media environment creates an enormous amount of available information. Moreover, audiences do not rely on a single medium to inform themselves about science but rather use an individual media repertoire – individually curated and select media sources from the pool of all sources available (e.g., Hasebrink & Popp, 2006; Verboord, 2023). As a result, audiences use a wide range of media content from many different sources when seeking scientific information.

In addition, audience segmentations in science communication research receive growing popularity and become increasingly relevant (e.g., Guenther & Weingart, 2018; Klinger et al., 2022; Schäfer et al., 2018), for instance, for target group appropriate science communication. In the context of trust in science, this approach was used to identify five different groups in the German population that vary in terms of their trust in science (Reif et al., 2025). These trust groups are based on individuals' levels of trust in science as well as their stated reasons for

this trust connected to the five dimensions of trust in science (i.e., expertise, integrity, benevolence, transparency, and dialogue).

Ordered from the highest to lowest levels of trust in science, the five trust groups were labeled as follows: (1) “Fully trusting,” characterized by consistently high agreement across all dimensions, with a slight emphasis on expertise; (2) “Highly trusting” and (3) “Moderately trusting,” both of which showed comparatively high value placed on scientific expertise, though the latter scored slightly below average overall; (4) “Rather untrusting,” with low-to-moderate levels of trust in science; and (5) “Untrusting” expressing little or no trust in science. These groups also demonstrated notable differences in their patterns of media use for science-related information. For instance, the “Fully trusting” group reported the highest overall media use, particularly favoring public TV, but used social media less frequently. The “Highly trusting” and “Moderately trusting” groups also frequently consumed public TV. In contrast, the “Rather untrusting” group used media sources less often in general, while the “Untrusting” group showed comparatively higher use of right-wing populist media sources (Reif et al., 2025).

These insights regarding the trust groups resonate with research on media repertoires (e.g., Hasebrink & Popp, 2006; Verboord, 2024). It appears that differences in both the frequency and type of media use, may affect how trust in science develops across population segments. This perspective offers a possible explanation for why some groups maintain stable levels of trust, while others show changes – either increases or declines – in response to media exposure. Nevertheless, empirical research on this topic remains limited and by now it is unclear if and to what extent exposure to trust cues in content about science can explain stability and shifts in trust in science across population groups. Therefore, **RQ4** asks: ***To what extent does exposure to trust cues in (digital) content about science affect trust in science?***

Answering the fourth RQ will provide insights into how the frequency of trust cues across different media and their exposure can affect trust in science. This study thus captures the latent effect of such exposure. These findings are crucial for understanding whether trust cues indeed have an impact on audiences’ trust in science. In addition to this investigation, previous research only approximated the idea of trust cues by investigating selected information connected to the dimensions of trust (mostly limited aspects referred to expertise or integrity). Furthermore, research about their perception is mixed. For example, communicating (un)certainty, which is often associated with the dimension of integrity, appears to have little impact on how trustworthy scientists are perceived (e.g., Ratcliff & Wicke, 2022). In contrast, practices such as self-correction among scientists referring to the dimension of integrity have been shown to positively influence both perceived trustworthiness and audience engagement with science (e.g., Altenmüller et al., 2021). Similarly, open science practices connected to the

dimension of transparency have a favorable effect on trust in scientists (e.g., Rosman et al., 2022; Song et al., 2022).

However, these studies did not include all five dimensions of trust nor the trust cues that have been systematically identified in Paper 1. Also, research about the deliberate evaluation of trust cues by audiences is still missing but important to achieve a comprehensive understanding of trust cues. For this, a holistic consideration of the media content perspective combined with the audience perspective is needed. For this reason, **RQ5** asks: ***How do public audiences perceive trust cues?***

To answer the five RQs, a media content perspective (RQ1–3) and an audience perspective (RQ4–5) are taken into consideration. The five RQs were operationalized and addressed within the publications included in the appendix (see Papers 1–5). The following Chapter 5 outlines the methodological implementation of each study and presents the summarized results. Linking back to the MPTSE model, the five derived RQs are located at the information level and form one part of the environment of evaluation indicators. Hence, answering these five RQs helps to close the research gap on trust cues and, in doing so, contributes to a more complete understanding of which indicators public audiences are exposed to and how they evaluate them in forming a conclusion about their trust in science.

## 5 Findings: Trust Cues in Content about Science, Their Effects, and Perception

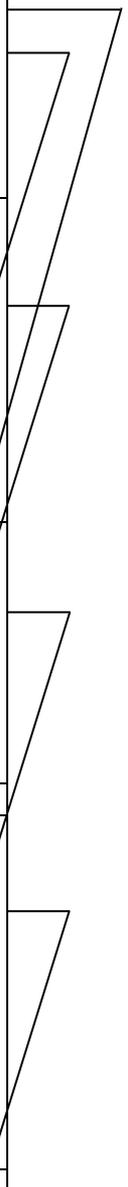
The specific examination of trust cues in media content about science represents a significant and relevant research gap in the scientific literature. To address and at least partially close this gap by answering the overall RQ about *how trust in science is mediated between content about science and its audiences*, a methodological triangulation was employed. For this, a combination of qualitative, exploratory methods and quantitative, comparative methods was used.

The research design of this dissertation is structured in such a way that each individual study, with its respective methods and findings, serves as the foundation for the subsequent one. The relations between Papers 1–5 are displayed in Table 1. Hence, each study reacts to the call for future research of the previously conducted study and addresses its limitations to some extent. Thus, synergy effects between the studies can be used. In total, the five studies used qualitative and quantitative content analysis as well as an effect study combined with survey data and, in addition, focus groups. Furthermore, here, two analytical perspectives are incorporated in the research: the perspective of media content and the perspective of public audiences.

To illustrate this twofold design, methodological approaches and findings of both perspectives are outlined in the following sections. Chapter 4.1 focuses on media content and, thus, addresses RQs 1–3. Furthermore, Chapter 4.2 centers on public audiences, thereby responding to RQs 4 and 5. Simultaneously, the RQs 1–5 represent the overarching research interest for Papers 1–5. In total, this procedure aims to build a solid foundation for research on mediated trust cues in content about science. Table 1 visualizes the relations between the five studies.

**Table 1.** Relations between Papers 1–5.

Paper	RQ	Method	Call for Future Research
<i>Media content perspective</i>			
Paper 1: Schröder, J. T., Brück, J., & Guenther, L. (2025). Identifying trust cues: How trust in science is mediated in content about science. <i>Journal of Science Communication</i> , 24(01), A06. <a href="https://doi.org/10.22323/2.24010206">https://doi.org/10.22323/2.24010206</a>	What trust cues can be identified in content about science mediating trust between science and publics, and how do they link to the established dimensions of trust in science?	Qualitative content analysis	Generalizability of the results and analysis of qualitative differences regarding actors, particularly gender
Paper 2: Schröder, Justin T. (2025). Trust cues in content about science: How the media presents female and male scientists differently. In: Antoinette Fage-Butler, Loni Ledderer, & Kristian Hvidtfelt Nielsen (eds.), <i>Science Communication and Trust</i> (pp. 385–406). Palgrave Macmillan.	How is trust in female and male scientists mediated differently in content about science?	Re-analysis of data based on qualitative content analysis	Generalizability of gender differences
Paper 3: Schröder, J. T., & Guenther, L. (2025). Mediating trust in content about science: Assessing trust cues in digital media environments. <i>Public Understanding of Science</i> , 0(0). <a href="https://doi.org/10.1177/09636625251337709">https://doi.org/10.1177/09636625251337709</a>	How does the use of trust cues in content about science vary across different (digital) media and genders of the scientists represented?	Quantitative content analysis	Effects of trust cue exposure
<i>Audience perspective</i>			
Paper 4: Guenther, L., Schröder, J. T., Reif, A., Brück, J., Taddicken, M., Weingart, P., & Jonas, E. (2024). Intermediaries in the limelight: How exposure to trust cues in content about science affects public trust in science. <i>Journal of Science Communication</i> , 23(09), A06. <a href="https://doi.org/10.22323/2.23090206">https://doi.org/10.22323/2.23090206</a>	How does exposure to trust cues in content about science affect public trust in science?	Linkage of quantitative survey data and data from quantitative content analysis	Perception and relevance assessment by audiences
Paper 5: Schröder, J. T., Engel, M., Schröder, I., & Guenther, L. (2025). Public trust in scientists: Exploring the perception and relevance of trust cues in media content. <i>Journal of Science Education, Part B</i> . Under review.	How do public audiences perceive trust cues?	Focus groups	Comparison of trust cue perceptions between different cultural contexts



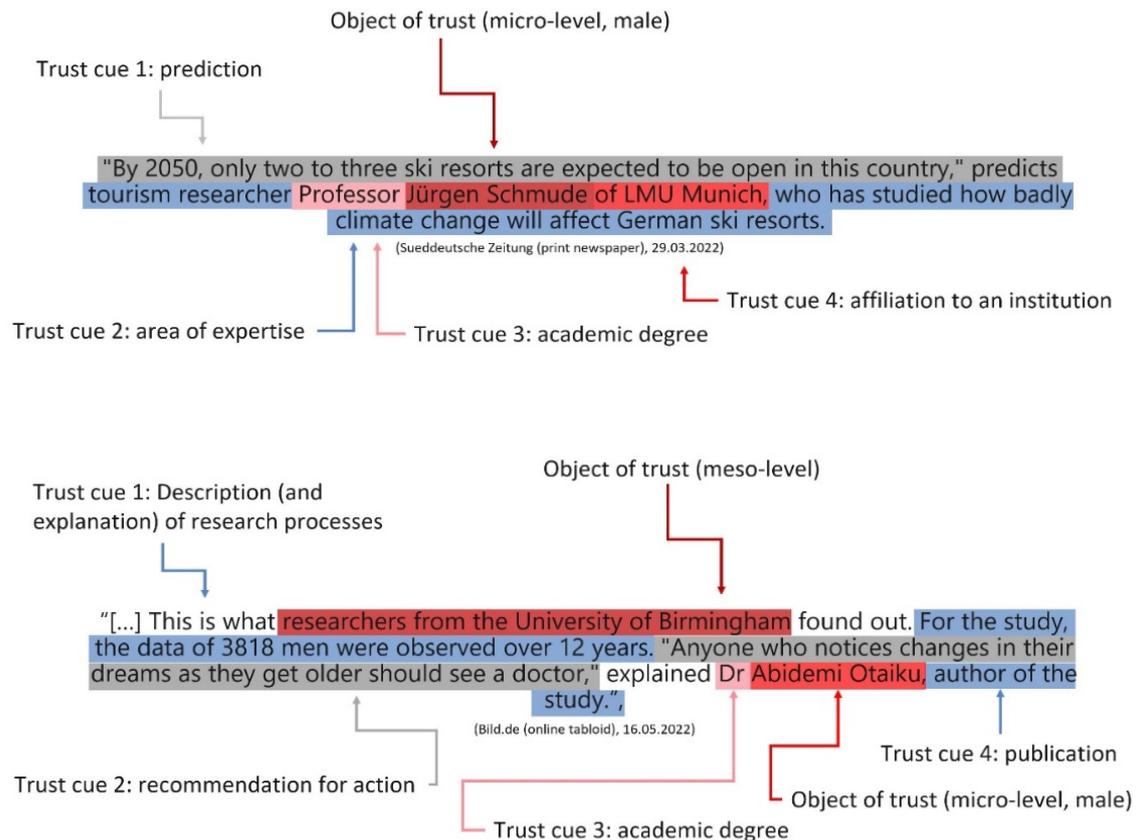
## 5.1 Media Content Perspective

To examine the media content perspective, this dissertation primarily relied on the method of content analysis. Content analyses are key methods in communication science and are particularly well-suited for studying messages (e.g., texts such as articles and transcripts). In total, three studies were conducted to explore the media content perspective, each resulting in a separate academic publication (see Papers 1–3). Methodologically, these studies are closely interconnected.

To answer RQ1 (i.e., identification of trust cues in content about science), an initial study (see Paper 1: Schröder et al., 2025a) was conducted using an exploratory qualitative content analysis to uncover how trust in science is addressed in content about science (e.g., Kuckartz, 2017). For this, the five dimensions of trust (e.g., Reif & Guenther, 2022; Reif et al., 2024; see also Hendriks et al., 2016) were guiding as deductive categories; however, the process remained inductively open for further aspects that might be considered trust-evoking. Hence, the study combined a deductive and an inductive approach (e.g., Kuckartz, 2017). The aim of the study was to identify trust cues as comprehensively as possible. To achieve this goal, various types of media were included that displayed the diversity of digital media environments. This approach made sense, as public audiences use a repertoire of diverse media to engage with science (e.g., Verboord, 2024). Consequently, journalistic media was considered alongside social media, other internet-based, non-journalistic media (e.g., blogs and news aggregators), and right-wing populist media. The selection of included media was based on existing survey data (e.g., EC, 2021; WiD, 2023) and cross-referenced with findings from a separate study in the context of trust in science (see Reif et al., 2024). Based on this, media contents were collected in three constructed weeks (see also Elmer et al., 2008; Guenther et al., 2019; Hester & Dougall, 2007), starting with a Monday in March 2022 and finishing with a Sunday in August 2022. The data collection used a combination of diverse data bases, search strings, and manual checks. Initially,  $N = 5,262$  media contents were collected (for a detailed overview, see Paper 1). They were manually checked to see if (1) they referred to a scientific actor, and if (2) they contained information that might evoke public trust in science. Only by fulfilling both criteria, were the media contents considered relevant for coding. After this check, the media collection was reduced to a sample of  $n = 761$  media contents. Based on this, a smaller subsample was built with  $n = 158$  media items used for the qualitative coding.

The coding process included three steps: (1) trust-relevant aspects were collected openly, (2) results were summarized and condensed to form overarching content-based categories, and (3) they were linked to the dimensions of trust in science where it made sense. Trust cues were always coded connected to the object of trust, i.e., scientists at the micro level, scientific organizations at the meso level, and the system of science at the macro level. Formal

categories were coded as well, including media type, the source of trust cues (e.g., journalists, scientists, social media users), authors, topic of the media content, and the corresponding research discipline.<sup>11</sup> Thus, a variety of trust cues in content about science could be identified. This coding process is visualized in Figure 2.



**Figure 2.** Examples of the Qualitative Coding (see Schröder et al., 2025a).

In total,  $n = 1,329$  individual trust cues were coded; coders condensed them into 35 distinct trust cues in media content about science that were grouped into 14 categories. The trust cues matched the dimension of expertise, integrity, benevolence, transparency, and dialogue. However, not all trust cues could be assigned to an overarching category – these essentially functioned as both trust cues and categories in one. And even though coders remained open to creating new dimensions of trust in science if needed, none of the identified trust cues could be matched with the existing dimensions. Since the trust cues exclusively focused on one dimension each, the terms expertise, integrity, benevolence, transparency, and dialogue cues were used. The greatest variety was evident for integrity cues – with twelve different cues –

<sup>11</sup> For more details about this methodological approach, please see Paper 1.

followed by nine benevolence cues, seven expertise cues, five dialogue cues, and finally two transparency cues.

In this regard, expertise cues referenced the academic education, professional experience, and qualifications of scientific actors as objects of trust. This included their academic degree(s), organizational affiliation, and/or their reputation. Integrity cues addressed independence (e.g., funding sources, interests), assurances of scientific quality (e.g., uncertainties in research and peer review), and references to scientific standards and processes in general. Benevolence cues addressed ethical norms, social responsibilities (e.g., in researchers' communication of research-related risks or their assessment of public events and current affairs), and benefits for society that science might provide (e.g., science-based recommendations). Transparency cues referred to comprehensible language (that also includes technical terminology) and the accessibility of research results.<sup>12</sup> Dialogue cues indicated the participation of scientific actors in public events, their journalistic and direct media presence (e.g., use of social media), and their public engagement in research. Dialogue presupposes some kind of reciprocity (i.e., possibility to ask questions or interaction), which distinguishes dialogue from transparency. Table 3 lists, inter alia, all trust cues along with their corresponding categories and dimensions. To enhance understanding, two examples are illustrated here: one of expertise cues, taken from the online science blog *SciLogs* on 09.06.2022 (see Klartext, 2022), and another of an integrity cue, taken from *Sueddeutsche Zeitung* on 16.05.2022 (see Hoferichter, 2022).<sup>13</sup>

Benjamin Breitenbach *studied biomedical chemistry in Mainz in 2009 including a research stay at the University of Auckland, New Zealand* [academic education]. During his *PhD at Johannes Gutenberg University Mainz* [academic education], he investigated nanodimensional polymer therapeutics in the field of drug delivery.

Kolb and Bünemann's team *used an algorithm to search for new binding sites in the structures of 113 different GPCR proteins* [description and explanation of research processes]. In doing so, they found several 'pockets' that have not been used as drug targets so far.

To answer RQ2 (i.e., qualitative comparison of the use of trust cues between female and male scientists; see Paper 2: Schröder, 2025), the coded trust cues from the qualitative content analysis ( $n = 1,329$ ) were filtered by levels; this made it clear that most cues were found at the micro level. Hence, scientists were the most frequently addressed scientific actors with 78%

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<sup>12</sup> Transparency here means that science itself is presented as being transparent regarding its research, but not every piece of science-related information must be communicated in a transparent manner. For instance, when journalists disclose the funding source of a research project, the communication is transparent on the part of the journalists, not the scientific actors. While such information may help audiences assess the independence and, hence, the integrity of the research, it does not directly reflect the transparency of scientific actors.

<sup>13</sup> An example of each trust cue is provided in the Appendix of Paper 1.

( $n = 1,033$ ) of all trust cues. This highlights the prominent role of individual scientists in media coverage of scientific issues. These micro-level cues were then compared between female and male scientists.

Overall, all five dimensions of trust could be identified for both genders. While some patterns were shared across genders, the study also revealed clear qualitative differences in how these trust cues were used for female and male scientists. The similarities and differences in the use of trust cues can be described alongside the dimensions of trust.

Regarding expertise, both female and male scientists were frequently portrayed as experts, with references to their education, qualifications, and their area of expertise.<sup>14</sup> However, male scientists' affiliations with a scientific organization and their academic titles were emphasized. In contrast, female scientists were sometimes introduced with less emphasis on organizational backgrounds, and their expertise was occasionally contextualized through their non-academic or personal experiences, which were less commonly used for men.

The integrity of both female and male scientists was communicated through discussions of research processes and descriptions of how they adhered to scientific standards. Yet, male scientists were more often associated with quality assurance mechanisms, such as peer review, acknowledgement of uncertainties, and the limitations of research.

The dimension of benevolence exhibited the most prominent gender-based differences. Female scientists were frequently depicted as personally invested and socially driven, with their motivations often tied to emotional or biographical narratives. For example, stories highlighted how personal loss, family responsibilities, or social values inspired their scientific work. These portrayals align with traditional gendered expectations of empathy and care. In contrast, male scientists were more likely to be portrayed as rational advisors, offering science-based recommendations in a factual, detached manner. Their contributions were depicted as objective and policy-oriented, without references to personal life or emotional motivations.

Regarding the dimensions of transparency and dialogue, the study found no major gender differences. Both female and male scientists were similarly represented in terms of their media presence, participation at public events, and use of understandable or technical language.

These findings demonstrate how gender stereotypes are addressed not only in content about science per se but also in the context of mediated trust in science. Female scientists are often humanized, with media presenting them as emotional or family-oriented, emphasizing care, compassion, and social responsibility. Male scientists, on the other hand, are depicted as

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<sup>14</sup> Quotes from media contents for differences and similarities regarding the use of trust cues connected to female and male scientists across all dimensions of trust can be found in Paper 2.

rational voices, delivering expertise with minimal personal influence. This might result in differences in trust between female and male scientists.

The findings from this qualitative groundwork (see Papers 1 and 2) were used to design a quantification of trust cues to answer RQ3 (i.e., differences in the use of trust cues across different media types and genders of the scientists represented; see Paper 3: Schröder & Guenther, 2025a). For this, a systematic codebook was developed using the 35 identified trust cues allowing for quantitative analysis of media content. In addition, further variables, such as media type, the source of trust cues (e.g., authors), level of the objects of trust (i.e., micro, meso, macro), and research discipline were included. Furthermore, the gender of scientists was included for all objects of trust at the micro level as well as for the sources of trust cues. The codebook itself has been peer reviewed and accepted for open access publication in the *Database for Variables for Content Analysis* (DOCA; see Schröder & Guenther, 2025b).

To carry out the quantitative content analysis connected to RQ3, all media contents that proved relevant for coding from the first three constructed weeks were included.<sup>15</sup> These three weeks were then supplemented by four additional constructed weeks collected from September 2022 until March 2023, covering a full year of media contents (in total,  $n = 10,244$  media contents were collected and checked). All added media contents were also manually checked for relevance for coding (i.e., they had to contain an object of trust and at least one trust cue). All in all,  $n = 1,806$  media contents were identified as coding-relevant, of which  $n = 906$  were randomly selected and coded in the quantitative study.<sup>16</sup> Hence,  $n = 906$  media contents with a total amount of  $n = 5,932$  coded trust cues were used to answer RQ3. For a sample overview as well as for all coded trust cues per media source, see Table 2. For the overall analysis, descriptive statistics and chi-square tests were used. This was also the case for investigating gender differences but with a specific focus on micro-level codes that could be clearly attributed to either female or male scientists. This attribution was based on name references and the use of gendered pronouns. Although the categories “female,” “male,” and “other” were included in the codebook and considered during the coding process, no instances were identified for the “other” category.<sup>17</sup>

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<sup>15</sup> The qualitatively coded media content was also considered here, as qualitative coding cannot be interpreted as quantitative coding. Consequently, some media items were used for both qualitative and quantitative coding.

<sup>16</sup> The other half of this sample will be used in future research.

<sup>17</sup> For more details about the applied method, please see Paper 3.

**Table 2.** Trust Cues per Media Source.

Media sources	Study sample		Number of trust cues per media source		Average number of trust cues identified per media source
	<i>n</i>	%	<i>n</i>	%	$\bar{\emptyset}$
<b>Journalistic media*</b>	664	73.3	4,635	78.1	6.98
Public TV (ARD Tagesschau, ZDF heute, Quarks, Gut zu wissen)	12	1.3	66	1.1	5.50
Private TV (RTL Aktuell, Sat.1 Nachrichten)	4	0.4	12	0.2	3.00
Print newspapers (Frankfurter Allgemeine Zeitung, Süddeutsche Zeitung, Spiegel, Zeit)	225	24.8	1,461	24.6	6.49
Online newspapers (FAZ.net, SZ.de, spiegel.de, zeit.de)	324	35.8	2,351	39.6	7.26
Tabloid newspaper (Bild, bild.de)	52	5.7	247	4.2	4.75
Popular special science magazines (Geo, P.M. Magazin, Spektrum der Wissenschaft)	47	5.2	496	8.4	10.55
<b>Right-wing populist, non-mainstream media</b>	36	4.0	266	4.5	7.38
Populist media (Epoch Times, Junge Freiheit, Compact)	36	4.0	266	4.5	7.38
<b>Social media</b>	67	7.4	139	2.3	2.07
Facebook (Wissenschaft aktuell, Harald Lesch Ultras, Fortschritt in der Wissenschaft)	32	3.5	68	1.1	2.13
Instagram (@doktorwissenschaft, @universumsfakten, @don.medicus, @diewissenschaftlerin)	4	0.4	5	0.1	1.25
X (c_drosten, dfg_public, BMBF_bund, helmholtz_de)	26	2.9	50	0.8	1.92
YouTube (MaiLab, Breaking Lab)	5	0.6	16	0.3	3.20
<b>(Non-journalistic) internet-based media</b>	139	15.3	892	15.0	6.43
Blogs (scienceblogs.de, scilogs.de)	15	1.7	61	1.0	4.07
News aggregators (t-online.de, web.de)	124	13.7	833	14.0	6.71
<b>Total</b>	906	100	5,932	100	6.55

\*Superordinate media types are in bold.

Across all media types, expertise emerged as the most frequently referenced dimension of trust in science, accounting for 45% of all trust cues ( $n = 2,660$ ), followed by integrity (23%,  $n = 1,363$ ), benevolence (23%,  $n = 1,332$ ), transparency (6%,  $n = 373$ ), and dialogue (3%,  $n = 204$ ).

When broken down by media type, similarities as well as clear differences became evident. Journalistic media was the most prominent source for trust cues ( $n = 4,392$ ), followed by further (non-journalistic) internet-based media ( $n = 797$ ), right-wing populist media ( $n = 226$ ), and social media ( $n = 137$ ). Across all media groups, expertise was the most prevalent addressed dimension of trust in science (with a total amount of 45%,  $n = 2,660$  across these media groups). In journalistic media, which contained most of all trust cues ( $n = 4,635$ ), expertise was dominant (46%,  $n = 2,148$ ), followed by integrity (23%,  $n = 1,086$ ), benevolence (22%,  $n = 1,001$ ), transparency (6%,  $n = 283$ ), and dialogue (3%,  $n = 117$ ). In comparison, populist media showed a relatively higher share of dialogue cues (7%,  $n = 19$ ). Internet-based media and social media even revealed a higher share for transparency cues (7%,  $n = 61$  and 10%,  $n = 14$ , respectively) as well as dialogue cues (6%,  $n = 57$  and 8%,  $n = 11$ , respectively). However, even though transparency and dialogue cues were relatively more prevalent in these media groups compared to journalistic media, they have been less frequently used across all media groups compared to integrity and benevolence cues.

The prevalence of sources (i.e., the actors who used the trust cue in writing or in a direct quote) – differentiated between journalism, science, and online actors such as social media users – of trust cues also varied between the media groups: Journalism was the dominant source overall (78%,  $n = 4,315$ ), followed by science (21%,  $n = 1,146$ ), and online actors (2%,  $n = 91$ ). In social media, however, online actors accounted for the majority (65%,  $n = 89$ ) of trust cues, ahead of science (35%,  $n = 48$ ). Table 3 displays a detailed overview of the distribution of trust cues.

**Table 3.** Overview of Dimensions of Trust in Science, Superordinate Categories of Trust Cues, and Trust Cues.

Dimensions	Categories*	Trust Cues**	Sample***	
			<i>n</i>	%
Expertise			2,660	44.8
	Academic education		53	0.9
	Professional experience		28	0.5
	<b>Qualification****</b>		<b>2,579</b>	<b>43.5</b>
	Academic degree		185	3.1

	Reputation	78	1.3
	Professional position	257	4.3
	<b>Affiliation to an organization</b>	<b>1,185</b>	<b>20.0</b>
	<b>Department or area/discipline of expertise</b>	<b>874</b>	<b>14.7</b>
Integrity		1,363	22.5
	Independence	82	1.4
	Client	27	0.5
	Funding source	37	0.6
	Interests	18	0.3
	<b>Scientific quality assurance</b>	<b>318</b>	<b>5.4</b>
	Correction / Revision	19	0.3
	(Un)Certainties (and Limitations)	226	3.8
	Peer review	14	0.2
	Continuity/ Permanence of research	58	1.0
	<b>Scientific standards and processes</b>	<b>963</b>	<b>16.2</b>
	Legal framework for research	11	0.2
	<b>Description (and explanation) of research processes</b>	<b>513</b>	<b>8.6</b>
	Working conditions in science	16	0.3
	Research collaboration	73	1.2
	<b>Publication</b>	<b>351</b>	<b>5.9</b>
Benevolence		1,332	22.5
	Ethical norms	19	0.3
	<b>Social responsibility</b>	<b>679</b>	<b>11.4</b>
	Research-related risks	5	0.1
	Prediction	176	3.0
	<b>Assessment of public events/current affairs</b>	<b>498</b>	<b>8.4</b>

<b>Benefits for society</b>	<b>634</b>	<b>10.7</b>
Social significance of science	19	0.3
Discoveries and breakthroughs	144	2.4
Applicability of results	240	4.0
(Science-based) recommendations	197	3.3
Personal reasoning for benevolent behavior	34	0.6
Transparency	373	6.3
Accessibility of results	46	0.8
<b>Comprehensible language</b>	<b>327</b>	<b>5.5</b>
Dialogue	204	3.4
Participation in public events	17	0.3
Media presence	175	3.0
Journalistic media presence	104	1.8
Direct media presence	23	0.4
Further media presence	48	0.8
Public engagement in research	12	0.2

\*The categories of trust cues were developed by grouping the identified trust cues thematically and assigning them to the respective dimensions of trust (see Paper 1). \*\* The trust cues were identified through qualitative content analysis within three constructed weeks with a database of  $n = 158$  media contents (see Paper 1). \*\*\* The values show the distribution of all trust cues in the overall sample ( $n = 906$  media contents), collected across seven constructed weeks (see Paper 3). \*\*\*\*Frequencies of trust cues and categories of trust cues with a distribution  $\geq 5\%$  are in bold.

The second part of RQ3 focuses on quantitative gender differences in the use of trust cues. The study found no significant differences across the media groups or the dimensions addressed between female and male scientists. Both genders were most frequently associated with expertise (female: 58%,  $n = 546$ ; male: 58%,  $n = 1,548$ ), followed by benevolence (female: 20%,  $n = 189$ ; male: 21%,  $n = 571$ ), integrity (female: 15%,  $n = 139$ ; male: 13%,  $n = 342$ ), dialogue (female: 5%,  $n = 46$ ; male: 4%,  $n = 113$ ), and transparency (female: 3%,  $n = 30$ ; male: 4%,  $n = 110$ ).

The most common trust cues used for both genders in total referred to scientists' qualifications (55%,  $n = 2016$ ) which signal expertise, followed by their social responsibility (11%,  $n = 392$ )

and the benefit of science for society (10%,  $n = 361$ ), both referring to benevolence and scientific standards and process (9%,  $n = 330$ ) as reference to integrity. Despite this similarity in content, there was a striking imbalance in representation overall: Only 26% of micro-level trust cues referred to female scientists ( $n = 950$ ), whereas 74% referred to male scientists ( $n = 2,684$ ).

The study also revealed that the gender of the source influenced this imbalance. Of all trust cues referred to female scientists, 62% ( $n = 495$ ) came from female sources and only 38% ( $n = 307$ ) from male sources. In contrast, 70% ( $n = 1,509$ ) of all trust cues connected to male scientists were used by male sources but only 30% ( $n = 654$ ) by female sources.

Overall, the three studies offer a well-rounded answer to three RQs, beginning with the broad identification of trust cues in media (i.e., Paper 1), moving into an exploration of gendered portrayals of scientists as the most important scientific actors in content about science (i.e., Paper 2), and culminating in a large-scale comparative analysis (i.e., Paper 3). This triangulated approach offers both detailed and wide-ranging insights into how trust in science is presented in media content. Together, the three studies provided a comprehensive picture of content-related trust cues in media content about science from a media content perspective with the aim of answering RQs 1–3 (see Papers 1–3).

## 5.2 Audience Perspective

Chapter 4.1 has already explored the perspective of media content, answering RQs 1–3 with the identification of trust cues in content about science, assessment of differences in their use across different media types, and a specific focus on scientists' gender. Nonetheless, to provide a more holistic picture concerning trust cues, public audiences need to be included in this research (for this argument, see Bentele, 1994). For this reason, Chapter 5.2 adopts this perspective and examines patterns of media perception by addressing RQs 4 and 5.

To examine whether and how exposure to trust cues in science-related media content affects public trust in science and to answer RQ4, the fourth study of this dissertation (see Paper 4: Guenther et al., 2024) applied a mixed-method design that integrated a quantitative large-scale content analysis with a two-wave panel survey in Germany. For this, the content analysis of the third study ( $n = 906$  media contents about science) with the identified trust cues ( $n = 5,932$ ; see Paper 3) build the foundation.

In total, 13 different media sources for content about science were included in the quantitative content analysis in Study 3. On average, 6.55 trust cues were found per media source (see Table 2).

In parallel to the media collection for the content analysis over one year, panel survey data were collected via YouGov's online access panel, representative of the German adult

population (18+ years old). The first wave ( $t_1$ ) was conducted in March/April 2022 ( $n = 4,824$ ), and the second wave ( $t_2$ ) in March/April 2023 ( $n = 1,030$ , recontacted respondents). Both waves included validated items capturing the five dimensions of trust (three items for each dimension) to gain a nuanced image about the current state of trust in science. The participants who took part in both waves were used to identify five trust groups using Latent Profile Analysis that differs according to their trust in science and its composition based on the five dimensions of trust in science (see Reif et al., 2024; see also Chapter 4): “Fully trusting” (16%,  $n = 163$ ), “Highly trusting” (22%,  $n = 230$ ), “Moderately trusting” (24%,  $n = 250$ ), “Rather untrusting” (20%,  $n = 207$ ), and “Untrusting” (18%,  $n = 180$ ). In addition, an index for trust in science ( $t_1$ :  $M = 3.16$ ;  $SD = 1.02$ ;  $\alpha = .92$ ;  $t_2$ :  $M = 3.10$ ;  $SD = .96$ ;  $\alpha = .92$ ) was built based on measures of trust in scientists (micro level), trust in scientists at universities and research institutes as well as scientists in private companies/industry (two items, meso level), and science as a system (macro level) to represent all levels. Furthermore, information about respondents’ media use across the same 13 categories used in the content analysis was collected. Mean values of media use between  $t_1$  and  $t_2$  were calculated to approximate exposure during the year.

To link both datasets, “trust cue exposure” (TCE) variables were constructed by multiplying normalized self-reported media use per source with the average number of trust cues identified for that source.<sup>18</sup> These values were then z-standardized. In this approach, trust in science at  $t_2$  was the dependent variable. Three hierarchical regression models controlling for trust in science at  $t_1$ , TCE, and socio-demographic variables (i.e., gender, age, education) were used. The analyses were conducted for the full sample as well as for the five trust groups. As mentioned above, patterns of media use varied across these groups; consequently, this research design enabled a fine-grained investigation of whether and for whom exposure to trust cues in content about science predicts changes in public trust in science over time.<sup>19</sup>

The findings of the study demonstrate that public trust in science is a highly stable construct over time. Across all regression models, trust in science at  $t_1$  was the strongest predictor of trust in science at  $t_2$ . In the overall sample, trust at  $t_1$  significantly predicted trust at  $t_2$  ( $\beta = .788$ ,  $p < .001$  in Model 1) and remained a robust predictor even when exposure variables and sociodemographics were included ( $\beta = .705$ ,  $p < .001$  in Model 2;  $\beta = .706$ ,  $p < .001$  in Model 3). Moreover, TCE in media content about science also showed additional, though modest, effects in the overall calculations. Specifically, TCE in public TV content was a positive predictor of trust in science at  $t_2$  ( $\beta = .089$ ,  $p < .001$  in Model 2;  $\beta = .095$ ,  $p = .001$  in Model 3). In contrast, TCE in populist media had a negative effect on trust in science ( $\beta = -.066$ ,  $p = .009$  in Model 2;  $\beta = -.062$ ,  $p = .015$  in Model 3). No other TCE variables – such as those related to

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<sup>18</sup> For the specific formula and more details about the methodology, please see Paper 4.

<sup>19</sup> For more details about the applied method, please see Paper 4.

newspapers, blogs, or social media platforms – reached statistical significance in the full sample. The inclusion of TCE variables led to a slight increase in explained variance ( $R^2 = 63.3\%$  in Model 2 and 3, compared to  $R^2 = 62.1\%$  in Model 1).

As mentioned previously, regression analyses were also conducted separately for five trust groups to examine heterogeneity across the population (see Table 4). In the “Fully trusting” group, trust in science at  $t_2$  was predicted solely by prior trust ( $\beta = .538, p < .001$ ), with no significant effects of TCEs. Similarly, the “Rather untrusting” group showed no significant effects of TCE. For this group, trust at  $t_2$  was predicted only by trust in science at  $t_1$  ( $\beta = .555, p < .001$ ). In contrast, the “Highly trusting” group displayed a significant negative effect of TCE in science blogs on trust in science at  $t_2$  ( $\beta = -.212, p = .016$ ), alongside a strong effect of prior trust in  $t_1$  ( $\beta = .518, p < .001$ ). For the “Moderately trusting” group, positive effects were observed for TCE on public TV ( $\beta = .125, p = .042$ ) and in science magazines ( $\beta = .188, p = .014$ ), in addition to trust in science at  $t_1$  ( $\beta = .398, p < .001$ ). Education also had a significant positive effect on trust in science in this group ( $\beta = .148, p = .019$ ). Finally, the group of the “Untrusting” showed a negative effect for trust in science by TCE in populist media ( $\beta = -.185, p = .048$ ), while trust at  $t_1$  again remained a significant positive predictor ( $\beta = .459, p < .001$ ).

Overall, these findings indicate that while trust in science tends to be stable, exposure to trust cues in specific media types can influence trust trajectories differently across population segments.

**Table 4.** Predicting Trust in Science ( $t_2$ ) via Linear Regression Models across Trust Groups.

Variables/Groups (Model 3)	Fully trusting, <sup>1</sup> $F(17) = 5.50$ ; $p = .001$		Highly trusting, <sup>2</sup> $F(17) = 6.24$ ; $p = .001$		Moderately trusting, <sup>3</sup> $F(17) = 6.91$ ; $p = .001$		Rather un-trusting, <sup>4</sup> $F(17) = 6.55$ ; $p = .001$		Untrusting, <sup>5</sup> $F(17) = 4.46$ ; $p = .001$	
	$\beta$	$p$	$\beta$	$p$	$\beta$	$p$	$\beta$	$p$	$\beta$	$p$
Trust in science (t1)	<b>.538</b>	<b>.000</b>	<b>.518</b>	<b>.000</b>	<b>.398</b>	<b>.000</b>	<b>.555</b>	<b>.000</b>	<b>.459</b>	<b>.000</b>
TCE on public TV	-.038	.669	.077	.249	<b>.125</b>	<b>.042</b>	.095	.220	.131	.182
TCE on private TV	.120	.171	.011	.876	.082	.215	.016	.823	.074	.453
TCE in printed newspapers	-.123	.183	.010	.892	-.014	.822	.091	.237	.038	.674
TCE in online newspapers	.146	.147	-.007	.930	.057	.443	-.057	.476	-.049	.674
TCE in tabloid newspapers	-.060	.538	-.063	.402	.046	.476	-.022	.765	-.105	.230
TCE in populist media	-.042	.669	-.004	.963	-.077	.264	-.096	.233	<b>-.185</b>	<b>.048</b>
TCE in news aggregators	.010	.913	-.003	.966	-.025	.718	.005	.940	.086	.359
TCE in science magazines	.164	.133	.027	.726	<b>.188</b>	<b>.014</b>	.058	.467	.040	.676
TCE in science blogs	.008	.946	<b>-.212</b>	<b>.016</b>	-.095	.236	.150	.053	.132	.235
TCE on social networking sites like Facebook	-.053	.638	-.030	.735	-.053	.485	-.045	.540	.155	.121
TCE on microblogging services like X	-.010	.925	.110	.199	.090	.217	.033	.664	-.129	.176
TCE on photo platforms like Instagram	-.083	.499	-.024	.791	-.017	.843	.040	.596	.093	.375
TCE on video platforms like YouTube	.022	.837	.082	.323	.046	.535	-.025	.754	.031	.763
Gender <sup>a</sup>	.125	.094	.003	.964	-.084	.150	-.060	.356	-.074	.333
Age	-.009	.908	-.066	.351	-.010	.887	.001	.990	-.127	.106
Education	-.133	.067	.094	.132	<b>.148</b>	<b>.019</b>	-.064	.366	-.021	.796
R <sup>2</sup> (%)	35.3		30.2		30.8		34.4		28.4	

Notes. Standardized regression coefficients; significant findings in bold; <sup>1</sup> $n = 141$ ; <sup>2</sup> $n = 207$ ; <sup>3</sup> $n = 226$ ; <sup>4</sup> $n = 181$ ; <sup>5</sup> $n = 149$ ; <sup>a</sup> = 1 "male," 2 "female".

After testing the effects of TCE, it was determined that public audiences should be deliberately included for specific trust cue evaluations regarding their perception and their relevance – aiming to answer RQ5 (see Paper 5: Schröder et al., 2025b). For this, a qualitative research design based on four online focus groups with a total of  $n = 23$  participants was employed.

Each focus group was exposed to fictional journalistic media articles that incorporated trust cues aligned with different dimensions of trust in science: expertise, integrity, benevolence, and a combined stimulus for the dimensions of transparency and dialogue – resulting in four stimuli. These articles were designed in three gender variants, featuring female, male, or gender-neutral scientists, to allow for comparative analysis. Three stimuli were shown in each focus group. The stimuli were rotated in such a way that, overall, all four stimuli could be used with female, male, and gender-neutral scientists. Thus, not only the dimensions of trust and their respected trust cues but also gender differences could be explored. The content of the stimuli was based on prior research identifying the most frequently used trust cues, resulting in 28 trust cues for stimuli development (see Table 3 for all trust cues with a distribution  $\geq 5\%$  in bold). Information about the participants as well as the stimuli used can be found in Paper 5.

During the sessions, participants engaged in open discussions about the stimuli. They were openly asked if the article contained any information that was relevant for trust in the scientists represented in the articles. During this discussion, they were also asked about the reasons why identified information seemed important for trust in scientists. Hence, it was possible to analyze if participants identified trust cues as well as why they were trust relevant. Furthermore, participants completed individual ranking tasks using *Miro*, an online whiteboard, to evaluate the relative importance of the dimensions of trust in science and categories of trust cues. The main goal was to discuss reasons for their decisions. The discussions were transcribed and analyzed through qualitative content analysis. The coding process involved paraphrasing and condensing statements before reaching consensus among coders. Deductive (e.g., dimensions of trust in science) and inductive (e.g., reasons for rankings of dimensions of trust in science) elements were combined in this research. In a last step, the codes were filtered according to genders of the scientists in the stimuli to compare answers connected to female, male, and gender-neutral scientists. Thus, the data links back to insights from Paper 2 and 3.<sup>20</sup>

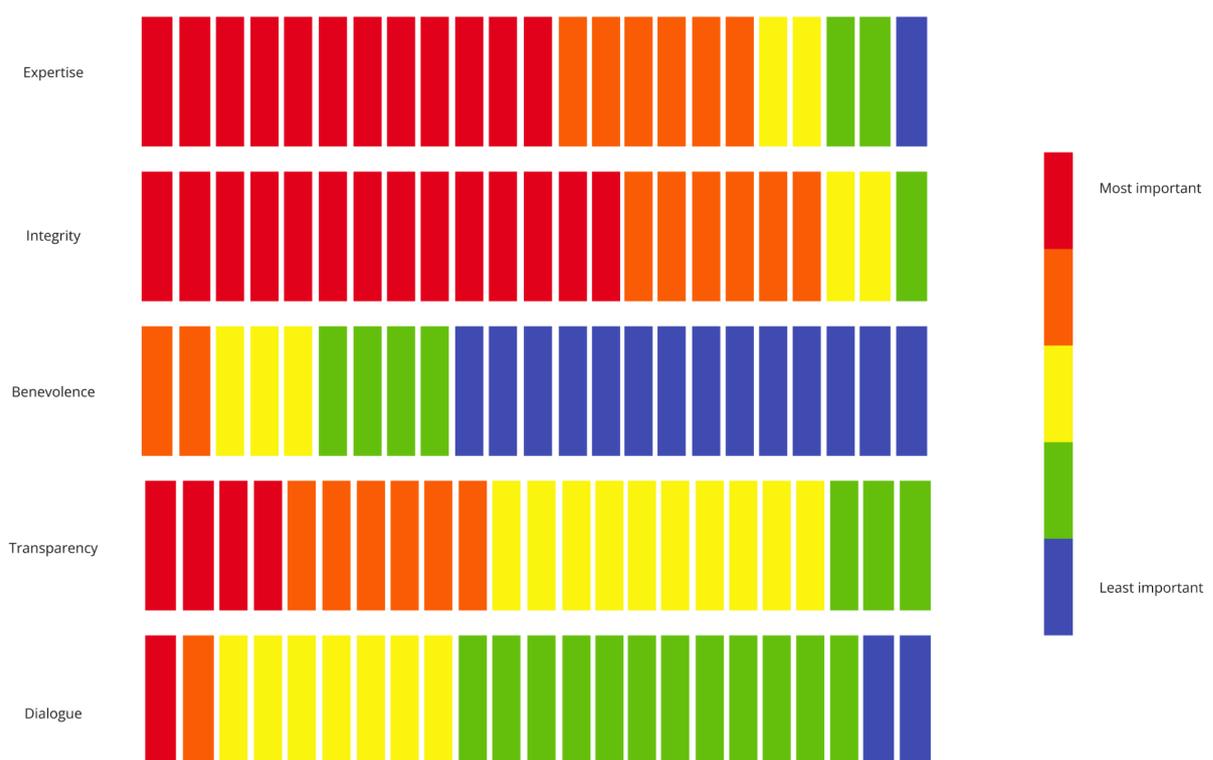
The results indicated that participants were able to identify all trust cues embedded in the stimuli with only one exception of media presence in journalistic media, a dialogue cue. Their reasons for considering respected trust cues as being important was highly individual. However, it became evident that expertise cues were generally perceived as important because they signaled specialized knowledge. Participants stated that if multiple expertise cues were combined, their effect increased. Regarding integrity cues, any measure that secured the quality of research as well as any information showing that research results were a collective product and not something an individual scientists concluded was perceived as

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<sup>20</sup> For more details about the applied method, please see Paper 5.

positive for participants' trust in scientists. In contrast, benevolence cues were perceived ambivalently, and context dependent. For instance, if recommendations were provided that were too detached from the research insights, they negatively impacted the trust in scientists who provide such recommendations. Transparency cues were generally perceived positively by participants, particularly because they empowered audiences to independently verify the information provided. Dialogue cues can positively influence audiences' trust in science as they were seen as a sign of scientists' ability to engage with the public. However, participants described that there was a transfer of trust in science from the intermediary toward the scientists (e.g., if a media outlet or organizer of an event where a scientist participates is (not) trusted, this affects the trust in the respected scientist accordingly).

The ranking of dimensions of trust and categories of trust cues made clear that expertise and integrity were the most important dimensions of trust regarding trust in scientists – followed in descending order by transparency, dialogue, and benevolence. Nonetheless, this is the overall picture, but rankings were again highly individual. The attributed relevance of the dimensions of trust in science across all focus groups are sorted by dimensions in Figure 3.



**Figure 3.** Participants' Relevance Assessment of the Dimensions of Trust in Science (see Schröder et al., 2025b).

Participants require information about the knowledge and abilities of scientists to judge their expertise. They do not necessarily care how this was acquired (e.g., a formal education versus practical experience), but the given information needs to convince the participants. Integrity is a prerequisite for participants' trust in scientists. It is especially important to them that scientists

comply with scientific research methods and that they act with as little external influences as possible, signaling independence and neutrality. In contrast, benevolence was considered as an influence on scientific research, which contradicts the participants' view of a neutral and rational science. Regarding transparency and dialogue, participants outline a nuanced and complex understanding. Transparency was seen as an action (e.g., scientists answering questions and publishing their work) and as the availability of information about the research processes, such as funding sources, that are decisive information for the participants' judgment. Participants also distinguished between two different kinds of dialogue: internal and external dialogue. They defined internal dialogue as openness to diverse approaches and perspectives within the scientific community, which was viewed as essential for academic work. In contrast, external dialogue with the lay public was considered less important, primarily due to perceived limitations in public expertise and, depending on the discipline, a general lack of interest in the research topic.<sup>21</sup>

When comparing the perception of male, female, and gender-neutral scientists, only minor differences emerged. However, subtle gender biases were noticeable: gender-neutral scientists were often perceived as male in the context of expertise and integrity, while in the context of dialogue and transparency, they were more likely recognized as female.<sup>22</sup>

All in all, the two studies on the audience perspective reflect the patterns of media perception in the context of mediated public trust in science, with a focus on trust cues that have been investigated from a content analytical point of view in the first perspective. The audience's assessment was evaluated by shifting the focus on the effect of TCE as well as deliberately asking public audiences about their perceptions and relevance of attribution of trust cues. Thus, RQs 4 and 5 could be answered, and the overall understanding of trust cues could be enriched by another perspective.

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<sup>21</sup> Quotes from participants regarding their perception of trust cues, the relevance they attributed to them, and the reasoning behind these assessments can be found in Paper 5.

<sup>22</sup> For more insights about the differences in gender perceptions see Paper 5.

## 6 Critical Reflection

At this point, a critical reflection of the dissertation will be provided. This includes a discussion of the findings from all five papers, with reference to the theoretical foundations outlined in Chapters 2 and 3, which will be addressed in Chapter 6.1. Furthermore, Chapter 6.2 critically assesses the overall research project by transparently outlining its limitations, which in turn leads to directions for future research. Finally, the contribution of this dissertation to research will be closely examined. For this reason, Chapter 6.3 reflects on how this work offers a theoretical, methodological, and empirical contribution to the field of mediated public trust in science.

### 6.1 Discussion

The overarching research interest of this dissertation was to explore how trust in science is mediated in content about science. To this end, RQs 1–5 were developed and address the identification of trust cues, their frequency, their effects, their perception, and their relevance along with gender differences across these aspects. Each of these RQs was investigated in a separate study (see Papers 1–5). Taken together, the dissertation employed a methodological triangulation that not only combined qualitative and quantitative research designs but also integrated both the media content perspective and the audience perspective. When synthesizing the findings of all five studies, several key results emerge.

***Key finding 1: Trust cues in content about science refer to the dimensions of trust, i.e., expertise, integrity, benevolence, transparency, and dialogue cues were identified. They address different aspects of these dimensions and provide public audiences with reasons to trust in science. Public audiences identify these trust cues and take them into account in their trust conclusion.***

As previously discussed in theoretical terms, trust cues are indeed closely related to the dimensions of trust in science (e.g., Hendriks et al., 2015, 2016; Mayer et al., 1995; Reif & Guenther, 2022; Reif et al., 2024), as they point to different aspects of these dimensions and thereby signal expertise, integrity, benevolence, transparency, and dialogue (see Paper 1: Schröder et al., 2025a). In this respect, trust cues align with what Bentele (1994) referred to as trust factors. While Bentele did not specify what constitutes such trust factors, he nevertheless emphasized that they can be found in media content, which, in turn, plays a crucial role in shaping public trust. This assumption is particularly confirmed in the context of epistemic trust, as most people encounter science and its actors indirectly – primarily through media (e.g., Brossard, 2013; EC, 2021; Mede et al., 2025; Schäfer, 2016; WiD, 2023). When considering the MPTSE model (see Chapter 2) which adopted the mediated trust relationship between science and its publics (e.g., Bentele, 1994; Reif & Guenther, 2022), trust cues in

content about science can be located at the information level that is embedded in the media content level.

Since trust cues, by definition, refer to an object of trust, such as scientists, scientific organizations, or the science system, they refer to the objects' expertise, integrity, benevolence, transparency, and dialogue (see Paper 1: Schröder et al., 2025a). These trust cues are recognized by public audiences when encountering media content and getting in contact with scientific actors (see Paper 5: Schröder et al., 2025b). Public audiences consider this information to be trust relevant and, hence, consider it when reaching a trust conclusion (see Paper 5: Schröder et al., 2025b). Consequently, the key idea of trust-evoking information in media content about science (e.g., Bentele, 1994; Reif & Guenther, 2022; Schäfer, 2016) can be validated from both the media content and the audience perspective.

***Key finding 2: Different types of media employ trust cues in varying ways within their content about science. However, there is a mismatch between the dimensions of trust in science most frequently addressed in media content and those dimensions that public audiences consider most relevant for trust in science.***

Digital media environments enable participation in discourse by a wide range of actors on various topics, including science (e.g., Bruns, 2018; Hermida, 2020; Schäfer, 2015; Schröder & Guenther, 2024; Taddicken & Krämer, 2021; Weingart, 2017; Weingart & Guenther, 2016). Due to the diversity of these actors – each pursuing different communicative intentions (e.g., Weingart, 2017; Weingart & Guenther, 2016) – and the structural characteristics of various media formats (e.g., print newspapers versus social media posts), audiences in digital media environments are exposed to a broad variety of media content. This diversity is also reflected in the use of trust cues, which differs significantly across media types (see Paper 3: Schröder & Guenther, 2025a). However, the distribution of trust cues by dimension across media groups does not align with the perceived relevance of these trust dimensions as attributed by public audiences (see Papers 3 and 5: Schröder & Guenther, 2025a; Schröder et al., 2025b). This suggests that a mediation of trust in science across media types did not realize its full potential. While this is not the explicit role of science communicators per se, strategic actors that intentionally want to foster trust in scientific actors could align their science communication using trust cues that refer to the most relevant dimensions of trust. This can be positive (e.g., scientists who want to foster trust in their own research) but also negative (e.g., populists referring to preferred and controversial scientists or even fake experts). Notably, although journalism remains the most important source of trust cues overall (as it produces the largest volume of content about science), it is right-wing populist media that, on average, make the most frequent use of trust cues. This may serve to foster trust in so-called fake experts or ideologically aligned scientists (e.g., Frischlich et al., 2022). Nevertheless, this is a generalized finding; perceptions of relevance are highly individual (Schröder et al., 2025b).

***Key finding 3: Exposure to trust cues influences changes in trust in science across different trust groups within public audiences, who have distinct media repertoires and are, therefore, exposed to different trust cues. However, from an overall perspective, the effect of trust cue exposure is not apparent when looking at general media use; it becomes more visible when analyzing specific trust groups within the German population. In line with this, the reasons public audiences assign relevance to certain trust cues are highly individual.***

In digital media environments, it is not only the media content itself that is diverse, but also the use of trust cues within that content (see Paper 3: Schröder & Guenther, 2025a). Bentele (1994) hypothesized that a greater presence of trust factors could lead to higher levels of trust. Even though this assumption might be correct, it is complex to empirically investigate. Public audiences rely on a repertoire of media content to inform themselves about science (e.g., EC, 2021; Mede et al., 2025; WiD, 2023; see also Hasebrink & Popp, 2006; Verboord, 2024). Consequently, as the composition of this media repertoire changes, so does their exposure to trust cues (see Paper 4: Guenther et al., 2024) and, hence, the influence on the overall trust in science may vary.

With regard to broader changes in public audiences' trust in science, the findings indeed indicate an influence of TCE. A more detailed analysis revealed different effects for distinct trust groups (see Paper 4: Guenther et al., 2024), highlighting the complexity of the issue. Different individuals use different media repertoires to engage with science, and thus, they are exposed to various trust cues, and additionally assign the dimensions of trust different reasons for their varying relevance, based on their personal attitudes and predispositions (Schröder et al., 2025b). In sum, the topic of mediated public trust in science is not only highly complex but also deeply individual.

***Key finding 4: In content about science, female scientists are underrepresented compared to male scientists. Although no statistically significant differences were found in the use of trust cues, qualitative differences indicate the presence of gender stereotypes in how trust cues are applied. The prominence of these stereotypes varies across the five dimensions of trust in science. Perceived differences between female and male scientists are limited but mainly concern the most influential dimensions of expertise and integrity, reflecting common gender stereotypes.***

Female scientists are in general underrepresented compared to male scientists (see Paper 3: Schröder & Guenther, 2025a; see also GMMP, 2020; Kitzinger et al., 2008). Significant quantitative gender differences in the use of trust cues were not evident, highlighting the importance of qualitative data that can reveal stereotypical gender representations using trust cues (see Paper 2: Schröder, 2025; see also Chimba & Kitzinger, 2009; Mitchell & McKinnon,

2019). Hence, gender stereotypes are not only relevant in science media content per se, but also in the context of mediated public trust in science. Since female and male scientists are portrayed differently, it can be assumed that they are also perceived differently. However, the analysis of gender differences in perception revealed only slight distinctions (see Paper 5: Schröder et al., 2025b). These differences did not apply to all dimensions of trust in science but were evident in the dimensions of expertise and integrity, which audiences considered the most important. That, in turn, leads to the assumption that there is an imbalance between trust in female and male scientists. Because scientists are the most important scientific actors in content about science (see Paper 3: Schröder & Guenther, 2025a; see also Amend & Secko, 2012; Guenther, 2019) – compared to scientific organizations and the system of science – this could have a significant effect on the overall trust in science.

It is important to note that the stimuli used in the study were not real media content, which might already convey stereotypes, but rather carefully constructed, stereotype-free articles that differed only in the gender of the scientist depicted. Given only minor differences found in perception, the use of trust cues may have similar effects for female and male scientists or, conversely, the gender of the scientists may not be significant in perception differences. It is likely more relevant in which context female and male scientists are presented. In this regard, responsibility may lie either with science communicators (such as journalists) who reproduce gender stereotypes, or with broader societal structures that create such differences and are merely reflected in media coverage. The slight variances that were observed could also be the result of pre-existing stereotypes already held by audiences.

All in all, the results help to close the research gap regarding the MPTSE by providing insights into trust cues as one explanatory component in audiences' evaluation processes of their trust in scientific actors. Since trust cues are indeed used in trust evaluations, they have been incorporated into the MPTSE. However, the research results show that the trust cues used vary across different media types and objects of trust, as well as across different levels and genders at the micro level, and that their relevance is highly individual. Therefore, expertise, integrity, benevolence, transparency, and dialogue cues are displayed without further specification. Moreover, the different objects of trust are proportionally visualized. See Figure 4 for a depiction of the MPTSE with a focus on the intermediary of trust.

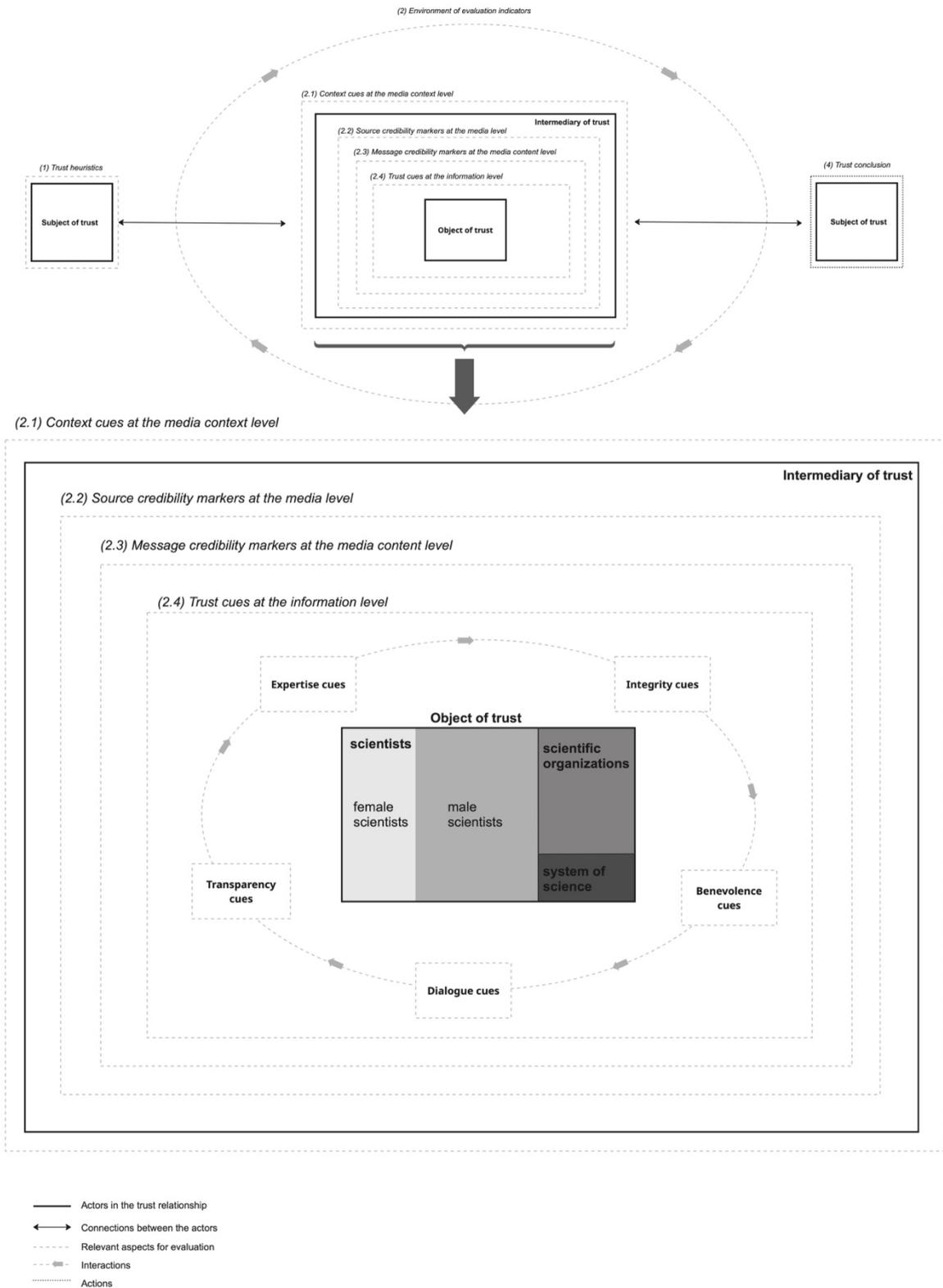


Figure 4. Adaption of the MPTSE according to Research Results.

## 6.2 Limitations and Directions for Future Research

Naturally, this dissertation comes with limitations. The specific limitations of each individual study are discussed in detail within the respective contributions. Here, the limitations of the dissertation as a whole are described from an overarching perspective.

First, there are limitations to the theoretical contribution of this dissertation. The proposed MPTSE represents only one possible suggestion for a framework with a focus on mediated public trust in science. There will certainly be alternative ways to organize and classify the concepts, depending on the theoretical perspective one adopts – let alone the research discipline from which the topic is approached. For this reason, it is important to bear in mind that this dissertation adopts a communication research perspective. Furthermore, the definitions of trust, trustworthiness, and credibility used here were selected based on a literature review and reflect those that, in the view of the author, were the most convincing. Other scholars might choose different definitions, which could shift the relationship between the concepts. This issue is a direct consequence of the previously mentioned lack of conceptual clarity in the field. Additionally, the empirical work relies heavily on the Theory of Public Trust by Bentele (1994), which was considered compelling but may also be subject to critique.

Second, from a methodological perspective, one could argue that a larger number of media content should have been examined for both the qualitative and quantitative content analyses or that more focus groups should have been conducted. However, the more significant limitation lies in the fact that the identified trust cues are based on German-language content. It remains unclear whether, and to what extent, trust cues differ in other languages. This applies not only to the general identification of trust cues, but also to their specific manifestations (i.e., what specific aspects trust cues address), which may vary across cultural contexts. These differences inevitably influence their effects on trust in science as well as the subjective relevance of trust cues for different audiences. It is quite plausible that, depending on the cultural context, different dimensions of trust in science may be perceived as more relevant compared to the German context.

Third, another limitation of this work concerns the research insights that focus on the textual level of media content. While text covers a substantial portion of communicated information, it neglects other multimodal aspects (e.g., audio, visual). As the trust evaluation process shows, audiences not only receive textual trust cues provided in content about science but also credibility markers (e.g., brandings) by media. In addition, especially in online media and TV, visual elements play a decisive role in media content and its perception. Audio elements are important in, for instance, social media, radio programs, and podcasts. Hence, multimodal trust cues are necessary to grasp the whole media perception of audiences with respect to their

media repertoire. Another limitation regarding the empirical evidence presented in this dissertation concerns gender differences between scientists. The stimuli used to answer RQ5 (see Paper 5: Schröder et al., 2025b) were fictional and, therefore, did not reflect how female and male scientists are portrayed in real media content (see Papers 2 and 3: Schröder, 2025; Schröder & Guenther, 2025a). For this reason, future research should examine the perception of female and male scientists in authentic media content with respect to trust cues to determine in what sense stereotypes addressed and trust cues used in interaction with each other, influence the perception of female and male scientists.

In sum, future research should expand the investigation of trust cues to other languages and test their effects in cross-cultural settings. Furthermore, future research should address multimodal trust cues and consider them in conjunction with textual trust cues to provide a more comprehensive understanding. Gender differences in the context of mediated trust in science need to be further explored. Consequently, this means that this dissertation could basically be replicated for different languages, cultural contexts, and with a focus on multimodal aspects – always considering gender aspects as relevant components.

### **6.3 Contribution to Theory, Methods, and Empirical Evidence**

This dissertation provides several scholarly contributions to the topic of mediated trust in science. The conceptual framework and the theoretical approach offer clear theoretical added value. The applied research methods, their triangulation, and the focus on the media content and audience perspectives represent a methodological advancement. The research insights gained from the individual studies, as well as from the overall synthesis of all contributions, enhance and expand the current state of research. Therefore, in the following, the (1) theoretical and (2) methodological as well as the (3) empirical contribution for this research area of mediated trust in science will be described in detail.

*(1) Theoretical contribution.* As previously described in Chapter 2, research on trust in science is diverse and diffuse, and thus challenging. This is especially true in the sense that many terms, such as trust, trustworthiness, and credibility are often used imprecisely or even synonymously, although they represent different concepts. This lack of clarity in wording contributes to the diffuseness of the current state of research regarding trust in science. When dealing with credibility and trustworthiness, one encounters research that focuses on cues as a basis for evaluation. However, these cues are often unstructured and do not clearly distinguish between credibility and trustworthiness. Therefore, this dissertation carefully considered a diverse range of definitions from the current literature to provide nuanced, clear, and selective definitions for the terms trust, trustworthiness, and credibility. Additionally, since research investigates a variety of cues connected to trustworthiness and credibility (but not as

much about trust), these are also not clearly differentiated; they often address the same concepts without making a clear distinction. This dissertation aimed for a clear distinction between cues for the different concepts and differentiates between *sources and message credibility markers* and *trust cues* as described in Chapter 2 based on an intensive literature review. This dissertation focuses on trust cues that have been overlooked by previous research, thus expanding the theoretical state of the field with its in-depth insights. The Theory of Public Trust by Bentele (1994) serves as the foundation for this research, because it emphasizes the significant role of media content in developing public trust. Additionally, the dimensions of trust in science guided the conceptualization of this research, enabling a systematic and structured investigation of trust cues. Research on trust cues based on these theoretical perspectives is, to date, unique and offers an opportunity to close research gaps in this field.

However, sorting the concepts of trust, trustworthiness, and credibility as well as related cues in the state of research only served as a starting point for describing, at a higher level, how mediated trust in science can emerge. For this reason, the present dissertation developed an analytical framework using the MPTSE. This process was intended to define and organize the terms trust, trustworthiness, and credibility and embedded credibility markers and trust cues according to analytical levels. To ensure completeness, trust heuristics and subsequent trust conclusions were also considered. This offers theoretical added value, as trust heuristics are primarily studied in psychology, often neglecting various types of cues; conversely, cues are often examined without considering subjective cognition. Only the interplay of both can provide a holistic understanding, because trust heuristics are the lens through which cues are viewed and evaluated, and, vice versa, cues are needed to process information in the first place. While analyzing trust heuristics and trust cues individually is certainly interesting, important, and reveals a high demand for further research, it does not reflect the full process taking place, but only provides information on individual aspects within that process.

(2) *Methodological contribution.* The methodological implementation of this dissertation is based on a complex triangulation design that begins with an exploratory qualitative phase, continues by quantifying the insights gained, and concludes with a return to qualitative analysis. This approach allows for both in-depth understanding and a certain degree of generalizability.

The starting point of the research was a qualitative content analysis, presented in Paper 1, which identified the trust cues that form the core focus of this dissertation. As outlined in the theoretical chapters of Papers 1–5 and in earlier sections of this work, there has so far been no systematic and structured identification of trust cues that explicitly draws on the Theory of Public Trust (Bentele, 1994) and the dimensions of trust in science. Research on trust in science has traditionally relied on surveys and experiments. While these approaches are

valuable, they often overlook the media content perspective. This is also true when it comes to the development of stimuli used in experimental designs, which are often not checked for trust cues or credibility markers. This dissertation addressed that gap by systematically analyzing the media content that underpins evaluations of trust in science. Using content analysis to focus on media representations, therefore, constitutes a methodological contribution of this dissertation to the research field of mediated trust in science. Moreover, by complementing this content perspective with the audience perspective (as in Papers 4 and 5), results were validated and, hence, the explanatory power of the content-analytical findings was significantly enhanced.

The methodological triangulation employed in this dissertation allows for a more holistic understanding of mediated public trust in science. This understanding would not have been achievable through a single-method or one-sided research design (e.g., solely qualitative or quantitative approaches, or with one research method only). This also becomes evident in the results of the individual studies. For instance, while the authors did not find any statistically significant quantitative differences in the use of trust cues related to female and male scientists (apart from the general underrepresentation of women; see Paper 3), the qualitative observations did reveal distinctions (see Paper 2). Only combined research design and methodological triangulation made it possible to gain these deeper insights. Moreover, integrating both content-analytical and audience perspectives is essential to fully capture the dynamics of mediated trust in science. The triangulation of mixed research designs and methods also ensures sound and valid research outcomes.

*(3) Empirical contribution.* The research insights of the five papers provide significant added value for research on mediated public trust in science, as this is the first time a systematic and structured investigation of trust cues has been conducted. This dissertation represents a comprehensive research program that not only applies methodological triangulation but also approaches the topic from two distinct perspectives. As a result, the insights presented here are based on valid and robust data. These findings can now be applied in a variety of contexts, including the analysis of different media types (either over time or at specific points), topic-specific investigations of trust cue use, as well as comparative analyses across topics. The results also offer a foundation for studying the effects of trust cue exposure depending on any audience segmentation or specific scientific research areas and topics. In addition, they can inform the development of stimuli for experimental designs or be considered in the context of strategic science communication.

In summary, the insights from the five papers included in this dissertation make it possible for the first time to examine mediated public trust in science with a dedicated focus on media content. These results thus make a substantial contribution toward closing a long-standing research gap in this area.

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## Appendix

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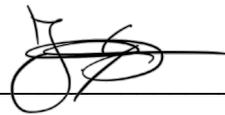
## Anhang 1: Eidesstattliche Versicherung

Ich, Justin T. Schröder, versichere an Eides statt, dass ich die Dissertation mit dem Titel „Mediated Public Trust in Science: Tracing Trust Cues between Media Content About Science and its Audiences“ selbst und bei einer Zusammenarbeit mit anderen Wissenschaftlerinnen oder Wissenschaftlern gemäß den beigefügten Darlegungen nach § 6 Abs. 3 der Promotionsordnung der Fakultät für Wirtschafts- und Sozialwissenschaften vom 18. Januar 2017 in der Fassung vom 07. Dezember 2022 verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht benutzt.

Hamburg, den 21.08.2025

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Ort/Datum



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Unterschrift Doktorand

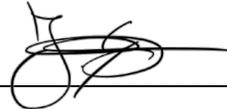
## **Anhang 2: Erklärung zur kommerziellen Promotionsberatung und früheren Einreichung der Dissertation**

Hiermit erkläre ich, Justin T. Schröder, dass ich keine kommerzielle Promotionsberatung in Anspruch genommen habe. Die Arbeit wurde nicht schon einmal in einem früheren Promotionsverfahren angenommen oder als ungenügend beurteilt.

Hamburg, den 21.08.2025

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### Anhang 3: Eigenständigkeitserklärung zur Nutzung von gKI (generative künstliche Intelligenz)

Ich versichere, dass ich KI-Tools lediglich als Hilfsmittel genutzt habe und ich bin mir bewusst, dass die Nutzung maschinell generierter Texte keine Garantie für die Qualität von Inhalten und Text gewährleistet.

Ich verantworte die Übernahme jeglicher von mir verwendeter maschinell generierter Textpassagen vollumfänglich selbst und dokumentiere im Folgenden, für welche Aufgaben ich KI-Tools genutzt habe.

Ich versichere, dass ich die erlaubten KI-Tools nur im mit der Betreuungskommission vereinbarten Umfang verwendet habe.

In der hier vorliegenden Arbeit habe ich gKI-Systeme wie folgt genutzt:

- gar nicht
- bei der Ideenfindung
- bei der Erstellung der Gliederung
- zum Erstellen einzelner Passagen, insgesamt im Umfang von ... % am gesamten Text
- zur Entwicklung von Software-Quelltexten/Programm-Code
- zur Optimierung oder Umstrukturierung von Software-Quelltexten
- zum Korrekturlesen oder Optimieren
- bei Übersetzungen
- zum Erstellen von Graphiken
- Weiteres, nämlich:

Ich versichere, alle Nutzungen vollständig angegeben zu haben. Mir ist bekannt, dass fehlende oder fehlerhafte Angaben als Täuschungsversuch gewertet werden können. Zudem bin ich bereit, auf Nachfrage meine Vorgehensweise (z.B. durch Arbeitsnotizen, Prompts oder mündliche Erläuterungen u.ä.) offen zu legen.

Mir ist bekannt, dass ein Verstoß gegen die genannten Punkte prüfungsrechtliche Konsequenzen hat und insbesondere dazu führen kann, dass die Dissertation abgelehnt wird.

Hamburg, den 21.08.2025

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## Anhang 4: Selbstdeklaration bei kumulativen Promotionen

### Selbstdeklaration bei kumulativen Promotionen (Fachbereich Sozialwissenschaften)

**Konzeption / Planung:** Formulierung des grundlegenden wissenschaftlichen Problems, basierend auf bisher unbeantworteten theoretischen Fragestellungen inklusive der Zusammenfassung der generellen Fragen, die anhand von Analysen oder Experimenten/Untersuchungen beantwortbar sind. Planung der Experimente/ Analysen und Formulierung der methodischen Vorgehensweise, inklusive Wahl der Methode und unabhängige methodologische Entwicklung.

**Durchführung:** Grad der Einbindung in die konkreten Untersuchungen bzw. Analysen.

**Manuskripterstellung:** Präsentation, Interpretation und Diskussion der erzielten Ergebnisse in Form eines wissenschaftlichen Artikels.

Die Einschätzung des geleisteten Anteils erfolgt mittels Punkteinschätzung von 1 – 100 %

Für mindestens einen der vorliegenden Artikel liegt die Eigenleistung bei 100 %.

Für den ersten Artikel liegt die Eigenleistung für

das Konzept / die Planung bei	75%
die Durchführung bei	65%
der Manuskripterstellung bei	90%

Für den zweiten Artikel liegt die Eigenleistung für

das Konzept / die Planung bei	100%
die Durchführung bei	100%
der Manuskripterstellung bei	100%

Für einen dritten Artikel liegt die Eigenleistung bei

das Konzept / die Planung bei	75%
die Durchführung bei	65%
der Manuskripterstellung bei	90%

Für einen vierten Artikel liegt die Eigenleistung bei

das Konzept / die Planung bei	25%
die Durchführung bei	25%
der Manuskripterstellung bei	20%

Für einen fünften Artikel liegt die Eigenleistung bei

das Konzept / die Planung bei 75%

die Durchführung bei 70%

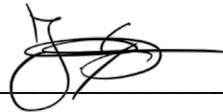
der Manuskripterstellung bei 90%

Die vorliegende Einschätzung in Prozent über die von mir erbrachte Eigenleistung wurde mit den am Artikel beteiligten Koautoren einvernehmlich abgestimmt.

Hamburg, den 21.08.2025

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## Publications of this Dissertation

- Paper 1:** Schröder, J. T., Brück, J., & Guenther, L. (2025). Identifying trust cues: How trust in science is mediated in content about science. *Journal of Science Communication, 24*(01), A06. <https://doi.org/10.22323/2.24010206>
- Paper 2:** Schröder, Justin T. (2025). Trust cues in content about science: How the media presents female and male scientists differently. In: Antoinette Fage-Butler, Loni Ledderer, & Kristian Hvidtfelt Nielsen (eds.), *Science Communication and Trust* (pp. 385–406). Palgrave Macmillan.
- Paper 3:** Schröder, J. T., & Guenther, L. (2025). Mediating trust in content about science: Assessing trust cues in digital media environments. *Public Understanding of Science, 0*(0). <https://doi.org/10.1177/09636625251337709>
- Paper 4:** Guenther, L., Schröder, J. T., Reif, A., Brück, J., Taddicken, M., Weingart, P., & Jonas, E. (2024). Intermediaries in the limelight: How exposure to trust cues in content about science affects public trust in science. *Journal of Science Communication, 23*(09), A06. <https://doi.org/10.22323/2.23090206>
- Paper 5:** Schröder, J. T., Engel, M., Schröder, I., & Guenther, L. (2025). Public trust in scientists: Exploring the perception and relevance of trust cues in media content. *Journal of Science Education, Part B*. Under Review.



## ARTICLE

## Identifying trust cues: how trust in science is mediated in content about science

Justin T. Schröder , Janise Brück  and Lars Guenther 

### Abstract

Most public audiences in Germany receive scientific information via a variety of (digital) media; in these contexts, media act as intermediaries of trust in science by providing information that present reasons for public audiences to place their trust in science. To describe this process, the study introduces the term “trust cues”. To identify such content-related trust cues, an explorative qualitative content analysis has been applied to German journalistic, populist, social, and other (non-journalistic) online media ( $n = 158$ ). In total,  $n = 1,329$  trust cues were coded. The findings emphasize the diversity of mediated trust, with trust cues being connected to dimensions of trust in science (established: expertise, integrity, benevolence; recently introduced: transparency, dialogue). Through this analysis, the study aims for a better understanding of mediated trust in science. Deriving this finding is crucial since public trust in science is important for individual and collective informed decision-making and crises management.

### Keywords

Digital science communication; Representations of science and technology; Science and media

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## 1 - Introduction

In an era defined by rapid advancements and unprecedented challenges, the role of science has become increasingly central in shaping our future. Science offers valuable insights, supports progress and informed decision-making, and provides responses to crises such as climate change and pandemics [Goldenberg, 2023; Hendriks et al., 2015; Schröder & Guenther, 2024].<sup>1</sup> In this context, *public trust in science* is among the most important variables for public audiences<sup>2</sup> to engage with scientific information [Leiserowitz et al., 2013; Plohl & Musil, 2021; Saffran et al., 2020]. At the same time, however, a decline of public trust in science and its implications have recently been discussed [e.g., Weingart & Guenther, 2016].

For public audiences, (*digital*) *media* are an important source of scientific information and a contact point with science [European Commission, 2021; National Science Board, 2018; Wissenschaft im Dialog, 2023] — especially in Germany, where nearly the entire population uses the internet [e.g., ARD/ZDF-Forschungskommission, 2023]. In Germany, a variety of media are well established as sources of scientific information, ranging from journalistic media to non-journalistic online media, including right-wing populist media [e.g., Wissenschaft im Dialog, 2023]. Hence, media use is an important variable for trust assessments of public audiences when it comes to scientific issues [e.g., Scheufele & Lewenstein, 2005].

Generally, when public audiences encounter media content, a *trust evaluation process* takes place: people use a variety of *trust heuristics*, i.e., cognitive shortcuts such as (ideological) predispositions, familiarity with a subject, and evaluation of probabilities [e.g., Kahneman & Frederick, 2005; Tversky & Kahneman, 1974] that build the basis of their trust assessments. Following this, audiences evaluate a multitude of indicators provided by media, which can be divided into two different research traditions [e.g., Grünberg, 2014]: on the one hand, research into media credibility examines media as objects of trust and focuses on the use of *credibility markers*, sometimes also called *trustworthiness indicators or cues* [e.g., Metzger & Flanagin, 2013]. This includes a variety of markers that allow public audiences to evaluate the credibility or trustworthiness of a media source and its content. For instance, a media brand, visuals used, the design of a website, or its usability are all part of the media environment and an initial point for the trust evaluation process [Choi & Stvilia, 2015; Einsiedel & Geransar, 2009; Metzger & Flanagin, 2013; Ross Arguedas et al., 2024; Wathen & Burkell, 2002]. For many social media the markers may also include platform affordances such as hyperlinks and interaction metrics [e.g., number of shares or likes; Boothby et al., 2021; Choi & Stvilia, 2015]. On the other hand, media trust research investigates media as intermediaries of trust [e.g., Grünberg, 2014; Reif, 2021] — in the context of trust in science, they mediate trust between science and public audiences by providing a variety of *indicators and cues in their content* that audiences can use to assess whether to trust science or not. Those content-related indicators serve as a secondary point and are, therefore, on a subsequent evaluation level

1. This is true on a general level; however, it should be acknowledged that science does not hold all the answers and science can also be used, for instance, to deny climate change and health risks [see Oreskes & Conway, 2010].
2. To account for a modern public sphere that considers media and communication diversity, we use the terms “publics” and “public audiences” [see also Taddicken & Krämer, 2021; Weingart, 2017]. The modern public sphere is constituted by the connection of traditional journalistic media, their online counterparts, online platforms, and social media. This leads to different publics: “a multitude of overlapping publics of different sizes, lifespans, visibility, and impact, across a variety of online and offline communicative channels and platforms” [Bruns, 2018, p. 339].

than the credibility markers. In this sense, the specific information provided in content about science is a vital aspect for the trust evaluation process.

As a starting point for the trust evaluation process, this study focuses on media content<sup>3</sup> and thus on indicators and cues in content about science as *trust-evoking cues* — as a shorthand, we introduce the term “*trust cues*”. Currently, research on such content-related trust cues is lacking; however, some researchers have provided hints for addressing specific dimensions of trust in science [e.g., Welzenbach-Vogel et al., 2021]. The lack of research is surprising as audience studies show that content-related trust cues can affect audiences’ trust in science [Hmielowski et al., 2014; Reif et al., 2020; Rosman et al., 2022]. Therefore, in this study, we exploratively identify trust cues provided by intermediaries of trust in science. Because public audiences “assess who to believe as a heuristic for what to believe” [Goldenberg, 2023, p. 370], research about trust cues is important for understanding how media content shapes mediated trust in science. We address this issue by relying on established literature that considers scientists, scientific organizations, and the science system [Giddens, 1990; Grünberg, 2014; Schäfer, 2016] as *objects of trust* and takes established *dimensions of trust in science* into account, i.e., references to science’s expertise, integrity, benevolence, transparency, and dialogue [Reif & Guenther, 2021; Reif et al., 2024; see also Besley et al., 2021; Fiske & Dupree, 2014; Hendriks et al., 2015, 2016; Mayer et al., 1995].

Hence, this study makes use of an explorative approach to examine how trust in science is mediated in content about science, by applying qualitative content analysis. Through this, we want to gain a better understanding of the factors that potentially influence mediated trust in science.

## 2 - Mediated trust in science

Although there is no agreement in research about how to best *define* trust [e.g., Grünberg, 2014; McKnight & Chervany, 1996], in sociology, psychology, and in communication research, trust is considered to be a relational variable that requires at least two actors: first, a subject of trust (here: publics) and, second, an object of trust [here: science; Giddens, 1990; Luhmann, 2014; Mayer et al., 1995]. A subject of trust decides to trust an object of trust — seeing trust as a relational variable, public audiences decide to trust science. We primarily consider trust from a communication research perspective, that is, strongly influenced by sociological thoughts [e.g., Grünberg, 2014; Reif, 2021] as a mechanism to reduce complexity [e.g., Luhmann, 2014]. Since we focus on public trust in science, the concept of *epistemic trust* is useful, because it refers to trust in science as a producer of valid knowledge; thus, it encompasses both the validity of scientific knowledge per se and science as a secure source of information [Origi, 2012; Sperber et al., 2010; Wilholt, 2013].

Since public audiences primarily receive scientific information via (digital) media outlets [e.g., European Commission, 2021; National Science Board, 2018], media play a decisive role for establishing public trust in science. Media are not only the objects of trust themselves, but they are also intermediaries of trust, acting between public audiences as subjects and science as objects of trust [e.g., Reif & Guenther, 2021]. Due to this double role, trust intermediaries increase the complexity of the trust relationships [e.g., Kohring, 2004;

3. Consequently, in this paper, there is no focus on (cognitive) trust heuristics of audiences, credibility markers or trustworthiness indicators.

Schäfer, 2016]. In this context, Bentele's [1994] *theory of public trust* suggests that *public trust* has emerged as a new form of trust in the public sector, and considers the media as a significant component in trust relationships [see also Hmielowski et al., 2014]. He states that the formation of trust in systems, organizations, and persons is strongly influenced by mediated information. This includes facts, events, and messages [e.g., Bentele, 1994; Reif, 2021]. Moreover, as the theory of public trust already suggests, objects of trust can be differentiated according to *levels*. A distinction is made between science as a system at the macro level, scientific organizations at the meso level (e.g., universities or research departments of companies), and scientists at the micro level [see also Mayer et al., 1995]. This distinction is decisive because people not only receive information about individuals such as scientists but also about organizations and the system of science [e.g., Luhmann, 2014; Schäfer, 2016]. Consequently, we have a *multilevel* perspective on science; in the following, when we talk about science, we always refer to science at different levels. Journalism remains the most important source when it comes to scientific information, at least in Europe [e.g., European Commission, 2021], and science journalists often try to include a 'human angle' in their science coverage [e.g., Guenther, 2019], therefore, scientists (micro level) are particularly likely to play an important role in content about science.

In digital media environments, journalistic and non-journalistic actors have access to digital public spheres [e.g., Schröder & Guenther, 2024; Taddicken & Krämer, 2021] and are therefore able to publicly communicate about scientific issues [Bucchi, 2013; Weingart & Guenther, 2016]. However, this includes actors with various interests, such as science public relations professionals, governmental actors, politicians, bloggers, or other communicators with a vast online reach (e.g., influencers), as well as publishers of misleading and false information [for example, populist, non-mainstream media or state propaganda; e.g., Weingart, 2017; Zimmermann & Kohring, 2020]. In this sense, in digital media environments, various science communicators not only make use of the various presentation styles and platform affordances available (e.g., images, hyperlinks), which serve as credibility markers when covering science, but also provide information in different ways and, thus, use content-related trust cues differently [see also Boothby et al., 2021; Choi & Stvilia, 2015; Metzger & Flanagin, 2013; Ross Arguedas et al., 2024]. This diversity may also explain why the connection between digital media use and public trust in science is ambivalent, with some studies reporting a positive relationship [for social media, see Huber et al., 2019] and others a negative one [for online sources, see Takahashi & Tandoc, 2016].

### 3 - Trust cues in content about science

Current research shows various aspects influencing audiences' trust in science. For instance, individuals can use cognitive trust heuristics to evaluate content in general [Kahneman & Frederick, 2005; Tversky & Kahneman, 1974] or markers regarding the environment in which the content is embedded to assess a sources' credibility [e.g., Wathen & Burkell, 2002]. However, there is little research regarding the deeper level of media content about science, specifically the information being conveyed by intermediaries.

Thus, to pay tribute to the importance of media, their messages, and the information they provide [based on the theory of public trust; Bentele, 1994], this study investigates trust cues. The distinction between *trust* and *trustworthiness* seems critical in this context: the perception of science as the object of trust is considered to be trustworthiness; the actual

behavior of a subject of trust based on this trustworthiness would be trust [e.g., Mayer et al., 1995]. However, this distinction becomes challenging when focusing neither on the subject nor object of trust, but instead on information provided by intermediaries. Therefore, content-analytical trust research operates in the limbo between trustworthiness and trust. As outlined already, we consider media content (including its messages and information) to evoke or promote trust in science, thus we decided to use the term “trust cues” as a shortcut for “trust-evoking cues”. They present public audiences with reasons to trust science. This consequently means that we do not fully cover the trust heuristics public audiences may use [e.g., Scheufele & Lewenstein, 2005; Tversky & Kahneman, 1974] or further multimodal aspects different media or platforms provide, including visual elements and platform affordances [Boothby et al., 2021; Choi & Stvilia, 2015; Metzger & Flanagin, 2013; Ross Arguedas et al., 2024].

Current research considers such reasons to trust in science to be dimensions of trust in science [e.g., Kohring, 2004]. This way, references to dimensions of trust in science enable public audiences to evaluate whether to trust science as the object of trust through media content. Although there appears to be an overlap in the respective definitions of the dimensions, there is no common understanding in research — especially across different research disciplines [e.g., Grünberg, 2014]. In this paper, we will include the established dimensions in research on epistemic trust: expertise, integrity, and benevolence [e.g., Hendriks et al., 2015, 2016]. Expertise is often referred to as ability and includes skills and competencies in a specific domain; integrity is connected to objectivity, honesty, and adherence to scientific standards; benevolence means the good will in research [e.g., Hendriks et al., 2015; Mayer et al., 1995]. To account for the significance of science communication, the addition of a dimension called *openness* has already been proposed [e.g., Besley et al., 2021]. Moreover, an extension with the additional dimensions *transparency* and *dialogue* was also suggested, to consider the concept of dialogue behind public engagement with science [All European Academies, 2019; Reif & Guenther, 2021; Resnick et al., 2015] in the context of public trust [Bentele, 1994]. We opted for the five-dimensional solution and extended the established dimensions by including two further dimensions of trust: transparency and dialogue. These five dimensions have already been tested for their reliability in surveys [Reif et al., 2024]. Since previous research agrees that these dimensions are essential for judging whether or not to trust science, we assume that trust cues are linked to these five dimensions and potentially refer to them.

Although studies on trust cues using content analysis are lacking, researchers have already started to address this issue — although they usually do not explicitly discuss dimensions of trust in science, insights can be derived from their work. For instance, regarding expertise, some have argued that information about the institutional background of presented research(ers) and publications is often missing in science news [e.g., Hijmans et al., 2003]; this finding provides insight into public trust in science as institutional backgrounds, affiliations, and publications are needed to assess the expertise of science as an object of trust. Similarly, for integrity, funding sources, relevant methodological, research-related criteria, as well as uncertainties are also seldom mentioned in science news [e.g., Cook et al., 2007; Guenther, 2019]. For benevolence, it has been observed that much more is reported about the benefits of science than about potential risks — although this varies across scientific disciplines [e.g., Summ & Volpers, 2016] and media outlets [e.g., Hijmans et al., 2003]. Information discussing the benefits science might provide for society is connected to

assessing its benevolence. For transparency, researchers have discussed the inclusion of hyperlinks to external sources in digital media content [Humprecht & Esser, 2018; Phillips, 2010; Reich, 2011; see also Reif, 2021], which could help audiences assess science's transparency.

Nevertheless, research on trust cues from a content-analytical perspective is widely lacking, which results in the need to fill this research gap with an explorative, structured, and systematic identification of content-related trust cues used in intermediaries. Thus, our RQ is: (a) *What trust cues can be identified in content about science mediating trust between science and publics, and (b) how do they link to the established dimensions of trust in science?*

## 4 ▪ Method

### 4.1 ▪ Sample selection and description

To answer the RQ, a qualitative content analysis was conducted. We collected the most important sources that public audiences in Germany use to inform themselves about science [e.g., European Commission, 2021; Wissenschaft im Dialog, 2023] for three constructed weeks [see also Elmer et al., 2008; Guenther et al., 2019; Hester & Dougall, 2007], starting with a Monday in March 2022 and finishing with a Sunday in August 2022. This helped us achieve a comprehensive and representative sample. The decision on which sources to incorporate was also based on a representative online survey that Reif et al. [2024] conducted in March 2022, which not only asked about frequencies of media use via a list of several sources but also contained an open-ended question about the preferred source(s) respondents used to inform themselves about science.

First, journalistic media, incorporating TV newscasts and special science TV programs, print and online newspapers, weekly news magazines and newspapers, and specialized science magazines were selected. Second, right-wing populist, nonmainstream media sources were considered. Third, several social media platforms<sup>4</sup> (see Table 1 for a detailed overview) were included. Fourth, to incorporate online contexts in more detail, we chose a variety of science blogs and online news aggregators as other (non-journalistic) online media.

Due to the large number of sources included, we had to rely on several databases and other approaches when generating the sample, such as MediathekView and OnlineTVrecorder for most TV newscasts and programs; Factiva for most print and online newspapers and magazines; FAZ Bibliotheksportal for Frankfurter Allgemeine Zeitung/FAZ.net; Google searches and manual savings for most of the populist media, blogs, and news aggregators; 4kdownloader for YouTube; manually saved content for Facebook and Instagram posts; and TweetDownloader for Twitter. The popular science magazines were purchased online. Where possible,<sup>5</sup> the keywords *wissenschaft\** or *studie\** or *forsch\** or *universität\** or *institut\** [in English: *scien\** or *stud\** or *research\** or *universit\** or *institut\**; see Guenther et al., 2019] were used to retrieve material likely to contain scientific content.

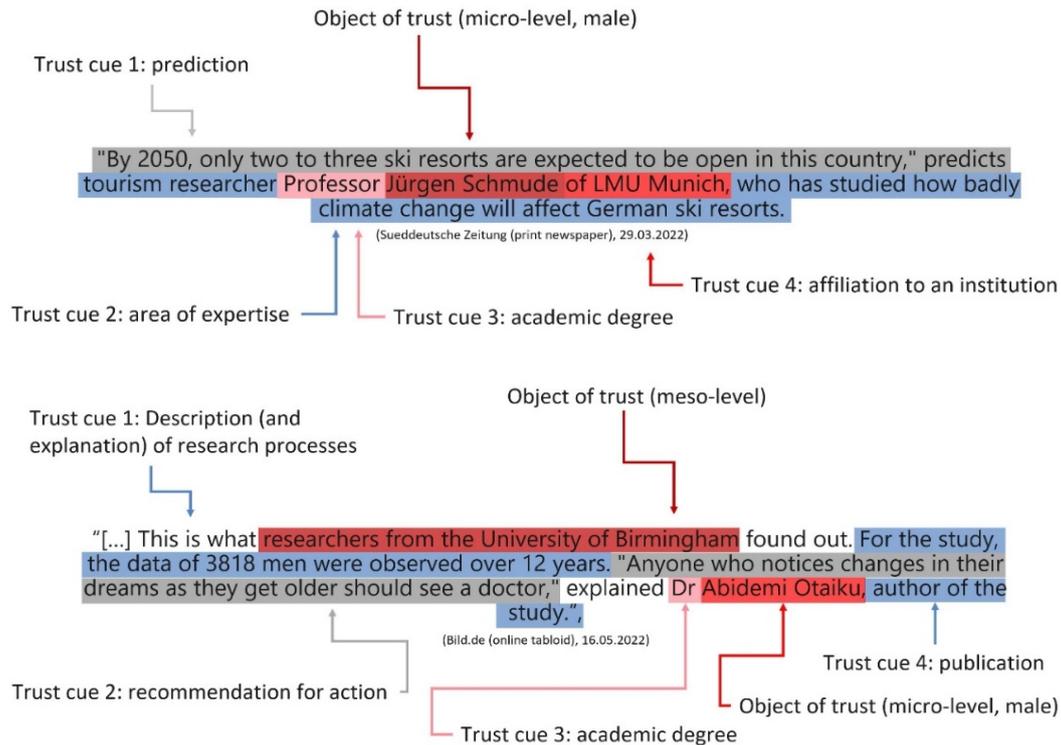
4. We included prominent German accounts for different science communicators such as influencers (e.g., MaiLab, BreakingLab, @diewissenschaftlerin), scientists (e.g., c\_drosten), public science funders (e.g., dfg\_public), governmental institutions (e.g., BMBF\_bund), and research institutes (e.g., helmholtz\_de).

5. Search strings were used for print and online newspapers, populist media, blogs, and news aggregators.

**Table 1.** Sample overview.

<i>Sources of information</i>	<i>Sample considered</i>		<i>Checked sample</i>		<i>Study subsample</i>	
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
<i>Journalistic media</i>						
Public television (ARD Tagesschau, ZDF heute)	42	.8	8	.8	5	1.3
Private television (RTL Aktuell, Sat.1 Nachrichten)	41	.8	2	1.1	2	3.2
Special science programs (Quarks, Gut zu wissen)	5	.1	5	.7	5	3.2
Print newspapers (Frankfurter Allgemeine Zeitung, Süddeutsche Zeitung, Spiegel, Zeit)	1.640	31.4	209	27.5	29	25.3
Online newspapers (FAZ.net, SZ.de, spiegel.de, zeit.de)	2.091	40.1	263	34.6	40	18.4
Print tabloid newspaper (Bild)	61	1.2	13	1.2	6	6.3
Online tabloid newspaper (bild.de)	222	4.3	37	4.3	10	3.8
Popular special science magazines (Geo, P.M. Magazin, Spektrum der Wissenschaft)	45	.9	41	5.4	4	2.5
<i>Right-wing populist, non-mainstream media</i>						
Populist media (Epoch Times, Junge Freiheit, Compact)	169	3.2	34	4.5	14	8.9
<i>Social media</i>						
Facebook (Wissenschaft aktuell, Harald Lesch Ultras, Fortschritt in der Wissenschaft)	110	2.1	15	2	11	7
Instagram (doktorwissenschaft, universumsfakten, don.medicus, diewissenschaftlerin)	54	1	2	.3	1	.6
Twitter (c_drosten, dfg_public, BMBF_bund, helmholtz_de)	172	3.3	15	2	7	4.4
YouTube (MaiLab, Breaking Lab)	7	.1	7	.9	4	2.5
<i>(Non-journalistic) online media</i>						
Blogs (scienceblogs.de, scilogs.de)	29	.6	18	2.4	6	3.8
News aggregators (t-online.de, web.de)	547	10.5	92	12.1	14	8.9
Total	5.262	100	761	100	158	100

In total,  $N = 5,262$  pieces of information were collected (see first column in Table 1). Since the steps taken did not ensure that all material downloaded was about science, or even included trust cues, a manual check had to be performed. For this, each piece of information (i.e., articles, newscasts, programs, posts) was checked to see if it contained (1) an object of trust connected to science (meaning that scientists, scientific organizations or the science system in general is referred to in the media content) and (2) any information about science that could potentially affect public trust in science (see also coding procedure in Figure 1). Through this step, the initial sample was reduced to  $n = 761$  (see second column in Table 1). Because the number of items remaining in the sample was still large for a qualitative assessment, we reduced the number, creating a smaller subsample (see third column in Table 1). For the first two weeks, a representative subsample was created. It contained a large proportion of (online/print) journalism, followed by news aggregators, and (print/online) tabloid media; hence, for these media, theoretical saturation was most likely reached. The subsample contained fewer TV sources, popular science magazines, and right-wing populist media. Furthermore, blogs and social media posts only occasionally qualified for inclusion, although an effort was made to consider them. Since our research goal was to identify trust cues in content about science, we wanted to ensure that each media type used by German



**Figure 1.** Examples of the qualitative coding with a focus on objects of trust and trust cues.

public audiences to be informed about science was properly represented, to increase our chances of accurately identifying the diversity of trust cues. Thus, in the third artificial week, we focused on these underrepresented media, with the goal of expanding upon the trust cues identified so far. These steps resulted in a subsample of  $n = 158$ .

#### 4.2 ■ Qualitative content analysis

For the analysis, we decided to use an explorative, qualitative approach with a deductive-inductive design [e.g., Kuckartz, 2014] to examine the media contents. Although we already had a clear idea of the dimensions of trust in science that we wanted to consider based on the extensive literature on the topic, it was unclear what specific cues make up these dimensions (e.g., further categories, cues, their composition). We therefore opted for an open approach, which was also flexible enough to potentially include new dimensions of trust in science, if any of the identified trust cues could not be assigned to an existing dimension.

For our analysis, we transcribed all content that was not yet in text form (e.g., for content received from TV or YouTube). The articles, transcripts, and the texts of social media postings<sup>6</sup> in our subsample served as our units of analysis. We defined a single word as our smallest unit of coding, while our largest unit of coding, i.e., the context unit, was an entire paragraph. Deductively, we assessed formal criteria (e.g., sources of information). For each object of trust mentioned, we identified the level (macro, meso, micro) and determined the specific trust-relevant criteria, i.e., the trust cues, as content-related criteria. Examples are provided in Figure 1.

6. Since we aimed to identify trust cues on a textual level, we did not include images or videos.

In the 158 coded pieces,  $n = 1,329$  cues were identified. Two independent coders tested and adjusted the coding process over several weeks before the actual coding was performed. They each coded all articles and discussed their codings regularly to increase the validity and reliability of the analysis [e.g., Kuckartz, 2014].

By testing the qualitative coding beforehand, we decided not to collect the dimensions of trust predetermined, but rather to assess information given in the pieces openly, which allowed for later inductive classification. “Openly” here means that coders summarized what they found in their own words, and copy-pasted relevant words or passages to support their findings. Furthermore, the ideas and thoughts of coders were openly collected and considered for the analysis in Excel. In this process, some deductive ideas were included about what trust cues the coders were expected to find. Hence, to generate findings, we (1) openly coded trust-relevant criteria, (2) summarized and condensed them in several iterative steps so that we were able to build superordinate, content-related categories, and (3) linked them to one of the dimensions of trust where appropriate (while being inductively open to creating further dimensions). Some trust cues, however, could not be grouped together and, therefore, do not have a superordinate category. For an overview of all trust cues, the developed categories, and the corresponding dimensions of trust, see Table 2.

Next, the trust cues will be described in detail, and concise examples will be provided for better understanding. Additional typical and relevant examples, which were translated into English by the authors, can be found for each trust cue in Tables S1–5 in the *Supplementary material*. These tables also provide examples of trust cues at different levels to show in what variety trust cues occur.

## 5 • Results

As described above, trust cues were identified and categorized, and each of the trust cues and superordinate categories could, in turn, be assigned to one of the five dimensions of trust in science. While we inductively assessed each piece of content for trust-relevant criteria and were open to creating new dimensions, all trust cues identified could be allocated to one of the existing dimensions of trust in science. Since each dimension can be referred to by different trust cues, we can more precisely speak of expertise, integrity, benevolence, transparency, and dialogue cues that each focus on a respective dimension [see Table 2 for a detailed overview; Reif & Guenther, 2021; see also Bentele, 1994; Besley et al., 2021; Fiske & Dupree, 2014; Hendriks et al., 2015, 2016; Mayer et al., 1995]. In the following pages, we describe each trust cue and provide examples for each superordinate category, which may include several trust cues using square brackets.<sup>7</sup> For a better overview, only the trust cues for the superordinate category described before are highlighted in the examples using italics; the level of the object of trust is also mentioned in square brackets.

### 5.1 • Expertise cues

Regarding the dimension of *expertise*, the identified trust cues could be grouped into three categories: academic education, professional experience, and qualification. *Academic*

7. Due to our explorative, qualitative approach, this study does not aim for a quantitative comparison of trust cues across media types; rather, a general, initial identification is at the core of the present paper. Nevertheless, Table S6 in the *Supplementary material* provides an overview of the identified categories of trust cues for each type of media.

**Table 2.** Overview of the dimensions of trust, including categories and trust cues.

<i>Dimensions of trust</i>	<i>Categories of trust cues</i>	<i>Trust cues</i>	<i>Frequencies</i>	
			<i>n</i>	<i>%</i>
Expertise			421	31.7
		Academic education	11	.8
		Professional experience	6	.5
		Qualification	404	30.4
		Academic degree	50	3.8
		Reputation	20	1.5
		Professional position	49	3.7
		Affiliation to an organization	140	10.5
	Department or area/discipline of expertise	145	10.9	
Integrity	Independence		521	39.2
			34	2.6
		Client	3	.2
	Scientific quality assurance	Funding source	15	1.1
		Interests	16	1.2
			153	11.5
		Correction/Revision	22	1.7
		(Un)Certainties (and Limitations)	98	7.4
		Peer review	/	/
	Scientific standards and processes	Continuity/Permanence of research	33	2.5
			334	25.1
		Legal framework for research	6	.5
		Working conditions in science	10	.8
		Research collaboration	31	2.3
		Publication	93	7
Description (and explanation) of research processes		194	14.6	
Benevolence			332	25.1
	Ethical norms		10	8
	Social responsibility		105	7.9
		Research-related risks	6	.5
		Prediction	48	3.6
	Benefits for society	Assessment of public events/current affairs	51	3.8
			217	16.3
		Social significance of science	29	2.2
		Discoveries and breakthroughs	26	2
		Applicability of results	51	3.8
(Science-based) recommendations		87	6.5	
Personal reasoning for benevolent behavior		24	1.8	
Transparency			18	1.4
	Accessibility of results		3	.2
	Comprehensible language		15	1.1
Dialogue			38	2.9
	Participation at public events		17	1.3
	Public engagement in research		/	/
	Media presence		21	1.6
		Journalistic media presence	14	1.1
		Direct media presence	7	.5
	Further media presence	/	/	

*education* and *professional experience* provide information about the academic education and the professional experience (including work experience in academic and nonacademic fields) of a scientist:

Benjamin Breitenbach [micro level] *studied biomedical chemistry in Mainz in 2009 including a research stay at the University of Auckland, New Zealand* [academic education]. During his *PhD at Johannes Gutenberg University Mainz* [academic education], he investigated nanodimensional polymer therapeutics in the field of drug delivery” [scilogs.de, 09.06.2022].

Lisa Kainz [micro level] is 33, an agricultural scientist, and *works for the animal rights organization PETA* [professional experience] in Stuttgart [zeit.de, 24.05.2022].

The category *qualification*, in turn, consists of the trust cues academic degree, reputation, professional position, affiliation to an institution, and a department or area or discipline of expertise. All trust cues seem straightforward, with the exception of *reputation*; trust cues for reputation are a little more complex as they include different aspects that reflect the image of a scientist or scientific institution, such as various forms of (symbolic) recognition, prizes and awards, the prominence of an individual, or success in prominent and prestigious positions. Here is an example of a qualification:

“*Professor* [academic degree] Jürgen Schmude [micro level], *tourism researcher* [department or area/discipline of expertise] at *LMU Munich* [affiliation to an institution], *who has studied how strongly climate change is affecting German ski resorts* [department or area/discipline of expertise].” [SZ, 29.03.2022].

Examples for each expertise cue, as well as the categories, can be found in Table S1 in the *Supplementary material*.

Hence, *expertise cues* illustrate science’s capacity to recognize, evaluate, and find solutions to problems via the application of specialized knowledge acquired through education, experience, and qualifications in the respective research domain.

## 5.2 ■ *Integrity cues*

*Integrity cues* are grouped into three categories: independence, scientific quality assurance, and scientific standards and processes. *Independence* can be expressed by three different trust cues: client, funding source, and interests. *Client* and *funding sources* disclose the body commissioning the research (mostly in the case of contract research) or reveal financial ties and resources. Integrity cues with regard to *interests* communicate (in)dependence from economic and social intentions; this also includes forms of forgery and conflicts of interest. For example:

A current example is the results of a study published in the *New England Journal of Medicine* (NEJM) [meso level] on the safety and efficacy of the third vaccination against COVID-19 with the Pfizer/Biontech vaccine. As *the methods section unmistakably reveals, the responsibility for the study was entirely in the hands of the vaccine manufacturers* [interests]. The two companies did not even have to bother to hide their omnipresence behind a known figure from medicine [FAZ.net, 24.05.2022].

The category *scientific quality assurance* encompasses four trust cues: correction/revision, (un)certainities (and limitations), peer review, and continuity/permanence of research. *Correction/revision* refers to the adjusting and correcting of scientific information and procedures to assure scientific quality. *(Un)certainities (and limitations)* denotes aspects of certainty as well as uncertainty, and limitations of the research. *Peer review* refers to the process of evaluating scientific work before it is published; it is a trust cue based on deductive work and could not yet be confirmed inductively. *Continuity/permanence of research* relates to research being performed constantly or on a long-term basis, including longitudinal studies and regularly repeated studies. For example:

*'My model is struggling a bit right now. Since we do not yet have sufficient data on the voting behavior of the new Academy, we have not been able to adjust it so far [(un)certainities (and limitations)]'*, admits the mathematician [micro level] [FAZ.net, 21.03.2022].

*Scientific standards and processes* include five different trust cues, such as the legal framework for research, working conditions in science, research collaboration, publication, and description (and explanation) of research processes. A *legal framework* for research refers to the regulatory context that provides guidance through frameworks and laws for science, as well as debates on the legitimacy of scientific research. *Research cooperation* signals the scientific collaboration between two or more researchers working together on a project or study. *Working conditions* in science describes both the environment in which scientists work and overarching judgments of working in science. *Publication* refers to the release of research results such as studies but also to references and source citations. *Description (and explanation) of research processes* denotes the presentation and explanation of research processes that provide further insights; included in this trust cue are descriptions of the research objective and news about scientific discoveries. For example:

Kolb and Bünemann's team [micro level] *used an algorithm to search for new binding sites in the structures of 113 different GPCR proteins* [description (and explanation) of research processes]. In doing so, they found several 'pockets' that have not been used as drug targets so far [SZ.de, 16.05.2022].

Table S2 in the *Supplementary material* contains examples for each category of trust cues associated with the dimension of integrity.

Consequently, *integrity cues* are indicators of science's objectivity, validity, and reliability, achieved through strict adherence to scientific standards and processes. This includes highlighting science's methodological approach and focus on quality control, as well as emphasizing its independence from external influences.

### 5.3 ■ *Benevolence cues*

Three categories of *benevolence cues* were identified: ethical norms, social responsibility, and benefit for society. *Ethical norms* refer to considerations of — as well as discussions and standards about — ethical issues related to science, and more broadly to scientific misconduct, animal testing, and the unethical use of scientific information. For example:

For the second part of the research — the genetic changes — I operate on laboratory animals. [...] That is sad, of course, but unfortunately, this is part of basic research. Due to my job, I have not yet had any confrontations with opponents of animal testing. However, I [micro level] *have attended events organized by Doctors Against Animal Experiments in order to better understand the other side's point of view* [ethical norms] [zeit.de, 03.07.2022].

The category *social responsibility* includes three trust cues: research-related risks, prediction, and assessment of public events/current affairs. Trust cues referring to *research-related risks* communicate risks associated not only with research in general but also with scientific processes or with danger caused by scientific information. *Prediction* refers to the prognosis of possible future events or outcomes based on scientific information or findings. *Assessment of public events/current affairs* includes scientific assessments that evaluate public events and/or current affairs within or outside a scientist's own field of research. For example:

US researchers [meso level] wanted to test a technology bringing reflective particles of lime dust into the stratosphere. *The fundamental fear in field experiments: Aerosols could behave like rabbits in Australia. Once released, they do damage and defy any attempt at recapture* [research-related risks] [Gut zu wissen, 28.08.2022].

Five different trust cues belong to the category of *benefit for society*: social significance of science, discoveries and breakthroughs, applicability of results, (science-based) recommendations, and personal reasoning for benevolent behavior. *Social significance of science* highlights the importance of science for society in the past, present, and future. *Discoveries and breakthroughs* refer to novel findings in research as well as successes achieved in a particular field of research. *Applicability* denotes the degree and significance to which scientific findings can be used in the everyday life of audiences. *(Science-based) recommendations* are pieces of advice provided based on scientific information; this also includes scientific demands to nonscientific parties, recommendations for action, and scientific advice for politics. Benevolence cues about *personal reasoning for benevolent behavior* communicate scientists' personal motives for helpful behavior toward publics.

These include motivation, selflessness, and emotionality related to research, as well as to a scientist's biography (if it explains their reasons for working in science). For example:

*'A stimulating fiscal policy that sets investment incentives' could mitigate this [(science-based) recommendations], judges the DIW [Deutsches Institut für Wirtschaftsforschung; meso level]. It is important that policy-makers prepare the economy for a supply freeze in order to reduce the severity of the potential shock [(science-based) recommendations] [zeit.de, 29.03.2022].*

With regard to the dimension of benevolence, examples for each category are given in Table S3 in the *Supplementary material*.

Concluding, *benevolence cues* signal that science has the goal of improving people's lives and promoting the advancement of societal welfare. This includes referring to the social responsibility of science, and the representation of scientific research as adhering to ethical norms and moral values.

#### 5.4 ▪ *Transparency cues*

The dimension of *transparency* includes two categories: accessibility of results and comprehensible language. *Accessibility of results* means research results are made publicly available in any form, for example: "Here is the *link to the study* [accessibility of results, meso level]." [FAZ.net, 09.06.2022]. *Comprehensible language* refers to the language used to describe research processes and results in a comprehensible — but also sometimes in an incomprehensible — manner, for example:

The parasite *Plasmodium falciparum* [comprehensible language] absorbs molecules from the blood that are toxic to it & which it therefore transformed into bio-crystals. Researchers @BNITM\_de [meso level] want to use this for new medicines [BMBF (Federal Ministry of Education and Research of Germany) via X/Twitter, 04.08.2022].

Again, examples of the categories/trust cues connected to the dimension of transparency are given in Table S4 in the *Supplementary material*.

*Transparency cues*, therefore, indicate that scientific research and knowledge is accessible to public audiences and comprehensible to all.

#### 5.5 ▪ *Dialogue cues*

For the dimension of *dialogue*, three categories were identified: participation at public events, public engagement in research, and media presence. *Participation in public events* pertains to the attendance of scientific representatives at public events organized by scientific but also by non-scientific individuals or organizations. *Public engagement in research* refers to public audiences engaging in research processes besides being the

subjects of studies. The category public engagement in research was built deductively and could not be validated inductively while coding. The two categories of participation at public events and public engagement in research are without further subcategories. *Media presence* concerns the participation of science in the media, such as a mention in an interview, participation in a talk show, or presence in social media. This category can be further subdivided into journalistic, direct (e.g., social media), and further presence (e.g., press releases; this aspect was developed deductively). For example:

Professor Stefan Rahmstorf of the Potsdam Institute for Climate Impact Research (PIK) [micro level] is one of the best-known climate researchers in Germany, a *popular expert on ARD and ZDF and a regular contributor to Spiegel Online* [media presence] [Junge Freiheit, 22.04.2022].

For dialogue, the examples for each category/trust cue can be found in Table S5 in the *Supplementary material*.

Hence, *dialogue cues* refer to how science actively engages with, and encourages interaction from, the public, with activities such as public lectures or citizen science projects.

## 6 - Discussion

To analyze media as primary sources for scientific information, we introduced the term “trust cues” — i.e., information provided in media content that present public audiences with reasons to place trust in science by addressing dimensions of trust in science.

We identified such content-related trust cues through an explorative approach using qualitative content analysis for a variety of information sources about science. The trust cues identified are located at the textual level, as our unit of analysis consisted of articles, transcripts, and the texts of social media postings. This study then systematically identified several cues for each of these dimensions in content about science. These can be referred to as expertise, integrity, benevolence, transparency, and dialogue cues. These cues match and extend the definitions of the dimensions of trust in science [Reif & Guenther, 2021; Reif et al., 2024; see also Bentele, 1994; Besley et al., 2021; Fiske & Dupree, 2014; Hendriks et al., 2015, 2016; Mayer et al., 1995]. Although our open, largely inductive approach allowed us to search for further trust cues, we did not find any cues that could not be assigned to those dimensions. Consequently, it can be said that media content does, in fact, address the five dimensions of trust in science and, therefore, that trust cues may be important for earning the trust of public audiences in science. Trust cues can be seen as an operationalization of these dimensions, and their analysis provides insights about *how* reasons to trust science are signaled and *which* reasons to trust science are presented. The theory of public trust [Bentele, 1994] underlines the importance of media and its contents for public trust in science. In this regard, the trust cues identified enable examination of the media content in the context of public trust in science and suggest that media content is indeed not a neutral component in trust relationships but — in line with the theory of public trust — is a critical influencing factor.

To date, most research on the trust evaluation process has focused on cognitive trust heuristics used by audiences [e.g., Kahneman & Frederick, 2005; Tversky & Kahneman, 1974]

or on markers that signal media credibility [Metzger & Flanagin, 2013; Ross Arguedas et al., 2024]. However, even though media content is of importance in this process, research focusing on content-related aspects in media is often missing. That is why the applied explorative, structured, and systematic approach to identifying such trust cues fills a research gap in media trust research and enhances our understanding of the trust evaluation process that takes place when public audiences come in contact with science via the media. Nevertheless, it is possible that future research may identify additional, topic-specific trust cues. Furthermore, this study provides the groundwork for further research on the effects trust cues have on public trust in science. With the identification of content-related trust cues, it becomes possible for future research to compare diverse media in terms of how they present reasons to trust in science. So far, because journalism dominates our subsample, the cues identified are trust cues used mainly in journalism. Based on the concept of trust cues, their occurrence can be connected to developments in public trust that takes media use into consideration. This includes finding answers for the ambivalent findings about social and online media and their effect on public trust in science [e.g., Huber et al., 2019; Takahashi & Tandoc, 2016] — the identified trust cues provide explanatory content that allows for a more differentiated view on the effects of media use on public trust in science. Therefore, they also provide the base for a well-founded discussion about a potential decline of public trust in science.

Most people use a variety of diverse media to stay informed; different media could use trust cues differently, and, therefore, could affect various aspects connected to trust in science [e.g., dimensions, categories of trust, and trust cues; Boothby et al., 2021; Metzger & Flanagin, 2013]. The trust cues identified in this study are solely textual cues. They can be embedded in a larger context by considering that there are various indicators other than textual trust cues that can affect trust in science via intermediaries. These include different aspects on which media credibility is based, such as the specific media outlet, the presentation of information, the presence of an image, text sentiment, and the number of likes on social media posts [Boothby et al., 2021; Choi & Stvilia, 2015; Wathen & Burkell, 2002], as well as the context in which the communication takes place, including the communicator and the manner of communication such as the style of language used [e.g., Vaupotič et al., 2021]. For this reason, even though the present content-related, textual analysis is vital to better understand mediated trust in science, it is only one building block in a broader trust relationship or trust evaluation process that should be considered for a complete and comprehensive examination.

The explorative qualitative approach employed by this study limits the significance of the results to some degree. In the present study, a qualitative design was used that does not fully support quantitative derivations, hence, we propose a quantitative content analysis that systematically investigates frequencies and distribution of trust cues across a larger and representative sample of media outlets. Since, in journalistic content, scientists (micro level) may play a more important role compared to scientific organizations and the science system [Guenther, 2019], it might be worth looking at differences between specific objects of trust, such as male and female scientists, who may be represented differently (e.g., regarding gender differences). Additionally, the linkage of trust cues to mis- or distrust is worthy of future research because, for instance, research that is ethically questionable or involves risks can be legitimized (e.g., autonomous weapons), and “alternative” experts that promote mis- or disinformation [see Oreskes & Conway, 2010] can also be described with trust cues.

Moreover, the trust cues identified and the categories developed for each dimension do not inform on their importance for audiences, meaning their effect on public trust in science [for first indications, see Reif et al., 2020; Rosman et al., 2022]. Likewise, they do not explain possible dynamic relations between dimensions, categories, and trust cues. Consequently, audience studies are needed to validate the effect of trust cues on public audiences and reveal potential dynamics or hierarchies between trust cues. However, taken together with trust heuristics and credibility markers, content-related trust cues can enhance our understanding of the overall trust evaluation process when engaging with content about science.

The study presented here has identified trust cues in intermediaries that can, in fact, be connected to the dimensions of expertise, integrity, benevolence, transparency, and dialogue, all of which potentially affect the trust relationship between science and public audiences. This provides motivation for research on the importance of science media content — as well as the role of intermediaries — for public trust in science.

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## About the authors

Justin T. Schröder (M.Sc.) is a research associate at the Department of Media and Communication (IfKW) at LMU Munich, Germany, and, in addition to that, he is currently pursuing his Ph.D. at the University of Hamburg, Germany. His main research interests are science communication, trust in science, and gender research in the context of science.

✉ [justin.schroeder@ifkw.lmu.de](mailto:justin.schroeder@ifkw.lmu.de)

Janise Brück (M.A.) is a research assistant and Ph.D. student at the Department of Media and Communication (IfKW) at LMU Munich, Germany. Her research focuses on science communication, especially on its interfaces: the relationship between science PR and science journalism, as well as its connections to related fields, particularly the interaction between science and politics.

✉ [janise.brueck@ifkw.lmu.de](mailto:janise.brueck@ifkw.lmu.de)

Lars Guenther (Ph.D.) is Professor of Communication Science at LMU Munich's Department of Media and Communication (IfKW) in Germany, and Extraordinary Associate Professor at the Centre for Research on Evaluation, Science and Technology (CREST) at Stellenbosch University in South Africa. He is interested into public perceptions of (controversial) science, science and health journalism, trust in science, as well as the public communication about risks and scientific (un)certainty.

✉ [lars.guenther@ifkw.lmu.de](mailto:lars.guenther@ifkw.lmu.de)

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## Supplementary material

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*Supplementary material**Table S1. Examples for expertise cues.*

Category	Trust cue	Level	Example	Source
Academic education	Academic education	Macro	n/a	
		Meso	n/a	
		Micro	Benjamin Breitenbach <u>studied biomedical chemistry</u> in Mainz in 2009 including a research stay at the University of Auckland, New Zealand. <u>During his PhD</u> at Johannes Gutenberg University Mainz, he investigated nanodimensional polymer therapeutics in the field of drug delivery.	scilogs.de, 09.06.2022
Professional experience	Professional experience	Macro	n/a	
		Meso	n/a	
		Micro	Lisa Kainz is 33, an agricultural scientist, and <u>works for the animal rights organization Peta</u> in Stuttgart.	zeit.de, 24.05.2022
Qualification	Academic degree	Macro	n/a	
		Meso	n/a	
		Micro	However, <u>Professor Kai Wirtz</u> , head of the study, assumes that the phytoplankton actively migrates. In the process, it absorbs CO <sub>2</sub> in the upper water layers and can take up nutrients in the lower layers. The mini-algae need both.	bild.de, 04.08.2022
	Reputation	Macro	n/a	
		Meso	n/a	

	Micro	<u>Bernd Rendel Prize 2022 for #Geology</u> : For their promising, original #research at the beginning of their careers, the #DFG honours @DirscherlMariel & @BourgonNicolas. The prize will be awarded in September at the annual meeting @DGGV_de - Congratulations! 🙌 <a href="https://t.co/OKzkPveMtO">https://t.co/OKzkPveMtO</a> <a href="https://t.co/HHVWGsFibW">https://t.co/HHVWGsFibW</a>	Twitter (dfg_public), 27.07.2022
Professional position	Macro	n/a	
	Meso	n/a	
	Micro	“Not at all isolated cases,” says Professor Günther Ziegler, <u>president of the FU Berlin</u> . There are numerous other projects nationwide that are not being continued.	Tagesschau, 19.07.2022
Affiliation to an organization	Macro	n/a	
	Meso	In addition to the DIW, the Macroeconomic Policy Institute (IMK) <u>of the Hans Böckler Foundation</u> also warns in its economic forecast of a deep recession in the event of a supply freeze or embargo.	zeit.de, 29.03.2022
	Micro	Jörg Peltzer is Professor of Comparative Regional History in European Perspective at the <u>University of Heidelberg</u> and British Academy Global Professor at the <u>University of East Anglia, Norwich, UK</u> .	FAZ (print), 01.06.2022
Department or area/discipline of expertise	Macro	n/a	
	Meso	A study just published by five cognitive and <u>genetic researchers</u> from European and British universities investigated the causes of “aesthetic shivers”. The main question was whether goose bumps when listening to music are more a cultural imprint or a genetic predisposition.	SZ (print), 25.06.2022
	Micro	Professor Jürgen Schmude, <u>tourism researcher</u> at LMU Munich, who has studied how strongly climate change is affecting German ski resorts.	SZ (print), 29.03.2022

*Table S2. Examples for integrity cues.*

Category	Trust cue	Level	Example	Source
Independence	Client	Macro	n/a	
		Meso	However, a new study shows that this is not necessarily true. The comparison does not take into account the differences between employees. This is the conclusion of researchers at the Leibniz Institute for Economic Research (RWI), who conducted the study <u>for the Association of German Temporary Employment Companies (iGZ)</u> .	t-online, 01.06.2022
		Micro	Stefan Wuchty, actually a bioinformatician, is working on real-time prediction at the University of Miami <u>on behalf of the US Department of Defense</u> .	PM Magazin, 14.04.2022
	Funding source	Macro	<u>The BMBF will strengthen peace and conflict research with 30 million Euros over the next few years.</u> This measure had been planned for a long time, but is now being expanded once again.	Twitter, 22.04.2022
		Meso	The Macroeconomic Policy Institute (IMK) warns of serious economic consequences of a gas supply freeze. The trade union-affiliated institute, which is <u>financed by the Hans Böckler Foundation</u> , has calculated various scenarios for this in a publication to be published on Tuesday.	FAZ.net, 29.03.2022
		Micro	For years Regine Schönenberg and her PhD student Claudia Pinson from Guatemala have been researching the social consequences of the destruction of nature in the Amazon region. But now <u>their project is in danger of falling victim to the austerity measures of the Federal Ministry of Education. Funds that had already been promised have been cancelled.</u>	Tagesschau, 19.07.2022
	Interests	Macro	n/a	
		Meso	A current example are the results of a study published in the “New England Journal of Medicine” (NEJM) on the safety and efficacy of the third vaccination against COVID-19 with the Pfizer/Biontech vaccine. <u>As the methods section unmistakably reveals, the responsibility for the study was entirely in the hands of the vaccine manufacturers.</u> The two companies did not even have to bother to hide their omnipresence behind a known figure from medicine.	FAZ.net, 24.05.2022
		Micro	At the beginning of 2021, the majority of her colleagues excluded her [Prof. Wallrabenstein] from a trial <u>because of impartiality</u> .	Instagram (Doktorwissenschaft), 21.03.2022

Scientific quality assurance	Correction/Revision	Macro	n/a	
		Meso	In concrete figures from the BA, there is a pay gap of 42.4 per cent between full-time employees, who earn an average gross salary of 3.347 Euros, and temporary workers, who earn 1.928 Euros. This comparison, however, is criticized by the study authors. <u>They argue that the BA only collects its values up to the contribution measurement limit and thus the data is distorted.</u>	t-online, 01.06.2022
		Micro	Chris Graf, director of research integrity at Springer Nature, declined to discuss details but called paper mills “bad for research and the publishing world”. In addition to investigating individual cases and retracting compromised papers, <u>“we have reviewed our processes and invested in technology to help us detect attempts to manipulate our systems.”</u>	SZ.de, 22.04.2022
	(Un)Certainties (and Limitations)	Macro	The dramatizations of alcohol consumption that occur again and again in scientific articles and the media may correspond to the zeitgeist of a health culture. <u>But they do not really fit the clinical data and even contradict epidemiology.</u>	Scilogs.de, 27.07.2022
		Meso	The IMK criticizes that the model used by colleagues <u>neglects “many of the channels that we know were central to the depth and duration of the collapse in economic activity in past crises”.</u>	FAZ.net, 29.03.2022
		Micro	<u>“My model is struggling a bit right now. Since we do not yet have sufficient data on the voting behavior of the new Academy, we have not been able to adjust it so far,”</u> admits the mathematician.	FAZ.net, 21.03.2022
	Peer review	Macro	n/a	
		Meso	n/a	
		Micro	n/a	
	Continuity/ Permanence of research	Macro	n/a	
		Meso	This is what researchers at the University of Birmingham found out. For the study, <u>the data of 3818 men were observed over 12 years.</u>	Bild (print), 09.06.2022
		Micro	Mobile phone use does not increase the risk of brain tumors, according to a large longitudinal study. An analysis of the “UK Million Women Study”, <u>which has been running in the United Kingdom for more than 20 years,</u> found no evidence of an increased risk of tumors with the usual use of mobile phones. This was reported by a team led by Joachim Schüz of the International Agency for Research on Cancer (IARC) in Lyon in the “Journal of the National Cancer Institute”.	t-online, 01.06.2022

Scientific standards and processes	Legal framework for research	Macro	n/a	
		Meso	n/a	
		Micro	<u>The question is whether the federal government will play along at all. So far, climate protection interventions in the marine environment have been strictly regulated. The so-called “Hohe-See-Einbringungsgesetz” does not even allow field experiments, which is why scientists run experiments in tanks or go to the marine areas of other countries. “We would not even be allowed to bring minerals into the Baltic Sea with a salt shaker,” says Riebesell.</u>	SZ, 29.03.2022
	Working conditions in science	Macro	<u>Today, more than eighty percent of the qualification positions are temporary. As a result, even after mastering all qualification levels, the grotesque alternative awaits at the end: professorship or unemployment. And this at the age of about forty.</u>	FAZ, 01.06.2022
		Meso	n/a	
		Micro	<u>Working hours: The contract stipulates 40 hours, but I usually cannot quite manage that. If I have to finish an article or if there is a deadline for trial applications, it can also be 50 to 60 hours a week. During such phases, there are days when I work until two in the morning. But it can also be that I finish work at 2 p.m. because there is nothing else to do. There is no classical recording of working hours. Our head of department is very accommodating – as long as the work is done, he does not care when.</u>	zeit.de, 03.07.2022
	Research collaboration	Macro	<u>Science has always functioned across national borders. There has been a European scientific community since the early modern era.</u>	zeit.de, 06.04.2022
		Meso	<u>Thomas Hamacher is Professor of Renewable and Sustainable Energy Systems at the Technical University (TU) of Munich in Garching and one of the project coordinators of the “Geothermal Alliance Bavaria”, a large-scale research network that brings together scientists from the TU Munich, the Friedrich Alexander University of Erlangen-Nuremberg, the University of Bayreuth as well as the Ludwig Maximilian University of Munich and the University of Applied Sciences Munich.</u>	SZ.de, 14.04.2022
		Micro	<u>The scientists led by Peter Kolb and Moritz Bünemann, together with colleagues from Canada, have investigated so-called G protein-coupled receptors (GPCR). They transmit singlae from the outside of a cell into its interior and play a role, for example, in inflammation and the transmission of sensory stimuli.</u>	SZ.de, 16.05.2022
	Publication	Macro	n/a	

		Meso	According to data <u>published by Statista in 2022</u> , Germany, which is small in terms of area, was in third place in the production of wind energy in 2020. In first place was China, followed by the USA.	Epoch Times, 04.08.2022
		Micro	This was reported by a team led by Joachim Schüz from the International Agency for Research on Cancer (IARC) in Lyon <u>in the “Journal of the National Cancer Institute”</u> .	t-online, 01.06.2022
Description (and explanation) of research processes		Macro	Just like ACLED, researchers all over the world <u>collect vast amounts of digital data from the internet</u> : for example, papers from authorities, media reports and activities in social networks. They not only want to document fights and violence - they want to be able to warn about them beforehand.	PM Magazin, 14.04.2022
		Meso	ICCT and Fraunhofer ISI had already published a study in September 2020, which was mainly based on data from the USA and Canada and came to a similar conclusion. The new version of the study focuses on cars in Europe. <u>The data of the approximately 9.000 vehicles comes partly from the provider Spritmonitor, where drivers can record and evaluate their fuel consumption, and partly from surveys of companies and car owners.</u>	zeit.de, 09.06.2022
		Micro	Kolb and Bünemann’s team <u>used an algorithm to search for new binding sites in the structures of 113 different GPCR proteins</u> . In doing so, they found several “pockets” that have not been used as drug targets so far.	SZ.de, 16.05.2022

*Table S3. Examples for benevolence cues.*

Category	Trust cue	Level	Example	Source
Ethical norms	Ethical norms	Macro	n/a	
		Meso	<u>Bill Gates has maintained close contacts with the Chinese Communist Party for 30 years. A recent donation is intended to help the regime bring foreign scientists and the necessary know-how into the country. This is not an isolated case; Germany's universities are also helping Beijing to become a military superpower.</u>	Epoch Times (online), 27.07.2022
		Micro	For the second part of the research – the genetic changes – I operate on laboratory animals. I use an extremely delicate glass cannula to introduce a virus into the brain that can change genes. Before I examine the brain and see to what extent it has altered, the animals have to be euthanized. That is sad, of course, but unfortunately, this is part of basic research. Due to my job, <u>I have not yet had any confrontations with opponents of animal testing. However, I have attended events organized by “Doctors Against Animal Experiments” in order to better understand the other side's point of view.</u>	zeit.de, 03.07.2022
Social responsibility	Research-related risks	Macro	The ocean could play a key role in geoengineering. The problem: <u>Even the scientific field tests are considered by many to be too risky for the ecosystem because no one can estimate the consequences.</u> The question is: How do we get scientific certainty without conducting the experiments?	Gut zu wissen, 28.08.2022
		Meso	US researchers wanted to test a technology bringing reflective particles of lime dust into the stratosphere. <u>The fundamental fear in field experiments: Aerosols could behave like rabbits in Australia. Once released, they do damage and defy any attempt to recapture them.</u>	Gut zu wissen, 28.08.2022
		Micro	Together with a team, Burkhardt had examined tissue samples from COVID-vaccinated people after their deaths and came to the disturbing conclusion that <u>the vaccination was a contributing cause of death in most cases.</u> Among the deaths analyzed by Burkhardt were also children.	Epoch Times (online), 21.03.2022

	Prediction	Macro	n/a	
		Meso	Researchers at the Yale School of Medicine <u>expect that within the next 10 years it will be possible to develop an age clock that can be used in clinical diagnostics.</u>	Instagram (Forschungswelt), 29.09.2022
		Micro	<u>Over the next 65 years, between 25 and 40 percent of these crusts will disappear</u> , says Emilio Rodriguez-Caballero, who was involved in the study and now works at the University of Almeria.	SZ (print), 09.06.2022
	Assessment of public events/current affairs	Macro	<u>If everyone did that, it would no longer be so nature-like. Then it would also be a major intervention in the climate.</u> For this reason, the scientific community has said that afforestation is also a form of climate engineering.	Gut zu wissen, 28.08.2022
		Meso	<u>The report “sends a clear warning that the energy transition is not happening”</u> , explained the Thinktank REN21, which designed the study.	SZ (print), 17.06.2022
		Micro	“Generally, <u>an energy embargo would be a political decision involving numerous considerations</u> ,” said IMK Scientific Director Sebastian Dullien. “However, <u>we want to point out that the economic and also the social consequences would most likely be grave and that the economic policy must be prepared to react accordingly.</u> ”	zeit.de, 29.03.2022
Benefit for society	Social significance of science	Macro	<u>The well-being of patients – and to some extent also of healthy people, for example when it comes to vaccinations – should be at the center of medical research.</u>	scilogs.de, 27.07.2022
		Meso	However, especially in times of war and crisis, it is true that <u>academic connectivity also gives us insights into hostile countries. In the 1950s and 1960s, for example, American scientists regularly reported to their authorities such as NASA or the Atomic Energy Commission who they had met and what their foreign colleagues were working on. This kept them up to date on the technological progress of their competitors. One should not make the mistake of thinking that science diplomacy is not influential just because it is described as “soft”.</u> It is a hard instrument.	Zeit (print), 09.06.2022

		Micro	And then even full-blooded researchers and pragmatists such as the chemist <u>Schlögl</u> reveal what drives them to the <u>interface between politics and science despite the occasionally heavy headwind. The conviction and the satisfaction of doing the right thing. The energy transition is an “existential question for humanity” that politicians should “no longer dawdle over”.</u>	FAZ (print), 01.06.2022
Discoveries and breakthroughs		Macro	<u>The discovery of the Higgs particle</u> celebrates its 10th anniversary tomorrow! A huge success, also for the German research landscape and the funding of the @BMBF_Bund. Public events are being offered in many places. More: <a href="https://t.co/78It7GacCL">https://t.co/78It7GacCL</a> #higgs10 <a href="https://t.co/o7pP0xDHjZ">https://t.co/o7pP0xDHjZ</a>	Twitter (BMBF_bund), 07.03.2022
		Meso	It sounds like a miracle: In a colorectal cancer study at the Memorial Sloan <u>Kettering Cancer Center</u> in New York, 14 out of 14 participants were cured. Without chemotherapy, radiation or surgery, just with the immune agent Dostarlimab.	Bild (print), 09.06.2022
		Micro	Now cho ga is “an incredible scientific discovery”, paleontologist Grant Zazula from the responsible authority told Global News. Hair and skin had been preserved. “If you look at her feet, she has tiny little finger and toenails that have not fully hardened.” She was about 140 centimeters long. First investigations indicated that she was about one month old when she died.	web.de, 25.06.2022
Applicability of results		Macro	n/a	
		Meso	But according to a new study, <u>environmental pollution, for example, is responsible for nine million annual deaths. This means that substances such as those mentioned above contribute to one of the greatest risks to our health.</u>	Geo, 12.08.2022
		Micro	This discovery has opened up the <u>possibility of intervention and finally gives answers to parents who have lost their child in such a tragic way. These families can now live with the knowledge that it was not their fault,</u> Harrington says of her medical breakthrough.	Bild (print), 16.05.2022

(Science-based) recommendations	Macro	<u>The influence that scientific policy advice now enjoys had become particularly clear in Corona politics – and was therefore also the subject of heated discussion.</u>	FAZ (print), 01.06.2022
	Meso	<u>“A stimulating fiscal policy that sets investment incentives” could mitigate this, judges the DIW. It is important that policymakers prepare the economy for a supply freeze in order to reduce the severity of the potential shock.</u>	zeit.de, 29.03.2022
	Micro	That the federal government is now abandoning the mask requirement in these days of all times is, in Brinkmann’s opinion, wrong. <u>“This is a bit too early. I would have found it very useful to keep certain measures in place. These clearly include testing and also the wearing of masks.”</u>	spiegel.de, 29.03.2022
Personal reasoning for benevolent behavior	Macro	n/a	
	Meso	n/a	
	Micro	<u>“That afternoon I quit my job as a lawyer and returned to the world of medical research. That day I made the decision to leave no stone unturned to solve the mystery of sudden infant death syndrome,”</u> Harrington writes on a crowdfunding page of the Sydney Children’s Hospital Foundation, which helps her fund her research.	spiegel.de, 16.05.2022

*Table S4. Examples for transparency cues.*

Category	Trust cue	Level	Example	Source
Accessibility of results	Accessibility of results	Macro	n/a	
		Meso	Here is the <a href="#">link to the study</a> .	FAZ.net, 09.06.2022
		Micro	n/a	
Comprehensible language	Comprehensible language	Macro	Science calls these “white swan events” because they are no more exceptional than white swans.	PM Magazin, 14.04.2022
		Meso	Even the most dangerous #malaria pathogen has weak points: The <a href="#">parasite Plasmodium falciparum</a> absorbs molecules from the blood that are toxic to it & which it therefore transformed into bio-crystals. Researchers @BNITM_de want to use this for new medicines. <a href="https://t.co/RML0XMOiWO">https://t.co/RML0XMOiWO</a> <a href="https://t.co/BVSMAsPwGw">https://t.co/BVSMAsPwGw</a>	Twitter, 04.08.2022
		Micro	Otherwise, as Müller, Pollak, Reimer and Schindler put it: The observable differences in the “ <a href="#">post-secondary educational decisions</a> ” of academic and working-class children are “ <a href="#">predominantly controlled by secondary influences of origin</a> ”.	FAZ.net, 21.03.2022

*Table S5. Examples for dialogue cues.*

Category	Trust cue	Level	Example	Source
Participation at public events	Participation at public events	Macro	The discovery of the Higgs particle celebrates its 10th anniversary tomorrow! A huge success, also for the German research landscape and the funding of the @BMBF_Bund. Public events are offered in many places. More: <a href="https://t.co/78It7GacCL">#higgs10</a> <a href="https://t.co/o7pP0xDHjZ">https://t.co/o7pP0xDHjZ</a>	Twitter (BMBF_bund), 03.07.2022
		Meso	<u>The “Science Day” is the start of seven events in the MUG’s anniversary year.</u>	SZ (print, online), 22.04.2022
		Micro	According to the study, 15 to 20 percent of patients still have symptoms, even though the infection occurred more than one and a half year ago. “This is alarming,” said Antonius Schneider, medical director of the institute and head of the study, <u>at the presentation on Tuesday in the district administration office.</u>	SZ (print), 01.06.2022
Public engagement in research	Public engagement in research	Macro	n/a	
		Meso	n/a	
		Micro	n/a	
Media presence	Media presence	Macro	n/a	
		Meso	<u>The TU did not respond to BILD’s enquiry about the allegations.</u>	bild.de, 06.04.2022
		Micro	Professor Stefan Rahmstorf of the Postdam Institute for Climate Impact Research (PIK) is one of the best-known climate researchers in Germany, <u>a popular expert on ARD and ZDF and a regular contributor to Spiegel Online.</u>	Junge Freiheit (online), 22.04.2022

**Table S6.** *Frequencies of trust cues across journalistic, populist, social, and further, (non-journalistic) online media.*

Dimensions	Categories	Media types				Total
		Journalistic media	Right-wing populist, non-mainstream media	Social media	(Non-journalistic) online media	
Expertise	Academic education	7	3	0	1	11
	Professional experience	5	0	0	1	6
	Qualification	294	27	20	62	403
Integrity	Independence	24	0	5	5	34
	Scientific quality assurance	97	7	8	41	153
	Scientific standards and processes	246	22	21	45	334
Benevolence	Ethical norms	3	6	1	0	10
	Social responsibility	78	18	1	8	105
	Benefit for society	152	13	10	42	217
Transparency	Accessibility of results	2	1	0	0	3
	Comprehensible language	6	2	4	3	15
Dialogue	Participation at public events	10	2	3	2	17
	Media presence	7	4	0	10	21
Total		931	105	73	220	1,329



# 19

## Trust Cues in Content about Science: How the Media Presents Female and Male Scientists Differently

Justin T. Schröder 

### Introduction

During the COVID-19 pandemic, science was enormously important to people's lives. Science had a significant impact on the behavior of people who wanted to protect themselves and others from infection, and science enabled the development of vaccines, which played a key role in fighting the pandemic. Despite female scientists being at the forefront of COVID-19 vaccine development, female scientists did not feature to the same extent as their male counterparts in related media coverage (Hubner, 2023; Joubert et al., 2023). This problem has persisted, with women continuing to be underrepresented not only in news coverage about COVID-19 (Araújo et al., 2022; Fletcher et al., 2021) but also in media coverage about science itself (Kitzinger et al., 2008a; Mitchell & McKinnon, 2019; Niemi & Pitkänen, 2017).

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J. T. Schröder (✉)  
LMU Munich, Munich, Germany  
e-mail: [justin.schroeder@ifkw.lmu.de](mailto:justin.schroeder@ifkw.lmu.de)

Not only during crises, but also in the context of everyday life scientific information is becoming more and more important in an increasingly complex society (Hendriks et al., 2015; Vaupotič et al., 2021). *Public trust in science* helps to reduce this complexity (Giddens, 1990). In the field of communication research, *trust* is viewed as a relational variable that involves a minimum of two parties: firstly, a subject of trust, and secondly, an object of trust. Most people receive scientific information, or, indeed, come into contact with science, through (digital) media (European Commission, 2021; National Science Board, 2018; Wissenschaft im Dialog, 2021), which in the case of science communication act as intermediaries of trust, meaning that they mediate trust between a subject of trust (publics)<sup>1</sup> and an object of trust (science). Media do so by providing *trust cues*: linguistic components, such as language and characteristics, that serve as indicators of trust that public audiences can use to assess whether or not to trust science (Schröder et al., 2024).

Given the differences in the presentation of female and male scientists in science media coverage, it seems plausible that variations also exist in how trust cues are depicted for each gender. This is particularly significant because female scientists play a vital role in advancing scientific knowledge, and modern societies increasingly rely on information derived from this knowledge for daily decision-making and the management of crises. Furthermore, equitable presentation is important as female scientists are role models, especially for young women with the desire to become scientists (Kitzinger et al., 2008b). As such, it is crucial to investigate potential differences in media coverage of female and male scientists with regard to the portrayal of trust in science.

Therefore, the overarching research question of this chapter is: *How is trust in female and male scientists mediated differently in content about science?* To answer this question, a qualitative content analysis will be

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<sup>1</sup> In this research, the terms “publics” and “public audiences” are used to account the constituency of the modern public sphere by linking diverse media types. This leads to “a multitude of overlapping publics of different sizes, lifespans, visibility, and impact, across a variety of online and offline communicative channels and platforms” (Bruns, 2018, p. 339).

applied to the most important sources of scientific information for German publics; thus, trust cues will be identified, with an emphasis on the differences regarding how they are used when referring to female and male scientists.

## Theoretical Background

### Female and Male Scientists in Science Media Coverage

Female scientists are significantly involved in scientific progress: Marie Curie discovered radioactivity, Ada Lovelace created the world's first computer program, and Ann Tsukamoto co-patented a process to isolate human stem cells. In general, gender diversity in science promotes novelty and innovation (Hofstra et al., 2020), contributing significantly to the enhancement of societal progress, problem solving, and crisis management. However, female scientists do not get the same recognition as male scientists; the under-recognition of women in media is known as the *Matilda effect*<sup>2</sup> (Knobloch-Westerwick & Glynn, 2013; Rossiter, 1993).

An imbalance in the representation of female and male scientists is also apparent when it comes to science media coverage (Araújo et al., 2022; Fletcher et al., 2021; Joubert et al., 2023; Kitzinger et al., 2008a; Mitchell & McKinnon, 2019; Niemi & Pitkänen, 2017). Drawing attention to this imbalance is crucial since most people receive scientific information, and get in contact with scientists, scientific organizations (e.g., universities or private research organizations), and the science system (Mayer et al., 1995), through (digital) media (European Commission, 2021; National Science Board, 2018; for a focus on scientists on X/Twitter, see Chapter 6). Given that journalism in general, and science journalism in particular, tends toward personalization, grounded in the news factor of a “human angle” (Amend & Secko, 2012; Guenther, 2019), scientists play an important role in science coverage. But female

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<sup>2</sup> Named after Matilda J. Gage, an American suffragist and feminist critic by Rossiter (1993).

and male scientists are not represented equally in science media coverage, neither in terms of frequency of coverage (e.g., citation) nor in terms of the characteristics of how female and male scientists are portrayed (e.g., through stereotypes).

Evidence shows that female scientists are cited significantly less often in science media coverage than male scientists (GMMP, 2020; Kitzinger et al., 2008a). Additionally, men are often cited first, and when female scientists are cited, they are usually cited as a secondary source (Kitzinger et al., 2008a). These trends were observed across diverse media outlets (Kitzinger et al., 2008a), and they explain why science media coverage is dominated by the voices of male scientists (GMMP, 2020).

However, it is important to highlight that media representations of female scientists differ from those of their male counterparts not only in terms of frequency but also, to some extent, in their portrayal of stereotypes (Chimba & Kitzinger, 2009; GMMP, 2020; Joubert et al., 2022; Klaus, 1998; Lünenborg & Maier, 2012; Mitchell & McKinnon, 2019). This can be linked to discussions around *being a woman in science*, which implies a primary identification as a woman, rather than as a scientist. It also encompasses considerations related to *family and domestic responsibilities*, involving relationships and parental status, as well as the challenges of balancing family life with a scientific career; here, aspects like having children, childcare as well as cooking are discussed in connection with female scientists (Chimba & Kitzinger, 2009; Mitchell & McKinnon, 2019). Furthermore, the media tends to focus more on the *physical appearance and attractiveness* of female scientists than on that of their male colleagues—this includes, for women, discussions about femininity and sexuality (Chimba & Kitzinger, 2009; Mitchell & McKinnon, 2019). Notably, however, evaluations of *individual brilliance and determination*, that refers to the intelligence and motivation of scientists, appear to be more balanced between women and men. In addition, *teamwork and interpersonal skills* are described similarly for female and male scientists, with references to their communication, kindness, teamwork, and other interpersonal skills and aspects of social conscience (Mitchell & McKinnon, 2019).

However, differences in the representation of female and male scientists in the context of public trust in science have not yet been investigated for science media coverage. This issue is important as media are crucial components in the trust relationship between science and its publics.

## The Trust Relationship Between Science and Its Publics

Whether taking medication when sick, commuting to work by car, or buying groceries for dinner at the supermarket, the influence of science permeates our daily lives. Hence, scientific information is not only important for addressing crises, such as the COVID-19 pandemic or climate change, but also for people's everyday decision-making (Hendriks et al., 2015; Vaupotič et al., 2021; for a focus on expertise in the COVID-19 pandemic, see Chapter 3). The public is increasingly reliant on science and scientific information (see Chapter 5 for “celebrity scientists” during the COVID-19 pandemic), and requires a mechanism for reducing complexity, which reinforces the importance of trust in science (Luhmann, 2014). As mentioned above, since most people come into contact with science through media (European Commission, 2021; National Science Board, 2018), these media act as intermediaries of trust, meaning that they mediate trust between publics and science through content (Bentele, 1994; Reif & Guenther, 2022). Given our focus on *public trust in science* (i.e., publics are the subject of trust), the concept of *epistemic trust* becomes particularly relevant. Epistemic trust pertains to trust in science as a reliable producer of valid and accurate knowledge. This extends to assurance of the inherent validity of scientific knowledge and to the reliability of science as a dependable source of information (Origgi, 2012).

We further define trust in science as a multidimensional construct that manifests itself in five dimensions that are also considered to be *reasons* to trust: expertise, integrity, benevolence, transparency, and dialogue (Hendriks et al., 2015, 2016; Reif & Guenther, 2022; Reif et al., 2024; Schröder et al., 2024; see also Chapter 20). *Expertise* illustrates science's

capacity to identify, evaluate, and target problems by using specialized knowledge acquired through education, experience, and qualifications (in the respective fields of research). *Integrity* means the assurance of objectivity, validity, and reliability achieved through adherence to scientific standards and processes. The orientation of science toward ethical norms and moral values, as well as awareness of science's responsibility to society, form the dimension of *benevolence*. Additionally, science is expected to make research and corresponding scientific information publicly accessible, which results in the dimension of *transparency*. *Dialogue* refers to science participating in and enabling interaction with public audiences (Reif et al., 2024; Schröder et al., 2024). All dimensions of trust can potentially be referred to by trust cues, understood here as linguistic markers and characteristics that can be used by audiences to assess whether to trust science at the message/content level, i.e., written words (Schröder et al., 2024).

In digital media environments, this includes the epistemic risk associated with the potential exposure to incorrect or misleading information by emerging science communicators (Schröder & Guenther, 2024; Taddicken & Krämer, 2021). Journalistic and non-journalistic actors can equally communicate about science issues (see also Weingart & Guenther, 2016), including actors with various interests, such as politicians or public relations professionals (Weingart, 2017).

Currently, however, research on trust cues is lacking. As such RQ1 of this chapter asks: *Which trust cues in content about science can be (a) identified, (b) categorized, and (c) how can trust cues be connected to the established dimensions of trust?* Since we argued that female and male scientists are represented differently in news media, this might also be true in the context of mediated trust in science. For this reason, RQ2 asks: *Which qualitative differences exist in the use of trust cues between female and male scientists?*

## Methods

Based on a general lack of research on trust cues connected to differences between female and male scientists, the present study uses an exploratory approach. To answer the RQs, a qualitative content analysis was conducted, aiming to reveal potential differences in how mediated trust in scientists varied by gender.

### Sample and Selection Process

Since we aimed to identify as many trust cues in content about science as possible, we tried to include a broad spectrum of sources public audiences in Germany most frequently use to stay informed about science (European Commission, 2021; Wissenschaft im Dialog, 2021). Hence, we included journalistic (i.e., quality and tabloid media), right-wing populist, social (i.e., X/Twitter, YouTube, Instagram, Facebook), and other online media (i.e., blogs and news aggregators). Their content was collected in three constructed weeks (Hester & Dougall, 2007), starting on a Monday in March 2022, and ending on a Sunday in August 2022. This approach of data collection was used to secure a comprehensible and representative sample.

For this study, *journalistic media*, incorporating television (TV) newscasts (Public TV: ARD Tagesschau, ZDF heute; Private TV: RTL Aktuell, Sat.1 Nachrichten) and special science TV programs (WDR Quarks, BR Gut zu wissen), print and online newspapers (Frankfurter Allgemeine Zeitung, FAZ.net, Süddeutsche Zeitung, SZ.de, Bild, bild.de), weekly news magazines/newspapers (Spiegel, spiegel.de, Zeit, zeit.de), and specialized science magazines (Geo, P.M. Magazin, Spektrum der Wissenschaft) were selected. Furthermore, *right-wing populist, non-mainstream media* sources were included (epochtimes.de, jungefreiheit.de, compact-online.de). Moreover, several *social media* (Facebook groups: Wissenschaft aktuell, Harald Lesch Ultras, Fortschritt in der Wissenschaft; Instagram: @doktorwissenschaft, @universumsfakten, @don.medicus, @diewissenschaftlerin; X/Twitter: c\_drosten, dfg\_public,

BMBF\_bund, helmholtz\_de; YouTube: MaiLab, Breaking Lab)<sup>3</sup> were considered. In addition, to incorporate online contexts more detailed than in previous research, we chose science blogs (scienceblogs.de, scilog.de) and online news aggregators (t-online.de, web.de). Due to the extensive number of information sources included, multiple databases (e.g., Factiva and MediathekView) and approaches were used to generate the sample.

In total,  $n = 5,262$  pieces of information were collected and manually checked to ensure that all material included (1) an object of trust (scientists, scientific organizations, and references to the science system) and (2) aspects that the coders considered useful for assessing whether to trust this object of trust—this, consequently, excluded plain descriptions of research and scientific information. Thus, the initial sample was reduced to  $n = 763$  pieces of information about science. Next, a smaller representative picture of the material was produced for the qualitative content analysis: For this, a representative sample of the population was created for the first two weeks; it contained a large share of (online/print) journalism, followed by news aggregators, and (print/online) tabloid media. In the third artificial week, focus was placed on underrepresented media (i.e., TV sources, popular science magazines, populist media, blogs, and social media), with the aim of extending the trust cues identified. In total, a sample of  $n = 158$  pieces of information was built.

## Qualitative Content Analysis

Here, a qualitative content analysis was applied on articles and transcripts (e.g., YouTube, TV) with a deductive-inductive approach (Kuckartz, 2014). Deductively, we assessed formal criteria (source of information, media type). Inductively, we gathered the level of trust for each object of trust connected to science identified in the sample, i.e., we assessed whether the content referred to scientists at the micro-level, scientific organizations at the meso-level, or the science system at the macro-level.

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<sup>3</sup> In this study, accounts for different science communicators are included: influencers (e.g., MaiLab), scientists (e.g., c\_drosten), public science fundings (e.g., dfg\_public), governmental institutions (e.g., BMBF\_bund), and other research institutes (e.g., helmholtz\_de).

Furthermore, we inductively gathered the gender of all objects of trust at the micro-level (female, male, other), as well as specific trust-relevant criteria, i.e., the trust cues (see model in Reif & Guenther, 2022; see also Schröder & Guenther, 2024). With this approach, we aimed to examine a wide variety of media content to identify a broad range of trust cues that are generally associated with science (RQ1). Subsequently, to address RQ2, we focused on all codes related to scientists (i.e., the micro-level). Hence, codes for scientific organizations (meso-level) and the science system (macro-level) were not considered for the comparison.

To improve the validity and reliability of the analysis, two independent coders conducted the qualitative content analysis after testing and adjusting the coding process over several weeks (Kuckartz, 2014). In the 158 coded pieces of media content included in the analysis,  $n = 1,329$  trust cues were collected overall (which are the base for RQ1), with 136 of these pieces containing  $n = 1,033$  cues connected to scientists at the micro-level (in order to answer RQ2).

The coders refrained from pre-defining the dimensions of trust (i.e., expertise, integrity, benevolence, transparency, and dialogue) and instead adopted an open approach to assess the information, allowing for inductive classification. This entailed coders summarizing their findings in their own words, copying and pasting relevant words or passages, and collecting thoughts on their coding more generally. Trust cues were iteratively summarized and condensed; hence, most trust cues were grouped into superordinate categories, though some constituted singular categories in themselves. To answer the RQs, we first looked at quantitative frequencies; however, since this is a qualitative study, these were only used as a guide to see which qualitative differences were worth investigating in more detail.

## Results

We considered all coded trust cues ( $n = 1,329$ ) to answer RQ1 and focused on the trust cues connected to the micro-level, i.e., references to scientists, to answer RQ2 ( $n = 1,033$ ).

## Identification of Trust Cues in Content About Science (RQ1)

For RQ1, a qualitative content analysis was used to identify trust cues in content about science. The inductively identified trust cues were condensed in superordinate categories of trust cues, which could, in fact, each be connected to one of the five dimensions of trust. Hence, we can refer to them as expertise, integrity, benevolence, transparency, and dialogue cues, depending on which dimensions the cues relate to. To answer RQ1, in the following, (a) the identified trust cues and (b) their respective categories will be described for (c) each dimensions of trust they are connected with.

*Expertise cues* refer to academic education, professional experience, and qualification. Academic education and professional experience are categories in themselves and do not have further subcategories, i.e., trust cues. Qualification, on the other hand, can be referred to by trust cues mentioning an academic degree, a professional position, an affiliation to an organization, a department or area of expertise, or reputational aspects.

*Integrity cues* include references to scientific standards and processes, methods of scientific quality assurance, and independence. Scientific standards and processes are discussed with trust cues referring to publications, descriptions, and explanations of research processes, and research collaborations, as well as the legal framework in which science can act, or working conditions in science. Furthermore, scientific quality assurance includes the discussion about corrections or revisions in research, peer review processes, continuity and permanence of research, and (un)certainities as well as limitations of research. Independence is addressed by trust cues referring to clients (often for contract research), funding sources, or further interests connected to research projects.

*Benevolence cues* address ethical norms in research, the social responsibility of science, and its benefits for society. Ethical norms do not have any further subcategories; social responsibility is referred to by trust cues communicating research-related risks, predictions made by science, and scientific assessments of public events and current affairs

that provided a better understanding of these events for public audiences. In addition, benefits for society are referred to by discussing the social significance of science in general, discussing discoveries and breakthroughs, giving science-based recommendations, and making scientific information applicable to the everyday lives of people.

*Transparency cues* are connected to the accessibility of research results as well as the use of (in)comprehensible language, i.e., the use of simple words to explain scientific issues or, conversely, the use of technical jargon in research. There are no further expressions of these cues.

*Regarding dialogue cues*, public engagement in research is discussed, including media presence as well as the participation at public events. Media presence can be in journalistic media but also directly in social media or it can refer to other types of media presence, e.g., public relations content.

## Qualitative Differences Between Female and Male Scientists (RQ2)

RQ2 asks to what extent qualitative differences in the portrayal of female and male scientists in content about science and in the context of trust in science, i.e., using trust cues, exist. To answer RQ2, we further analyzed the trust cues found at the micro-level ( $n = 1,033$ ) with a special focus on gender; here, 297 cues are clearly connected to women and 487 to men.<sup>4</sup> In order to get an impression of where to start for the analysis of qualitative differences, we considered the distribution of trust cues. Overall, the order of prevalence of stated dimensions of trust remains consistent across female and male scientists: For both genders, the focus lies at expertise, followed by integrity, benevolence, dialogue, and transparency. Furthermore, the use of trust cues differs between genders

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<sup>4</sup> It was not possible to identify individuals with other gender; hence, in the following we will only refer to female and male scientists. Further 249 trust cues were connected to groups consisting of female and male scientists or remained unknown.

within the dimensions of trust and within the subordinate categories. In the following, only qualitative differences will be discussed in detail.<sup>5</sup>

For female scientists, *expertise* is represented via expertise cues referring to their qualification, addressing, for instance, their department or area of expertise: “*Virologist Sandra Ciesek*” (Ganster, 2022 [FAZ.net, journalistic quality media]). This is similar for the presentation of male scientists but, additionally, their specific affiliation is emphasized more often than that of female scientists: “Fernando Maestre, an *ecologist of drylands at the University of Alicante*” (Pennisi, 2022 [SZ.de, journalistic quality media]). Professional experience of male scientists in nonacademic contexts is not given relevancy, whereas it is (albeit seldomly) mentioned for female scientists: “Lisa Kainz is 33, an agricultural scientist, and *works for the animal rights organization PETA in Stuttgart*” (Schipperges, 2022 [Zeit.de, journalistic quality media]).

For female scientists, *integrity* cues mainly refer to scientific standards through research processes that are described or explained (e.g., “Head of testing Christine Hentschel *cuts up various everyday objects, arranges the plastics by color, and weighs them on a precision balance. The centrifuged plastic-solvent mixture is evaporated in the gas chromatograph [...] and forced through a tube with a carrier gas*” (Beller & Lauter, 2022 [GEO, journalistic specialized science magazine]), as well as the mention of overarching research goals: “Harrington now wants to work on a blood test for babies so that the enzyme can serve as a biomarker to determine the risk of sudden infant death syndrome. *‘It is the hope that the results could lead to the development of a screening test in a few years,’* the researcher said in an interview” (Porwol, 2022 [Bild.de, journalistic tabloid media]). This is also the case for male scientists; however, integrity in their case is additionally indicated via quality assurance, discussing (un)certainities and limitations of research: “Christoph Reuter took a closer look at the meta-analysis and came to the conclusion *that many of the studies included had some methodological flaws themselves*” (Schwenkenbecher, 2022 [SZ.de, journalistic quality media]).

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<sup>5</sup> Trust cues are shown in italics in the examples. References are provided according to APA7 but media type is added for more context.

For scientists in general, *benevolence* is represented through addressing benefits of science and research for society—and is usually connected to male scientists differently than it is to female scientists. For female scientists, for example, benevolence is indicated via the assessment of public events and current affairs: “In a guest article for F.A.Z.-Einspruch, Wallrabenstein *called the plans for the expatriation of IS fighters ‘boundlessly selfish in the literal sense of the word’. Germany is forgetting a promise it made after the Holocaust: ‘to be a home for displaced persons and never to produce any again itself’* (Grunert, 2022 [FAZ, journalistic quality media]).” Furthermore, personal reasoning for benevolent behavior is discussed for female scientists, whereas this is almost never described for their male counterparts: “Research leader Dr. Theres Harrington *was driven by a stroke of fate: in 1991, she lost her son Damien to what is known as sudden infant death syndrome. At the time, Harrington was an attorney, but had previously worked as a biochemist. [...] three years later, a friend’s child also died. ‘That afternoon, I quit my job as a lawyer and returned to the world of medical research. That day, I made the decision to leave no stone unturned to solve the mystery of sudden infant death syndrome,’* Harrington writes on a crowdfunding page for the Sydney Children’s Hospital Foundation [...]” (Porwol, 2022 [Bild.de, journalistic tabloid media]). In this example, the role of being a mother and the career that resulted from her personal fate is discussed. This case is different for men; for them, benefits for society are expressed mainly in giving (science-based) advice and recommendations: “In view of the economic risks, *he [Sebastian Dullien] advocates for reducing dependence on energy supplies from Russia and doing so as quickly as possible—but not imposing an embargo in the short term*” (Pennekamp, 2022 [FAZ.net, journalistic quality media]). Personal aspects of male scientists such as being a father are not discussed at all.

The dimensions of *dialogue* and *transparency* do not show differences in their presentation between female and male scientists. Dialogues cues primarily refer to the media presence of scientists: “Professor Stefan Rahmstorf [...], a welcome *expert on ARD and ZDF, and a regular author for Spiegel Online*” (Behrens, 2022 [jungfreiheit.de, right-wing populist media]). For transparency cues, gender differences do not

appear while addressing linkages to external studies or research material that is rather gender-neutral (e.g., “Here is the link to the study”; Hoferichter, 2022 [SZ.de, journalistic quality media]), or using professional jargon, i.e., (in)comprehensible language (e.g., “The two Nobel laureates invented the general *CRISPR-Cas9* method a few months before Zhang, but Zhang described the application of *CRISPR-Cas9 in eukaryotes*” (@doktorwissenschaft, 2022 [Instagram, social media]).

## Discussion and Future Research

By means of a qualitative content analysis of the most important sources public audiences in Germany use to stay informed about science, trust cues were identified which could, in turn, be categorized as well as assigned to the dimensions of trust: expertise, integrity, benevolence, transparency, and dialogue (Reif & Guenther, 2022). This corroborates contemporary research about dimensions of trust that are referred to in media content about science (Hendriks et al., 2015, 2016; Reif & Guenther, 2022; Reif et al., 2024; Schröder et al., 2024). It was found that most trust cues refer to scientists (micro-level), which is where the personalization tendencies of science journalism become apparent (Amend & Secko, 2012; Guenther, 2019). These identified trust cues were then compared between female and male scientists. In general, the imbalance in regard to the portrayal of female and male scientists found in previous research was substantiated in this chapter.

A more detailed consideration of media content revealed further similarities and differences in the use of trust cues connected to female and male scientists. For the dimensions of expertise and integrity there are only small differences in the way female and male scientists are portrayed. These two dimensions can be interpreted as part of the stereotype of *individual brilliance and determination* that refers to the drive and intelligence of scientists (Chimba & Kitinger, 2009; Mitchell & McKinnon, 2019); according to previous research, differences between genders for this stereotype are small, a finding which also seems to hold in the context of public trust in science. Differences between female and male scientists are more prevalent for benevolence cues. Women are described

in a more personal manner, and as more caring for society than men. In the example provided, the personal experience of the women is described as the reason why she is working in science; it should be noted that this is not only personal but can also be interpreted as part of her social conscience. Here, stereotypes of *being a woman in science* and *family and domestic responsibilities* as well as *teamwork and interpersonal skills* become visible. This stands in contrast to the use of benevolence cues for male scientists; men give advice in an unemotional and impersonal way and, therefore, appear stricter and more dominant. With regard to the remaining dimensions, transparency and dialogue did not show any differences between genders.

In our coding, only 297 cues were clearly connected to women and 487 to men, which corroborates previous research about the under-recognition of female scientists in the media (GMMP, 2020; Kitzinger et al., 2008a). In conclusion, it seems like there are small yet recognizable differences between the portrayal of female and male scientists when it comes to public trust in science, when focusing on the established dimensions of trust. The main differences are that personal details seem to be more present in descriptions of female scientists in the media compared to their male counterparts. Hence, this research shows that qualitative portrayals of female and male scientists in the context of trust in science align with previous research about stereotypes of scientists in science media coverage. This research, therefore, supports previous research on gender representation of scientists and shows that stereotypes are also replicated in the context of trust in science (Chimba & Kitzinger, 2009; Mitchell & McKinnon, 2019).

Even though this research used a qualitative approach, it seems like the under-recognition of female scientists in the context of public trust in science may be more apparent when analyzed quantitatively, based on the prevalence of female and male scientists in science coverage for which RQ1 provided some initial insights. However, this finding needs to be substantiated with a more comprehensive quantitative examination. As such, even though qualitative differences exist to some extent, future research should focus on quantitative analysis of the use of trust cues connected to female and male scientists, to examine whether similarities and/or differences in addressed dimensions of trust and corresponding

aspects exist. Moreover, this would allow for comparisons across different media types and outlets. Additionally, it seems reasonable to include sources for trust cues, such as journalists or other scientists in the media, in this future research in order to reveal potential biases (see, e.g., Niemi & Pitkänen, 2017). It should be noted that the prevalence of trust cues in content about science does not allow any statements about the actual effect they may have on public audiences. Therefore, audience studies could be used to test the diverse effects of trust cues connected to female and male scientists and, furthermore, whether they are perceived differently across demographics and between genders in particular.

Since the research on trust cues is still in its infancy, there is a lot of research that needs to be done and the study presented is only a first step toward a better understanding of public trust in science with a focus on media as intermediaries of trust.

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Research article

# Mediating trust in content about science: Assessing trust cues in digital media environments

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[journals.sagepub.com/home/pus](https://journals.sagepub.com/home/pus)**Justin T. Schröder** 

Ludwig-Maximilians-Universität Munich, Germany; Universität Hamburg, Germany

**Lars Guenther** 

Ludwig-Maximilians-Universität Munich, Germany

## Abstract

Intermediaries such as (digital) media use trust cues in their content, that is, information and linguistic markers that present public audiences reasons for trusting scientists, scientific organizations, and the science system. *Trust cues* refer to dimensions of trust in science such as expertise, integrity, benevolence, transparency, and dialogue. Because digital media environments are expected to be heterogeneous in content, the sources of trust cues, characteristics of objects of trust in science (e.g. the gender of scientists), and their impact on public trust in science may vary. In our quantitative content analysis, we identified trust cues across several sources of scientific information ( $n = 906$ ) and examined their heterogeneity in digital media environments. Our results reveal journalism as the most important source for trust cues and that scientists are the most prevalent object of trust—with female scientists being underrepresented. Differences across (digital) media imply varying impacts on public trust in science.

## Keywords

digital media environments, intermediaries of trust, quantitative content analysis, trust cues, trust in science

Scientific information, applied when using technology, making medical decisions, and considering ecological trends (e.g. Hendriks et al., 2015), is important in people's everyday decision-making. Because publics are somewhat dependent on science and scientific information, their trust in science is among the most important variables to engage with such information (e.g. Plohl and Musil, 2021; Saffran et al., 2020). Today, most people get in contact with science and receive scientific information through (digital) media (e.g. European Commission, 2021;

## Corresponding author:

Justin T. Schröder, Department of Media and Communication (IfKW), Ludwig-Maximilians-Universität Munich, Akademiestraße 7, 80799 Munich, Germany.

Email: [justin.schroeder@ifkw.lmu.de](mailto:justin.schroeder@ifkw.lmu.de)

Wissenschaft im Dialog, 2023), including in Germany, where nearly the entire population uses the Internet (e.g. ARD/ZDF-Forschungskommission, 2023), and online media is an important source of scientific information (e.g. Wissenschaft im Dialog, 2023). Given those trends, (digital) media are intermediaries of trust in science, and in that role, they mediate trust via trust cues. When it comes to science, trust cues are information, language, and linguistic markers used in content that provide public audiences, as subjects of trust, reasons to trust in science (e.g. Schröder et al., 2025). They enable public audiences to evaluate whether they should trust scientists, scientific organizations, and the science system as objects of trust. Because media content can indeed evoke trust in science (Guenther et al., 2024), in this article we use the term *trust cues* as shorthand for trust-evoking cues.<sup>1</sup>

At a time when scholars are discussing and fearing a decline in public trust in science (e.g. Kennedy and Tyson, 2023) and when findings of media's effects on trust in science remain mixed (see also Guenther et al., 2024),<sup>2</sup> it seems beneficial for researchers to focus on specific aspects of media content—for instance, the trust cues used. Although scholars have yet to focus on such cues, studies on audiences have provided hints of their effectiveness. For example, research has shown that communicating open science practices, which are directly linked to transparency, positively affects trust in science (e.g. Rosman et al., 2022; Song et al., 2022) and that assessments of trust improve when scientists correct themselves and communicate uncertainty (e.g. Altenmüller et al., 2021; Ratcliff and Wicke, 2023). Because those insights suggest that trust cues can indeed evoke trust in science, the intermediaries of such trust deserve a closer look.

Intermediaries of trust especially warrant attention in digital media environments, where a heterogeneity of actors and content means that diverse interests can access diverse audiences (e.g. Brossard and Scheufele, 2022; Huber et al., 2019; Schäfer, 2016). In digital media environments, not only professional journalists but also non-journalistic actors communicate about scientific issues and therefore become relevant sources of content about science (e.g. Taddicken and Krämer, 2021; Weingart, 2017). For the same reason, audiences face the risk of receiving misleading or false information, particularly in populist, non-mainstream media (e.g. Frischlich et al., 2022) and social media (e.g. Jennings et al., 2021; Xiao et al., 2021) compared with journalistic media. For that reason, digital media environments have been serving as an explanation for declining public trust in science (e.g., Weingart and Guenther, 2016). That means that when analyzing trust cues in content about science, differentiating professional journalistic, populist/non-mainstream, social, and other Internet-based media (e.g. blogs) is crucial to capturing the heterogeneity of actors and content in digital media environments.

The same heterogeneity also affects objects of trust, especially scientists and their representation in terms of gender. To date, research has generated mixed findings concerning scientists' gender and trust in science. For instance, some studies have demonstrated that trust assessments indicating expertise are associated with male scientists due to stereotypes, whereas others have revealed that participants tend to have higher trust in female than in male scientists (e.g. Hubner and Bullock, 2024). Owing to those discrepancies, the gender of scientists should be included in analyses of trust cues, for it can afford additional insights into how objects of trust are represented.

Altogether, investigating how trust cues in scientific content vary across different (digital) media (i.e. journalistic, populist, social, and other Internet-based media) and based on scientists' gender, can clarify how those factors may affect public trust in science. A deeper, more detailed analysis of media content could also illuminate recent developments regarding public trust in science. In those ways, such research can form a foundation for further analyses of media's effects on trust in science and elucidate the trust relationship between science and digitized publics. Thus, in our study, we asked the following overarching research question: *How does the use of trust cues in*

*content about science vary across different (digital) media and genders of the scientists represented?*

## I. Theoretical background

*Trust* is a multifaceted concept that has been examined in various fields of study and thus has numerous definitions. In this article, we view trust from a sociological-theoretical perspective within communications research (e.g. Reif and Guenther, 2022; Schröder et al., 2025), which characterizes trust as a mechanism for reducing complexity (e.g. Kohring, 2016; Luhmann, 2014). For instance, when a subject of trust has trust in an object of trust, it means that the subject has confidence in the object to achieve future tasks and/or expectations and, in turn, is willing to risk the possibility that such tasks and/or expectations might not be achieved (e.g. Giddens, 1990; Kohring, 2016). In that way, the subject makes itself vulnerable (e.g. Goldenberg, 2023; Mayer et al., 1995; Reif and Guenther, 2022; Resnick et al., 2015). However, trust is crucial for dealing with complexities in modern societies (e.g. Luhmann, 2014). In the context of our research, focused on public trust in science, an especially valuable concept is epistemic trust, which means depending on science as a producer of reliable knowledge, both its inherent validity and its perception as a secure, dependable source of information (e.g. Origi, 2012; Sperber et al., 2010).

### *Trust cues in content about science*

Bentele's (1994) theory of public trust, which recognizes media's role in the trust relationship between science and its publics,<sup>3</sup> suggests that *public trust* has emerged as a distinct form of trust within the public sector. According to the theory, trust in individuals, organizations, and systems is influenced by information conveyed through media, including facts, events, and messages (e.g. Bentele, 1994; Reif, 2021). Our conceptualization of trust cues aligns with Bentele's theory of public trust (1994) insofar as it focuses on media content (for an overview, see Schröder et al., 2025) and emphasizes the importance of content about science. By extension, trust cues are conceived as influential linguistic components in content about science that present public audiences with reasons to trust in science, specifically by addressing established dimensions of trust in science. Thus, trust cues are an operationalization of those dimensions.<sup>4</sup>

When it comes to trust in science, multiple dimensions have been distinguished, including the well-established dimensions of expertise, integrity, and benevolence (e.g. Hendriks et al., 2015, 2016; Mayer et al., 1995). Albeit initially developed for science at the micro (e.g. Hendriks et al., 2015) and meso levels (Mayer et al., 1995), their applicability at the macro level has also been conceptualized (e.g. Reif and Guenther, 2022) as well as empirically tested and validated (Reif et al., 2024). Moreover, in recent research, new dimensions have been suggested, including openness (e.g. Besley et al., 2020) and, considering the reciprocal concept of dialogue behind *public engagement with science*, transparency and dialogue (e.g. Reif and Guenther, 2022). Indeed, Schröder et al. (2025) included transparency and dialogue, which can also be applied at all three levels, in developing the concept of the trust cues. Because all dimensions of trust in science can be referred to by trust cues, we refer to them as expertise, integrity, benevolence, transparency, and dialogue cues, respectively. For each dimension, respective trust cues were identified by Schröder et al. (2025) in a qualitative pilot study with a diverse media sample. The result of this study was a list of 35 trust cues identified, with definitions and examples.

In this regard, *expertise* illustrates science's capacity to identify, evaluate, and target problems by using specialized knowledge acquired through education, experience, and qualifications (in the respective fields of research). Thus, *expertise cues* refer to mentions of the academic

education, professional experience, and qualifications possessed by a scientific object of trust, including their academic degree(s), organizational affiliation, and/or their reputation (e.g. Hijmans et al., 2003; for all definitions see also Reif et al., 2024). *Integrity* means the assurance of objectivity, validity, and reliability achieved by adhering to scientific standards and processes. As such, *integrity cues* refer to mentions of independence (e.g. funding sources), assurances of scientific quality (e.g. uncertainties in research and peer review), and references to scientific standards and processes in general (see also Guenther et al., 2019). The dimension of *benevolence* refers to science's orientation toward ethical norms and moral values as well as awareness of its responsibility to society (see also Hendriks et al., 2015). In that regard, *benevolence cues* address ethical norms, social responsibilities (e.g. in researchers' communication of research-related risks or their assessment of public events and current affairs), and benefits for society that science might provide (e.g. science-based recommendations). *Transparency* refers to the expectation that scientific actors should make research and related scientific information publicly accessible; by extension, *transparency cues* refer, for example, to comprehensible language that also includes technical terminology and the accessible presentation of research results (e.g. Reich, 2011; Reif, 2021). Concerning the dimension of transparency, it is important for science to be transparent regarding its research and not necessarily for a piece of science-related information to be communicated transparently. For example, if journalists mention a research project's funding source, this information is communicated transparently (by journalists, not by scientific actors) but does not allow public audiences to evaluate science itself being transparent but rather to evaluate its independence. *Dialogue* refers to science that participates in and enables interaction with public audiences (e.g. Reif et al., 2024). Thus, *dialogue cues* mean the participation of scientific objects of trust in public events, their journalistic media presence and direct media presence (e.g. use of social media), and their public engagement in research. Dialogue presupposes a certain form of reciprocity (i.e. questions can be asked, and interaction can occur). Such reciprocity distinguishes dialogue from transparency, which refers to science being transparent but without considering interactions.

Taken together, all dimensions can be addressed by actors at the macro, meso, and micro levels (e.g. Reif and Guenther, 2022; Schröder et al., 2025). In our study, we investigated the extent to which trust cues can be identified at each level. Apart from our study, few content analyses have (indirectly) considered those five dimensions of trust in science or analyzed linguistic markers that can be interpreted as trust cues (e.g. Welzenbach-Vogel et al., 2021; for an overview see Schröder et al., 2025). Table 2 presents an overview of all trust cues that we examined, their respective superordinate categories, and the dimensions of trust in science that they refer to (see also Schröder et al., 2025). These trust cues have not been quantified yet to examine their prevalence across (digital) media.

### *Heterogeneity in (digital) scientific content*

With the Internet and digitalization, a wide range of communicators have gained access to (digital) public spheres that allow them to bypass journalistic selection criteria (e.g. Pavlik, 2000). Consequently, a variety of actors can now express themselves online and thereby reach public audiences (e.g. Brossard, 2013; Schäfer, 2016; Schröder and Guenther, 2024; Taddicken and Krämer, 2021). For that reason, digital media can facilitate greater heterogeneity in *content*, the *sources of trust cues*, and *objects of trust in science*.

In this article, heterogeneity in terms of content is defined from the perspective of trust as a multidimensional concept, such that scientific content can refer to expertise, integrity, benevolence, transparency, and dialogue expressed via a range of trust cues. Aside from journalists, various science communicators have emerged online to address scientific topics using

multiple sources with diverse interests. In social and other Internet-based media, science public relations professionals, political and governmental actors, bloggers, and other communicators with broad influence online—for instance, influencers—may discuss such topics. In populist media, by contrast, alternative experts and state propaganda may emerge (e.g. Weingart, 2017), and online sources may thus share misleading and/or false information, as seems to be more prevalent in populist, non-mainstream media (e.g. Frischlich et al., 2022; Taddicken and Krämer, 2021) and on social media (e.g. Jennings et al., 2021; Xiao et al., 2021) than in journalistic media. Last, heterogeneity in objects of trust in science encompasses science performed at multiple levels, including scientists (i.e. micro level), scientific organizations (i.e. meso level), and the science system (i.e. macro level). Recognizing the heterogeneity of (digital) media environments and the complexity of trust, in our first research question (RQ1) we asked: *How does the use of trust cues differ across (digital) media with respect to (a) the dimensions of trust in science, (b) science as the object of trust at different levels (i.e. micro, meso, and macro), and (c) their sources?*

Scientists play an especially important role in journalistic media because journalists, in their coverage of science, typically search a human angle, which is also a news factor in science journalism (e.g. Amend and Secko, 2012; Guenther, 2019). In light of that trend, scientific actors at the micro level may also be important in other types of media. Concerning how scientists are represented, previous research has revealed that female and male scientists are not equally represented in science media coverage (e.g. Fletcher et al., 2021; Kitzinger et al., 2008; Mitchell and McKinnon, 2019; Niemi and Pitkänen, 2017), in terms of not only frequency (e.g. citations and voices heard) but also certain characteristics (e.g. stereotypes; Chimba and Kitzinger, 2009; GMMP, 2020; Joubert et al., 2022; Kitzinger et al., 2008; Mitchell and McKinnon, 2019). That imbalance is negative in critical ways. After all, although women contribute significantly to scientific progress and gender diversity is supposed to drive innovation (e.g. Hofstra et al., 2020),<sup>5</sup> female scientists are significantly underrepresented compared with their male counterparts in the coverage of science (e.g. GMMP, 2020) in various types of media (Kitzinger et al., 2008). In the context of trust in science, initial research has revealed qualitative similarities and differences between female and male scientists. For instance, when describing a scientist's expertise, their qualifications were in the spotlight regardless of their gender. However, the personal biographies detailing scientists' motivations in their work were provided only for female scientists, whereas scientific advice conveying their benevolence toward society was provided only for male scientists (Schröder, 2025). On that basis, quantitative gender differences in the context of public trust in science can be assumed.

Differences in gender representations are also tied to journalists' selection of sources and framing processes (e.g. Niemi and Pitkänen, 2017) as well as to their own gender. Gender aside, journalists covering science predominantly cite male scientists while limiting their references to female scientists (e.g. GMMP, 2020; Kitzinger et al., 2008); however, female journalists choose sources who are women significantly more often than male journalists do (GMMP, 2020). Thus, taking journalists' gender into account might provide additional insights into how it impacts the representation of gender in science coverage.

Considering all of the above, in our study we hypothesized that gender accounts for the heterogeneity of scientific objects of trust in science as well as in selecting sources of science coverage, which seems important for analyzing trust in science. For additional insights into that issue, in RQ2 we asked: *How does the gender of the object of trust in science at the micro level relate to (a) the dimensions of trust in science, (b) the trust cues represented, (c) the sources of trust cues, and (d) the gender of the source?*

## 2. Methodology

To answer the RQs, we conducted a quantitative content analysis of a sample of content from (digital) media sources most frequently used by public audiences in Germany to gain information about science (e.g. European Commission, 2021; Wissenschaft im Dialog, 2023).

### *Sample selection*

We considered the heterogeneity of (digital) media environments and sought a sample encompassing outlets and accounts typically accessed by German publics when using media to acquire scientific information (e.g. European Commission, 2021). Next, we constructed four groups for comparison: (1) professional journalistic (i.e. print and online) media, including diverse outlets and formats that nevertheless all follow the same professional logic; (2) right-wing populist, non-mainstream media, which depart from journalism's logic and are more likely to contain misleading and/or false information (e.g. Frischlich et al., 2022); (3) social media, for the purpose of better comparability, all with a reference to scientific accounts or contents; and (4) other Internet-based media (i.e. blogs and news aggregators), given their dissimilarity to the other groups. Table 1 provides an overview of the sample.

Media content was collected for a full year, in seven constructed weeks from March 2022 to March 2023. Given the extensive array of media sources involved, we relied on multiple databases and methods for sample generation.<sup>6</sup> When possible, established search strings were used for the selection (Guenther et al., 2019; Schröder et al., 2025);<sup>7</sup> in cases that precluded using those search strings, we collected the content manually. The material was checked if it contained (1) an object of trust connected to science and (2) trust cues, and in total,  $n = 1812$  were considered to be relevant. On that basis, we constructed a representative, randomized sample with half of those relevant pieces ( $n = 906$ ).

### *Quantitative content analysis*

In our quantitative content analysis, we followed a deductive approach with the help of a standardized codebook (see Document S1 in the Supplemental Material) developed based on inductive, qualitative content analysis in a previous study (Schröder et al., 2025). The codebook contains the 35 trust cues shown in Table 2. Because we wanted to compare various types of media, we focused exclusively on text and thus coded articles (i.e. print and online media), transcripts of videos (i.e. from TV and YouTube), and texts of individual posts (i.e. from social media). This poses a limitation that we will discuss later.

Four coders were trained and performed all coding,<sup>8</sup> which considered three formal criteria—media source ( $\alpha = .99$ ,  $CR = .99$ ), media type ( $\alpha = .99$ ,  $CR = 1$ ), and type of author ( $\alpha = .80$ ,  $CR = .91$ )—and four content-related criteria for each trust cue:<sup>9</sup> the source providing the respective trust cue (e.g. journalists, scientists, or social media users;  $\alpha = .76$ ,  $CR = .85$ ), the source's gender ( $\alpha = .83$ ,  $CR = .89$ ), the level of each object of trust (i.e. micro, meso, or macro;  $\alpha = .74$ ,  $CR = .93$ ), and the gender of micro-level objects of trust ( $\alpha = .88$ ,  $CR = .92$ ).

To answer RQ1, we used descriptive statistics and chi-square tests. For RQ2, by contrast, we considered only micro-level codes that were clearly connected to female and male scientists (e.g. name mentioned or pronoun used). The categories “female,” “male,” and “other” were considered during the codebook's development and the coding process; however, no coding for “other” was performed.

**Table 1.** Sample overview.

Media sources	Checked sample		Study sample		Number of trust cues per media source		Average number of trust cues identified per media source
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
<b>Journalistic media</b>	1374	75.8	664	73.3	4.635	78.1	6.98
Public television (ARD Tagesschau, ZDF heute, Quarks, Gut zu wissen)	30	1.66	12	1.32	66	1.1	5.50
Private television (RTL Aktuell, Sat. I Nachrichten)	9	0.5	4	0.4	12	0.2	3.00
Print newspapers (Frankfurter Allgemeine Zeitung, Süddeutsche Zeitung, Spiegel, Zeit)	475	26.2	225	24.8	1461	24.6	6.49
Online newspapers (FAZ.net, SZ.de, spiegel.de, zeit.de)	666	36.8	324	35.8	2351	39.6	7.26
Tabloid newspaper (Bild, bild.de)	109	6.02	52	5.74	247	4.2	4.75
Popular special science magazines (Geo, P.M. Magazin, Spektrum der Wissenschaft)	85	4.7	47	5.2	496	8.4	10.55
<b>Right-wing populist, non-mainstream media</b>	72	4.0	36	4.0	266	4.5	7.38
Populist media (Epoch Times, Junge Freiheit, Compact)	72	4.0	36	4.0	266	4.5	7.38
<b>Social media</b>	123	6.8	67	7.4	139	2.3	2.07
Facebook (Wissenschaft aktuell, Harald Lesch Ultras, Fortschritt in der Wissenschaft)	57	3.1	32	3.5	68	1.1	2.13
Instagram (@doktorwissenschaft, @universumsfakten, @don. medicus, @diewissenschaftlerin)	6	0.3	4	0.4	5	0.1	1.25
X (c_drosten, dfg_public, BMBF_bund, helmholtz_de)	50	2.8	26	2.9	50	0.8	1.92
YouTube (MaiLab, Breaking Lab)	10	0.6	5	0.6	16	0.3	3.20
<b>(Non-journalistic) internet-based media</b>	243	13.4	139	15.3	892	15.0	6.43
Blogs (scienceblogs.de, scilogs.de)	27	1.5	15	1.7	61	1.0	4.07
News aggregators (t-online.de, web.de)	216	11.9	124	13.7	833	14.0	6.71
<b>Total</b>	1812	100	906	100	5932	100	6.55

### 3. Results

#### *Frequencies of trust cues (RQ1)*

In total, we coded  $n=5932$  trust cues. Most trust cues were identified in journalistic media, followed by Internet-based media, populist media, and social media, and the cues most often referred to the dimension of expertise, followed by integrity, benevolence, transparency, and dialogue.

Regarding the number of trust cues in relation to the amount of content from each type of media source, articles contained most trust cues in populist media, followed by journalistic media, further Internet-based media, and social media. However, a closer look revealed tremendous differences within the category of journalistic media; most trust cues were found in science magazines, followed by online and printed newspapers, public TV, and, trailing far behind, tabloid newspapers and private TV (see Table 1). The most common category of trust cues referred to qualification (i.e. dimension of expertise) and most often referred to the department or area of expertise and affiliation to an organization. Other categories of trust cues frequently referred to represented benevolence (i.e. social responsibility and benefits for society), integrity (i.e. scientific quality assurance and scientific standards and processes), and transparency (i.e. comprehensible language), as shown in Table 2.

*Dimensions of trust in science (RQ1a).* The trust cues differed significantly across media types,  $\chi^2(12, n=5932)=83.361, p<.001, V=.068$ . In journalistic media, most trust cues found referred to expertise, followed by integrity, benevolence, transparency, and dialogue. This order is also true for social media, but with a higher frequency of integrity and benevolence cues, whereas transparency and dialogue cues appeared less often. Meanwhile, although expertise cues were also the most frequent in populist media, benevolence cues were the second-most common, followed by integrity cues and, further behind, dialogue and transparency cues. That order described further Internet-based media as well, in which benevolence cues were also the second-most frequent (see Table 3).

*Levels (RQ1b).* Significant differences additionally emerged between the use of trust cues connected to scientists (i.e. micro level), scientific organizations (i.e. meso level),<sup>10</sup> and the science system (i.e. macro level) across different (digital) media,  $\chi^2(6, n=5932)=46.113, p<.001, V=.062$ . Overall, trust cues mostly referred to science at the micro level, followed by science at the meso level and science at the macro level, meaning that the science system was rarely addressed. At the same time, proportionally more trust cues referred to the macro and the meso levels on social media despite occurring in very few cases (see Table 3). Micro-level objects occurred with the greatest frequency in journalistic media.

In general, although each dimension of trust was identified at all levels, not all trust cues were found at each level. At the macro level, trust cues referring to academic education and professional experience (i.e. expertise), participation in public events and media presence (i.e. dialogue), and the accessibility of results (i.e. transparency) were not identified. At the meso level, only trust cues referring to academic education (i.e. expertise) were absent, whereas all trust cues were identified at the micro level.

*Sources of trust cues (RQ1c).* The sources of trust cues, namely journalism (e.g. journalists and news agencies), science (e.g. scientists and scientific organizations), and online actors,<sup>11</sup> differed across the media types,  $\chi^2(6, n=5552)=3570.726, p<.001, V=.567$ . Because journalistic content was the most prevalent type of media in the sample, journalism was unsurprisingly also the chief source of trust cues, followed by science and online actors. That ranking also held true when examining journalistic, populist, and other Internet-based media separately. On social media, online actors were the most common sources of trust cues, followed by science (see Table 3), and proportionally the greatest prevalence of trust cues from science was found on social media, followed by populist media. However, in absolute terms, science as a source was most common in journalism, thereby

**Table 2.** Overview of trust cues, superordinate categories, and dimensions of trust in science.

Dimensions	Categories	Trust Cues	Sample		
			<i>n</i>	%	
Expertise			2660	44.8	
	Academic education		53	0.9	
	Professional experience		28	0.5	
	<b>Qualification*</b>		<b>2579</b>	<b>43.5</b>	
		Academic degree	185	3.1	
		Reputation	78	1.3	
		Professional position	257	4.3	
		<b>Affiliation to an organization</b>	<b>1185</b>	<b>20.0</b>	
		<b>Department or area/discipline of expertise</b>	<b>874</b>	<b>14.7</b>	
	Integrity			1363	22.5
Independence			82	1.4	
			Client	27	0.5
			Funding source	37	0.6
			Interests	18	0.3
<b>Scientific quality assurance</b>			<b>318</b>	<b>5.4</b>	
		Correction/Revision	19	0.3	
		(Un)Certainties (& Limitations)	226	3.8	
		Peer review	14	0.2	
		Continuity/Permanence of research	58	1.0	
<b>Scientific standards and processes</b>			<b>963</b>	<b>16.2</b>	
		Legal framework for research	11	0.2	
		<b>Description (and explanation) of research processes</b>	<b>513</b>	<b>8.6</b>	
		Working conditions in science	16	0.3	
	Research collaboration	73	1.2		
	<b>Publication</b>	<b>351</b>	<b>5.9</b>		
Benevolence			1332	22.5	
	Ethical norms		19	0.3	
		<b>Social responsibility</b>	<b>679</b>	<b>11.4</b>	
		Research-related risks	5	0.1	
		Prediction	176	3.0	
		<b>Assessment of public events/current affairs</b>	<b>498</b>	<b>8.4</b>	
	<b>Benefits for society</b>		<b>634</b>	<b>10.7</b>	
		Social significance of science	19	0.3	
	Discoveries and breakthroughs	144	2.4		
	Applicability of results	240	4.0		

(Continued)

**Table 2.** (Continued)

Dimensions	Categories	Trust Cues	Sample	
			<i>n</i>	%
Transparency	Accessibility of results <b>Comprehensible language</b>	(Science-based) recommendations	197	3.3
		Personal reasoning for benevolent behavior	34	0.6
			373	6.3
			46	0.8
Dialogue	Participation in public events Media presence  Public engagement in research		<b>327</b>	<b>5.5</b>
			204	3.4
			17	0.3
		Journalistic media presence	175	3.0
		Direct media presence	104	1.8
		Further media presence	23	0.4
	48	0.8		
	12	0.2		

\*Frequencies of trust cues and categories of trust cues with a distribution  $\geq 5\%$  are in bold.

implying that source heterogeneity varied across (digital) media and, consequently, that trust cues may be used differently depending on the source of trust cues.

### *Gender of objects of trust (RQ2)*

To answer RQ2, we considered only micro-level codings, 26% of which were for female scientists ( $n=950$ ) and 74% of which were for male scientists ( $n=2684$ ).

*Dimensions of trust in science (RQ2a).* No significant difference emerged between the dimensions of trust in science addressed and the gender of the object of trust (see Table 4). That is, the most frequently addressed dimensions were the same for both genders: expertise, followed by benevolence, integrity, dialogue, and transparency.

*Trust cues (RQ2b).* Regarding trust cues and their superordinate categories, no significant gender differences were identified, meaning that female and male scientists were generally referred to in similar ways. Even so, examining the general distribution of trust cues could yield additional insights.

Overall, of all categories,<sup>12</sup> the following were most frequently mentioned for scientists: qualifications (i.e. expertise), social responsibility and benefits for society (i.e. benevolence), and scientific standards and processes (i.e. integrity).

Concerning trust cues, the most prevalent overall were organizational affiliation (i.e. expertise), department or area/discipline of expertise (i.e. expertise), assessment of public events or current affairs (i.e. benevolence), professional position (i.e. expertise), and descriptions (and explanations) of research processes (i.e. integrity).<sup>13</sup> On that basis, expertise seems to be the

**Table 3.** Frequencies of trust cues across (digital) media referring to dimensions of trust in science, different levels, and sources.

	Journalistic media		Populist media		Internet-based media		Social media		Total	
	n	%	n	%	n	%	n	%	n	%
<b>Dimensions of trust in science*</b>										
Expertise	2148	46.3	115	43.2	355	39.8	42	30.2	2660	44.8
Integrity	1086	23.4	53	19.9	185	20.7	39	28.1	1363	23.0
Benevolence	1001	21.6	64	24.1	234	26.2	33	23.7	1332	22.5
Transparency	283	6.1	15	5.6	61	6.8	14	10.1	373	6.3
Dialogue	117	2.5	19	7.1	57	6.4	11	7.9	204	3.4
<b>Levels of the object of trust in science*</b>										
Micro	3960	85.4	214	80.5	709	79.5	103	74.1	4986	84.1
Meso	626	13.5	51	19.2	174	19.5	30	21.6	881	14.9
Macro	49	1.1	1	0.4	9	1.0	6	4.3	65	1.1
<b>Total*</b>	4635	100	266	100	892	100	139	100	5932	100
<b>Type of source**</b>										
Journalism	3539	80.6	171	75.7	605	75.9	/	/	4315	77.7
Science	853	19.4	55	24.3	190	23.8	48	35.0	1146	20.6
Online actors	/	/	/	/	2	0.3	89	65.0	91	1.6
<b>Total**</b>	4392	100	226	100	797	100	137	100	5552	100

\*All codings were included in this calculation (n=5932).

\*\*Only sources that could be assigned to a type of source were included (n=5552).

**Table 4.** Frequencies of dimensions of trust in science, categories and trust cues, sources of trust cues, and gender of the sources.

	Female scientists		Male scientists		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<b>Dimensions of trust in science*</b>						
Expertise	546	57.5	1548	57.7	2094	57.6
Integrity	139	14.6	342	12.7	481	13.2
Benevolence	189	19.9	571	21.3	760	20.9
Transparency	30	3.2	110	4.1	140	3.9
Dialogue	46	4.8	113	4.2	159	4.4
<b>Categories of trust cues*</b>						
Qualification (Expertise)	528	55.6	1488	55.4	2016	55.5
Social responsibility (Benevolence)	95	10.0	297	11.1	392	10.8
Benefits for society (Benevolence)	93	9.8	268	10.0	361	9.9
Scientific standards and processes (Integrity)	106	11.2	224	8.3	330	9.1
<b>Trust cues*</b>						
Affiliation to an organization (Expertise)	231	24.3	596	22.2	827	22.8
Department or area/discipline of expertise (Expertise)	181	19.1	518	19.3	699	19.2
Assessment of public events/current affairs (Benevolence)	77	8.1	224	8.3	301	8.3
Professional position (Expertise)	56	5.9	196	7.3	252	6.9
Description (and explanation) of research processes	60	6.3	122	4.5	182	5.0
<b>Total*</b>	950	100	2684	100	3634	100
<b>Sources of trust cues**</b>						
Journalism	693	76.6	1899	74.6	2592	75.1
Science	203	22.4	641	25.2	844	24.5
Online actors	9	1.0	6	0.2	15	0.4
<b>Total**</b>	905	100	2546	100	3451	100
<b>Gender of sources***</b>						
Female sources	495	61.7	654	30.2	1149	38.8
Male sources	307	38.3	1509	69.8	1816	61.2
<b>Total***</b>	802	100	2163	100	2965	100

\*All objects of trust in science at the micro level for whom gender was evident were included ( $n = 3634$ ).

\*\*All sources at the micro level that could be assigned to journalism, science, or online actors and refer to female and male scientists were included ( $n = 3451$ ).

\*\*\*All sources and objects of trust in science at the micro level for whom gender was evident were included ( $n = 2965$ ).

dimension of trust in science most often referred to, whereas transparency and dialogue seem to play only a minor role.

*Sources of trust cues (RQ2c).* In general, all sources of trust cues referred to male scientists more often than female scientists in the context of trust in science. Furthermore, significant differences emerged regarding the sources of the cues and the gender of the object of trust,  $\chi^2(2, n = 3451) = 11.254$ ,

$p < .01$ ,  $V = .057$ : Journalistic media more often referred to male than female scientists, and those differences were similar for science as a source. However, this was not the case for online actors, who referred to female scientists more often than male scientists, even though there are fewer cases of online actors (see Table 4).

*Gender of sources (RQ2d)*. Significant differences also emerged between the gender of the source and the gender of the scientist referred to,  $\chi^2(1, n = 2965) = 244.357$ ,  $p < .001$ ,  $\phi = .287$ . In the overall analysis (see Table 4), most trust cues that were clearly attributable to a source pertained to men, with significantly fewer directed toward women. Furthermore, whereas female sources of trust cues referred to both female and male scientists with almost equal frequency, for male sources of trust cues, the situation is different: they referred mostly to male scientists and only in a few cases to female scientists. From another angle, most trust cues used for female scientists originated from female sources of trust cues whereas most trust cues for male scientists came from male sources of trust cues.

#### 4. Discussion

In our study, we investigated (digital) media as intermediaries of trust in science, with particular focus on the heterogeneity of digital media environments in terms of content, sources of trust cues, and objects of trust in science. In the process, we considered trust in science to be a multidimensional, multilevel construct and performed a quantitative content analysis of the most important sources that public audiences in Germany use to engage with science. Four of our findings merit sustained attention.

##### *Key finding 1: Overall, expertise was the dimension of trust in science most frequently referred to, although differences across (digital) media also emerged*

Our content analysis revealed that all dimensions of trust in science were addressed in all media types, with expertise cues being the most prevalent trust cues overall. As a consequence, exposure to expertise cues could exert the strongest trust-evoking impact on public audiences. At the same time, the dimensions of trust manifested to varying extents across diverse media types. Whereas social media placed greater emphasis on transparency and dialogue cues, populist and other Internet-based media prioritized benevolence as the second-most frequent dimension of trust in science. Thus, the media types emphasized different aspects, that is, dimensions of trust in content about science, and therefore media types are indeed heterogeneous in terms of their contents. That finding also implies varying effects of media types on audiences' trust in science.

##### *Key finding 2: Journalism is probably the most important source for trust cues*

Considering the *sources of trust cues* that we investigated (i.e. journalism, science, and online actors), journalism contributed most to trust cues overall; science surfaced as the second-most frequent source, followed by online actors. That pattern generally held across journalistic, populist, and other Internet-based media; even so, on social media, online actors were the primary source, followed by science. Because most media content in our sample comes from journalistic sources, it is unsurprising that most sources also came from journalism. By extension, journalism could be the most influential source for audiences' assessments of trust in science. The second-most

common source was science because scientists were (in)directly quoted, provided insights, or even contributed entire pieces (e.g. in blogs) as a means to discuss scientific topics. This implies that communication by science itself plays an important role in evoking trust. Interestingly, science more often featured in populist media than other types of media. We did not assess tonality, and thus no inferences about pro- or antiscientific communication could be made from the data. However, in the coding process, coders had the impression that populist media are not inherently against science but instead have their own experts and are hostile only to certain scientific topics (e.g. gender, COVID-19, and climate change-related issues). Based on our results, social media seem to provide more heterogeneity in sources of trust cues than other types of media.

### *Key finding 3: Trust cues mostly referred to scientists*

Concerning scientific objects of trust, trust cues predominantly pertained to science at the micro level, specifically to scientists. That finding suggests that tendencies toward personalization, as a noteworthy news factor in science media coverage (e.g. Amend and Secko, 2012; Guenther, 2019), could be transferred to other types of media as well. Nevertheless, on social media, trust cues more often related to the macro and meso levels than they did in other types of media. The increased emphasis on objects of trust in science at the meso level in social media may be attributed to the fact that organizations can communicate by using those platforms. However, the strong focus on the micro level in the sample prevented us from assessing whether different media types are heterogeneous in terms of objects of trust in science across the micro, meso, and macro levels. Nevertheless, individuals at the micro level potentially have the strongest impact on audiences' trust, with possible *spillover effects* to the meso and macro levels.

### *Key finding 4: Concerning trust in science, our sample showed that female scientists are underrepresented, although Internet-based media have the potential to change that*

Focusing on scientific objects of trust at the micro level, we did not identify any significant differences in the trust cues used and the dimensions of trust in science referred to between female and male scientists. Thus, female and male scientists were generally referred to in similar ways, even though how they were presented in terms of context and stereotypes may have varied (Schröder, 2025). Quantitatively speaking, however, women were underrepresented. Even so, such was not the case for online actors, who primarily referred to female scientists. Female sources of trust cues referenced both female and male scientists, albeit with men slightly dominating. The opposite, however, was true for male sources of trust cues, who referred to male scientists far more often than women. The gender of the sources of trust cues thus seems to have a major effect on the representation of female scientists in science media coverage, a finding that aligns with research showing the connection between the gender of the source and the scientists mentioned (e.g. GMMP, 2020; Kitzinger et al., 2008). However, findings with respect to the gender of the source can be partly explained by the fact that sources and objects of trust cues can be identical (e.g. a female scientist is quoted describing her academic education or a male scientist is quoted explaining his study). Nevertheless, journalism seems to mirror an imbalance in the scientific community, at least in Germany, namely that most individuals in the research landscape, especially in senior positions, are men (Nationale Akademie der Wissenschaften Leopoldina, 2022).

When linked to recent developments regarding public trust in science and its decline (e.g. Kennedy and Tyson, 2023; Weingart and Guenther, 2016), our findings show that different media

refer to trust in science in different ways and that contents, sources of trust cues, and objects of trust in science may be more heterogeneous on social media and to some degree also in populist and Internet-based media than in journalistic media. Although those outcomes do not clearly indicate any potential positive or negative impacts of (digital) media on trust in science, our findings do reveal variations in which types of (digital) media mediate trust in science.

Based on our findings, future research should focus on how audiences perceive trust cues used in content about science and how such perceptions, along with differences between female and male scientific objects of trust, affect them. At the same time, audiences do not access information from only one medium but from a variety of media that together form their media repertoire. For that reason, only the composition of an individual's media diet and the trust cues contained therein provide insights into the effects on trust in science. Future research should thus explore the extent to which exposure to trust cues in different media repertoires affects the stability or dynamics of trust in science within audiences (e.g. Guenther et al., 2024).

Beyond that, we identified trust cues solely at a textual level. To more precisely depict digital media and draw conclusions about the *mediated environment of trust (in science)*, scholars need to conduct expanded content analyses that include multimodal elements such as (audio) visual and platform-specific cues that could serve as further heuristics (e.g. Metzger and Flanagin, 2013).

### Limitations

Our findings come with limitations. The most crucial ones pertain to the sample, which was representative of the collected material but included only media mirroring the average media use by German publics (European Commission, 2021). Based on this media use, we chose exemplary media outlets and accounts and collected data from them during constructed weeks over the course of a year. Thus, only a selection of existing channels and accounts dealing with scientific content in social media were included. For that reason, although the data are representative of the overall data collected and of specific media outlets and accounts in our sample, they are not representative of media types in general (e.g. journalistic media in general).

In addition, regarding the content investigated, our analysis considered the textual level only, and the results pertain to science in general, not to specific scientific topics. For that reason, we could only approximate the content that audiences encounter about science in digital media environments.

Last, we considered trust cues to be trust-evoking and viewed trust and distrust as distinct concepts (e.g. Luhmann, 2014; Reif and Guenther, 2022; Resnick et al., 2015). Therefore, a separate analysis would be required to determine whether distrust can also be analyzed using those and/or different cues. Nonetheless, it is also possible that trust cues can be applied to alternative experts (e.g. in populist media).

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### ORCID iDs

Justin T. Schröder  <https://orcid.org/0000-0002-0132-9647>

Lars Guenther  <https://orcid.org/0000-0001-7760-0416>

### Data availability statement

The data that support the findings of this study are available from the corresponding author [JTS], upon reasonable request.

### Supplemental material

Supplemental material for this article is available online.

### Notes

1. Most authors agree that trust and distrust are distinct concepts that do not merely represent two ends of the same scale (e.g. Luhmann, 2014; Reif and Guenther, 2022; Resnick et al., 2015). In this article, we focus exclusively on trust-evoking cues.
2. Some studies have shown a positive relationship, particularly on social media (e.g. Huber et al., 2019), whereas others have reported a negative one, especially in the context of online media sources (e.g. Takahashi and Tandoc, 2016).
3. Because (digital) media not only serve as objects of trust (i.e. trusted by subjects of trust) but also function as intermediaries (e.g. Reif and Guenther, 2022), two distinct research traditions have emerged: one focused on media's credibility and views media as the object of trust, the other (i.e. media trust research) focused on media's role as an intermediary of trust (e.g. Reif, 2021). In that context, our focus is science as the object and media as intermediaries of trust, which aligns with the tradition of media trust research.
4. In the debate seeking to differentiate *trust* from *trustworthiness*, one proposal is that an object of trust can be *perceived* as being trustworthy, with trusting *behavioral intentions* defined as a willingness to make oneself vulnerable based on those perceptions (Mayer et al., 1995). Consequently, whereas the perception of science as the object of trust would exemplify trustworthiness, the behavior of a subject of trust based on such trustworthiness would exemplify trust. However, because trust cues focus on neither the subject nor object of trust but instead on information provided by intermediaries, neither the perception of the content nor the resulting behavior is investigated. Therefore, content-analytical trust research operates in the *limbo between trustworthiness and trust*. Because we understand such cues to be trust-evoking, we refer to trust cues instead of trustworthiness cues.
5. Even so, men do outnumber women in fields of science, as is also true in Germany (e.g. Nationale Akademie der Wissenschaften Leopoldina, 2022). To some extent, media replicate that imbalance.
6. We used MediathekView and OnlineTVrecorder for most TV newscasts and programs; Factiva for most print and online newspapers and magazines; FAZ Bibliotheksportal for Frankfurter Allgemeine Zeitung/FAZ.net; Google searches and manual savings for most of the populist media, blogs, and news aggregators; 4kdownloader for YouTube; manual savings for Facebook and Instagram posts; and TweetDownloader for Twitter (now X). Popular science magazines were purchased online.
7. For print and online newspapers, populist media, blogs, and news aggregators, we used “wissenschaft\*,” “studie\*,” “forsch\*,” “universität\*,” and “institut\*” (in English: “scien\*,” “stud\*,” “research\*,” “universit\*,” and “institut\*”) to retrieve material likely to contain scientific content (see also Guenther et al., 2019).
8. Four coders repeatedly coded the same media contents and subsequently discussed them. By way of those discussions, ambiguities were resolved, and the codebook was refined. Once a unified understanding was

established, a pretest was conducted for reliability testing by coding 25 contributions and calculating reliability values. Weaknesses were examined more closely and discussed again. Last, a reliability test was conducted with 100 randomly selected pieces of media content.

9. We used Krippendorff's alpha ( $\alpha$ ) and Holsti (CR) to assess intercoder reliability.
10. For the meso level, we further differentiated universities and university research (54%,  $n=1603$ ) from non-academic research institutions (18%,  $n=537$ ), government institutions (6%,  $n=164$ ), and private sector research (2%,  $n=56$ ). In total, 20% ( $n=605$ ) of all meso-level codings could not be clearly associated with one of those categories.
11. Because online actors outside journalistic and scientific fields can be clearly distinguished from actors in those fields, they were grouped together despite being heterogeneous. Online actors included all individuals from social media and other Internet-based media, including interested groups of online users, bloggers, science influencers, science-related governmental organizations, and science funding organizations.
12. Only categories  $\geq 5\%$  in the overall sample are mentioned here.
13. Only trust cues  $\geq 5\%$  in the overall sample are mentioned here.

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### Author biographies

Justin T. Schröder (MSc) is a research associate at LMU Munich's Department of Media and Communication (IfKW), Germany, with a focus on science communication. In addition, he is perusing his PhD at the University of Hamburg, Germany.

Lars Guenther (PhD) is Professor of Communication Science at LMU Munich's Department of Media and Communication (IfKW) in Germany, and Research Fellow at the Center for Research on Evaluation, Science and Technology (CREST) at Stellenbosch University in South Africa. He is interested into public perceptions of (controversial) science, science and health journalism, trust in science, as well as the public communication about risks and scientific (un)certainty.

## Codebook

### "Trust Cues for quantitative coding of media content about science"

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Justin T. Schröder<sup>a,b</sup> & Lars Guenther<sup>a</sup>

<sup>a</sup>Department of Media and Communication, LMU Munich, Munich, Germany

<sup>b</sup>Institute for Journalism and Communication Studies, Universität Hamburg, Germany

Correspondence concerning this article should be addressed to Justin T. Schröder, Department of Media and Communication (IfKW), Ludwig-Maximilians-Universität Munich, Germany, Akademiestraße 7, 80799 Munich, Germany, E-mail:

[justin.schroeder@ifkw.lmu.de](mailto:justin.schroeder@ifkw.lmu.de); ORCID: 0000-0002-0132-9647. Additional contact details:

Lars Guenther ([lars.guenther@ifkw.lmu.de](mailto:lars.guenther@ifkw.lmu.de); ORCID: 0000-0001-7760-0416).

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## General information

Within the DFG project "The Trust Relationship between Science and Digitized Publics" (TruSDi), we want to quantify so-called *trust cues* in content about science. These trust cues emerged from qualitative coding and are used here to answer research questions such as:

- (1) What trust cues can be identified in content about science?
- (2) How are trust cues distributed across the different dimensions of trust?
- (3) How do trust cues differ with regard to different levels of trust?
- (4) How do trust cues differ with regard to the various media involved (journalistic, social, and populist)?

First of all, the following *definitions* are relevant:

**Trust cues** are defined as linguistic markers (Bentele, 1994; Reif, 2021; Schäfer, 2016), i.e., cues that can be used to judge whether scientists, their institutions, and science as a system can be trusted. Thus, they become indicators of whether and how much trust should be placed in science. We cover the fact that the objects of reference can be individual scientists (micro), their institutions (meso), or the system of science (macro); therefore, we consider **levels of trust**. Based on the current state of research, we also include five **dimensions of trust**: expertise, integrity, benevolence, transparency, and dialogue (Bentele, 1994; Fiske & Dupree, 2014; Hendriks et al., 2015, 2016; Reif, 2021; Reif & Guenther, 2022). These trust dimensions form the construct trust. Trust cues can thus refer to different levels and dimensions (and express themselves differently in journalistic, social, and populist media).

The units of analysis are *contents about science*. This can include, for example, a whole journalistic article (including the headline), a post, a blog entry, or a transcript of a (news) program. In the case of TV contributions, the belly bands are not considered. Likewise, images and infographics are not included in all other media materials, i.e., (science) magazines, captions, cross-references, info boxes, and infographics are also not coded. This is also true for social media posts; here, no images or videos, including the text in them, are coded. The coding unit can be a single word, a chain of words, several sentences, or even entire text blocks. It is likely that several sentences of a contribution will be coded and will accordingly contain a trust cue and its context. The length of the coding unit depends on the respective trust cue and its content complexity. Consequently, coders must be specifically trained to identify these cues.

The criteria for the relevance of a contribution is therefore (1) that there is a scientific object of trust with a reference to the levels of trust, i.e., it is on the macro (system), meso (institutional), or micro (individual) level, and (2) there is at least one trust cue in the sense of the dimensions of trust. If this is not the case, the contribution is not relevant for this coding.

General coding instructions include reading posts at least three times. The first reading is for comprehension and overview. Formal categories are coded after the second reading; at that

time, it is also determined whether the contribution is relevant. After the third reading, the remaining content categories are coded.

**Attention:** Please only code when there is enough time and the person coding is able to fully concentrate. This also comprises background noise. Questions will arise, especially at the beginning, so the following applies—please ask one more time, instead of not asking! Since these are contributions about scientific contents and we are not always all familiar with the respective terminology, unclear terms can be googled. However, please keep in mind that the primary goal is to code the articles as ordinary recipients would perceive them. Therefore, the first page of Google results should be sufficient to get a quick overview.

### **Formal categories**

Formal categories are located at the level of the contribution. They can be coded after the second reading of the post.

#### **(1) Contribution ID**

Each contribution has a unique ID that is given by the study leaders. This ID can be adopted openly.

[open: ID]

The post ID follows the logic: "number of the constructed week (here: KW)\_Date\_numbering," e.g., KW1\_21032022\_0001. It will also be the file name of the corresponding post.

#### **(2) Coder**

This concerns ensuring that each coding person is given a unique identifier.

- 1 Justin Schröder
- 2 Janise Brück
- 3 Miriam Wollenweber
- 4 Sarah Zimmermann

#### **(3) Relevance**

Here, it should be stated whether the contribution is relevant for coding. As specified, this is the case if (1) a scientific object of trust with a reference to the levels of trust is included, and (2) there is at least one trust cue in the sense of the dimensions of trust.

- 0 Not relevant
- 1 Relevant

If the contribution is not relevant for coding (code 0), then the coding is stopped at this point.

#### **(4) Medium**

In this category, the respective medium is of more specific interest.

- 1 ARD Tagesschau
- 2 ZDF heute
- 3 RTL Aktuell
- 4 Sat.1 Nachrichten
- 5 WDR Quarks
- 6 BR Gut zu wissen
- 7 Frankfurter Allgemeine Zeitung
- 8 Süddeutsche Zeitung
- 9 Spiegel
- 10 Zeit
- 11 FAZ.net
- 12 SZ.de
- 13 spiegel.de
- 14 zeit.de
- 15 Bild
- 16 bild.de
- 17 Geo
- 18 P.M. Magazin
- 19 Spektrum der Wissenschaft
- 20 Epoch Times
- 21 Junge Freiheit
- 22 Compact
- 23 scienceblogs.de
- 24 scilogs.de
- 25 t-online.de
- 26 web.de
- 27 Wissenschaft aktuell
- 28 Harald Lesch Ultras | Leschmolit:innen | Wissenschaft erklärt
- 29 Zukunft - Fortschritt in der Wissenschaft, Forschung, Natur und Technik
- 30 doktorwissenschaft
- 31 universumsfakten
- 32 forschungswelt
- 33 don.medicus
- 34 diewissenschaftlerin
- 35 c\_drosten
- 36 dfg\_public
- 37 BMBF\_bund
- 38 helmholtz\_de
- 39 MaiLab
- 40 Breaking Lab

### **(5) Media type**

The underlying media type of the contribution is recorded here. We distinguish between four different media types:

- 1 Journalism (television, [online] newspapers, tabloids, science magazines)
- 2 Populist media
- 3 Online media (blogs, news aggregators)
- 4 Social media (Facebook, Instagram, X / Twitter, YouTube)

This digit will be filled in automatically by the Excel coding as soon as the code for (4) has been assigned. Nevertheless, please make sure to double check this digit.

### **(6) Author**

By including many different media, we also distinguish authors. Authors are all listed actors after the "by," or everything in the author line.

- 0 Not (clearly) identifiable
- 1 Journalist (including news anchors and presenters)
- 2 News agency
- 3 Scientist
- 4 Scientific institution
- 5 Influencer
- 6 Social media user
- 7 Politician
- 8 Blogger
- 9 Other

The authors can usually be derived from the respective mediums; however, there are exceptions, such as scientists who publish guest articles in journalistic mediums. For this reason, we will take a closer look at (additional) information about the authors. While scientists (3) and politicians (7) are straightforward, further information/explanations are needed for the other author groups.

All authors who cannot be clearly identified or derived are coded with (0). This also includes several authors who belong to different groups, or if no author is named (except, for example, the medium itself). The (1) journalists also include authors of science magazines or populist media, as long as they are not clearly named as part of another group, e.g., scientists. In addition, news anchors and presenters belong to journalists.

If an abbreviation is given as the author, it may be a news agency (2). There is a list of news agency abbreviations in the appendix of this codebook that is to be used for verification at appropriate times.

Scientific institutions (4) are all research institutions, including funding organizations (e.g., DFG, BMBF).

Influencers (5) are considered here as science influencers and appear on YouTube (specifically, MaiLab, Breaking Lab) and Instagram (specifically, doktorwissenschaft, don.medicus, diewissenschaftlerin). The Instagram accounts "universumsfakten" and "forschungswelt" are exceptions, since no authors can usually be identified there; consequently, 0 is coded.

Social media users (6) are Facebook users (specifically, users who share posts in the groups "Wissenschaft aktuell," "Harald Lesch Ultras | Leschmolit:innen | Wissenschaft erklärt," and "Zukunft - Fortschritt in der Wissenschaft, Forschung, Natur und Technik").

A special feature is the use of Twitter; here, both scientists (c\_drosten) and scientific institutions (dfg\_public, BMBF\_bund, helmholtz\_de) appear.

(8) Bloggers include people who are not specifically named as scientists (or as part of another group) who publish articles on science blogs.

### **(7) Subject**

There are a variety of scientific topics; therefore, we openly collect the respective topic of the contribution here:

[open: subject]

Good orientations to determine the topics are headings, leads, or even the affiliations of presented scientists.

### **(8) Reference to climate issues and COVID-19**

The subject of the contribution will specify whether it relates to climate issues or to COVID-19. The main subject of the contribution does not have to be COVID-19 or climate change, but the contribution will be related to them with references or examples. However, the terms "Klimawandel," "Klimakrise," "Pandemie," "Corona," "SARS-CoV-2," and/or "COVID-19" (English: "climate change," "climate crisis," "pandemic," "Corona," "SARS-CoV-2," and/or "COVID-19") must be *explicitly* mentioned. Environmental pollution is not an equivalent of climate change.

- 0 Not (clearly) identifiable/no reference
- 1 Climate reference
- 2 COVID-19 reference
- 3 Both climate and COVID-19 reference

### **(9) Scientific discipline**

The respective identified topic is now assigned to a scientific discipline. Under (1) Humanities, research on historical events is coded. Economic topics are coded under (2). For some subjects, the boundaries between natural sciences and medicine are diffuse. In order to make the boundaries clearer, natural sciences are understood as a greater picture, while medicine focuses on the health/disease of humans (and animals). To distinguish between (4) engineering/technology and (5) natural science, basic research (e.g., basic research in physics, such as magnetism, or the work at CERN) belongs to (5) natural science, and practical

applications belong to (4) engineering/technology (even if physical aspects play a role here, e.g., motors, machines, or artificial intelligence). If it involves interdisciplinary topics with no clear focus, (0) is coded. Other disciplines not covered by the coded categories are assigned to (6).

- 0 Not (clearly) identifiable
- 1 Humanities
- 2 Social sciences
- 3 Medicine
- 4 Engineering/technology
- 5 Natural sciences
- 6 Other

### Content categories

The content categories now refer to the trust cues; in the event of uncertainty, it is not about the whole contribution, but about specific passages within the contribution. The coding of the content categories follows the logic of a *coding chain*. First, a trust cue is identified, and it is followed by additional categories (described below) that are coded for that trust cue. When a new trust cue is identified, the coding chain must be run again. If multiple passages refer to the same trust cue, all posts in the contribution will be considered in the coding. In some cases, there will be passages that contain multiple cues; **these should then be coded multiple times**, accordingly. It is possible to assign the same cues several times in a row if the reference object (i.e., the object of trust) changes or a different specification is addressed (e.g., Cue 335, where the goals of research can be addressed one time and the research process itself can be addressed another time—the cue would be coded twice.). However, if the trust cue, the expression, the trust object, or the author do not change, the coding is always done chronologically; the first corresponding passage is relevant for coding, and the following passage (related to the entire unit of analysis) is ignored. If several specifications occur in one sentence, they are considered and coded individually, since it is a matter of content separation. The specifications of trust cues are numbered in (10), in the respective definitions of the cues. In general, prior knowledge in the sense of the chronology of the text is considered (e.g., an institutional affiliation that is not continuously mentioned in the further course of the article). Likewise, information that is only provided in the later course of the article can be added retroactively (see also the institutional affiliation mentioned in the later course that refers to a previously mentioned trust object).

Thus, the text is thought of as a unit. The corresponding text passages and phrases to which the cues are attached are underlined in the following examples. The cues listed under (10) are sorted hierarchically: The 100, 200, 300, 400, and 500 stand for the dimensions of the highest level. One level below are the categories (e.g., 110, 120, 130, etc.). The categories are groupings of trust cues, which in turn form the smallest unit (e.g., 131, 132, 133, etc.). **When coding (10), the smallest unit is always coded.** In some cases (such as category 110 Academic

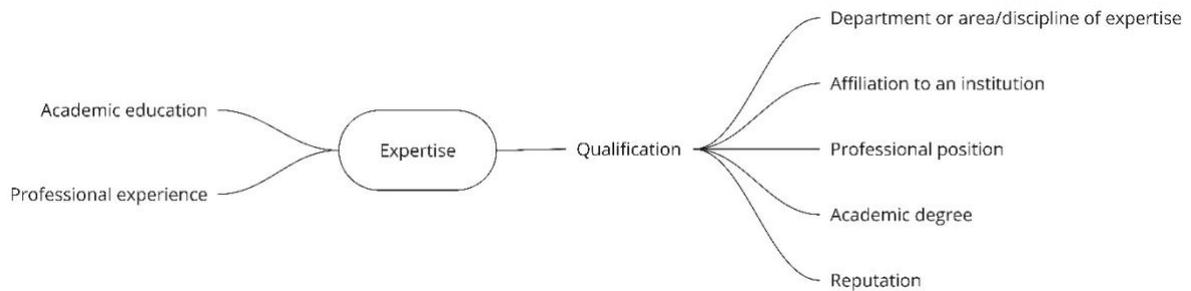
Education), there is no smaller unit than the category itself; in that case, the code for the category is assigned accordingly under (10) (e.g., 110, 120, etc.). The codes to be assigned in each case are bolded below. After the trust cues (or the categories) have been coded under (10), further boxes for the superordinate category and for the corresponding dimension (see also (11)) are filled in automatically. Nevertheless, these should always be checked! All codes must be **explicitly** addressed in media content in order to be coded. The following applies in the case of the reference point for coding. Different terms for general groups/persons are grouped together; "female and male researchers and scientists" are the same as "researchers." At this point, the object of trust would not change.

## (10) Trust Cue

Here, we code the respective identified trust cue in the following expressions.

### Expertise

Expertise denotes the function and ability of science, scientific institutions, and scientists to identify, analyze, and/or solve problems based on specific knowledge and experience, education, and qualification in the field of research.



### Expertise Cues (100er)

**110 Academic education:** refers to the academic education of scientists, including the (ongoing) doctorate, but not the student status. Example: *“Benjamin Breitenbach studied biomedical chemistry in Mainz in 2009 including a research stay at the University of Auckland, New Zealand. During his PhD at Johannes Gutenberg University Mainz, he investigated nanodimensional polymer therapeutics in the field of drug delivery.”*

**120 Professional experience:** refers to the professional (work) experience of scientists in non-academic fields. Work experience refers to an additional activity (the reference can be "works for") besides the research-related profession (this is not coded as work experience, e.g., "works as a researcher"). Example: *“Lisa Kainz is 33, an agricultural scientist, and works for the animal rights organization Peta in Stuttgart.”*

**130 Qualification** (please code only sub-expression)

**131 Department or area/discipline of expertise:** refers to the field/discipline in which a scientist has expertise, as well as the specific field mentioned. If corresponding terms occur more than once, they are coded only once (e.g., "the astronomers"), unless it is clearly evident that different persons are described with the same technical term. The mere mention of a research or subject area at the macro level is not sufficient to be coded here (e.g., "astronomy"). Furthermore, the code is not assigned if the research or subject area is part of a name (e.g., if institutes occur as objects of trust at the meso level, such as subject-specific Leibniz or Max Planck Institutes). Examples: *“Professor Jürgen Schmude, tourism researcher at LMU*

*Munich, who has studied how strongly climate change is affecting German ski resorts.*"

*"The epidemiology group led by Fabian Leendertz, now director at the Helmholtz Center, has been in Central Africa looking at all those animals - and taking appropriate samples to the lab ..."*

*"Agricultural meteorologist Mathias Herbst of the German Weather Service (DWD) ..."*

*"... For more than 25 years, the graduate engineer has been conducting research in the field."*

**132 Affiliation to an institution:** refers to the affiliations of scientists to an institution, as well as to the subdivisions of larger institutions. Example: *"Jörg Peltzer is Professor of Comparative Regional History in European Perspective at the University of Heidelberg and British Academy Global Professor at the University of East Anglia, Norwich, UK."*

**133 Professional position:** refers to the specific professional positions of scientists. Here, a specific role of a person must be mentioned, such as a leadership position, or similar; it is not about the profession (e.g., "doctor," or "researcher"). This position can also be described by means of a verb (e.g., someone is in charge of something). Example: *"Not isolated cases at all", says Professor Günther Ziegler, President of the Free University of Berlin."*

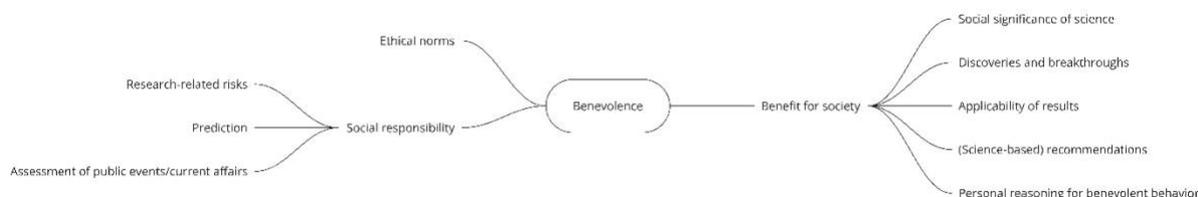
**134 Academic degree:** refers to the academic degrees of scientists. Example: *"However, Professor Kai Wirtz, head of the study, assumes that the phytoplankton actively migrates. In the process, it absorbs CO<sub>2</sub> in the upper water layers and can take up nutrients in the lower layers. The mini-algae need both."*

*"She is a Professor."*

**135 Reputation:** refers to specifically named aspects that reflect the images of scientists or a scientific institution, such as (1) various forms of (symbolic) recognition, (2) prizes, (3) nominations and awards, including competitions, (4) the prominence of a person, or (5) succession to prominent (and prestigious) positions. For this purpose, the win, a placement, or a nomination must be mentioned; a call or participation is not sufficient. Explicit mention of not winning is also coded. Linguistic emphasis on reputation (e.g., "the renowned scientist") is also coded. In addition, the code is assigned when it is emphasized that institutions or scientists are distinguished by having discovered something (or someone is recognized for something, which is not the same as when it is emphasized that something special was done). Example: *"Bernd Rendel Prize 2022 for #Geology: For their promising, original #research at the beginning of their careers, the #DFG honours @DirscherlMariel & @BourgonNicolas. The prize will be awarded in September at the annual meeting @DGGV\_de - Congratulations! 🍷 <https://t.co/OKzkPveMtO> <https://t.co/HHVWGsFibW>."*

## Benevolence

Benevolence denotes science, scientific institutions, and scientists serving the common good. This includes the orientation towards ethical norms and moral values as well as the social responsibility that scientific knowledge aims for positive impacts on the world and society.



### Benevolence Cues (200er)

**210 Ethical norms:** refers to both considerations and discussions and standards about ethical issues related to science and, in a broader sense, to (1) scientific misconduct, (2) animal testing, and (3) the unethical use of scientific information. This concerns concrete ethical considerations, and the connection to science must be given, i.e., even if animal testing is mentioned, the ethical discussion about it must be in focus. Merely mentioning "animal testing" is not sufficient to be coded here. Example: *"Bill Gates has maintained close contacts with the Chinese Communist Party for 30 years. A recent donation is intended to help the regime bring foreign scientists and the necessary know-how into the country. This is not an isolated case; Germany's universities are also helping Beijing to become a military superpower."*

### 220 Social responsibility (please code only sub-expression)

**221 Research-related risks:** refers to risks to the public associated with research in general and scientific processes or risks from scientific information; however, they must necessarily result from the research. This also includes minor risks in research; they may include side effects of drugs. It is important that the risks be specifically named; a vague "there could be risks" is not sufficient here. Reference points for the risks are ecosystems/environment and also study participants, but always from research. Example: "The ocean could play a key role in geoengineering." The problem: *"Even the scientific field tests are considered by many to be too risky for the ecosystem because no one can estimate the consequences. The question is: How do we get scientific certainty without conducting the experiments?"*

**222 Prediction:** refers to the prediction of (1) possible *future* events, or (2) outcomes based on scientific information/knowledge that lies in the future. It must be a concrete description of what is to happen in the future; a vague "let's hope" is not sufficient for a future forecast. The reference to the future must be clearly established here, and it also serves to distinguish it from code 223 (reference to the present). In addition, it must be a clear description/statement; vague assumptions or

derivations (e.g., when addressing "nuclear power models") are not coded here (negative example: "Many dark particles in the ice could lead to it absorbing more sunlight and melting faster"). Example: "Over the next 65 years, between 25 and 40 percent of these crusts will disappear, says Emilio Rodriguez-Caballero, who was involved in the study and now works at the University of Almeria."

"And it should only be a matter of time before astronomers can announce the discovery of a terrestrial twin."

**223 Assessment of public events/current affairs:** refers to scientific assessments that evaluate specific public events and/or current affairs (such as elections, disease outbreaks, fish kills in the Oder River) that are within, but also outside, their specific research areas. This also includes the current assessment in process descriptions, even if infectious disease numbers/case numbers are decreasing/increasing (reporting numbers without classification, however, is not sufficient; see the subsequent description). In addition, this code is *not assigned* for presentations of results without classification; there must be an *explicit* classification, evaluation, or transfer to public events or current social issues. Here, a reference to the present or the past (e.g., "what would have happened if ...", or "even in this country, there is already good immune protection") must be established (a reference to the future indicates code 222). These assessments must be described, but not followed directly (e.g., mention that an assessment is made). Example: "The report 'sends a clear warning that the energy transition is not happening,' explained the Thinktank REN21, which designed the study."

"... the largest hunting dinosaur ever discovered in Europe."

**230 Benefit of society** (please code only sub-expression)

**231 Social significance of science:** relates to aspects of the importance of science for society in the past, present, and future. Example: "The well-being of patients – and to some extent also of healthy people, for example when it comes to vaccinations – should be at the center of medical research."

**232 Discoveries and breakthroughs:** refers to new research results, discoveries, and the success associated with them. However, it does not have to be a discovery *with* a great success, but the success should be directly related to discoveries and breakthroughs. The great success or the special feature must be named as such. In principle, all different discoveries are included in the unit of analysis—unless they are declared as not special, for example, because they are part of the daily business of research (e.g., when researchers discover new planets "constantly"/"daily"; this also includes "heat records"); these are not relevant for coding here. This is also true the other way around: research results that were "surprising" do not necessarily equate to discoveries, breakthroughs, or milestones in research if they are not declared as such later on. Discoveries are often introduced with "find." Example: "It sounds like a miracle: In a colorectal cancer study at the Memorial Sloan Kettering Cancer Center

*in New York, 14 out of 14 participants were cured. Without chemotherapy, radiation or surgery, just with the immune agent Dostarlimab.”*

**233 Applicability of results:** refers to the applicability (and significance) of scientific findings to the everyday life and lifeworld of non-scientific parts of the public—for example, concretely for individuals (e.g., “We have to stay at home.”). This also includes findings from medicine (e.g., that something can save lives, more people can survive, etc.). Concrete actions or recommendations for action are more likely to be coded at (234). Example: *“But according to a new study, environmental pollution, for example, is responsible for nine million annual deaths. This means that substances such as those mentioned above contribute to one of the greatest risks to our health.”*

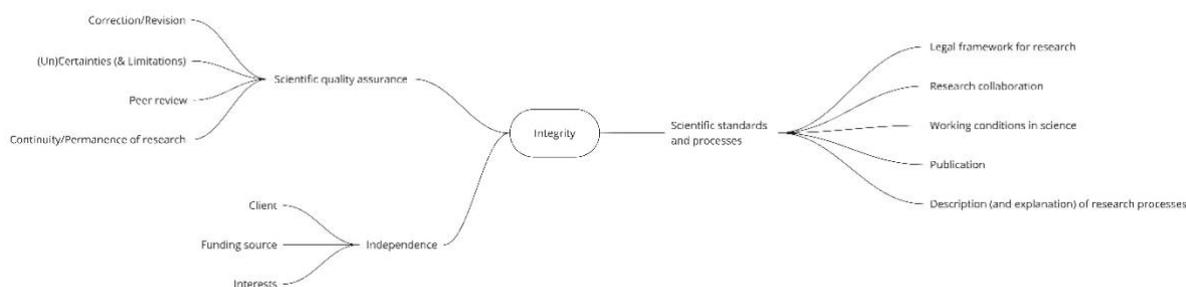
**234 (Science-based) recommendations:** refers to advice based on scientific information and originating from science. They include scientific claims and concrete, practical recommendations for action to external parties. This refers to the public, politics, and science, and scientific advice for politics. Example: *“That the federal government is now abandoning the mask requirement in these days of all times is, in Brinkmann’s opinion, wrong. ‘This is a bit too early. I would have found it very useful to keep certain measures in place. These clearly include testing and also the wearing of masks.”*

*“Drosten also gave behavioral advice suitable for everyday life at the time, such as staying outside a lot, not suspecting an infected person around every corner and drinking beer from the bottle better ....”*

**235 Personal reasoning for benevolent behavior:** refers to scientists' personal motives for benevolent behavior toward the public/parts of the public and/or individuals. These include (1) motivation, (2) selflessness, (3) emotionality in relation to research, and (4) biography (if it explains the reasons for working in science). These must be explicitly stated. Example: *“That afternoon I quit my job as a lawyer and returned to the world of medical research. ‘That day I made the decision to leave no stone unturned to solve the mystery of sudden infant death syndrome’, Harrington writes on a crowdfunding page of the Sydney Children’s Hospital Foundation, which helps her fund her research.”*

## **Integrity**

Integrity denotes the assurance of objectivity and reliability by adhering to scientific standards and processes. This includes the appropriate use of methods, independence from external expectations/interests, and maintained quality assurance.



## Integrity Cues (300er)

### 310 Independence (please code only sub-expression)

**311 Client:** refers to the client of the research (usually in contract research). Example: *“Stefan Wuchty, actually a bioinformatician, is working on real-time prediction at the University of Miami on behalf of the US Department of Defense.”*

**312 Funding source:** refers to the disclosure of financial resources in research. These resources or sources must be named specifically (e.g., “the pharmaceutical industry” is not sufficient). The point of reference here is always the object of trust that is (not) being funded. Example: *“The Macroeconomic Policy Institute (IMK) warns of serious economic consequences of a gas supply freeze. The trade union-affiliated institute, which is financed by the Hans Böckler Foundation, has calculated various scenarios for this in a publication to be published on Tuesday.”*

**313 Interests:** refers to the (in)dependence on economic and social intentions and demands of any kind in connection with science that affect its integrity. This also includes the fact that science takes place or does not take place, e.g., due to economic interests (“influence on science and research”). The point of reference must always be science; it is not about the interests of other people or the public as such. Example: *“A current example is the results of a study published in the ‘New England Journal of Medicine’ (NEJM) on the safety and efficacy of the third vaccination against COVID-19 with the Pfizer/Biontech vaccine. As the methods section unmistakably reveals, the responsibility for the study was entirely in the hands of the vaccine manufacturers. The two companies did not even have to bother to hide their omnipresence behind a known figure from medicine.”*

### 320 Scientific quality assurance (please code only sub-expression)

**321 Correction/Revision:** refers to the adjustment and correction of *scientific* information and procedures to ensure scientific quality. This is not about applications (e.g., that babies were used in experiments in the past and not today), or about mere criticism of research (results); it is about the concrete correction/revision of research (results). Corrections and revisions of non-scientific information (e.g., political statements) are not relevant for coding—these could possibly be coded at 223, 233 or 234, depending on the context. Example: *“In concrete figures from the BA, there is a pay gap of 42.4 per cent between full-time employees, who earn an average gross salary of 3,347 Euros, and temporary workers, who earn 1,928 Euros. This*

*comparison, however, is criticized by the study authors. They argue that the BA only collects its values up to the contribution measurement limit and thus the data is distorted.*

**322 (Un)Certainties (& Limitations):** refers to aspects of (1) certainty (often introduced by verbs, such as "support," "prove," or "confirm") as well as (2) uncertainty, and (3) limits/restrictions of concrete research. Limitations are not meant in the sense of the limits of research in general. Example: *“The IMK criticizes that the model used by colleagues neglects ‘many of the channels that we know were central to the depth and duration of the collapse in economic activity in past crises.’”*

**323 Peer review:** refers to the existence and process of evaluating a manuscript before it is published. Example: *“In fact, neutral peer review of scientific papers by independent researchers is a fundamental aspect of scientific publications.”*

**324 Continuity/Permanence of research:** refers to research that is conducted on a continuous and/or long-term basis, including longitudinal studies and regularly repeated studies/outcomes. The act of research and/or the results must be in the foreground. It is about a period of time ("for years they have been struggling with one problem in particular") and not about research that took place at a point in time in the past ("10 years ago"). This also includes when data has been collected over a longer period of time and is now being evaluated. Example: *“This is what researchers at the University of Birmingham found out. For the study, the data of 3818 men were observed over 12 years.”*

**330 Scientific standards and processes** (please code only sub-expression)

**331 Legal framework for research:** refers to the regulatory context, which provides orientation for science through frameworks and laws, as well as to debates about the legitimacy of scientific research. Conditions that research must fulfill/adhere to (e.g., researchers must present a protection concept to comply with data protection) are also coded here. (The [non] approval of drugs does not belong to this category). Example: *“The question is whether the federal government will play along at all. So far, climate protection interventions in the marine environment have been strictly regulated. The so-called ‘Hohe-See-Einbringungsgesetz’ does not even allow field experiments, which is why scientists run experiments in tanks or go to the marine areas of other countries. ‘We would not even be allowed to bring minerals into the Baltic Sea with a salt shaker,’ says Riebesell.”*

**332 Research collaboration:** refers to scientific cooperation between two or more research groups that are working together on a project/study. Possible cooperation partners relevant for code assignment here must be part of the groups listed under category (13), i.e., universities or university research, non-university research institutions, government institutions, or private-sector research (it must be emphasized here that these must necessarily be private-sector research units and not companies in general). Example: *“The scientists led by Peter Kolb and Moritz”*

*Bünemann, together with colleagues from Canada, have investigated so-called G protein-coupled receptors (GPCR)."*

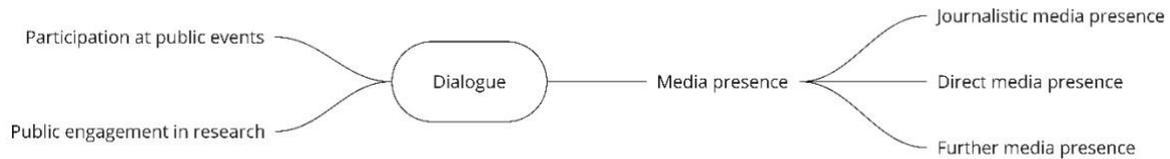
**333 Working conditions in science:** refers to the working conditions of scientists as well as to the overall assessment of working in science. Example: *"Today, more than eighty percent of the qualification positions are temporary. As a result, even after mastering all qualification levels, the grotesque alternative awaits at the end: professorship or unemployment. And this at the age of about forty."*

**334 Publication:** refers to the publication of research results such as studies, but also to references and source citations. Here it is about explicitly named publications, i.e., the publication(s) form or location (journal), but also when the act of publication is mentioned (e.g., when NASA publishes images, also "a recently published study"), related to an object of trust. This trust cue is often introduced with the verb "publish." Merely mentioning the word "study" is not sufficient (even if it implies some kind of publication). This is also where source citations are coded at the end of a post (if multiple sources are listed, we assign this code once). Example: *"This was reported by a team led by Joachim Schüz from the International Agency for Research on Cancer (IARC) in Lyon in the 'Journal of the National Cancer Institute.'"*

**335 Description (and explanation) of research processes:** refers to the description and/or explanation of research processes that provide further knowledge; for this, it is sufficient to mention a concrete action that is part of the research process ("For this purpose, the researchers mapped the galaxies"). For this, (1) a method, a process, or (2) a goal must be explicitly indicated (for data analysis: calculate, analyze, test); they must not be unspecific or metaphorical (negative examples: "dig through the data to show how something works," "identify"). The code also includes the objective of the research, it is part of the research process, and it is usually indicated as "to do/discover something" or as a "promise" (more concretely, it answers what one wants to achieve/what the goal is). The goal must be explicitly stated and not implicitly inferred (Negative example: "A large study from Israel now provides further data on how effectively the fourth dose of vaccine protects against coronavirus infection as well as severe COVID-19 disease."). Descriptions away from specific research projects, such as open questions in research disciplines or general research interests, are not relevant to coding here. This also applies to the mention of a scientific result per se; it is not relevant for coding. Example: *"Kolb and Bünemann's team used an algorithm to search for new binding sites in the structures of 113 different GPCR proteins. In doing so, they found several 'pockets' that have not been used as drug targets so far."*

## Dialogue

Dialogue denotes that science, scientific institutions, and scientists participate in and enable interaction with, and engagement by, different publics. Activities and measures range from public lectures and discussions to citizen science projects.



### Dialogue Cues (400er)

**410 Participation at public events:** refers to the participation of representatives of science in public events organized by scientific or non-scientific persons or institutions. Example: *"The 'Science Day' is the start of seven events in the MUG's anniversary year."*

**420 Public engagement in research:** refers to the participation of the public/parts of the public in research processes, apart from being part of the investigation. This also includes citizen science. Example: *"Initially, about 11,500 volunteer lay scientists helped identify evidence of asteroids in the more than 37,000 composite images."*

**430 Media presence:** refers to the willingness for media presence and the concrete participation of science in the media, such as a mention of an interview (also in press materials), and participation in a talk show, podcast, or presence in social media. Different media/platforms are considered one, unless there is a temporal difference (if the temporal reference changes, it is assigned multiple times). Likewise, if there is *no willingness* (e.g., "did not respond to BILD's request"), it is coded here. This trust cue is not assigned again for the same trust object (and the same temporal reference) if corresponding mentions are contiguous. The media presence always starts from the scientific trust objects; otherwise, the text passage is not relevant for coding (e.g., mention that someone was reported about). Here, three further characteristics are distinguished according to the channel (if the temporal reference or channel of the media presence changes for the same object of trust, it can be coded several times here):

**431 Journalistic media presence:** refers to the ("willingness for") media presence in journalistic media. For this purpose, the medium must be mentioned specifically by name. Example: *"Professor Stefan Rahmstorf of the Postdam Institute for Climate Impact Research (PIK) is one of the best-known climate researchers in the republic, a welcome expert on ARD and ZDF, and a regular author for Spiegel Online."*

**432 Direct media presence:** refers to (the willingness for) direct media presence, such as social media. For this purpose, the channel must be mentioned specifically and by name. Example: *"Should major problems arise, he [Christian Drosten] wants to have his say, for example, in interviews. Or on Twitter, where more than 900,000 people follow him."*

**433 Further media presence:** refers to all references to ("willingness for") media presence that are not journalistic or direct, as in press materials. This also includes any media presence that emanates from the researchers but does not include a clear naming of channel or medium. Example: *"... Christoph Neumann-Haefelin, head of the Translational Virus Immunology research group at the University Hospital um Freiburg, Germany, said in a video chat Thursday afternoon."*

## Transparency

Transparency denotes that science, scientific institutions, and scientists make research and related information accessible to different publics in a clear and comprehensible manner.



### Transparency Cues (500er)

**510 Accessibility of results:** refers to research results that are available in the public domain. Example: *"Here is the link to the study."*

**520 Comprehensible language:** refers to the language used to describe research processes and results in an (un)understandable way. Examples of incomprehensible language are technical terms, (technical) terminologies (e.g., "exoplanets"), foreign words, proper names (such as names of devices/abbreviations or names of diseases. "COVID-19" and "Corona" may be assumed and do not need to be coded; "SARS-CoV-2", on the other hand, may be coded because a deliberately chosen complex representation is assumed here). Examples of comprehensible language are explanations (they are often introduced with "that means," "that is," "simply stated"). Since (un)intelligible language practically does not always have a direct reference to an object of trust, it should, if reasonable, be connected to the object of trust from the previous or subsequent sentences or the paragraph (approximately 10 lines). Do not generally code science as the object of trust. Example: *"Otherwise, as Müller, Pollak, Reimer and Schindler put it: The observable differences in the 'post-secondary educational decisions' of academic and working-class children are 'predominantly controlled by secondary influences of origin.'"*

## (11) Dimension of trust

Here, the underlying dimension of trust is coded for each trust cue individually.

- 1 Expertise
- 2 Benevolence

- 3 Integrity
- 4 Dialogue
- 5 Transparency

### **(12) Level of trust**

Here, the underlying trust level is encoded. The following definitions are designed to prioritize the smallest level of aggregation over a higher level. Orientation is also provided by the sentence before it or the paragraph in which the trust cue is located. It is coded case by case and is not assigned retroactively. The levels can be ordered as follows (from largest to smallest aggregation): macro, meso, and micro.

- 1 Macro: Science as a system. This includes science and research fields but also science networks and research cooperations if members are not mentioned by name. It also includes the rules and laws that define science as a system. Examples: "science," "research," "shark research," "epidemiology," "computational biology," "scientific policy advice."
- 2 Meso: Scientific institutions like universities, non-university research institutions, and private-sector research and government institutions (with scientific links!). This also includes groups of researchers who are not mentioned by name but who can be assigned to an institution ("Oxford University researchers") as well as studies that are related to an institution instead of specific researchers ("Oxford University study"). Examples: "Universities," "University of Applied Sciences," "German universities," "DIW researchers," "MIT team," "Cognitive and genetic researchers from European and British universities," "Researchers from the Yale School of Medicine," "Study [from WWF]," "Scientific journals," "Study from the University of Hamburg."
- 3 Micro: Individually named scientists, as well as their behavior, practices, and interactions (e.g., their studies and publications). This also includes groups of scientists who are not associated with an institution ("researchers") or for whom the reference point is at the micro level ("head of the research group"). Doctors and other medical personnel are only relevant for coding if there is a clear reference to research; this also applies to "experts," where a clear research reference must be established. Examples: "scientists," "researchers," "US researchers," "AIDS researchers," "Australian research team," "chief scientists," "ecologists," "astronomers," "Danish study," "many studies," "findings," "scientific experts," "authors," "international group of scientists."

It is not clear for all occurring actors whether they are coding-relevant trust objects; especially in the case of physicians and medical offices or institutions, the boundaries between research and practice are sometimes diffuse. Therefore, the following rules apply here: If physicians are involved in research or communicate research, they are considered an object of trust in science and are coded accordingly. If physicians have a representative role for the field of medicine and thus represent research, they are rated as an object of trust of science and are coded accordingly (e.g., president of the German Medical Association).

Practicing physicians do not automatically represent research and science; they are not relevant for coding as long as it is not specifically stated that they are active in research (this also applies to common recommendations for action by physicians). University hospitals are relevant to coding because of their proximity to research.

Furthermore, libraries (also "scientific libraries" or "university libraries") are only relevant for coding if their research (activity) is explicitly mentioned. Science museums are relevant for coding, but "normal" museums are not relevant for coding.

Fictitious scientific actors of any kind that appear in film or book descriptions are generally not relevant for coding.

### **(13) Classification of the level of trust**

If codes (2) or (3), i.e., meso or micro, are assigned at (12), then we code the underlying assignment even more precisely.

- 1 Universities, university research
- 2 Non-academic research institutions
- 3 Government institutions
- 4 Private-sector research

If the code (1) was assigned in (12), we always code the (0) here. There may be cases where several individuals or groups are coded together under (12); if these individuals or groups have different affiliations, the (0) is assigned here (this also applies to research collaborations involving multiple institutions with different classifications). Should single objects of trust (i.e., no group) have multiple affiliations, (1) is given priority over all other codes. That is, if an object of trust has multiple affiliations, none of which is (1), (0) is coded at this point. If there are several affiliations, one of which is (1), then (1) is assigned at this point. (0) includes all other institutions or associations that cannot be clearly assigned to the other categories, such as the "Drug Commission." (1) also includes university hospitals and (2) Max Planck, Leibnitz, Fraunhofer, Helmholtz, and market and opinion research institutes and also the "German Medical Association." In addition, affiliated institutes are coded with (2). (3) belongs, for example, to NASA, federal offices, the BMBF, the German Weather Service, the German Institute of Aeronautics and Astronautics (DLR), or the Robert Koch Institute (RKI); in addition, (scientific) commissions that have been convened, for example, to advise politicians, belong to (3). Companies that conduct private-sector research, such as chemical or pharmaceutical groups (e.g., Biontech), belong to (4).

### **More content related codes**

#### **(14) Gender**

If code (3), i.e., micro, is assigned at (12), then we code gender aspects even more precisely here.

- 0 Does not apply/not (clearly) identifiable
- 1 Female

- 2 Male
- 3 Diverse

For groups consisting exclusively of female actors, the (1) is assigned. For groups consisting only of male actors, the (2) is assigned. For groups consisting of both female and male actors, the (0) is assigned. If the code (1) or (2) is assigned for (12), i.e., macro or meso, the (0) is always coded here.

### **(15) Source**

Here we code the source of the trust cue. This can be the same as the source, but it does not have to be the case with (in)direct speech. Indirect speech also refers to the person to whom the statement is attributed (and not to the author), especially if it is linguistically implied (e.g., "they mean," "the two ask," "they expose," "according to the researcher"). If such cases are not clear, (1) journalist is coded.

- 0 Not (clearly) identifiable
- 1 Journalist (including newscasters and presenters)
- 2 News agency
- 3 Scientist
- 4 Scientific institution
- 5 Influencer
- 6 Social media user
- 7 Politician
- 8 Blogger
- 9 Other

Explicit explanations and distinctions of the groups can be found under the formal category "(6) Author" and are also valid here. Again, if a (0) was coded under (6) (not [clearly] identifiable), and the author and source are the same here, a (0) must be coded.

### **(16) Gender of the source**

If a source is identified in (15) (all codes except "0"), then we code gender aspects more precisely here.

- 0 Does not apply/not (clearly) identifiable
- 1 Female
- 2 Male
- 3 Diverse

The same rules apply here as for (14). For sources (including groups in rare cases) that are female or consist solely of female actors, the (1) is assigned. For authors (including groups) that are male or that consist solely of male actors, the (2) is assigned. For groups that consist of both female and male actors, the (0) is coded.



Public (dis)trust in science in digital media environments

ARTICLE

## Intermediaries in the limelight: how exposure to trust cues in content about science affects public trust in science

Lars Guenther, Justin T. Schröder, Anne Reif, Janise Brück, Monika Taddicken, Peter Weingart and Evelyn Jonas

### Abstract

A potential decline in public trust in science has often been linked to digital media environments, which serve as intermediaries of trust by providing cues for why (not) to trust science. This study examines whether exposure to trust cues in content affects public trust in science (across population groups). The study employs a mixed-method design, combining content analysis ( $n = 906$ ) and panel survey data ( $n = 1,030$ ) in Germany. The findings reveal that exposure to trust cues in certain media predicts public trust in science. Variations across trust groups indicate a nuanced nature of trust-assessing processes in digital media environments.

### Keywords

Public perception of science and technology; Public understanding of science and technology; Science and media

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## 1 - Introduction

Climate change and COVID-19 are prominent examples of how modern societies are characterized by increasing complexity and multiple crises. In such contexts, there is a heightened need for scientific information. *Public trust in science* is among the most important variables for the public to reduce complexity and engage with this type of information [e.g., Plohl & Musil, 2021; Saffran et al., 2020; Wintterlin et al., 2022]; at the same time, a supposed decline of public trust in science and its implications have recently been discussed [e.g., Neuberger, 2014; Reif & Guenther, 2021; Weingart & Guenther, 2016; for institutional trust: Verboord, 2023]. These researchers name digital media environments, along with their diversity regarding actors, topics, and content, as a potential reason for this decline.<sup>1</sup> In many countries, including Germany, large parts of the population that traditionally used journalistic media for information about science now obtain this information online [e.g., European Commission, 2021; Guenther et al., 2022; National Science Board, 2018] – while this includes journalistic online media, the relevance of non-journalistic social and fringe/populist sources cannot be underestimated [e.g., Wissenschaft im Dialog, 2023]. In digital media environments, journalistic and non-journalistic actors with various (sometimes vested) interests access digital public spheres and can, therefore, publicly discuss scientific issues [e.g., Huber et al., 2019; Taddicken & Krämer, 2021; Weingart, 2017].

When audiences use various (digital)<sup>2</sup> sources to inform themselves about science, these media act as *intermediaries* of trust in science. Information mediated by (digital) media affects the development of *public trust* in specific systems, organizations, and individuals [Bentele, 1994; see also Verboord, 2023]. That is why (digital) media are not only objects of trust themselves, but they provide cues for trust in objects such as science via content indicators [e.g., see also Kohring, 2016; Reif, 2021; Schäfer, 2016] that provide reasons why (or why not) to trust science and presented scientific information. In this paper, we call these indicators *trust cues*. While they have already been identified in content about science [see Schröder et al., 2023] and their importance has been shown in audience studies [e.g., studies on how cues in media content affect audiences' trust in science; Reif et al., 2020; Rosman et al., 2022], research on public trust in science has focused less on intermediaries and has yet to examine if and how the frequency of trust cues in content affects public trust in science. Answering this question can provide insights into what sources of information potentially affect public trust in science (positively or negatively) via their use of trust cues. Studies to date have either focused on the effects of the frequency of media use on public trust in science [e.g., Huber et al., 2019; Wintterlin et al., 2022], often pointing to small or no effects, or to effects of very specific contents [e.g., Hendriks et al., 2020]. We argue that there are two main reasons why science-related information use has not emerged as a (significant or strong) predictor of trust in science: firstly, researchers did not establish the connection to specific content, and secondly aggregated analyses were performed for overall samples.

*Audience segmentation* prevents analyzing overall samples; they can acknowledge the diversity of audiences [e.g., Guenther & Weingart, 2018; Klinger et al., 2022; Schäfer et al., 2018] and group-specific (changes in) trust in science [Reif et al., 2023]. Thus, in the present study, we propose to combine two novel approaches – trust cues in content and audience segmentation in a panel survey – to not only examine if exposure to trust cues in media

1. Although negative connections are often emphasized, the diversity of actors, topics, and contents in digital media environments does also have positive implications.
2. We use parentheses here and in the following to indicate that we mean both digital and non-digital media.

content about science affects public trust in science but also to assess if this varies across population groups. In contrast to previous research, we will put intermediaries of trust in science in the limelight.

## 2 - Public trust in science, trust cues, and audience groups

### 2.1 - Defining public trust in science

Although this varies across definitions and research traditions (e.g., in sociology, psychology, and communication research), *trust* is often described as a mechanism to reduce complexity; trust comes into play in situations characterized by (uncertainty and) risk [e.g., Giddens, 1990; Luhmann, 2014]. In addition, *public trust in science* is an important variable when engaging with scientific information. It plays a crucial role in the relationship between science and its publics [for an overview: Reif & Guenther, 2021]. Seen as a relational variable, trust in science requires at least one subject of trust (i.e., who trusts), which, in this paper, are *publics* (and *public audiences*, respectively), and one object of trust (i.e., who is trusted), which is *science* [see also Giddens, 1990; Luhmann, 2014; Mayer et al., 1995]. More specifically, and with a focus on trust in science, the concept of *epistemic trust* seems appropriate. This refers to science as a producer of valid knowledge and thus includes aspects of the validity of scientific knowledge and the assessment of science as a secure source of information [e.g., Origi, 2012; Sperber et al., 2010; see also Wintterlin et al., 2022]. This concept does include the risk of not being informed correctly.

Furthermore, based on established definitions, we define trust in science as a *multilevel* [e.g., Giddens, 1990; Grünberg, 2014; Luhmann, 2014; Schäfer, 2016] and *multidimensional* construct [e.g., Bentele, 1994; Besley et al., 2021; Fiske & Dupree, 2014; Hendriks et al., 2015, 2016; Mayer et al., 1995; Reif & Guenther, 2021]. Multilevel means that there is a distinction between science as a system (i.e., macro-level), scientific organizations (i.e., meso-level; e.g., universities or research departments of companies), and scientists [i.e., micro-level; see also Mayer et al., 1995]. Trust assessments may differ in terms of whether science is considered a system or refers to its organizations or scientists. Multidimensional means that when referring to epistemic trust in science, we refer to several established dimensions underlying this construct; some describe them as reasons to trust science. In detail, that is expertise, integrity, benevolence, transparency, and dialogue orientation [Hendriks et al., 2015, 2016; Reif & Guenther, 2021; see also Besley et al., 2021; Resnick et al., 2015; Wintterlin et al., 2022]. According to Reif et al. [2023], *expertise* can be defined as science's capacity to recognize, evaluate, and solve problems by applying specialized knowledge acquired through education, experience, and qualifications in the respective research domain. *Integrity* indicates sciences' objectivity, validity, and reliability, achieved through adherence to scientific standards and processes. This includes highlighting science's methodological approach, focusing on quality control, and emphasizing its independence from external influences. *Benevolence* means that science has the ultimate goal of improving people's lives and promoting the advancement of societal welfare. This definition includes referring to the social responsibility of science and the representation of scientific research as adhering to ethical norms and moral values. *Transparency* means that scientific research and knowledge are accessible to public audiences and comprehensible to all. Lastly, *dialogue orientation* refers to how science actively engages with and encourages interaction with the public through activities such as public lectures or citizen science projects.

With these definitory steps in mind, we will examine if exposure to trust cues in media content about science affects public trust in science (across population groups).

## 2.2 ▪ *Trust cues in content about science*

Deriving from the role of (digital) media as intermediaries of scientific information, we rely on Bentele's [1994] *theory of public trust*, which considers that intermediaries are a significant factor in trust relationships. Following this theoretical approach, the formation of trust in any object of trust, such as science, is strongly influenced by information presented by the media; this includes the media's representation of facts and events. That is why we have developed the concept of *trust cues* and defined them as indicators and the specific language characteristics/linguistic markers in content about science [see also Bentele, 1994; Kohring, 2016; Reif, 2021; Schäfer, 2016], which may give hints for how much to trust science and scientific information, respectively. Trust cues can be assigned to different levels represented (science as a system, scientific organizations, or scientists) and, because of their focus on reasons why to trust science, to different dimensions, thus forming expertise, integrity, benevolence, transparency, and dialogue cues. So far, few studies have focused on such cues [see Welzenbach-Vogel et al., 2021] or provided insights that can be interpreted as trust cues. Indeed, trust cues have been found for all established trust dimensions. For instance, expertise cues could link to information about the organizational background of presented research(ers) or publications [e.g., Hijmans et al., 2003], while integrity cues could refer to funding sources, relevant methodological criteria, as well as scientific uncertainties [e.g., Cook et al., 2007; Guenther et al., 2019].

Based on the theory of public trust [Bentele, 1994] and a lack of research on this issue, Schröder et al. [2023] focused on identifying trust cues provided by intermediaries of public trust in science. They used qualitative content analysis on a comprehensive and representative sample of 158 media pieces (drawn from journalistic, non-journalistic online, social, and right-wing populist media). With a working definition in mind of what expertise, integrity, benevolence, transparency, and dialogue orientation mean (see above), two coders used a mainly inductive approach to openly collect all trust-relevant criteria mentioned in these pieces, along with the respective levels (macro, meso, or micro<sup>3</sup>). Multiple dimensions were counted within a single source. A list of  $n = 1,329$  cues was then condensed in several iterative steps and linked to the established dimensions of trust [for more information, see Schröder et al., 2023]. In that way, 35 trust cues were identified and summarized, and the dimensions of trust were specified further: For expertise, trust cues pertain to academic education (e.g., where scientists studied, obtained their PhD), professional experience (e.g., how long scientists have been working in a field), and qualification (e.g., degrees, positions, criteria indicating reputation such as prizes). For integrity, the cues focus on independence (e.g., from clients, funders), scientific quality assurance (e.g., peer review, uncertainty), and scientific standards and processes (e.g., collaborations, publications, descriptions of the research (process)). Benevolence cues address ethical norms (e.g., misconduct), social responsibility (e.g., predictions and assessments of current affairs), and societal benefits (e.g., breakthroughs, discoveries, applicability). Lastly, for transparency, trust cues refer to the accessibility of results (e.g., making them publicly available) and comprehensible language, while for dialogue orientation, trust cues refer to the participation at public events, media

3. Hence, science as a system (macro-level), scientific organizations (i.e., meso-level), and scientists (micro-level) — as outlined before.

presence (e.g., interviews, talk shows, or presence on social media), and public engagement in research.

The identified trust cues also varied across (digital) media sources [Schröder & Guenther, 2024]. This variation seems crucial because digital media environments include many voices, actors, and contents representing various interests – some journalistic, some not, and not all communicators count as experts [see also Taddicken & Krämer, 2021; Weingart & Guenther, 2016]. Thus, the kind of (digital) media used likely affects public trust in science. For instance, “although not all content in alternative counter-news is fake news, these outlets do attract a specific [...] audience” [Frischlich et al., 2023, p. 80], and their representations of science may affect trust in science.

However, studies so far have not tested if exposure to trust cues affects public trust in science; instead, studies have investigated the connection between the frequency of (science-related) media use and trust in science. The findings in this area are mixed. Wintterlin et al. [2022] did not detect a relationship between media use and trust in science. At the same time, there is some indication that social media use can positively predict trust in science [Huber et al., 2019]. For online sources more broadly, Takahashi and Tandoc [2015] present evidence of a negative connection. Trust in science also shows a negative connection to social media use in Schäfer et al. [2022] [for similar findings related to institutional trust, see Reinemann et al., 2022]. The mixed evidence reminds scholars of research in political communication, where various distinctive and yet incompatible hypotheses about the relationship between media use and trust exist [e.g., media use either positively (“virtuous circle” hypothesis) or negatively (“media malaise” hypothesis) predicts political trust; Verboord, 2023].

Consequently, we see at least two obstacles to research to date; the first is that media use, instead of exposure to trust cues, has been tested, and the second is that the evidence of an effect of media use is mixed at best. This supports ongoing research, which is why our first research question (RQ1) is: *To what extent does exposure to trust cues in (digital) content about science affect trust in science?*

### 2.3 ■ Audience groups of public trust in science

Deriving from the fact that segmentation analyses have developed into a popular and useful approach in science communication research [e.g., Guenther & Weingart, 2018; Klinger et al., 2022; Schäfer et al., 2018], for instance, to arrive at more targeted communication, Reif et al. [2024] have proposed to use this technique in identifying so-called *trust groups*.<sup>4</sup> In such a setting, variables referencing public trust in science are used to identify groups within a population.

Reif et al. [2024] used measures relating to the five dimensions of trust introduced earlier (i.e., expertise, integrity, benevolence, transparency, and dialogue orientation), each with three items formulated as reasons to trust in scientists (i.e., “Scientists can be trusted because they...”). These items were presented in a randomized order with five response options (from “strongly disagree” to “strongly agree”). Later, Reif et al. [2024] computed mean indices of these five dimensions and performed a *Latent Profile Analysis* (using

4. We refer to groups instead of segments to account for the fact that we used a segmentation approach with a limited number of very specific items (i.e., only related to dimensions of trust in science).

package *tidyLPA* in *RStudio*) to identify groups of trust in science. Following both scree plots and fit indices, they identified five distinct groups and validated this finding with an additional discriminant analysis (96% correctly classified cases).

Hence, the trust groups considered here [see Reif et al., 2024] are, in descending order regarding their trust in science: “Fully trusting,” who show complete trust in science and only slightly more agreement to science’s expertise than integrity and benevolence. “Highly trusting” and “Moderately trusting” give special importance to science’s expertise, though the score for “Moderately trusting” was slightly below the mean value. “Rather untrusting” are not trusting as much (and, e.g., only moderately in science’s expertise), and a fifth group is “Untrusting” towards science.

Noteworthy, these groups also showed variance concerning the frequency in which they used media sources to inform themselves about science. “Fully trusting” used all sources the most frequently, especially public television (TV), but social media less often. “Highly trusting” and “Moderately trusting” also often used public TV. “Rather untrusting” used the sources less frequently, and “Untrusting” were, in comparison, more frequent users of populist media.

This reminds, to some degree, of studies focusing on *media repertoires*, with outcomes ranging from minimalists who use media infrequently to omnivores who use them very frequently [see Verboord, 2023]. In total, it seems likely that the way population groups use different media sources, combined with the fact that these sources may differ with respect to how they represent trust cues, affects trust in science. From this perspective, this can potentially explain why some groups may not experience changes in their trust in science while others may experience increases or decreases regarding their trust in science. However, research on this needs to be expanded upon. Consequently, RQ2 reads: *To what extent does exposure to trust cues in (digital) content about science affect trust in science across trust groups?*

### 3 - Methods

Answering the RQs requires a mixed-method design. This linkage study combines content analysis with panel survey data in two waves. Our focus is on Germany — the biggest economy in Europe, with a tradition of public surveys on perceptions of science and technology, which show variations with respect to trust in science [e.g., Wissenschaft im Dialog, 2023].

#### 3.1 ■ *Content analysis to identify trust cues in content about science*

For the whole year between the two waves of the panel survey (March 2022–March 2023), in seven constructed weeks, we collected data of the most important sources that public audiences in Germany use to inform themselves about science [e.g., European Commission, 2021; Wissenschaft im Dialog, 2023].<sup>5</sup> The sources include relevant journalistic media, incorporating TV newscasts and special science TV programs, print and online newspapers, weekly news magazines/newspapers, and special science magazines. We also included

5. Most important, in this case, means that user frequencies guided our selection of media sources. For each media source, we identified, compared, and selected media with a large user reach. This search was based on the questionnaire items.

right-wing populist, non-mainstream media sources. For broader inclusion of digital contexts, we chose popular science blogs and online news aggregators as further (in many cases non-journalistic) online media. Lastly, we selected several popular social media and non-journalistic accounts (see Table 1 for all media sources). For data collection, we relied on various databases and approaches and, where possible, used established search strings [Guenther et al., 2019; for more details, see also Schröder et al., 2023].

In total,  $n = 10,244$  pieces of information were collected and then manually checked for relevance ( $n = 1,812$ ); relevance was determined by two requirements: the presence of both a scientific object of trust and a trust cue. For the present study, we used data from a quantitative content analysis applied for half of the relevant pieces identified (random selection;  $n = 906$ ). Based on the qualitative study [Schröder et al., 2023], a standardized codebook, which included the 35 trust cues mentioned earlier, was developed [see also Schröder & Guenther, 2024]. Four coders were trained and conducted the coding after their reliability was tested successfully (ranges are  $\alpha = .74-.99$ ;  $CR = .85-1$ ). This paper will use the average number of trust cues per media sources, as shown in Table 1. The table shows that the highest number of trust cues was found in science magazines and the lowest across social media. In the 906 pieces, 5,932 trust cues were coded — which sets the average of 6.55 trust cues per media source for the whole sample.

### 3.2 ■ Panel survey in two waves

For the panel data, we made use of YouGov's online access panel, representative for Germans over the age of 18, at t1, achieved via quota plans [t1: March/April 2022,  $n = 4,824$ ; t2: March/April 2023,  $n = 1,030$ ; for more information, see Reif et al., 2023, 2024].<sup>6</sup> The survey at t1 was our baseline measurement of trust in science; the survey at t2 was our follow-up one year after data collection to measure changes regarding trust in science. The questionnaires were fairly similar between t1 and t2.

The surveys contained the five dimensions of trust (expertise, integrity, benevolence, transparency, and dialogue orientation), each presented by three items measuring reasons to trust scientists [see also Reif et al., 2023]. As mentioned before, these items were used to identify groups of trust in science. In the following, we base our study on the 1,030 individuals who participated in both waves. The five groups, for t1, reached the following frequencies: "Fully trusting" ( $n = 163$ ; 16%), "Highly trusting" ( $n = 230$ ; 22%), "Moderately trusting" ( $n = 250$ ; 24%), "Rather untrusting" ( $n = 207$ ; 20%), and "Untrusting" ( $n = 180$ ; 18%).

Central further variables for this paper are additional four direct trust in science measurements, which — for both t1 ( $M = 3.16$ ;  $SD = 1.02$ ;  $\alpha = .92$ ) and t2 ( $M = 3.10$ ;  $SD = .96$ ;  $\alpha = .92$ )<sup>7</sup> — were used to create an index<sup>8</sup> based on the items capturing trust in science

6. The quota plans considered gender, age (starting from 18), and federal state, to ensure representativeness of the sample regarding German census data. For t2, respondents from t1 were invited, along with a re-quotation, but this nevertheless resulted in a slightly skewed sample with more older and well-educated respondents [see Reif et al., 2023].
7. Our additional trust in science variables are multilevel but not multidimensional, as variables with a reference to the dimensions were used to identify trust groups. Noteworthy is that the small decrease in public trust in science between t1 and t2 differed across the five groups, indicating a trend towards the middle of the scale [see Reif et al., 2024].
8. A sum index, normalized by the scale points (i.e., divided by 5). The specific wording of the question was "How much do you trust in...".

**Table 1.** Average number of trust cues and media use per media source.

Media sources	Trust cues in content			Panel survey in two waves <sup>a</sup>	
	<i>n</i> <sub>source</sub> (906)	Trust <i>cue</i> <sub>source</sub> (5.932)	Average number of trust cues per media source	<i>M</i>	<i>SD</i>
<i>Genuine journalistic media sources</i>					
Public TV (ARD Tagesschau, ZDF heute, Quarks, Gut zu wissen)	12	66	5.50	2.95	1.21
Private TV (RTL Aktuell, Sat.1 Nachrichten)	4	12	3.00	2.38	1.08
Printed Newspapers (Frankfurter Allgemeine Zeitung, Süddeutsche Zeitung, Spiegel, Zeit)	225	1.461	6.49	2.52	1.15
Online Newspapers (FAZ.net, SZ.de, spiegel.de, zeit.de)	324	2.351	7.26	2.44	1.16
Tabloid newspapers (Bild, bild.de)	52	247	4.75	1.67	.91
Science magazines (Geo, P.M. Magazin, Spektrum der Wissenschaft)	47	496	10.55	2.36	1.10
<i>Right-wing populist, non-mainstream media sources</i>					
Populist media (Epoch Times, Junge Freiheit, Compact)	36	266	7.38	1.82	1.03
<i>Further online media</i>					
News aggregators (t-online.de, web.de)	124	833	6.71	2.39	1.07
Science blogs (scienceblogs.de, scilogs.de)	15	61	4.07	1.93	.97
<i>Social media</i>					
Facebook (Wissenschaft aktuell, Harald Lesch Ultras, Fortschritt in der Wissenschaft)	32	68	2.13	1.92	1.07
X (c_drosten, dfg_public, BMBF_bund, helmholtz_de)	26	50	1.92	1.44	.80
Instagram (@doktorwissenschaft, @universumsfakten, @don.medicus, @diewissenschaftlerin)	4	5	1.25	1.68	.98
YouTube (MaiLab, Breaking Lab)	5	16	3.20	2.40	1.12

Notes. <sup>a</sup>1 “never” to 5 “very often”.

(macro), scientists at universities and research institutes as well as scientists in private companies/industry (2 items, meso), and scientists (micro), to represent all levels (scale from 1 “do not trust at all” to 5 “trust a great deal”). At both points in time, respondents were also asked for their science information-specific media use — of which the 13 items/categories represented in Table 1 corresponded between content analysis and panel survey (scale from 1 “never” to 5 “very often”). In the first step, we created mean variables between t1 and t2 to mirror self-reported media use across the whole year of data collection (see Table 1). The data supported that survey respondents most frequently encountered science via public TV and least frequently through tabloid newspapers and microblogging services like X (formerly Twitter).

### 3.3 ▪ Linking content analysis and panel survey data

We created linkage variables to link the content analysis with the panel survey data [for an overview, see De Vreese et al., 2017]. We refer to them as “trust cue exposure variables” (TCE) and created one for each of the 13 media sources that corresponded between content analysis and survey. As the following formula shows, these exposure variables ( $TCE_{source}$ ) are the multiplication of source-specific media use ( $u_{source}$  [0;.5;1] as the average of media use frequencies between t1 and t2, weighted by no (0, for  $M = 1.0$ ), moderate (.5, for  $M = 1.1-3.0$ ), and high (1, for  $M = 3.6-5.0$ ) use [see Wirz et al., 2018] and trust cues (as the average number of trust cues per source ( $trust\ cues_{source}$  divided by  $n_{source}$ ), divided by the average number of trust cues across all sources ( $trust\ cues_{all}$  divided by  $n_{all}$ ), which is 6.55). Finally, all values were z-standardized. Higher values of the TCE variables indicate an overrepresented exposure to trust cues. The formula is as follows:

$$TCE_{source} = u_{source} * \left( \frac{trust\ cues_{source}}{n_{source}} / \frac{trust\ cues_{all}}{n_{all}} \right)$$

Noteworthy, our linkage variable is one option out of many and uses proxies for both the frequency of trust cues across media sources and for science information-specific media use. For the statistical analysis, we determined the trust in science at t2 variable to be the dependent variable. In hierarchical regression analyses, we tested the same indicator of trust in science at t1,<sup>9</sup> the 13 trust exposure variables, and sociodemographic information as predictors in three models – for the whole sample (RQ1) and the groups that are based on dimensions of trust (RQ2).

## 4 ▪ Results

The findings, with respect to RQ1 (effects of trust cue exposure on trust in science), revealed that trust in science at t2 was significantly predicted by trust in science at t1 (see Table 2); across all models (also concerning RQ2), this variable was always the strongest predictor. This finding and the means reported show that trust in science was a stable construct for our respondents and that their trust assessments did not change as much over the year between the survey waves.

In addition, in Model 2, trust cue exposure on public TV was a positive but weak predictor of trust in science at t2, while trust cue exposure in populist media was a negative and weak predictor. This means that the more respondents were exposed to trust cues on public TV, the higher their trust in science was at t2. At the same time, their trust in science at t2 was higher the less they were exposed to trust cues in populist media.

Including trust cue exposure variables in Model 2 only slightly increased the explained variance of the analysis, which underlines the stability of trust in science assessments over time.

The effects of trust cue exposure on the whole sample were rather limited in total, but this may not be the case for specific trust groups. This is the focus of RQ2 (effects of trust cue exposure on trust in science per group); Table 3 presents the final models for all groups.

9. Theoretically, we assumed trust in science at t1 to be the strongest predictor of trust in science at t2. Hence, with further variables such as the TCE variables, we tested whether they can provide additional explanations.

**Table 2.** Predicting trust in science (t2) via linear regression models.

Predictors	Model 1; $F(1) = 1,481.38$ ; $p < .001$		Model 2; $F(14) = 112.28$ ; $p < .001$		Model 3; $F(17) = 92.42$ ; $p < .001$	
	$\beta$	$p$	$\beta$	$p$	$\beta$	$p$
Trust in science (t1)	<b>.788</b>	<b>&lt;.001</b>	<b>.705</b>	<b>&lt;.001</b>	<b>.706</b>	<b>&lt;.001</b>
Trust cue exposure on public TV			<b>.089</b>	<b>&lt;.001</b>	<b>.095</b>	<b>.001</b>
Trust cue exposure on private TV			.037	.137	.037	.138
Trust cue exposure in printed newspapers			-.006	.827	-.002	.947
Trust cue exposure in online newspapers			.024	.374	.020	.468
Trust cue exposure in tabloid newspapers			.004	.861	.003	.909
Trust cue exposure in populist media			<b>-.066</b>	<b>.009</b>	<b>-.062</b>	<b>.015</b>
Trust cue exposure in news aggregators			.009	.715	.012	.636
Trust cue exposure in science magazines			.047	.082	.046	.091
Trust cue exposure in science blogs			.010	.728	.007	.819
Trust cue exposure on social networking sites like Facebook			-.014	.603	-.012	.651
Trust cue exposure on microblogging services like X			.012	.657	.012	.667
Trust cue exposure on photo platforms like Instagram			.017	.564	.009	.766
Trust cue exposure on video platforms like YouTube			.006	.830	.003	.915
Gender <sup>a</sup>					-.004	.858
Age					-.029	.208
Education					.005	.826
R2 (%)	62.1		63.3		63.3	

Notes. Standardized regression coefficients; significant findings in bold;  $n = 904$ ; <sup>a</sup> = 1 "male", 2 "female".

For "Fully trusting" only trust in science at t1 was a significant predictor of trust in science at t2, probably again indicating stable and high trust, especially for those respondents with the highest trust scores.

In the case of "Highly trusting", despite trust in science at t1 being the strongest predictor (i.e., the more they trusted science at t1, the higher their trust in science was at t2), trust in science at t2 was also negatively influenced by trust cue exposure in science blogs. This means that the less respondents were exposed to trust cues in science blogs, the higher their reported trust in science was at t2.

Exposure to trust cues on public TV and in science magazines were positive predictors of trust in science at t2 for "Moderately trusting"; besides trust in science at t1 being the strongest predictor again. Hence, the higher the trust respondents reported at t1, the more they were exposed to trust cues on public TV and in science magazines, the higher they trusted science at t2. For "Moderately trusting", one of the sociodemographic information also had a significant effect: education. Hence, the more educated respondents were, the higher their trust in science at t2.

For "Rather untrusting", none of the TCE variables had an effect; however, trust in science at t1 predicted trust in science at t2 positively.

**Table 3.** Predicting trust in science (t2) via linear regression models across trust groups.

Predictors/Groups (Model 3)	Fully trusting <sup>1</sup> ; F(17) = 5.50; p < .001		Highly trusting <sup>2</sup> ; F(17) = 6.24; p < .001		Moderately trusting <sup>3</sup> ; F(17) = 6.91; p < .001		Rather un-trusting <sup>4</sup> ; F(17) = 6.55; p < .001		Untrusting <sup>5</sup> ; F(17) = 4.46; p < .001	
	$\beta$	p	$\beta$	p	$\beta$	p	$\beta$	p	$\beta$	p
Trust in science (t1)	<b>.538</b>	<b>&lt;.001</b>	<b>.518</b>	<b>&lt;.001</b>	<b>.398</b>	<b>&lt;.001</b>	<b>.555</b>	<b>&lt;.001</b>	<b>.459</b>	<b>&lt;.001</b>
Trust cue exposure on public TV	-.038	.669	.077	.249	<b>.125</b>	<b>.042</b>	.095	.220	.131	.182
Trust cue exposure on private TV	.120	.171	.011	.876	.082	.215	.016	.823	.074	.453
Trust cue exposure in printed newspapers	-.123	.183	.010	.892	-.014	.822	.091	.237	.038	.674
Trust cue exposure in online newspapers	.146	.147	-.007	.930	.057	.443	-.057	.476	-.049	.674
Trust cue exposure in tabloid newspapers	-.060	.538	-.063	.402	.046	.476	-.022	.765	-.105	.230
Trust cue exposure in populist media	-.042	.669	-.004	.963	-.077	.264	-.096	.233	<b>-.185</b>	<b>.048</b>
Trust cue exposure in news aggregators	.010	.913	-.003	.966	-.025	.718	.005	.940	.086	.359
Trust cue exposure in science magazines	.164	.133	.027	.726	<b>.188</b>	<b>.014</b>	.058	.467	.040	.676
Trust cue exposure in science blogs	.008	.946	<b>-.212</b>	<b>.016</b>	-.095	.236	.150	.053	<b>.132</b>	.235
Trust cue exposure on social networking sites like Facebook	-.053	.638	-.030	.735	-.053	.485	-.045	.540	.155	.121
Trust cue exposure on microblogging services like X	-.010	.925	.110	.199	.090	.217	.033	.664	-.129	.176
Trust cue exposure on photo platforms like Instagram	-.083	.499	-.024	.791	-.017	.843	.040	.596	.093	.375
Trust cue exposure on video platforms like YouTube	.022	.837	.082	.323	.046	.535	-.025	.754	.031	.763
Gender <sup>a</sup>	.125	.094	.003	.964	-.084	.150	-.060	.356	-.074	.333
Age	-.009	.908	-.066	.351	-.010	.887	.001	.990	-.127	.106
Education	-.133	.067	.094	.132	<b>.148</b>	<b>.019</b>	-.064	.366	-.021	.796
R <sup>2</sup> (%)	35.3		30.2		30.8		34.4		28.4	

Notes. Standardized regression coefficients; significant findings in bold; <sup>1</sup>n = 141; <sup>2</sup>n = 207; <sup>3</sup>n = 226; <sup>4</sup>n = 181; <sup>5</sup>n = 149; <sup>a</sup> = 1 “male”, 2 “female”.

Lastly, for “Untrusting,” trust in science at t2 was negatively predicted by trust cue exposure in populist media and positively predicted by trust in science at t1. This means that the higher the trust respondents stated at t1, the higher their trust in science was at t2. In addition, the less they were exposed to trust cues in populist media, the higher their trust in science was at t2.

## 5 • Discussion

Certainly, the need for scientific information is a crucial characteristic of modern societies. We have defined public trust in science as a central variable in any relationship between science and its publics [e.g., Reif et al., 2024; Wintterlin et al., 2022]. Derived from the supposed decline of public trust in science and its assumed connection to digital media environments, we explored the role of intermediaries on public trust in science. More specifically, in a linkage study, we combined the content and audience perspectives when examining if exposure to trust cues in (digital) media content about science affects public trust in science and whether this varies across population groups.

We emphasized that answering this question would provide insights into what sources of information potentially affect public trust in science (positively or negatively) via their representation of trust cues. The findings indicate that trust in science seems to be a relatively stable construct within the present study's sample — at least in the year between the two data collection points. Thus, they seem to reflect the asymmetry in trust formation described by Slovic [1993]. According to this, it takes a long time to build trust, for instance, through several confirmations that this trust is well given or through positive events, but only a moment to break it, for instance through negative events, which often receive higher (media) visibility and have more impact (“Trust is fragile”; p. 677). Hence, maybe in the year between data collection, no major event supported building more trust in science or eroding the already existing trust. At the same time, at t1, COVID-19 and potential negative events associated with it may have been more present when respondents made their judgments.

Findings, however, also point to a nuanced nature of trust-assessing processes in (fragmented) digital media environments. For the whole sample (RQ1), trust cue exposure on public TV was a weak positive predictor of trust in science — which, overall, may be explained by the fact that the content analysis revealed that they have a moderate frequency of using trust cues in their content; at the same time, the panel survey revealed that they are the source where most German audiences are exposed to scientific information. Reports on public TV are often longer, and there are specific science TV programs offered by German public TV channels [see Ruhrmann et al., 2015]. Naturally, there may be specific audience characteristics to consider here: not everyone watches public TV and specialized programs. It could be that only people with a special interest in science watch these programs and probably pay close attention to the content. At the same time, only specific audiences would likely pay attention to content in populist media [see also Frischlich et al., 2023], which showed a weak but negative effect on trust in science at t2. The content analysis showed that they, indeed, also use trust cues [although differently, see Schröder & Guenther, 2024], and the panel survey showed that they are not used by many but still by some. We think that this finding should motivate researchers to pay closer attention to how populist media mediate trust in science.

The overall findings outlined were not replicated for all trust groups. The segmentation approach generally showed more variety and stronger effects — accounting for the diversity of science communication audiences [see Schäfer et al., 2018; Schäfer et al., 2022]. “Fully trusting” and “Rather untrusting” were unaffected by trust cue exposure to any of the 13 media sources we tested — at the same time, for both groups, the explained variance was the highest across all groups. For “Fully trusting,” this may be explained by the fact that they already reached the highest trust scores and may experience a particularly stable trust in science [see also Reif et al., 2024]. This assumption, as well as an explanation for the “Rather untrusting,” should be investigated further. The findings may also be linked to the null effects found in some studies testing the effect of media use on trust in science [e.g., Wintterlin et al., 2022]. If trust in science is indeed a stable construct, showing little variation over a whole year, then this may explain why previous studies did not show (strong) effects or why their effects did not point in a clear direction.

Regarding the trust groups, trust in science at t2 of “Highly trusting” was negatively affected by trust cue exposure in science blogs. In this case, it would be worthwhile to know more about the specific blogs respondents used or had in mind when making their assessment. Although the current analysis is novel in its approach, it is not fine-grained enough to shed more light on this and provide explanations. This should remind researchers that in future studies, we need to find ways to ask for media use in more detail than we often do today, which would provide further explanations.

At the same time, “Moderately trusting” were positively affected by trust cue exposure on public TV (just as the overall sample; this is the biggest trust group) and in science magazines. This group was the only one in which one of the sociodemographic information — education — had a significant effect. Furthermore, the nuanced nature of trust-assessing processes in digital media environments was also apparent for “Untrusting”. For them, trust cue exposure in populist media was a negative predictor (just as in the overall sample). This reflects to some degree the potential negative effects [e.g., Takahashi & Tandoc, 2015] of online media on trust in science, as stated in previous research. Reif et al. [2024] had also already established that “Untrusting” are indeed more frequent users of

populist media. Hence, in total, the present study was able to find (unique) effects of some journalistic and populist (online) media for some population groups; however, surprisingly, we were not able to find effects for journalistic media like (online) newspapers, social media, or other online media, although many of them contained quite a number of trust cues and many of them are used frequently by audiences.

Nevertheless, the findings give some direction on how to reach specific audiences of science communication when the goal is to affect their trust in science — and this targeted communication is something that is often defined as the central goal of audience segmentation [see also Guenther & Weingart, 2018; Klinger et al., 2022]. It is worth mentioning that in those cases where genuine journalistic sources had an effect, it was always a positive one on trust in science. When considering further online media, such as blogs and populist media, it was always a negative one. Hence, our study may be placed between the “media malaise” and “virtuous circle” hypotheses stated for political communication [see Verboord, 2023].

With the central goal of putting intermediaries in the limelight, the present study has limitations. Since this is a linkage study, both methodologies (content analysis and panel survey) and their connection have limitations — we will focus on the most important ones next. For the content analysis, this refers to the sample selected, using constructed weeks, and selecting subsamples for analytical steps. In total, our findings with respect to the frequency of trust cues can only be seen as a proxy. The set of media sources selected also differs considerably, for instance, regarding their length. Furthermore, we treated each identified trust cue unweighted, but their importance may vary among audiences. That is why we propose to test the identified trust cues in interviews or focus groups. For the panel survey, limitations relate to the representativeness of the data (which was only assured for t1), the measures developed [see Reif et al., 2023, including the ones on science information-specific media use, which is also only a proxy and does not fully capture the diversity of actors and content in digital media] and using interpretative techniques such as Latent Profile Analysis to identify groups of trust in science. Further, although developed after thoroughly considering the data, our linkage variables are only one potential way of linking content analytical and survey data [see De Vreese et al., 2017]. We also did not include covariates in our regressions as this is beyond the scope of the RQs but should be tested in future studies.

Hence, this study is a small but important further step into exploring the connection between a potential decline of public trust in science and digital media environments. We would like to emphasize that we see it as a central advancement of our study to analyze trust in science as a multilevel and multidimensional construct — combining novel approaches in content analysis (i.e., measurement of trust cues) and audience segmentation (i.e., identifying trust groups). In many ways, our approach was more detailed, for instance, not working with frequencies of media use alone and not just performing analyses with aggregated data. We have laid out quantitative connections. In the next step, these deserve explanation and enrichment, which we propose to achieve through qualitative interviews with members of the trust groups.

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## About the authors

Lars Guenther is Professor of Communication Science at LMU Munich's Department of Media and Communication.

✉ [lars.guenther@ifkw.lmu.de](mailto:lars.guenther@ifkw.lmu.de)

Justin T. Schröder is Research Associate at LMU Munich's Department of Media and Communication and University of Hamburg.

✉ [justin.schroeder@ifkw.lmu.de](mailto:justin.schroeder@ifkw.lmu.de)      ✕ @JTSchr

Anne Reif is PostDoc at the University of Hamburg.

✉ [anne.reif@uni-hamburg.de](mailto:anne.reif@uni-hamburg.de)      ✕ @reif\_anne

Janise Brück is Research Assistant at LMU Munich's Department of Media and Communication.

✉ [janise.brueck@ifkw.lmu.de](mailto:janise.brueck@ifkw.lmu.de)      ✕ @janisebrueck

Monika Taddicken is Professor of Communication Science at Technische Universität Braunschweig.

✉ [m.taddicken@tu-braunschweig.de](mailto:m.taddicken@tu-braunschweig.de)      ✕ @m\_taddicken

Peter Weingart is Professor Emeritus at the University of Bielefeld.

✉ [peter.weingart@uni-bielefeld.de](mailto:peter.weingart@uni-bielefeld.de)

Evelyn Jonas is Research Assistant at the Technische Universität Braunschweig.

✉ [evelyn.jonas@tu-braunschweig.de](mailto:evelyn.jonas@tu-braunschweig.de)      ✕ [@evelynjonas\\_237](https://twitter.com/evelynjonas_237)

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# Public Trust in Scientists: Exploring the Perception and Relevance of Trust Cues in Media Content

Justin T. Schröder<sup>a,b</sup>, Martina B. Engel<sup>a,b</sup>, Inken Schröder<sup>a,b</sup>, & Lars Guenther<sup>a</sup>

<sup>a</sup>Department of Media and Communication, LMU Munich, Munich, Germany

<sup>b</sup>Institute for Journalism and Communication Studies, Universität Hamburg, Germany

*Abstract.* Trust in science is often mediated via trust cues, i.e., information provided in content about science referring to dimensions of trust in science (i.e., expertise, integrity, benevolence, transparency, dialogue) as reasons for placing trust in scientists. Even though trust cues have been identified in media content, perspectives of public audiences have thus far been neglected. Therefore, we conducted four online focus groups ( $n = 23$  German participants) to assess the perceptions and relevance of trust cues. Our findings show that even though evaluations are individual, for most participants expertise and integrity cues were most important for their trust in scientists.

*Keywords.* public trust in science, trust cues, science journalism, focus groups, qualitative research

## Introduction

As the world becomes increasingly complex due to ongoing technological progress and rapid social change, it becomes more and more difficult for most people to fully understand specific developments. Especially in this situation, social trust is important (e.g., Luhmann, 2014), as it helps people cope with uncertainty surrounding necessary but unfamiliar changes, reducing the complexity of modern societies (e.g., Kohring, 2004; Luhmann, 2014). *Trust in science* is particularly important for public audiences engaging with scientific information, for example, in making informed decisions (e.g., Fischhoff & Scheufele, 2013; Intemann, 2023; Schäfer, 2016). Although trust in science in general, and trust in scientists in particular (e.g., Cologna et al., 2025) seems to remain high globally, there is ongoing concern that public trust in both is declining.

As most people encounter science indirectly through the media rather than in direct contact, this not only serves as an important source of information, but it also acts as an intermediary of trust (e.g., Bentele, 1994; Reif & Guenther, 2022; Schäfer, 2016). In this regard, journalism is the primary source of scientific information; furthermore, non-journalistic (online) media becomes increasingly important (e.g., Schröder & Guenther, 2024; European Commission, 2021; Mede et al., 2025; Wissenschaft im Dialog, 2023). Media is a key aspect in the trust evaluation process carried out by public audiences, and it helps in determining whether scientists can be trusted. In this regard, public audiences use trust heuristics to evaluate information (e.g., Kahneman & Frederick, 2005; Metzger & Flanagin, 2015; Tversky & Kahneman, 1974); hence, they apply heuristics to various media-related indicators, such as media brands, images, metrics, and forms of presentation, to assess media credibility (e.g., Boothby et al., 2021; Choi & Stvilia, 2015; Fogg et al., 2003; Metzger & Flanagin, 2013; Ross Arguedas et al., 2024). The actual information provided in media content is also evaluated. In this content, public audiences encounter scientists as main scientific actors (e.g., Schröder & Guenther, 2025; Guenther, 2019), and receive information about them, including reasons to place trust in them (e.g., Schröder et al., 2025, c; Intemann, 2023; Reif et al., 2024). Among those reasons, the gender of scientists seems to be an important factor influencing the trust placed in them (e.g., Hubner & Bullock, 2024). Previous research suggests that male scientists are perceived as more competent than female scientists (e.g., Mengel et al., 2019), since science is considered to be a male domain (e.g., Carli et al., 2016). According to this, female scientists automatically act counter-stereotypical, which results in less sympathy (see Hubner & Bullock, 2024). However, current research challenges this, showing that female scientists are perceived as more likeable, competent, and more trustworthy (e.g., Kim et al., 2024). Although mixed, the findings suggest that the

scientist's gender may influence how the information is provided and the reasons to trust scientists are perceived.

Reasons to trust relate to dimensions of trust in science: expertise, integrity, benevolence, transparency, and dialogue (e.g., Hendriks et al., 2015; Mayer et al., 1995; Reif & Guenther, 2022; Reif et al., 2024). Schröder et al., (2025) examined these reasons in media content using their conceptualization of *trust cues*, i.e., information in media content that is considered trust-evoking and refers to the dimensions of trust in science as reasons to trust. For instance, expertise can be addressed by providing information about the qualifications of a scientist, such as the academic title or the affiliation to an institution.

Trust cues in content about science have been studied, and initial evidence suggests an effect of exposure on trust in science (Guenther et al., 2024; see also Altenmüller et al., 2021; Ratcliff & Wicke, 2022; Rosman et al., 2022; Song et al., 2022). The ways public audiences perceived these cues and assess their relevance remains underexplored. It is open to debate how audiences identify, assess, and rank trust cues concerning their trust in scientists. Therefore, the overarching research question (RQ) of this paper is: *How do public audiences perceive trust cues?* To answer this, four focus groups with German participants were conducted.

## Theoretical considerations

The *theory of public trust* (Bentele, 1994) emphasizes the decisive role of media in the trust relationship between science and its publics. As an intermediary of trust, media facilitates trust between a subject (i.e., a trustor), such as public audiences that places trust, and an object of trust (i.e., a trustee), such as science that is trusted. Public audiences, consequently, place trust in science based on the information received by intermediaries. However, media is also an object of trust in itself (Bentele, 1994; Giddens, 1990; Luhmann, 2014; Mayer et al., 1995; Reif & Guenther, 2022). Hence, two research fields have developed in this context: one examines media credibility, treating it as the object of trust, while the other—media trust research—focuses on media's role as an intermediary of trust (e.g., Bentele, 1994; Grünberg, 2014; Reif & Guenther, 2022). The focus of the present study is on media as an intermediary, with science being the object of trust, aligning with the tradition of media trust research (based on the theory of public trust; Bentele, 1994). However, since we aim to present a holistic image for a better understanding of the interconnections between both concepts, we also describe, inter alia, the role of media credibility as part of the *trust evaluation process*.

Our approach to *trust* is primarily rooted in communication research, drawing from sociological perspectives (e.g., Grünberg, 2014), in which trust functions as a mechanism for reducing complexity (e.g., Luhmann, 2014). When a subject places trust in an object, the subject has confidence that the object will fulfill future tasks and/or expectations, while also accepting the risk that these may not be achieved (e.g., Giddens, 1990; Kohring, 2016). That is why subjects of trust expose themselves to vulnerability (e.g., Goldenberg, 2023; Mayer et al., 1995; Reif & Guenther, 2022; Resnick et al., 2015). Given our focus on trust in science, the concept of *epistemic trust* is particularly relevant, as it pertains to trust in science as a producer of valid knowledge. This encompasses both the intrinsic validity of scientific knowledge and the reliability of science as a source of information (e.g., Origi, 2012; Sperber et al., 2010; Wilholt, 2013). However, trust (in science) is not conveyed easily, as it is the result of a complex evaluation process.

To inform themselves about various scientific topics, audiences rely on a wide range of media (European Commission, 2021; Wissenschaft im Dialog, 2023), with the significance of online media increasing considerably (e.g., Mede et al., 2025; for Germany: Wissenschaft im Dialog, 2023). In digitized media environments, various actors can publish and distribute content with different interests across multiple media formats (Brossard & Scheufele, 2022; Huber et al., 2019; Schäfer, 2016) using distinct presentation modes, i.e., the possibilities that media (technically) provide. When public audiences engage with media and its content, a trust evaluation process takes place (e.g., Schröder et al., 2025). This process describes that audiences (1) use individual trust heuristics (i.e., cognitive shortcuts such as predispositions, familiarity with a topic, and probability judgments; e.g., Kahneman & Frederick, 2005; Tversky & Kahneman, 1974) for assessment (2) use a diverse range of indicators such as credibility markers (e.g., metrics, visuals, brandings) that indicate a sources' believability (e.g., Metzger & Flanagin, 2013; Ross Arguedas et al., 2024) and content-related trust cues (i.e., information provided in media content). Consequently, (3) this evokes a reaction, i.e., trust could be explicitly granted or denied, or, if an evaluation seems unclear, further acts to verify information could be performed (e.g., Flanagin & Metzger, 2000).

Regarding content-related trust cues, information provided in content about science delivers reasons for trust in scientists (e.g., Schröder & Guenther, 2025; Schröder et al., 2025; Intemann, 2023). These reasons can be connected to dimensions of trust in science, i.e., expertise, integrity, benevolence, transparency, and dialogue (e.g., Reif & Guenther, 2022; Reif et al., 2024). That is why content-related trust cues are relevant (Guenther et al., 2024; Schröder & Guenther, 2025; Schröder et al., 2025) and will be addressed in this paper.

## Trust cues in content about science

As emphasized, media content is a decisive factor in the trust evaluation process, as media use significantly contributes to assessment of trust in scientists (e.g., Scheufele & Lewenstein, 2005). The content provides public audiences with reasons to determine whether the scientists can be trusted or not.

Research on content-related trust cues has recently increased. An initial study by Schröder et al. (2025), identified 35 different, dimension-specific *trust cues* (see Table 1). In this regard, expertise cues signal scientists' capability to identify, analyze, and solve problems by providing information about their academic education, professional experience outside of academia, and knowledge and ability in their area of expertise. Integrity cues address adherence to scientific standards and processes, methods of quality assurance, and independence from external influences to show that scientific findings remain unaltered. Benevolence cues refer to ethical standards in research, social responsibility, and benefits of science and scientific research for society. Transparency cues provide information about the accessibility of research results and the use of comprehensible language. Dialogue cues refer to scientists' media presence, participation at public events, and measures for public engagement in research (for the definitions, see Guenther et al., 2024; Schröder & Guenther, 2025; Schröder et al., 2025). In a subsequent study, Schröder and Guenther (2025) compared the use of trust cues for each dimension of trust across media types, such as journalistic articles, social media posts (e.g., Instagram, X, Facebook, and YouTube), right-wing populist media, and other internet-based media (e.g., blogs posts). The most common trust cues describe a scientists' affiliation to an organization, their department or area of expertise, and the description of research processes.

While studies have identified these trust cues in media content, the perspective of public audiences has only marginally been considered, and some findings are mixed. For example, the communication of (un)certainty (connected to the dimension of integrity) does not seem to affect the perceived trustworthiness of scientists (e.g., Ratcliff & Wicke, 2022). However, self-correction of scientists may positively impact the trustworthiness of scientists and enhance the willingness of audiences to further engage with science (e.g., Altenmüller et al., 2021). In addition, open science practices positively influence the trustworthiness of scientists (e.g., Rosman et al., 2022; Song et al., 2022). Guenther et al. (2024) tested the effects of exposure to trust cues in media content on trust in science. This exposure only weakly affects trust in science across participants, but it has a greater influence on some specific groups that differ according to their trust in science. For instance, for moderately

trusting people, the use of public television and science magazines had a positive effect on their trust in science, while people who were untrusting toward science were negatively affected by trust cues in right-wing populist media. Hence, findings indicate that trust cues can affect trust in scientists. Nevertheless, studies to date have been either limited in the number of trust cues they consider or these have been collapsed in the quantitative analyses. For this reason, RQ1 asks more openly: *How do public audiences perceive trust cues (regarding dimensions of trust in science: expertise, integrity, benevolence, dialogue, and transparency)?*

Furthermore, although exposure to trust cues may affect the trust public audiences have in science (Guenther et al., 2024), it remains unclear how they perceive the relevance of individual trust cues. It seems likely that the relevance of the dimensions of trust in science varies from person to person (e.g., based on individual attitudes toward science or specific expectations; see also Metzger & Flanagin, 2015), which would also apply to the trust cues themselves. Following this, RQ2 is: *How relevant do public audience think (a) the dimensions of trust in science and (b) their respective trust cues are for their assessments of trust in scientists?*

## Differences in the perception of female and male scientists

Based on their gender, scientists are portrayed differently in media content and also perceived differently by public audiences. For this reason, gender is an important influencing factor in research on trust in scientists.

In the context of trust in scientists, even though there are no significant differences in the overall use of trust cues between female and male scientists (Schröder & Guenther, 2025), differences were found in how these trust cues were presented. For instance, personal biographies were often highlighted for female scientists, whereas scientific advice was predominantly given by male scientists. Such findings can be linked to stereotypes (Schröder, 2025). Schröder and Guenther (2025) also found that women were underrepresented, with only 26% of all trust cues identified in a sample including various media types collected over one year in Germany referring to female scientists.

This matches previous work on gender representation of scientists: female scientists are significantly underrepresented in media coverage compared to their male counterparts (Joubert et al., 2022). Men are more frequently portrayed as experts in scientific contexts, whereas women are more likely to be depicted as deviating from the norm or characterized by their appearance, shifting the focus away from their professional status (Chimba &

Kitzinger 2009; Mitchell & McKinnon 2019). Such gendered portrayals can result in women being taken less seriously in scientific contexts and reinforce the perception of science as a male-dominated field (see also Hubner & Bullock, 2024; Carli et al., 2016).

In addition to the representation of scientists' gender, research on their perception by audiences seems to be mixed or even suggests a shift from male scientists being perceived as more competent and trustworthy to female scientists (see Hubner & Bullock, 2024). On the one hand, children do associate scientists with men (e.g., Miller et al., 2018) and students tend to rate their male professors as more competent than female professors (Mengel et al., 2019). Men are usually perceived as more agentic than women, which aligns with stereotypes of successful scientists (Carli et al., 2016). On the other hand, in social media, female scientists who post selfies are also perceived as more competent than male scientists doing the same (Jarreau et al., 2019) and in images showing a work environment as more competent, likeable, and trustworthy compared to images of male scientists (e.g., Hubner & Bullock, 2024).

Hence, female and male scientists are not perceived equally, which might also affect their perception in the context of trust cues that provide information about scientists. Therefore, RQ3 asks: *To what extent do public audiences perceive trust cues linked to female scientists differently than to male scientists?*

## Methodology

To answer the RQs, four focus groups were conducted online. Interview guides and fictional stimuli were developed, and a qualitative content analysis was performed to analyze transcripts.

### *Planning and conducting the focus groups*

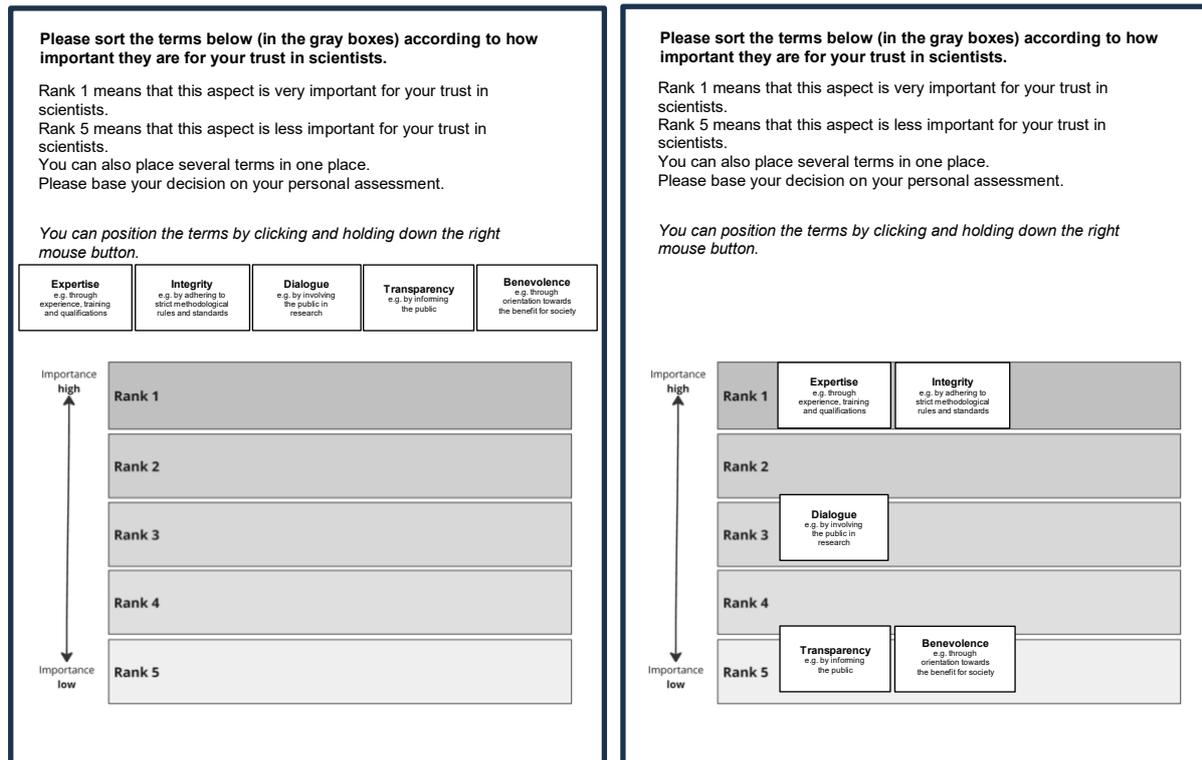
The focus groups took place in January and February 2024. Participant recruitment was carried out via Prolific, with support from the WISO Research Lab at University of Hamburg (Germany). In total, four focus groups were conducted ( $n = 23$ ). We decided on four focus groups because this number allowed us to rotate (1) the dimensions of trust in science presented in our stimuli (expertise, integrity, benevolence, and a combined version of transparency and dialogue due to the limited number of trust cues) and (2) the gender of the scientist (female, male, gender-neutral). Each group was presented with three different dimension-based stimuli, each featuring a different gender. This approach ensured the most efficient way to test all dimension-based stimuli across all gender variations (i.e., each

stimulus was presented with a female, male, and gender-neutral scientist across the focus groups).

A pretest was conducted with a separate focus group ( $n = 5$ ) prior to the main study. This way, we were able to identify weaknesses and adapt accordingly. At the beginning of the focus groups, we provided a definition of science, to establish a common understanding among participants during the focus groups with a follow-up question about the sources they used to get information about science. To ensure unbiased responses, we started with an open-ended question, asking which characteristics scientists should have to be considered trustworthy (based on Berdahl et al. 2016; see also Wissenschaft im Dialog, 2021). To investigate the relevance of the dimensions of trust in science and the trust cues, rankings were conducted. After considering various tools, we opted for *Miro* – an online whiteboard – to facilitate the ranking process. Each participant was tasked with ranking the dimensions (expertise, integrity, benevolence, transparency, and dialogue) as well as the trust cues within these dimensions.

To ensure individual workspaces while maintaining oversight, each participant was assigned their own area on the whiteboard. This setup allowed them to work independently, while we could simultaneously monitor all edits. This enabled us to identify both similarities and differences in their rankings (see Figure 1 for images of the procedure). To better describe the participants and to classify their statements, we also asked about their media use and used the *Public Trust in Science Scale* (PuTruS; see Reif et al., 2024) to gain insights on their trust in science (see Table S1 in the Supplement for a detailed overview of the participants, and document S2 for the interview guide).

**Figure 1.** Schematic presentation of the Miro sorting task before (left) and after (right) completion by participants



*Note.* The figure illustrates the change in arrangement of elements on the digital whiteboard (Miro).

### *Development of stimuli*

For the development of the stimuli, we included only the most relevant trust cues identified in media content by Schröder and Guenther (2025), based on a 5% cut-off within the categories of trust cues. This way, we were able to include trust cues for each dimension of trust in science (see Table 1 for an overview of all trust cues included in this study).

Since journalism was the most important source for trust cues (Schröder & Guenther, 2025), we decided to develop stimuli that read journalistically. The selection of the topic for the stimuli was guided by previously conducted studies (Schröder et al., 2025, c), in which the research discipline was identified. This analysis highlighted natural sciences (specifically the field of biology) as a relevant area. To ensure comparability across stimuli, this thematic focus was consistently maintained; the specific topics were then chosen randomly. Within the chosen topics, original articles were identified via Google News. Articles selected provided the basis for stimuli development, with names being anonymized using a name generator (Jonas, n.d.). The articles were then supplemented with relevant trust cues and direct speech to enhance engagement, as they were otherwise highly descriptive. Hence, we developed stimuli for expertise, integrity, benevolence, and – because of the small number

of trust cues – a combined stimulus for transparency and dialogue.<sup>1</sup> There were three versions for each article varying the scientists' gender, i.e., female, male, and gender-neutral. The stimuli were collaboratively reviewed and refined (e.g., clarity of the text) within the research team (Figure S3 presents the stimuli with highlighted trust cues). Since we wanted to focus on content-related trust cues and minimize the influence of credibility markers (such as media brands), we decided against embedding this media article in a typical media environment; we only used plain texts with headlines.

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<sup>1</sup> That is also the reason why, overall, we conducted four focus groups instead of five.

**Table 1.** *Overview of trust cues*

<b>Dimensions</b>	<b>Categories</b>	<b>Trust Cues</b>	
Expertise	Academic education	<i>Academic education*</i>	
	Professional experience	<i>Professional experience</i>	
	Qualification		<i>Department or area/Discipline of expertise</i>
			<i>Affiliation to an organization</i>
			<i>Professional position</i>
			<i>Academic title</i>
	Reputation		
Benevolence	Ethical norms	<i>Ethical norms</i>	
	Social responsibility	<i>Predictions</i>	
		<i>Assessment of public events/current affairs</i>	
		Research-related risks	
	Benefit for society	<i>Discoveries and breakthroughs</i>	
<i>Applicability of results</i>			

*(Science-based) Recommendations*

*Personal reasoning for benevolent behavior*

Social significance of science

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Integrity

Independence

*Client*

*Funding sources*

*Interests*

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Scientific quality assurance

*(Un)certainties and limitations*

*Continuity/permanence of research*

Peer Review

Correction/Revision

---

Scientific standards and processes

*Research collaboration*

*Publication*

*Description (and explanation) of research processes*

Legal framework for research

Working conditions in science

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Transparency

Accessibility of results

*Accessibility of results*

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	Comprehensible language	<i>Comprehensible language</i>
Dialogue	Participation at public events	<i>Participation at public events</i>
	Public Engagement	<i>Public Engagement</i>
	Media presence	<i>Journalistic media presence</i>
		<i>Direct media presence</i>
<i>Further media presence</i>		

\*Note. All trust cues above a 5%-threshold are in italics. In cases where no additional expressions are listed for a category, these categories are trust cues as well.

### *Qualitative content analysis*

All focus groups were transcribed in an initial step using *Trint*. *MAXQDA* was used for manual review, correction, and semantic verification of the transcription. The transcription followed the guidelines established by Kuckartz (2018).

Three individuals assigned coding units to the dimensions and categories of trust, which served as deductive categories. The coding units, for example, dealt with general characteristics, reasons for rankings, and perceptions of each stimulus (i.e., the topics addressed during the focus groups). If assignment to the deductive categories was not possible, the coders developed new categories inductively. Each coder paraphrased every statement for all topics and, subsequently, condensed it to the key messages (see Mayring & Fenzl, 2019). In the next step, the coders met and discussed each paraphrase and key message until consensus was reached. In addition to the topic-related codes, we also included a category for the evaluation of the article by participants, to be able to separate statements about the trust cues in the stimuli and statements about the articles on a meta-level, which can rather be associated with credibility, e.g., message markers.

Regarding RQ1, we checked the trust cues identified in the stimuli and collected the participants' perspectives regarding each one. For the relevance of the dimensions of trust in science and the categories of trust cues (RQ2), we not only analyzed the reasons for the ranking but also tried to display the overall evaluation of relevance using a heat map. To answer RQ3, we filtered the participants' statements according to the gender of the scientists in the stimuli (i.e., male, female, and gender-neutral) and compared them. In this way, we were able to identify differences in the perception of female and male scientists.

## Results

### Perception of trust cues for each dimension of trust (RQ1)

In our stimuli, 28 trust cues referred to different aspects of dimensions of trust in science. The participants identified all trust cues, except for *media presence in journalistic media* (a dialogue cue).

#### *Expertise cues*

Addressing expertise in media content about science was generally perceived as important and relevant. In detail, *academic education* in the form of a doctoral degree seemed positive

for trust in scientists, as it suggested specialized knowledge, particularly when combined with other cues, such as a field of study and experience. However, participants considered that a doctorate was not a guarantee for expertise, as it could be fraudulent or subject to varying standards, depending on the discipline. *Professional position* positively impacted trust in scientists and served as a clear indicator of expertise, signaling a high level of education. *(Non-academic) professional experience* by scientists was also viewed positively, as it reflected a commitment to ethical standards according to the participants. In contrast, the *area/discipline of expertise* was noted but evaluated neutrally. However, the area/discipline of expertise can have a positive effect on trust in scientists when combined with a doctoral degree and professional experience. The *affiliation of scientists to an organization* was perceived positively and served as a clear indicator of expertise.

Another expertise cue, according to participants, was extensive (i.e., long-term) experience in a specific research area.

*And, of course, how long they have experience in the field. If they are completely unfamiliar with the subject, then something doesn't fit. If they used to develop something about computer mice, then they somehow can't have medical information. (P4.2)<sup>2</sup>*

### *Integrity cues*

Integrity cues positively influenced participants' trust in scientists. Any measure that ensured the quality of research was evaluated positively. This applied particularly to aspects that demonstrated that research findings were not developed by a single researcher but were validated by multiple individuals, e.g., through *research collaborations*. The traceability of the research process and the methods employed were important as well. In detail, the communication of *(un)certainty* can have a positive impact, as the research is thus perceived as nuanced rather than absolute and definitive. However, if the communication of *(un)certainty* does not appear coherent in terms of the scientific argument, this can be interpreted as inconsistency and, therefore, negative for trust assessments. Characteristics of independence, i.e., disclosing *clients*, *funding sources*, and *interests* were seen positively. However, the participants explained in detail that a transfer of trust takes place according to the point of reference: when a client, funding source, or party of interest is viewed positively, trust in scientists can benefit from this—and, vice versa.

*And so, for me, those [opinions of scientists and scientific processes] are more internal influences, meaning things that relate to science itself. And when I think of external influences, I tend to think much more about societal pressure or financial*

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<sup>2</sup> The second participant from group four.

*influences or something like that. Because, yeah, externally, I basically see it as things coming from non-scientists. (P4.8)*

The *description and explanation of research methods* enhanced understanding of the research process that, in turn, fostered trust. *Publication* of research was recognized, as it is associated with both expertise and transparency (e.g., demand for citation links). In general, participants voiced a lack of expertise and transparency cues in the integrity stimuli, particularly regarding links to studies.

#### *Benevolence cues*

Benevolence was perceived ambivalently; its evaluation depended on the context. The *applicability of results* can have a positive effect if perceived as realistic (i.e., including limitations and boundaries). However, if the applicability was perceived as too detached from the research, it might negatively influence participants' trust in scientists. *Discoveries and breakthroughs* could negatively impact trust if they were not adequately explained or did not connect to the pre-existing knowledge: "*From my experience, I have never heard of this method before. If it's supposed to be so revolutionary, then one would probably have heard about it by now*" (P3.5). Scientists as subjects of trust who adhere to *ethical norms* were generally perceived as benevolent. Nevertheless, participants believed that scientists could not influence the misuse of scientific findings, leading them to decouple this aspect from ethical norms. Overall, the impact of this cue on trust in scientists seemed to be linked to the topic and coherence of the text.

*Personal recommendations* from scientists could make participants feel like they were being patronized, which resulted in a negative impact on their trust in scientists. Moreover, recommendations needed to be causally justified by research. But, in total, no positive feedback regarding recommendations was reported. The mention of *personal motivations* of scientists was considered unnecessary and irrelevant by most participants. For the participants, this was not a reason to trust scientists. In some cases, however, personal motivations were viewed positively, as they could indicate the independence (integrity) of the scientists. Additionally, for scientists, personal motivation was latently assumed. Vague, uncertain, or distant future *predictions* could raise doubts and negatively impact trust. In the overall assessment of the benevolence stimulus, when expertise, integrity, and transparency cues were perceived as lacking, this prevented a full trust for the scientist.

#### *Transparency and dialogue cues*

Transparency cues were generally positive for the participants, especially because they enabled audiences to verify information on their own. Dialogue cues can have a positive impact, as they are interpreted as scientists' ability to connect with the public. However, it is noteworthy that there is a transfer of trust from the intermediaries (e.g., the organizers of events or a media outlet) to the scientists. The *availability of information* via a link is generally viewed positively, as it allows participants to independently and conveniently verify given information. However, this positive perception can be neutralized if the participants are unfamiliar with the source or if they question its reliability. Some participants indicated that the link had no effect on them, as they would conduct independent inquiry regardless. If a text alternated between *comprehensible language* and technical terminology (i.e., inconsistent language use), this was viewed negatively and considered unprofessional. Consistency in language was important. The use of specialized terms depended on the target audience. While such terms can make a text more interesting, they can also be perceived as an attempt to make the text merely appear more scientific, which can provoke skepticism.

*Direct media presence* (e.g., social media use) is interpreted as a sign of scientists' ability to address public audiences, as simultaneously participants are aware of pseudo-scientific actors on social media. Direct media presence is perceived as a willingness to engage in dialogue, but whether it has a neutral or positive impact on trust remained unclear.

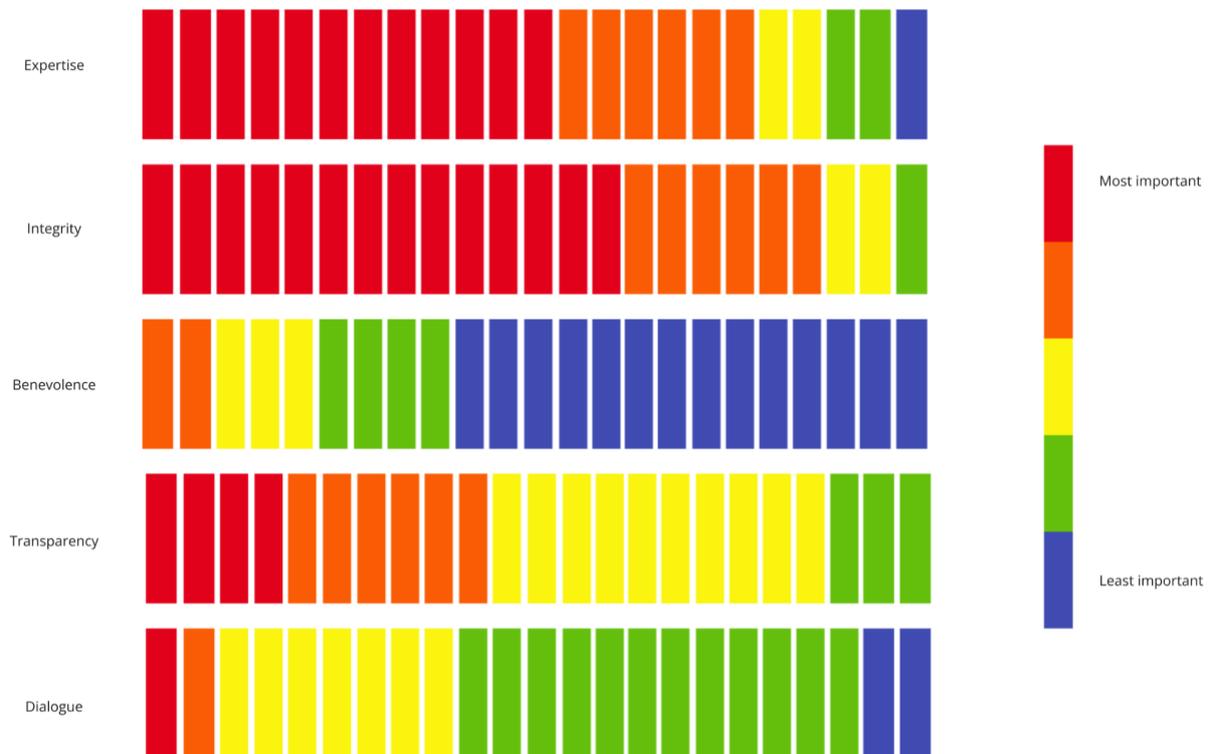
*Public engagement* by scientists was generally viewed positively, as it demonstrated their willingness to interact and their enthusiasm for research. However, it could have a negative impact if the engagement was perceived as self-promoting or if the text came across as sensationalistic. Participants expressed a desire for sufficient information about public engagement activities. *Participation in public events* was generally perceived positively, because it made research findings accessible. However, the event organizer and their credibility played a pivotal preceding role (as well as the selection criteria, as only credible contributions were expected to be included). Overall, the participants noted that expertise and integrity cues were missing in this stimulus to determine trust for the scientist.

## Relevance of the dimensions of trust in science and their corresponding trust cues (RQ2)

We asked participants to rank the dimensions of trust in science according to their importance for trust in scientists. We used the same approach to rank categories of trust cues for each dimension. The overall relevance of the dimensions of trust is displayed in

Figure 2, using a heat map. In the following, we describe the results for the dimensions (RQ2a) combined with the trust cues for each dimension (RQ2b).

**Figure 2.** Participants' relevance assessment of the dimensions of trust



Overall (RQ2a), Figure 2 shows that participants ranked the dimensions of expertise and integrity the highest, followed by transparency, dialogue, and benevolence. *Expertise* is seen as deep understanding (e.g., understanding scientific theories and subject-specific knowledge), which can be affirmed through formal evidence, which is, for some, part of the definition of a scientist. Although *academic education* is one possible pathway to expertise, it is not the only way to acquire it. Most participants also viewed *professional experience outside academia* as a potential indicator of a scientist's actual knowledge and abilities. They considered it a welcomed addition and noted that its importance or added value was also dependent on the specific case or field. For most participants, *knowledge and ability in their area of expertise* was seen as the primary indicator. It was not considered important where this knowledge and ability were acquired, but they appreciated having some information for their assessment.

*So, I think that to trust people who make scientific statements, it is most important to me that they actually know what they are talking about and that they understand how they arrive at the results they want to present. Where this knowledge comes from—whether it comes from experience, inside or outside of science, within academia, or from other sources—is not that important to me, as long as I have the impression that they know what they are doing. (P2.8)*

For the participants, *integrity* was a prerequisite for trust in scientists. Openly asked, the participants mainly addressed adherence to scientific standards, the use of methods and control mechanisms, such as peer review procedures and collaborations. Moreover, participants also expanded the meaning of the term “integrity” to include ethical standards. With direct query, *adherence to scientific standards and processes* was considered essential for scientific work because it distinguished so-called “alternative sciences” (or pseudo-science) from valid scientific information and was regarded as a form of quality assurance. *Methods of quality assurance* were often already incorporated into work according to scientific standards and processes. Regarding *independence from external influences*, participants distinguished between two types of influences: On the one hand, some influences were seen as unavoidable and even desirable (e.g., peer review processes and public funding). On the other hand, external influences could also be negative or potentially harmful (e.g., private funding or anything that might steer research outcomes in a preferred direction).

For the participants, *benevolence* was seen as an influencing factor to scientific work rather than a dimension of trust in science because it contradicts the idea of rational and “cold” science, whose sole objective should be to obtain knowledge.

*That’s how I understood it a little—that benevolence is something that is acceptable to society. But that should not be the goal of a scientist, to produce what is acceptable, but rather to discover something that may not be acceptable to society. Instead, facts should be established. (P4.2)*

In addition, a long-term assessment of which research results contribute to the common good and to what extent was perceived as questionable. In more detail, the use of *ethical standards* appeared to be evaluated differently depending on participants’ understanding of science. For some, ethical norms were a fundamental principle of science and, therefore, of scientific work, while for others, it was desirable but not essential. For them, a violation would not necessarily call the validity or value of the findings into question. As a result, compliance with ethical norms was not considered a criterion for trust by the participants.

*When it comes to the significance [of scientific results], then [ethical norms] are not important to me. But in general, of course, it is important to me that research is conducted ethically and so on. However, I still find it trustworthy even if that were not*

*the case. Not emotionally trustworthy, but in terms of the factual basis—even if unethical methods were used in the research. (P3.4)*

Additionally, participants perceived overlaps with social responsibility. As such, *social responsibility* was considered to be dependent upon the specific research project. In addition, participants explained that not all scientific disciplines have a direct impact on the *benefit for society*. Participants noted that some fields only contribute to societal well-being over time and in indirect ways.

*[...] sometimes scientific matters are relevant and may ultimately serve the good of society in the long run, even if an individual researcher doesn't see it directly. In basic research, for example, it may eventually contribute to the good of society, even if that's not the case in the next ten years. (P2.8)*

Most participants believed that science should not prioritize the benefit for society as its main goal (except for a patient's well-being in medical fields). Instead, the primary goal of science should be the pursuit of knowledge that eventually contributes to societies' well-being.

*Transparency* was understood as two distinct aspects: transparency as an action and transparency as the availability of information. Scientists act transparently when they answer questions about their work, publish findings, participate in conferences, or take other actions that signal a certain form of openness. Transparency regarding the availability of scientific information means that information on the research process or influences such as funding should be available. Here, aspects of integrity were primarily associated with transparency: *"That's why transparency definitely ended up as number one for me. Also, [...] where the funding for the research, for the science being done, is coming from. Very important."* (P2.2). While complete transparency was not necessary according to the participants, information should be made available upon request. Furthermore, *comprehensible language* used for explanations of scientific terms was interpreted as audience-appropriate science communication. It was viewed positively and generally considered desirable. However, it was not a criterion for the quality of the underlying research, nor was it a reason to trust: *"Just because someone explains a term to me that sounds scientific or explains something to me, that is not a criterion for me to trust them."* (P2.1)

*Dialogue* was differentiated by the participants between dialogue within science (internal) and outside of academia (external). Internal dialogue was described as an openness to other approaches and perspectives of the professional public and the scientific community respectively, which is decisive for academic work. External dialogue was understood as the exchange with and inclusion of the (lay) public. Internal dialog was considered crucial while

external dialog was described as less important, due to a lack of expertise on the part of the public and, depending on the field, a lack of interest in the respective research area.

*I mean, if multiple research groups are working on the same topic, that generally suggests that it is somewhat more trustworthy. [...] I didn't see it as involving the entire public but rather the scientific community, where other groups are also included. I mean, of course, the average person cannot be included—that's obvious. Scientific research is far too specialized to involve every single person. (P3.5)*

The *media presence* of scientists per se did not seem to be an indicator of trust. It was more decisive that the scientist be present in a reputable—this way trust can be transferred to the scientist. The same held true for public events; participating in public events was seen as positive if there was an opportunity for direct questioning. Presence on social media was sometimes perceived as unreliable and sometimes as audience-appropriate communication. The respondents also explained that scientists should only comment on their area of expertise, as otherwise, the roles between “experts” and “communicators” becomes blurred.

*If the science communicator—well, in certain areas, I actually prefer them, because, for example, Harald Lesch comes to mind. He is actually a physicist, but by now he publishes on an incredible range of subjects. I think that doesn't do his credibility any good anymore because it's simply outside his core field. And as a viewer, it then becomes difficult to distinguish between when he is speaking as a science communicator and when he is actually an expert. (P4.1)*

Participants recognized that implementing *public engagement* can be challenging and acknowledged that the public is not necessarily interested in all scientific topics. Public involvement (e.g., counting birds or collecting water samples) was not considered crucial for trust in scientists, although a few participants viewed it as a welcome addition.

## Differences in the perception of female and male scientists

### (RQ3)

For the expertise stimuli, no differences in the perception were found across genders. However, the scientist in the gender-neutral expertise stimulus was perceived as a man by the participants. All scientists, regardless of gender, were discussed in similar ways and perceived positively.

In contrast, the female scientist in the integrity stimulus was perceived more critically than the male scientist. For female scientists, limitations were seen as an inconsistency. Research cooperation was partly positive but also acted as a means to maintain an international appearance. Furthermore, an emphasis on independence was seen as contradictory. For the male scientist, mentioning different research conditions as limitations

was interpreted as positive for trust in scientists and made the researcher more serious. The gender-neutral individual was again referred to as a male in the integrity stimulus.

For benevolence, no significant differences in the evaluation could be identified. Overall, benevolence cues referring to the scientists were perceived as rather negative for all genders. Again, the gender-neutral stimulus was referred to as a man.

However, in the transparency-dialogue stimuli, gender differences were observed. Concerning the female scientists, media presence and public engagement indicated the scientist's social ability. Public engagement also showed the researcher's personal motivation. Here, the gender-neutral protagonist was referred to as a female. Conversely, the male scientist was assessed critically. Public engagement was seen ambivalently because of the risk of showmanship. Nevertheless, participation in events was perceived as scientific and, hence, positive.

## Discussion

Trust cues in media content are a decisive factor in the trust evaluation process. Trust cues provide information about expertise, integrity, benevolence, transparency, and dialogue of scientists. Even though they have been identified, compared across diverse media outlets, and investigated as to their effect on trust in science (Guenther et al., 2024; Schröder & Guenther, 2025; Schröder et al., 2025; see also Altenmüller et al., 2021; Ratcliff & Wicke, 2022; Rosman et al., 2022; Song et al., 2022), the perspective of public audiences has not been included in research about trust cues. Hence, the present study asks, "*How do public audiences perceive trust cues,*" and determined answers by conducting four focus groups.

The results of this study showed that audiences indeed identify trust cues based on media content. Expertise and integrity (cues) were by far the most often considered aspects in trust evaluations. Expertise cues in particular seemed crucial for obtaining key information necessary to assess trustworthiness. Furthermore, expertise and integrity as prerequisites combined with transparency cues seemed desirable for trust evaluations. The high importance of expertise and integrity was also apparent in the rankings of the dimensions, where these received the highest scores compared to the other dimensions (see also Figure 2). In contrast, the benevolence stimulus was rated exclusively negatively with expertise, integrity, and transparency, which was reported as missing. Benevolence is one of the established dimensions of trust in science (Hendriks et al., 2015; Mayer et al., 1995), but it was perceived as negative for the participants' trust in this study—at least when addressed alone. For this reason, it should be questioned what role the dimension of benevolence plays

compared to the other dimensions of trust. Furthermore, the factors influencing how it is perceived should be examined.

In addition, transparency and dialogue, as newly added dimensions of trust in science (see Schröder et al., 2025; Reif & Guenther, 2022; Reif et al., 2024), were ranked higher, on average, than the established dimension of benevolence. Hence, these dimensions should be considered in future studies, as they are relevant to public audiences, which align with theoretical considerations on the concept of public engagement with science (e.g., Schröder et al., 2025, c; Reif & Guenther, 2022; Reif et al., 2024).

This suggests three important insights: First, the dimensions should not be considered in isolation but rather in interaction, as they often complement or reinforce each other. Second, there seems to be a hierarchy of dimensions of trust in science. Third, the findings indicate that participants collect and process information about scientists until they reach a point of saturation of information at an undefined (and likely highly individual) level during the evaluation process. Once this threshold is reached, they no longer question the legitimacy of scientists and are thus willing to place trust in them. However, if information is missing, they try to verify this information or remain skeptical.

Regarding the gender of the scientists, we only saw small differences in their evaluations. This could mean that female and male scientists may actually be evaluated in the same way when presented similarly. Consequently, this underlines the significance of how media present scientists in their coverage, which is shaped by the underrepresentation of women and the reinforcement of gender stereotypes (Schröder, 2025; Carlie et al., 2016; Chimba & Kitzinger 2009; Mitchell & McKinnon 2019). We also saw that the gender-neutral scientist was referred to as a man in the context of expertise, integrity, and benevolence. Only in the transparency-dialogue stimulus was the scientist considered to be a woman. Even though this could be due to group effects, references to stereotypes can be drawn: The scientist is considered a man in “hard” aspects that are mostly connected to men (e.g., expertise, integrity) and a woman when it comes to “soft” skills (e.g., transparency, dialogue; see Hubner & Bullock, 2024).

Applying these findings to the trust evaluation process, this study shows parallels to the use of trust heuristics (e.g., Kahneman & Frederick, 2005; Tversky & Kahneman, 1974). The reasoning behind the importance of the dimensions of trust is highly individual and subjective. Consequently, the assessment appears to be influenced by different participant perspectives, such as their understanding of the scientific system and their views on the purpose of research (see also Metzger & Flanagin, 2015 for the individuality of trust

heuristics). This also applies to the relevance of specific trust cues implemented in the stimuli, which were evaluated based on personal views. Overarchingly, this indicates that information provided in media content about scientists is relevant to audiences, and they actively perceive this information and consider it in their trust evaluation.

In addition, some of the openly coded aspects in the focus groups transcripts fall into the category of credibility markers and specifically relate to the message level (e.g., consistency of the text; e.g., Metzger & Flanagin, 2015), which highlights that content-related trust cues are difficult to capture exclusively. Therefore, the creation of stimuli should always be considered holistically, taking at least message-related credibility markers into account, as well as the context of the contribution, the overarching composition of the text, and the language used.

Furthermore, the evaluation of the stimuli revealed that some participants were uncertain and wanted to search individually to verify whether the information was accurate or if other sources supported it. This aligns with the verification behavior within the trust evaluation process (e.g., Flanagin & Metzger, 2000; Metzger & Flanagin, 201).

Overall, while individual aspects of the trust evaluation process can be examined, these factors are never solely responsible for the final assessment of trust in scientists.

## Limitations

Naturally, this study comes with limitations. Regarding the content, it is important to note that we tested specific media content outside of its typical environment. It was a deliberate choice to focus specifically on content-related trust cues and to minimize the influence of credibility markers. However, this does not fully reflect typical media use. Future research could, therefore, take a holistic approach, embedding content-related trust cues alongside credibility markers. Additionally, since we used stimuli that focused on one dimension exclusively (except for the transparency-dialogue stimulus) the interactions between the dimensions of trust in science within a media article were not analyzed in this study even though the participants discussed these relationships. This could be expanded to explore the relationship between trust cues and credibility markers. Our findings suggest that credibility markers also played a role in our study (e.g., message markers), even if unintentionally. Furthermore, we selected trust cues based on a 5% cut-off (see Schröder & Guenther, 2025), but a low frequency of trust cues in journalism does not necessarily mean they are unimportant to audiences; rather, it provides insights into journalistic selection processes.

From a methodological perspective, the findings of this study could be further validated through additional focus groups.

Nevertheless, this study makes a valuable contribution to the investigation of trust cues. We have demonstrated methodically that exploratory focus groups involving complex interaction elements can be conducted online and used for further research. Furthermore, we have emphasized the audience's perspective on the aspects that make participants trust scientists in media content. This contributes to a more complete picture of research on mediated trust in scientists.

## Ethics Declarations

The authors confirm that all participants provided informed consent prior to participation. At the conclusion of each session, a debriefing was conducted to disclose the fictional nature of the stimuli. To ensure transparency, the original articles were made available for download, allowing participants to compare them with the fictionalized versions. Participants were given the opportunity to ask questions following the focus group interview and were provided with the researchers' contact information to enable follow-up communication at any time.

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# Appendix

**Document 1:** Table S1. Overview of participants' demographics, including information about their media use

**Document 2:** Guideline for focus groups

**Document 3:** Stimuli

**Document 1:** Table S1. Overview of participants' demographics, including information about their media use

**Table S1.** Overview of participants' demographics, including information about their media use

Participant ID	Gender	Age (in years)	Degree	Points of getting in contact with science news	Trust in science (PuTruS-5)	PuTruS - 5 index	Overall impressions of the participant
P1.1	Male	63	Secondary school certificate	Journalistic media: newspapers, TV, trade/industry magazines; direct contact: museums, trade fairs	Expertise: 0 Integrity: 5 Benevolence: 5 Transparency: 5 Dialogue: 1	3.2	No scientific background, scientifically interested, humorous, much input from personal life
P1.2	Female	N/A	Doctorate	Journalistic media: trade/industry magazines; online media: podcasts	Expertise: 3 Integrity: 5 Benevolence: 0 Transparency: 2 Dialogue: 0	2	Scientific background, self-confident, discusses much from an overarching perspective on the science system
P1.3	Female	58	Vocational school certificate	Journalistic media: TV; online media: internet, podcast	Expertise: 4 Integrity: 5 Benevolence: 4 Transparency: 5 Dialogue: 3	4.2	Not very critical, agreed with other participants rather than expressing her own views
P1.4	Female	23	Secondary school certificate	Journalistic media: news formats (like Tagesschau); direct contact: studies; specialized media: scientific literature	Expertise: 4 Integrity: 4 Benevolence: 5 Transparency: 5 Dialogue: 4	4.4	Input was limited to the university context, appears to be impersonal
P2.1	Female	52	High school diploma	Journalistic media: online newspapers	Expertise: 4 Integrity: 4 Benevolence: 4	4.0	Inconsistent and unstructured contributions, sometimes

					Transparency: 3 Dialogue: 3		unclear expressions, argued based on everyday experience
P2.2	Male	29	High school diploma	N/A	Expertise: 4 Integrity: 3 Benevolence: 3 Transparency: 5 Dialogue: 3	3.6	Relatively unobtrusive and calm, clear and understandable expression
P2.3	Male	55	Secondary school certificate	Journalistic media: documentaries	Expertise: 3 Integrity: 3 Benevolence: 2 Transparency: 3 Dialogue: 2	2.6	Interested in science, occasionally humorous but mostly serious, sometimes inconsistent and unstructured in his argumentation, often argued on an overarching level and focused on complex questions (e.g., the meaning of science)
P2.4	Male	31	Bachelor's degree	Journalistic media: newspapers; social media: YouTube	Expertise: 4 Integrity: 5 Benevolence: 2 Transparency: 3 Dialogue: 3	3.4	Polite, thoughtful, provided critical contributions
P2.5	Female	39	Secondary school certificate	Journalistic media: TV, newspapers, documentaries; social media: YouTube, Instagram	Expertise: 5 Integrity: 5 Benevolence: 5 Transparency: 4 Dialogue: 4	4.6	Appeared disinterested at times, contributions rarely went beyond what was asked
P2.6	Female	29	Master's degree	Direct contact: doctoral studies	Expertise: 4 Integrity: 5	2.4	Confident, sometimes meticulous and overly correct

					Benevolence: 0 Transparency: 3 Dialogue: 0		in her argumentation
P3.1	Female	28	Master's degree	Journalistic media: newspapers; direct contact: studies	Expertise: 5 Integrity: 5 Benevolence: 3 Transparency: 4 Dialogue: 3	4.0	Strong scientific background, calm, clear expression
P3.2	male	38	Vocational high school diploma and training	Social agents: acquaintances; online media: Reddit	Expertise: 3 Integrity: 3 Benevolence: 1 Transparency: 4 Dialogue: 2	2.6	Very interested, actively engaged, no scientific background
P3.3	Female	18	Student	Journalistic media: magazines; social media: TikTok, YouTube	Expertise: 5 Integrity: 4 Benevolence: 3 Transparency: 4 Dialogue: 4	4.0	Authentic, down-to-earth
P3.4	Male	28	High school diploma	Direct contact: studies	Expertise: 4 Integrity: 5 Benevolence: 1 Transparency: 1 Dialogue: 3	2.8	Calm, organized, with a slight tendency toward disinterest (in the setting, not necessarily the topic)
P3.5	Male	27	Master's degree	Direct contact: doctoral studies; specialized media: scientific journals	Expertise: 4 Integrity: 5 Benevolence: 1 Transparency: 2 Dialogue: 3	3.0	Very direct, sometimes cynical, occasionally arrogant

P3.6	Male	29	High school diploma	Direct contact: studies; specialized media: scientific journals	Expertise: 5 Integrity: 5 Benevolence: 2 Transparency: 2 Dialogue: 3	3.4	Serious, organized, thoughtful, scientific background was evident
P4.1	Male	32	Master's degree	Online media: websites of research institutes, Google scholar; social media: YouTube	Expertise: 4 Integrity: 5 Benevolence: 1 Transparency: 3 Dialogue: 2	3.0	Intense when speaking, a "talkative" person who needs to be slowed down
P4.2	Male	36	Bachelor's degree	Journalistic media: newspapers; specialized media: scientific journals, databases; social media: X	Expertise: 4 Integrity: 4 Benevolence: 2 Transparency: 3 Dialogue: 3	3.2	Friendly, engaged (sometimes overly engaged), occasionally incoherent argumentation
P4.3	Female	27	High school diploma	Journalistic media: E-Mail newsletters, newspapers; social media: X, Instagram	Expertise: 5 Integrity: 4 Benevolence: 3 Transparency: 4 Dialogue: 2	3.6	Reserved, even shy, but when actively engaged, provided coherent and clear arguments
P4.4	Female	26	Bachelor's degree	Direct contact: studies	Expertise: 4 Integrity: 4 Benevolence: 2 Transparency: 4 Dialogue: 1	3.0	Calm, organized, clear in her argumentation and stance
P4.5	Male	29	Master's degree	N/A	Expertise: 4 Integrity: 5 Benevolence: 2 Transparency: 5 Dialogue: 2	3.6	Somewhat reserved, brought little new to the conversation

P4.6	Male	38	Bachelor's degree	Direct contact: studies; online media: ChatGPT; specialized media: scientific journals	Expertise: 4 Integrity: 4 Benevolence: 2 Transparency: 2 Dialogue: 1	2.6	Serious demeanour, relied much on his personal experience
P4.7	Male	24	Bachelor's degree	Direct contact: studies; social media: YouTube	N/A	N/A	Calm, focuses on details regarding phrasing, serious and factual

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*Note.* N/A = no answer; the last column describes the researchers' impression of the participant

## Document 2: Guideline for focus groups

### General information

(Description of the participants, zoom links, etc.)

### Welcome (ca. 5 minutes)

- *Introduction of the moderator*
- *Introduction of the notetakers*
- *Duration of the focus group: approximately 120 minutes*
- *Purpose: Today, we would like to show you some texts related to the topic of science and collect your impressions.*
- *“I will occasionally refer to my notes to keep the focus group going.”*
- *“There are no wrong or right answers – we are interested in your genuine opinion.”*
- *Disclaimer: **Recording of the video**, but everything will be anonymized for analysis and then deleted.*
- *Do you agree on being recorded? (a clear “yes” is important; obtain data protection declaration)*
- *“Before we begin, are there any questions?”*

### Brief introduction (ca. 10 minutes)

(One after another (as a warm-up to familiarise everyone briefly))

*Let’s start with a quick introduction: Please tell me who you are and, for example, what you do professionally.*

### Thematic introduction via media use (ca. 10 minutes)

*Today’s session is about the topic of “science.” By this, we mean everything that contributes to our understanding of the world. This encompasses observations and examinations related to nature, medicine, physics, psychology, as well as social and human sciences like economics and history. When we talk about scientific information, we’re referring to knowledge, facts, or explanations that assist us all in better comprehending phenomena, making informed decisions, or simply satisfying our curiosity.*

(One after another (Icebreaker with self-expression))

*Where do you typically come in touch with science? (Follow-up: Which media sources do you usually use to obtain information about science?)*

### Operationalization of the dimensions of trust

What characteristics do you consider important in scientists for you to trust them? (based on Berdahl et al., 2016)

(Alternative/Follow-up: What skills do you think someone needs to be a good scientist? (Wissenschaftsbarometer, 2021))

Please describe in more detail what you mean by this. (Objective: to get a more precise description so that we can infer the intended dimension of trust in science (probably not explicitly name) and simultaneously operationalize the dimension.)

### **Hierarchizing the dimensions of trust in science (ca. 20 minutes)**

(Here we hierarchize the five dimensions of trust in science)

Now, we would like to show you a few digital cards with statements. Please click on the link provided to get to a digital whiteboard (if unclear: a workspace). You will find various terms there. Please put them in order:

Position 1 indicates that this aspect is the most important for your trust in scientists. Position 5 means that, among these five aspects, this one is the least important for your trust in scientists. You can also place multiple cards in one position if you feel they are equally important.

*We all open the Miro link (to make sure that everyone arranges the dimensions and keeping track of the assignment to facilitate further discussion about the arranged orders)*

Please briefly describe the order you've chosen and why you specifically selected this order. Please explain your decision. (Ask: Why is this dimension in position 1, why this one in position 5, and why everything else in between?)

### **Discussing stimulus material: Dimension 1 gender-neutral (ca. 20 minutes)**

Now, I'd like to show you examples from the media.

[Show material for Dimension 1 (gender-neutral) (consisting of the  $\geq 5\%$  cues)]

In this article, *Person X*, who works in research, is mentioned. What aspects mentioned affect your decision if you can trust this person (/the researcher)?

To what extent is this aspect (Dimension 1 - gender-neutral) important to you in trusting scientists? Why? How do the others perceive this?

*Link to the dimension (e.g., expertise): "You just mentioned the term 'expert/expertise (/other dimension)', ..."*

What does that mean to you? How is it expressed? (Alternatively: What significance does this aspect/dimension have for you when it comes to scientists?)

Now, I would like you to once again arrange statements in order. We'll proceed just as we did before: I will show you several aspects, and you can rank them on positions 1 to 5, depending on how important this aspect is to you for your trust in scientists. Position 1 means this aspect is the most important among those mentioned for trust in scientists. Position 5 means this aspect is the least important for your trust in scientists among all the aspects.

### **Discussing stimulus material: Dimension 2 (male researcher) (ca. 20 minutes)**

Now, I would like to show you some more examples from the media.

[Show material for Dimension 2 (male) (consisting of the  $\geq 5\%$  cues)]

In this article, *Person X*, who works in research, is mentioned. What aspects affect your decision if you can trust this person (/the researcher)?

To what extent is this aspect (Dimension 2 - male) important to you in trusting scientists? Why? How do the others perceive this?

*Link to the dimension (e.g., expertise): "You just mentioned the term 'expert/expertise (/other dimension)', ..."*

What does that mean to you? How is it expressed? (Alternatively: What significance does this aspect/dimension have for you when it comes to scientists?)

You're already familiar with this by now. I would like you to once again arrange statements in order. We'll proceed just as we did before: I will show you several aspects, and you can rank them on positions 1 to 5, depending on how important this aspect is for your trust in scientists. Position 1 means this aspect is the most important among those mentioned for trust in scientists. Position 5 means this aspect is the least important for your trust in scientists among all the aspects.

### **Discussing stimulus material: Dimension 3 (female researcher) (ca. 20 minutes)**

I would like to show you some more examples from the media.

[Show material for Dimension 3 (female) (consisting of the  $\geq 5\%$  cues)]

In this article, *Person X*, who works in research, is mentioned. What aspects affect your decision if you can trust this person (/the researcher)?

To what extent is this aspect (Dimension 2 - female) important to you in trusting scientists? Why? How do the others perceive this?

*Link to the dimension (e.g., expertise): "You just mentioned the term 'expert/expertise (/other dimension)', ..."*

What does that mean to you? How is it expressed? (Alternatively: What significance does this aspect/dimension have for you when it comes to scientists?)

And one last time: I would like you to again arrange statements in order. We'll proceed just as we did before: I will show you several aspects, and you can rank them on positions 1 to 5, depending on how important this aspect is to for your trust in scientists. Position 1 means this aspect is the most important among those mentioned for trust in scientists. Position 5 means this aspect is the least important for your trust in scientists among all the aspects.

### **Closing question:**

We talked about a lot of aspects today. Are there any additional aspects related to this topic that you would like to share?

### **Measurement of public trust in science (ca. 5 minutes)**

*Thank you very much. Before we end of our conversation, I would like to ask you to participate in a very brief survey (PuTruS-5, see Reif et al., 2024), which will be shared here on Zoom. Please click on the statements that most closely align with your views.*

*Scientists can be trusted because they...*

- 1) *...are experienced experts in their particular topic.*
- 2) *...adhere to strict rules and standards in their work.*
- 3) *...work for the common good.*
- 4) *...inform the public about relevant results of their research.*
- 5) *...sufficiently involve the public in their research.*

### **Debriefing**

To wrap up, I'd like to hear your thoughts on what you believe this study was about. What do you think? (*Objective: identify bias in the gender context*)

Now that our conversation is ending, I want to point out important aspects of the study. The media material presented today was introduced as genuine and unaltered. However, I'd like to reveal that the texts, while inspired by original content, were edited for the purpose of this study; they're fictitious. This includes the provided values and probabilities.

The focus of our study today was to observe which trust cues have an impact on your trust in scientists. For this reason, we modified or manipulated the texts with words and terms that, according to our research, could have an effect. We assume that various aspects related to expertise, integrity, benevolence, transparency, and willingness to engage in dialogue of scientists might affect the trust placed in them.

If you'd like to see the original material, we have provided **a link** with the corresponding articles. (Share download link)

Furthermore, we showed three articles featuring different genders: a gender-neutral example, a female scientist, and a male scientist. With this study, we aimed to explore whether there are differences in the perception of female and male scientists.

Please rest assured again that none of the statements you made today will reveal your identity, as your name will not be mentioned, and all responses will be anonymized. It will then no longer be possible to draw conclusions about your identity. As discussed, the recording of our conversation will be deleted after transcription and will not be forwarded internally or externally.

Now, I'd like to give you the opportunity to ask any questions you may have about the study. Do you have any questions?

**Closing**

Thank you and goodbye

### Document 3: Stimuli

Gender-neutral [female; male] expertise stimuli, translated from German

#### Habitat Loss: Decline in Amphibian Population

The Little Water Frog was recently distinguished as the Animal of the Year 2023 in Germany, but new scientific findings point to a concerning trend regarding native amphibian populations. Approximately half of the 20 amphibian species living in Germany are currently listed on the 'Red List of Endangered Species'. Particularly dramatic declines have been observed in recent years among the Yellow-Bellied Toad, Common Toad, and Midwife Toad.

**Dr.** [female: Katrin; male: Jörg] Hensen, **head** of the **Herpetology Department** at the Institute of Biology **of the University of Leipzig**, explains: "Amphibians are particularly sensitive to environmental changes due to their dual life in water and on land." When they are larvae and still breathe through their fine gills, amphibians are very susceptible to environmental toxins in the water. Later, when they are fully grown, they need clean water to reproduce, but also a healthy terrestrial habitat and clean air to breathe. **Dr.** Hensen identifies the main causes of the decline in amphibian populations as habitat destruction due to sealing and drainage, as well as landscape fragmentation caused by road construction

**Since obtaining a Ph.D. in 2010**, **Dr.** [female: Katrin; male: Jörg] Hensen has been studying the effects of pesticides used in agriculture on these sensitive creatures. It became evident that the use of pesticides in agriculture also has adverse effects. These findings led to several years of involvement with the Agricultural Chamber of Lower Saxony to raise awareness about the endangerment of amphibians. In 2016, **Dr.** [female: Katrin; male: Jörg] Hensen returned to scientific research exclusively.

*Note. The gender-neutral scientist had no name in the expertise stimulus, as we were able to create neutrality here with the academic title.*

Trust Cues (> .05) Expertise

Qualification

- **Department or area/discipline of expertise**
- **Affiliation to an organization**
- **Professional position**
- **Academic title**

**Academic education**

**Professional experience**

Gender-neutral [female; male] integrity stimuli, translated from German

## How Extreme Weather Changes Marine Ecosystems

Heat records and excessively dry winters: New scientific findings reveal how the increasing occurrences of extreme weather conditions are altering sensitive ecosystems in the long term.

Luca [female: Lea; male: Axel] Albers works on a long-term research project on behalf of the Federal Agency for Nature Conservation, which examines the transformation of underwater nature and the consequences of more frequent extreme weather events on our lakes and rivers. The project is funded by the German Federal Environmental Foundation (DBU). Albers nonetheless places great importance on the independence of the research from clients and funders.

“The problem we observe is the decline in biodiversity,” says Albers. “More and more ‘generalists’ are evolving. These are individuals of a species that cope better with extreme situations. As a result, they spread widely and reduce biodiversity. It’s a global phenomenon. The same species are repeatedly found in different waters worldwide.”

As part of the project, inland waters are being examined worldwide. With the help of AI-supported modelling techniques, the impact of various factors is calculated, allowing for a precise determination of the influence of weather changes. As this cross-border research is not exposed to the same conditions everywhere, it is not possible to generalize the findings. The same kind of influences do not apply everywhere. Currently, research institutes from the USA, Australia, India, Ghana, and Japan collaborate on this project. Albers published an initial study on the topic with the German data in the *Journal of Experimental Biology* in 2019. Through future research, Luca [female: Lea; male: Axel] Albers and colleagues hope to gain further insights into the changes in the underwater world caused by extreme weather events.

Trust Cues (> .05) Integrity

Independence

- Client
- Funding sources
- Interests

Scientific quality assurance

- (Un)certainities and limitations
- Continuity/ Permanence of research

Scientific standards and processes

- Research collaboration
- Publication
- Description (and explanation) of research processes

Gender-neutral [female; male] benevolence stimuli, translated from

### German **Black Fungi Live off Radioactive Radiation**

Mushrooms decompose almost everything: bread, wood, or even stone. New findings show that they can even convert radioactive radiation into biological energy, by altering their electron structure.

Luca Dähne [female: Lea; male: Axel] researches these mushrooms professionally and sees **revolutionary new possibilities for generating energy** in their properties, as they could theoretically serve as an inexhaustible energy source. "It is not unlikely **that we can exploit the abilities of mushrooms for human energy supply, at least partly, in perhaps 30 years,**" says Dähne.

The motivation behind conducting research in this field is personal. "I try to keep my **consumption of non-natural raw materials and resources low, but I still like warm showers, driving a car, and watching series. Personally, and with my research, I want to contribute to ensuring that humanity maintains its comfort – without exterminating itself.**" Dähne fears that this research could also be misused. **History has shown that the military and wealthy oligarchs misuse such developments for wars or exploitation. Dähne wants to ensure that the research on mushrooms benefits the general public.**

Despite this discovery, it should not be assumed **that the current global energy crisis can be solved with it.** Also, in regard to the current winter and the constantly rising energy prices, personal commitment is needed, **especially to address the energy crisis,** explains Dähne. "I can only recommend keeping your own energy consumption low, using the bicycle more often, and turning off the lights when they are not needed."

Trust Cues (> .05) Benevolence

**Ethical norms**

Social Responsibility

- **Prediction**
- **Assessment of public events/current affairs**

Benefit for society

- **Discoveries and breakthroughs**
- **Applicability of results**
- **Science-based recommendations**
- **Personal reasoning for benevolent behavior**

Gender-neutral [female; male] transparency/dialogue stimuli, translated from German

### Newly Discovered Disease Threatens Caribbean Coral Reefs

Coral populations in the Caribbean are steadily decreasing, and new scientific findings shed light on the reasons: a rapidly spreading disease is causing extensive coral mortality.

The 'Stony Coral Tissue Loss Disease' (SCTLD) leads to the putrefaction of the stony corals' epidermis. "SCTLD simply means that the spongy tissue of the corals is slowly but surely dying off," explains Mika [female: Claudia; male: Robert] Weber. Weber is investigating coral mortality in the Mesoamerican Reef, also known as the Great Mayan Reef. The outbreak was first recorded in 2014 in Southern Florida and has since spread across large parts of the Caribbean. The press release on Mika [female: Claudia; male: Robert] Weber's recent study paints a grim picture. Almost 30 coral species often die within weeks due to SCTLD ([Link to the study: https://journal-of-marine-science.com/article/72.43-12](https://journal-of-marine-science.com/article/72.43-12)).

In the course of an event organized by the German Foundation for Marine Protection on Tuesday evening, Weber presented the results of the study to provide information on the current state of research. Following the presentation, Weber gave an interview to our newspaper about STCLD: "According to my analysis, the stocks of coral species off the coast of Yucatan have decreased by nearly 90-94%. This can have fatal consequences for our marine environment."

To prevent further spreading of the disease, Weber collaborates with locals as well as German visitors. Through street posters and their channels on social media, people are urged to report back the location when spotting the disease. The research program's website also features images and other information for identifying SCTLD.

Trust Cues (> .05) Transparency

Comprehensible language

Accessibility of results:

Trust Cues (> .05) Dialogue

Participation at public events

Public Engagement

Media presence

- Journalistic media presence
- Direct media presence
- Further media presence