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RECONTEXTUALIZED KNOWLEDGE

RHETORIC – SITUATION – SCIENCE COMMUNICATION

Edited by Olaf Kramer and Markus Gottschling

NEUE RHETORIK / NEW RHETORIC

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EBSCO lishing : eBook Collection (EBSCOhost) - printed on 2/10/2023 10:59 AM via
AN: 2 96 ; Olaf Kramer, Markus Gottschling.; Recontextualized Knowledge :
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neue rhetorik
new rhetoric

Edited by
Joachim Knape, Olaf Kramer and Dietmar Till

Volume 36

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The volumes 1 to 29 of the series were published by Weidler Buchverlag Berlin.

ISBN 978-3-11-067628-0
e-ISBN (PDF) 978-3-11-067631-0
e-ISBN (EPUB) 978-3-11-067634-1

Library of Congress Control Number: 2020945810

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at http://dnb.dnb.de.

© 2021 Walter de Gruyter GmbH, Berlin/Boston
Printing and binding: CPI books GmbH, Leck

www.degruyter.com

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Markus Gottschling and Olaf Kramer

Recontextualized Knowledge

Introduction: A Rhetorical View on Science Communication

1 From Public Relation to Participation. Developments in Science Communication

Science needs communication to stay connected to society and to find answers to future challenges. This statement may sound like a truism, but universities and research institutions have yet to fully realize its consequences and implications. Traditionally, science communication relied on knowledge deficit models (cf. Scheufele 2014; Akin/Scheufele 2017). Defining science communication as a process of monodirectional transmission, such models based themselves on the assumption that the public possesses a knowledge deficit which the dissemination of knowledge can erase, preferably through mass media. After all, so the reasoning goes, the public should have an interest in scientific research, so the more scientists and scientific institutions send, the more they will eventually listen. At the root of knowledge deficit models lies an ignorant presupposition. Namely, that the onus rests on non-specialists to develop their own science literacy, informing themselves about scientific discourse and its societal consequences: the facts speak for themselves. "If the public does not accept or recognize these facts, then the failure in transmission is blamed on journalists, 'irrational' public beliefs, or both" (Nisbet/Scheufele 2009). Operating within the knowledge deficit model, scientists could ignore that science literacy only plays, as Nisbet/Scheufele (2009) describe it, a "limited role in shaping public perceptions and decisions," and consequently overlook that their own efforts in communicating to the public "might be part of the problem."

In recent years, however, science communication has experienced significant development, becoming an umbrella term for a diverse, heterogenous and rapidly growing discipline in theory and practice (cf. Schäfer 2017). Whereas, up to the 2000s, the term usually denoted the communication of scientific knowledge to non-specialists through science journalism or PR departments of scientific institutions, more recently, substantial new developments have emerged. Drawing on a plethora of preliminary work, Bonfadelli et al. (2017b) understand science communication as all forms of communication focused on scientific knowledge or scientific work, both within and outside institutionalized

https://doi.org/10.1515/9783110676310-001

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science, including its production, contents, uses, and effects (cf. Bauer/Bucchi 2007; Bubela et al. 2009; Lüthje et al. 2012; Schäfer et al. 2015; Schäfer 2017). Such a broad definition then encompasses not only traditional forms of institutionalized science PR, but also academic conferences and colloquia, Twitter threads, slack channels, science festivals, science slams, and science journalism.

Accordingly, a model which focuses more on explanation, participation, and popularization of – and in – science, and aims at creating "Public Understanding of Science and Humanities" (PUSH), was proposed in the UK as early as 1985 (cf. The Royal Society 1985). This spawned international offshoots such as, for example, the *PUSH Memorandum* (Wissenschaft im Dialog 1999), issued by Germany's largest scientific institutions, which led to the creation of the science-PR initiative "Wissenschaft im Dialog" (Science in Dialogue). In recent years, "Public Engagement with Science and Technology" (PEST) has emerged as a more comprehensive approach to intensifying the contact between science and society (cf. NCCPE 2010). The development of PEST methodology has changed the objectives of science communication. Rather than promoting, showcasing or advertising institutes, technologies or specific research results, scientists aim to establish a procedural understanding of research. PEST formats build public trust by emphasizing the "expertise," "benevolence," and "integrity" of communicators (cf. Schoorman et al. 1995; Hendriks et al. 2015; Bromme 2020) through participatory formats in which both dialogue partners can learn and benefit from, as well as influence, each other. The first accompanying studies of formats, such as "Die Debatte" (The Debate), "Pint of Science," and "Science Notes," show promising results for the evaluation of such formats by the participating scientists as well as the audiences (cf. Bittner et al. 2018; Könneker et al. 2019; Taddicken et al. 2020). While the PEST approach cannot eliminate the bounded understanding of non-specialists, participation in the scientific process can cultivate their scientific literacy. This, in turn, strengthens their informed trust in science (Hendriks et al. 2015; see also Kienhues et al. 2018) and may lead to more non-specialists engaging in deliberative processes (Layton et al. 1994).

The aforementioned paradigm-shift from explanation and knowledge transfer to dialogue and participation has, in the last decade, been mirrored in the blossoming international research on science communication and its methodology (e.g., Bonfadelli et al. 2017a; Jamieson et al. 2017; Leßmöllmann et al. 2019). Based in the communication sciences, the "Science of Science Communication" – in line with its self-styled title as a capital-S-Science – now predominantly understands itself as empirically-shaped media effects studies, which primarily deal with STEM, i.e., Science, Technology, Engineering, and Mathematics, topics of high public relevance such as genetics, climate science, and

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health research (Kessler et al. 2019). With the turn from the knowledge deficit model toward a more participatory approach, modeling also began to take social, media, and political contexts into account. As a consequence of this development, Akin/Scheufele (2017) promoted a third model, focusing on “science communication in context.”

2 Science Communication as Rhetorical Communication

Science is assuming an increasingly active role within the social and political “context” which Akin/Scheufele (2017) invoke. Today, science influences and changes social and political discourses – and is itself changed and influenced by them. Because of this, science finds itself in a legitimation discourse in need of public trust (cf. Weingart 2005). At the same time, however, repeated attacks from populist-motivated doubts and hostilities (cf. Mede/Schäfer 2020) necessitate political positioning and social legitimization by scientists and scientific institutions (cf. Roche/Davis 2017; Broks 2017).

This development places the communication of scientific insights, discourses, and processes in the context of political communication (cf. Scheufele 2014). Science communication as political communication must introduce scientific discourse into social and political debates to inform public discourse on possible future developments in society. However, by entering public debate, science is entering a field that is not simply driven by neutral information and rational decisions, but by group-specific interests, personal motivations, and affective reactions. This is where rhetoric as a research discipline comes into play, because at its heart lies persuasion through communication in the face of conflicting interests and, often enough, conflicting evidence.

> [W]e translate *sēmeion* as *signum* [“a sign,” MG/OK]– though some have used *indicium* (“indication”) or *vestigium* (“trace”) instead. It is that from which something else is inferred, for example murder from blood. But it may be the blood of a sacrificed animal that has got on to the clothes, or just a nosebleed: a man whose clothes are bloody has not necessarily committed homicide. (Quintilian 2002)

These considerations by the Roman rhetorician Quintilian in the fifth book of his *Institutio Oratoria* are not only instructive for forensic rhetoric, but also for obviating the necessity of persuasively linking facts and their implications. Forensic argumentation is dependent on evidence, on reliable signs that can

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prove the position of the prosecutor or the defense attorney. Yet, as Quintilian points out, only in very rare cases do signs allow a unanimous interpretation. They are precarious and often will not convince the other side spontaneously. Signs are not mechanical instruments of persuasion, though one side might present and treat them in such a way. They might refer to a certain fact, yet their reference function to this fact is insecure as is its interpretation, which always depends on the perspective from which one evaluates the fact.

We can learn a great deal from the difficulties of arguing in front of a court when it comes to science communication. When scientists present their findings arising from specific methods, which have proven to create valid results, they tend to ignore different perspectives addressees might take and how this influences the ways in which they perceive facts. The situational context of communication can lead to different evaluations and assessments of facts, which are a defining characteristic of forensic rhetoric. The rigorous methods and structures of scientific research are capable of producing validated facts. Yet, this rational point of view ignores the cultural and psychological factors which influence the way people think.

By focusing on interconnected perspectives in communicative situations, rhetoric can complement the capital-S "Science of Science Communication," particularly with regard to the context of political and social debates. The strength of a rhetorical approach to science communication research lies in its ability to make the intersections of communication processes visible. Science communication processes – and especially those which are concerned with public engagement – are multimodal, multicodal, and multi-perspectively intertwined. In these processes, conditions of different formats, specific scientific content, cultural assumptions and imprints, as well as individual expectations of the audience and other actors, converge.

Science communication is not a simple process of transmitting information from one person to the other. Even in science-internal communication, when informing other experts, making facts count necessitates relating to their prior knowledge, as they, too, will have to incorporate new findings into their own systems of understanding. As a result, situational, sociocultural or psychological factors influence even expert communication. In this regard, internal and external science communication converge – and we should, according to Hilgartner (1990), move away from the "idealized notion of pure, genuine scientific knowledge," in which the processes of popularization and simplification for a non-specialist audience would only distort. By sharing knowledge with others, we participate in a process of communication embedded in a wide range of situational factors.

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In rhetoric, the layers and interferences of science communication are understood and operationalized as unique cognitive and situative resistances which must be minimized to ensure successful communication (Knape 2013). At the same time, a rhetorical view holistically orients itself towards the audience of the communication (Kjeldsen 2018). *Aptum* (Latin for appropriateness) represents a key characteristic for audience orientation is. In a target-group-oriented approach, the category of aptum regulates the quantity, as well as quality, of the rhetorical means of persuasion, as determined by Aristotle (2000):
– *logos*, concerning the subject and content level;
– *ethos*, concerning the character of the communicator; and
– *pathos*, concerning the formal and stylistic level of affect.

As a production-oriented discipline of speaking, writing, and presenting persuasively, rhetoric not only relies on logos, but also takes ethos and pathos into account. Even though the scientific method promises to ignore these "impure" factors of communication and to focus solely on facts, science depends on affect and image. Science communication can and should use linguistic, psychological and rhetorical operations such as simplification, narrativization, and perspective taking to spread knowledge, build trust, and stay connected to society. Style does not contaminate science – quite the opposite. The communication of scientific theories and facts has always been interwoven with rhetorical features, as a disciplinary branch called *the rhetoric of science* has shown time and time again (Gross 1990; Campbell 1990; Goankar 1993). Hilgartner (1990) even warns that "the dominant view of popularization," i.e., as a process of simplification and distortion, "grants scientists something akin to the epistemic equivalent of the right to print money." If scientists assume that it is too difficult to communicate the topics, processes, and results of its research clearly and vividly, society cannot build trust in scientific work – and cannot, in turn, serve its duty as a watchdog for science. This applies to PR-departments of scientific institutions, as well as individual scientists communicating within the laboratory, educating students, counseling politics, and engaging the public.

3 Recontextualization as a Basic Operation of Rhetorical Science Communication

Within the paradigm of science communication, rhetoric concerns itself less with forensic or deliberative persuasion, than with analyzing how communica-

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tive, stylistic, and psychological categories and means are distributed and balanced to build trust and identification (Burke 1950) between science and the public. Successfully establishing this reciprocal communication produces an "invitation to understanding" (Foss/Griffin 1995). Invitational rhetoric, in this sense, focuses on the perspectives of all participants in rhetorical situations of scientific discourse. Such rhetorical situations represent constellations of time, place, audience, exigence, and wider context (Bitzer 1968; Gottschling/Kramer 2012) in which science and scientific discourse are negotiated publicly. It is easy to see that the concept of the rhetorical situation applies to all forms of popularization of scientific discourse: events, live presentations, and digital formats, as well as public and political debates on scientific developments and their consequences. When scientists try to address others – be it experts, policy makers or a wider audience – they become part of societal, as well as political, debates and deliberations. As such, they involve themselves in processes of recontextualization (cf. Linell 1998), appropriating discourse to those specific sociocultural, psychological, and cognitive conditions which define the rhetorical situation in which they communicate.

In recent history – with the rise of populism, "fake news," and the proclamation of a "post-truth era" – science communication had to learn that neither scientific results nor empirical data convince people by, and through, themselves. It is not facts, but their recontextualization for a specific audience, which is the key to interesting, instructing, and motivating such an audience. According to Calsamiglia/van Dijk (2004), the popularization of scientific discourse involves, not only the reformulation, but the recontextualization of scientific knowledge and discourse produced in specialized contexts to which a lay public has limited access.

With the advent of artificial intelligence, data seems universally-available; however, this does not yet equal universal accessibility for non-specialist audiences. In science communication, speakers must prepare information in such a way that an individual is motivated to process it and to develop new knowledge structures. In order to advance knowledge and insight, it is necessary to recontextualize information, i.e., to rhetorically translate scientific knowledge into commonsense knowledge, to compile precise knowledge with what Calsamiglia/van Dijk (2004) call "approximate" or "fuzzy" knowledge and to implement it in different cultural contexts that might be fundamentally opposed to the findings of science.

Regarding science communication merely as the simplification of scientific discourse fundamentally subscribes to a model of loss. With the concept of recontextualization, this perception changes. Through recontextualization,

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specialists adapt scientific discourse to the appropriate conditions of specific situations, their audiences, and their constraints. The further removed the audience from the communicator's own scientific discourse and peers, the more complicated the process of adaptation will be, the more complicated it will be to make facts count.

This is not only the result of differences at the level of expertise of the communication partners, but also of their social, cultural, and psychological circumstances. The audience must point the way to a successful recontextualization of knowledge; therefore, recontextualization requires *perspective taking*, the psychological task of evaluating a situation through the eyes of a counterpart (Batson 2009; Myers/Hodges 2009). Shifting one's perspective toward the audience is not without difficulties for the communicators, either because the concrete thoughts and feelings of the target group are unknown or difficult to access – think of communication in social media, for example – or because it sometimes seems complicated to maintain enough distance from one's own perspective. Nevertheless, perspective taking from a rhetorical point of view provides the psychological framework for measures of recontextualization within science communication. Successful science communication needs scientists who are willing to change their perspective, to take the audience seriously and to see the world through their eyes. Science communication, therefore, is not a question of simplification of a complex problem or theory, but about a recontextualization of research processes and results. The recontextualization of knowledge – which highlights the individual or social importance and possible implications of research and raises the understanding of scientific research as a process – defines good science communication.

A rhetorical approach toward science communication, then, concerns itself with the recontextualization of scientific discourse to the perspectives of specific audiences, depending on:

a) the layers of the communication process, i.e., sender, message, channel, noise, receiver;
b) the determinants of the rhetorical situation, i.e., exigence, audience, constraints; and
c) the means of persuasion, i.e., logos, ethos, pathos.

At the same time, in its methodology, rhetorical science communication research is open to the integration of empirical methods from communication and education sciences, as well as psychology, discourse analysis from linguistics and hermeneutics from literary and cultural theory. The following chapters will show these diverse approaches to the topic.

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4 Chapter Overview

Part I: Science Communication and the Public Sphere

Part I is concerned with science in processes of public communication. Additionally, all three chapters assembled in this section answer fundamental questions about the technique of recontextualizing scientific knowledge for politics and the public.

In their chapter *Where Perspective Taking Can and Cannot Take Us*, **Sara D. Hodges**, **Sara Lieber**, and **Kathryn R. Denning** take an in-depth look at an established strategy for increasing prosocial behavior and the foundation for recontextualization in science communication. Perspective taking does not always help, and can sometimes even "backfire," increasing the distance between interlocutors. Taking into account the processes thought to underlie perspective taking, they identify the contexts and variables that may moderate perspective taking's more usual prosocial effects and instead lead to less interpersonal harmony, especially in highly polarized social and political contexts.

Markus Gottschling explores the mechanisms of recontextualization within science communication by means of close reading. The chapter analyzes how genetic engineer Kevin Esvelt approaches communicating a timely and potentially disruptive topic: CRISPR/Cas9 and gene drive. Esvelt, Gottschling argues, is consciously *Creating a Rhetorical Situation* about open and responsible science. Esvelt's goal is to disarm a possibly harmful debate around the regulation of science by shifting it from the future to the present. Such a strategy, the chapter argues, presents an example of precontextualization in science communication: technology futures become the groundwork for scientific argumentation in public discourse. Esvelt uses precontextualization to establish the plausibility of current actions regarding future events, thus establishing the latter as persuasive frameworks for today's political discourse.

Sophia Hatzisavvidou's contribution sketches the effects of context change on the communication of scientific evidence. *Communicating Sustainability* demonstrates how certain aspects of scientific discourse have been used strategically to create and enhance political consensus. Using tools from the tradition of rhetoric, Hatzisavvidou discusses the evolution of "sustainability" from a technical term into a key element of policy discourse. Her chapter shows the value of rhetorically analyzing the usage of such essential components of scientific discourse, eventually enabling an exploration of continuity and transformation in public policy.

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Part II: Narratives and Stories

Part II brings together texts that deal with a crucial part of both classical rhetorical speech structure, as well as a contemporary trend in science communication: narration. Narrative techniques such as storytelling, anecdotes, questions, and dialogue are not only entertaining, as the chapters in this part demonstrate. They structurally enhance the pure presentation of facts, increase memorability, and support learning.

Speakers in various presentation situations pursue being memorable. In his chapter titled *Memorable Stories in Science and Popular Science*, **Martijn Wackers** examines how speakers use anecdotes in research presentations and TED talks to influence audience information retention. The paper presents an exploration of the usage of anecdote in a corpus of TED talks and research presentations. Comparing both, Wackers shows that anecdotes in TED talks are longer, more elaborate, contain more narrative elements, use more vivid language and make the relevance more explicit than their counterparts in research presentations, suggesting a higher possibility of information retention.

The rhetoricity of complex stories in the podcast *Radiolab* concerns **Thomas Susanka**'s chapter. *Questions and Dialogue in Science Communication* asks a crucial question regarding the success of science communication: how to ensure participatory engagement, in light of severe situational constraints which mute the audience and confine it to passivity? To arrive at an answer, Susanka analyzes the radio show's trademark polyphony of voices and sounds, arguing that it is precisely this polyphony which enables vicarious learning, a rarely employed method – at least in science communication – of learning through overhearing dialogue.

Kristin Raabe's contribution tackles storytelling as a recontextualization technique for scientists communicating with the public from a practical perspective. Her chapter, *Scientists on the Hero's Journey*, recounts Raabe's own experiences as an educator for scientists wanting to improve their science communication. Stories, for her, are essential for recontextualizing the hard and rocky process of scientific inquiry. In order to adapt their stories to specific communicative situations, she proposes that scientists use methods which have been in the toolbox of scriptwriters and filmmakers for quite a long time: the narrative pattern of the Hero's Journey, the Five-Act-Drama-Theory of Gustav Freytag, and the mind map of the German documentary filmmaker Gregor A. Heussen.

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Part III: Education and Knowledge Transfer

Even if science communication and its methodology have recently focused more on entertainment and participatory methods, one of its central goals remains the dissemination of scientific knowledge to the public. Part III pays tribute to this fact. The chapters look at science communication's highly sought-after areas and target groups, including health communication and the transfer of knowledge in schools.

Science Revisited by **Nina Janich** analyzes the representation of scientific knowledge and ignorance in the three volumes of the German *Kinder-Uni* (The Children's University) book series. The chapter employs methods of textual and discourse linguistics to examine how these three volumes aimed at children represent and recontextualize accounts of scientists and scientific work, as well as scientific discourse. Janich shows that the series predominantly represents science in terms that are optimistic regarding scientific progress – as an adventure-filled search for mysteries and wonders which leads steadily to greater and more reliable knowledge, while largely marginalizing scientific uncertainties and controversies.

In his chapter, *How Laypeople Process Health News Articles*, **Joachim Kimmerle** looks at why laypeople are inclined to underestimate the tentativeness of health research findings reported in the media. The chapter presents research that examines people's ability to critically evaluate scientific information in terms of recognizing the tentativeness of research findings. With his research, Kimmerle attempts to support non-specialists' understanding of scientific information. He suggests that journalists should help their readers recognize tentativeness by addressing the tentativeness of research findings explicitly in journalistic texts and by avoiding one-sided positive reporting of research findings in health news articles.

Christoph Kulgemeyer's chapter, *Towards a "Culture of Explaining" in Science Teaching,* turns toward communication in the science classroom. Kulgemeyer understands explaining as a process that requires adaptive teaching, evaluation, orientation at prior knowledge, and interaction between explainer and explainees. The chapter links literature on instructional explanations from science education with a more general theory of teaching quality. The chapter also presents results from a study on student teachers' explaining quality. When student teachers assume that explaining means a transmission of knowledge, this causes lower explaining performance; however, a high self-efficacy on the part of the student teachers results in a higher explaining performance.

The goal of **Julia Siebert**'s and **Anett Richter**'s approach is to bringing Citizen Science's transformative potential into the classroom, laid down in their

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Chapter *An Opportunity to Induce Bottom-Up Change in Society*. Siebert and Richter provide a detailed analysis of the potential of Citizen Science, a participatory method of engaging the public with processes and procedures of science in order to build mutual trust. In their chapter, Siebert and Richter summarize the discussions around Citizen Science up to the year 2018. In addition, they envision how the concept and approach of Citizen Science might be further developed, and successfully anchored, in society and politics. A key factor for them is formal education. Citizen Science enriches educational concepts by facilitating a higher level of learning through the active engagement of students in real scientific investigations, while simultaneously enhancing general scientific and societal literacy that go far beyond the specific scientific discovery.

5 Acknowledgements

The work of the Presentation Research Center at the Rhetoric Department of Tübingen University (Germany) focuses on the role of presentations in science communication – be it in scientific discourse, education or communicating to a wider public. This wide and challenging field depends on – and, indeed, could not be tackled without – close cooperation between specialists from diverse scientific and practical backgrounds, requiring support from the various communicative and institutional stakeholders involved. Thus, we are very thankful and indebted to the inspiring, open, and fruitful exchange with all colleagues and supporters who contributed to this volume and, in fact, made it possible.

In particular, the publication of this book would not have been conceivable without the generous and reliable support of the Klaus Tschira Foundation (Heidelberg, Germany), which not only funds our research center, but also enables us to explore various ways and formats of researching and promoting science communication. We would especially like to thank Beate Spiegel for her continued support and belief in our projects, as well as her vision in bringing a rhetorical perspective to science communication.

The idea for this volume originated from the conference *Recontextualizing Knowledge*, held in Tübingen in 2017. In this context, we would like to thank the entire team of the Presentation Research Center, and especially Jutta Krautter, for their dedicated and valuable work before, during and after the conference. Regarding this volume, we want to thank Martina Overbeck for her help and contribution with the editing process, as well as the team at De Gruyter and Konvertus, especially Susanne Rade and Gabriela Rus.

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References

Akin, H. & Scheufele, D. A. (2017). Overview of the Science of Science Communication. *The Oxford Handbook on the Science of Science Communication* (Eds. K. H. Jamieson, D. M. Kahan, & D. A. Scheufele). Oxford: Oxford University Press, 25–33.

Aristotle (2000): Téchnē Rhētorikḗ [The “Art” of Rhetoric. Edited and translated by J. H. Freese]. Cambridge, MA: Harvard University Press.

Batson, C. D. (2009). Two Forms of Perspective Taking: Imagining how Another Feels and Imagining how You Would Feel. *Handbook of Imagination and Mental Stimulation* (Eds. K. D. Markman, W. M. P. Klein, & J. A. Suhr). New York, NY/Hove: Taylor & Francis, 267–279.

Bauer, M. & Bucchi, M. (Eds.) (2007). *Science, Journalism and Society: Science Communication Between News and Public Relations*. London: Routledge.

Bittner, L., Ruoß, R., & Niemann, P. (2018): Science Notes: Forschung in Clubatmosphäre präsentieren. Eine Rezeptionsstudie. *Science In Presentations Arbeitsberichte*, 5.

Bitzer, L. F. (1968). The Rhetorical Situation. *Philosophy & Rhetoric*, 1(1), 1–14.

Bonfadelli, H., Fähnrich, B., Lüthje, C., Milde, J., Rhomberg, M., & Schäfer, M. S. (Eds.) (2017a). *Forschungsfeld Wissenschaftskommunikation*. Wiesbaden: Springer. DOI 10.1007/978-3-658-12898-2.

Bonfadelli, H., Fähnrich, B., Lüthje, C., Milde, J., Rhomberg, M., & Schäfer, M. S. (2017b). Einleitung. *Forschungsfeld Wissenschaftskommunikation*. Wiesbaden: Springer, 3–14. DOI: 10.1007/978-3-658-12898-2_1.

Broks, P. (2017): Science Communication: Process, Power and Politics. *Journal of Science Communication*, 16(4), C02. DOI: 10.22323/2.16040302.

Bromme, R. (2020). Informiertes Vertrauen: Eine psychologische Perspektive auf Vertrauen in Wissenschaft. *Wissenschaftsreflexion. Interdisziplinäre Perspektiven zwischen Philosophie und Praxis* (Eds. M. Jungert, A. Frewer, & E. Mayr). Paderborn: Mentis Verlag, 105–134.

Bubela, T., Nisbet, M. C., Borchelt, R., Brunger, F., Critchley, C., Einsiedel, E., Geller, G., Gupta, A., Hampel, J., Hyde-Lay, R., Jandciu, E. W., Jones, S. A., Kolopack, P., Lane, S., Lougheed, T., Nerlich, B., Ogbogu, U., O'Riordan, K., Ouellette, C., Spear, M., Strauss, S., Thavaratnam, T., Willemse, L., & Caulfield, T. (2009). Science Communication Reconsidered. *Nature Biotechnology*, *27*(6), 514–518. DOI: 10.1038/nbt0609-514.

Burke, K. (1950). *A Rhetoric of Motives*. New York, NY: Prentice-Hall.

Calsamiglia, H. & van Dijk, T. (2004). Popularization Discourse and Knowledge About the Genome. *Discourse & Society*, 15(4), 369–389. DOI: 10.1177/0957926504043705.

Campbell, J. A. (1990). Scientific Discovery and Rhetorical Invention: The Path to Darwin’s Origin. *The Rhetorical Turn. Invention and Persuasion in the Conduct of Inquiry* (Ed. H. W. Simons). Chicago, IL/London: University of Chicago Press, 58–90.

Foss, S. K. & Griffin, C. L. (1995). Beyond Persuasion: A Proposal for an Invitational Rhetoric. *Communication Monographs*, 62(1), 2–18.

Gaonkar, D. P. (1993). The Idea of Rhetoric in the Rhetoric of Science. *Southern Communication Journal*, 58(4), 258–295. DOI: 10.1080/10417949309372909.

Gottschling, M. & Kramer, O. (2012). Rhetorische Situation. *Historisches Wörterbuch der Rhetorik. Bd. 10* (Ed. G. Ueding). Tübingen: Niemeyer, 1126–1132.

Gross, A. G. (1990). *The Rhetoric of Science*. Cambridge, MA: Harvard University Press.

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Hendriks, F., Kienhues, D., & Bromme, R. (2015). Measuring Laypeople's Trust in Experts in a Digital Age: The Muenster Epistemic Trustworthiness Inventory METI. *PLoS ONE*, 10(10), e0139309. DOI: 10.1371/journal.pone.0139309.
Hilgartner, S. (1990). The Dominant View of Popularization: Conceptual Problems, Political Uses. *Social Studies of Science*, 20(3), 519–539. DOI: 10.1177/030631290020003006.
Jamieson, J. H., Kahan, D. M., & Scheufele, D. A. (Eds.) (2017). *Oxford Handbook on the Science of Science Communication.* New York, NY: Oxford University Press. DOI: 10.1093/oxfordhb/9780190497620.001.0001.
Kessler, S. H., Schäfer, M. S., & Fähnrich, B. (2019). Science Communication Research in the German-Speaking Countries. A Content Analysis of Conference Abstracts. *Studies in Communication Science*, 19(2), 243–251. DOI: 10.24434/j.scoms.2019.02.012.
Kienhues, D., Thomm, E., & Bromme, R. (2018). Specificity Reloaded: How Multiple Layers of Specificity Influence Reasoning in Science Argument Evaluation. *Scientific Reasoning and Argumentation: Domain-Specific and Domain-General Aspects* (Eds. F. Fischer, C. A. Chinn, K. Engelmann, & J. Osborne). London: Taylor & Francis, 251–270.
Kjeldsen, J. E. (2018). Rhetorical Audience Studies and Reception of Rhetoric. Exploring Audiences Empirically. Palgrave Macmillan. DOI: 10.1007/978-3-319-61618-6.
Knape, J. (2013). *Modern Rhetoric in Culture, Arts and Media. 13 Essays.* Berlin/Boston, MA: De Gruyter. DOI: 10.1515/9783110292503.
Könneker, C., Niemann, P., & Böhmert, C. (2019). Young Researchers and Science Communication: Results of an Extensive Survey. *Lindau Nobel Laureate Meetings*, January 30th, 2019. https://www.lindau-nobel.org/de/blog-young-researchers-and-science-communication/.
Layton, D., Jenkins, E., & Donelly, J. (1994). *Scientific and Technological Literacy Meaning and Rationales: An Annotated Bibliography*. UNESCO/Centre for Studies in Science and Mathematics Education: Leeds University.
Leßmöllmann, A., Dascal, M., & Gloning, T. (Eds.) (2019). *Science Communication*. Boston/Berlin: De Gruyter Mouton.
Linell, P. (1998). Discourse Across Boundaries: On Recontextualizations and the Blending of Voices in Professional Discourse. *Text*, 18(2), 143–157. DOI: 10.1515/text.1.1998.18.2.143.
Lüthje, C., Kristiansen, S., Danelzik, M., Fähnrich, B., Milde, J., Rhomberg, M., Schäfer, M. S., & Wolling, J. (2012). Selbstverständnispapier der Ad-hoc-Gruppe Wissenschaftskommunikation in der Deutschen Gesellschaft für Publizistik- und Kommunikationswissenschaft DGPuK. http://www.ipmz.uzh.ch/Abteilungen/Wissenschaftskommunikation/Personen/Schaefer/4_4.pdf.
Mede, N. G. & Schäfer, M. S. (2020). Science-Related Populism: Conceptualizing Populist Demands Toward Science. *Public Understanding of Science*, 29(5), 473–491. DOI: 10.1177/0963662520924259.
Myers, M. W. & Hodges, S. D. (2009). Making It Up and Making Do: Simulation, Imagination, and Empathic Accuracy. *Handbook of Imagination and Mental Simulation* (Eds. K. D. Markman, W. M. P. Klein, & J. A. Suhr). New York, NY: Psychology Press, 283–296.
NCCPE (National Coordinating Centre for Public Engagement) (2010). *The Engaged University. A Manifesto for Public Engagement*. Bristol: np. https://www.publicengagement.ac.uk/sites/default/files/publication/nccpe_manifesto_for_public_engagement_2019_0.pdf
Nisbet, M. C. & Scheufele, D. A. (2009). What's Next for Science Communication? Promising Directions and Lingering Distractions. *American Journal of Botany*, 96(10), 1767–1778. DOI: 10.3732/ajb.0900041.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Quintilian (2002): *Institutio Oratoria* [The Orator's Education, Vol. II, edited and translated by D. A. Russell]. Cambridge, MA: Harvard University Press. DOI: 10.4159/DLCL.quintilian-orators_education.2002.
Roche, J. & Davis, N. (2017): Should the Science Communication Community Play a Role in Political Activism? *Journal of Science Communication*, 16(1), L01.
Schäfer, M. S. (2017). Wissenschaftskommunikation ist Wissenschaftsjournalismus, Wissenschafts-PR … und mehr. *Wissenschaftskommunikation.de*, March 1st, 2017. https://www.wissenschaftskommunikation.de/wissenschaftskommunikation-ist-wissenschaftsjournalismus-wissenschafts-pr-und-mehr-3337/.
Schäfer, M. S., Kristiansen, S., & Bonfadelli, H. (Eds.) (2015). *Wissenschaftskommunikation im Wandel*. Köln: Herbert von Halem.
Scheufele, D. A. (2014). Science Communication as Political Communication. *PNAS*, 111 (Supplement 4), 13585–13592.
Schoorman, F. D., Mayer, R. C., & Davis, J. H. (1995). An Integrative Model of Organizational Trust. *Academy of Management Review*, 20(3), 709–734.
Taddicken, M., Wicke, N., & Willems, K. (2020). Verständlich und kompetent? Eine Echtzeitanalyse der Wahrnehmung und Beurteilung von Expert*innen in der Wissenschaftskommunikation. *M&K Medien & Kommunikationswissenschaft*, 68(1–2), 50–72.
The Royal Society (1985). *The Public Understanding of Science*. London: Luton Limited.
Weingart, P. (2005): *Die Wissenschaft der Öffentlichkeit*. Weilerswist: Velbrück Wissenschaft.
Wissenschaft im Dialog (1999). *Dialog Wissenschaft und Gesellschaft*. Essen: Stifterverband für die Deutsche Wissenschaft e.V. https://www.stifterverband.org/file/7544/download?token=CuhL7pW6.

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Part I: **Science Communication and the Public Sphere**

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Where Perspective Taking Can and Cannot Take Us

1 Introduction

To rhetoricians, the idea of perspective taking is built right into the field. What is rhetoric, if it is not considering how one's communication will be perceived by one's audience? This consideration is critical at the societal level when thinking about mass messaging, including communication about substantial topics like science and governance. At the other end of the scale, social psychologists (along with rhetoricians) have studied perspective taking all the way down to the highly personalized process of one person taking another specific person's perspective.

This kind of interpersonal perspective taking is intuitively, anecdotally, and often empirically associated with caring motives and prosocial outcomes: perspective taking is a step taken in the direction of greater understanding (for a review, see Hodges et al. 2011). Perspective taking has also been described as a way of "expanding the self" (e.g., see Galinsky et al. 2005) by including other people (and their perspectives) in the self-concept (Galinsky/Moskowitz 2000). Those other people then benefit from the generally self-favoring views and treatment granted to the self (Aron et al. 1991; Batson et al. 2003; Myers/Hodges 2012; Sassenrath et al. 2016; although see Galinsky/Ku 2004). Another path between perspective taking and prosocial behavior runs via perspective taking's arousal of empathic concern and compassion for others, which in turn triggers altruism in the form of helping (e.g., Batson 1987; Batson et al. 2007; Coke et al. 1978). There is some evidence that both paths also change perspective takers, e.g., by changing their attitudes towards certain groups (Batson et al. 2003; Batson et al. 1997), even when those targets are members of outgroups that are traditionally negatively stereotyped or otherwise maligned (Batson et al. 2002), or by changing perspective takers' conceptions of themselves (Goldstein/Cialdini 2007). Perspective taking has also been linked to other positive social outcomes such as better negotiation outcomes (e.g., Galinsky et al. 2008) and better close relationships (Verhofstadt et al. 2008).

However, perspective taking is no magical solution for improving human behavior. Despite a substantial body of research showing perspective taking as a means to more harmonious social interactions, perspective taking does not *always* lead to greater understanding and prosocial outcomes (Hodges et al. 2018;

https://doi.org/10.1515/9783110676310-002

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Ku et al. 2015; Sassenrath et al. 2016). Isolated studies demonstrating circumstances under which perspective taking has done no good – or even did harm – have accumulated. To understand these examples better, in this chapter we will first outline the processes and mechanisms that underlie perspective taking. Then, to understand why perspective taking may sometimes "backfire," – i.e., lead to more strife and greater distance between people, we will examine how altering aspects of perspective-taking contexts and players can inhibit, circumvent, or reverse the positive outcomes traditionally associated with perspective taking.

We will finish the chapter by examining a specific real-life context to further illustrate the puzzle of when perspective taking helps and when it does not – by considering the current political polarization in the United States – in terms of political parties and the implications of that polarization for perceptions of science. In such a highly polarized state, we need perspective taking's prosocial influence more than ever, but we present evidence that it is exactly under these circumstances that perspective taking can become less effective. As dismaying as this polarization is from a societal point of view, it provides a potential petri dish as the breeding ground for ineffectual or even damaging perspective taking.

2 Basic Beginnings of Perspective Taking

Inherent in perspective taking is first an acknowledgement that there *is* another perspective to be taken, and then an attempt to take it. Cognition is remarkably egocentric – the default perspective we take is our own. Even among the most sapient beings (humans), an awareness that our *perception* of the world is at least one degree removed from the *actual* world requires taking an additional, optional, and generally effortful step. It is in some ways remarkable that we should actually be aware of or consider that there is any perspective other than our own.

Awareness that our own perspective is the default can be understood when considering our visual perspective: where our eyes sit in our heads and where our heads are aimed determines our perspective. However, with a slight adaptation, many of the same tenets of visual perspective apply when thinking about the more metaphorical "conceptual" perspective that is made up of our cultural assumptions, personal experiences, and beliefs. When talking about taking others' perspectives, we often use visual metaphors (e.g., *viewpoint*; *seeing* things from another perspective), both when describing actual visual perspective taking (thinking about what another person literally sees at a particular moment with their eyes) *and* conceptual perspective taking (thinking about a person's mental contents in a particular situation or setting). Using visual metaphors for conceptual

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perspective taking is hard to avoid and almost impossible to resist, which is not surprising, given that the word "perspective" itself stems from the Latin verb "to look."

Although perspective taking is a challenging and somewhat amazing skill, humans start to show signs of perspective taking at a very young age. Two-year-olds can understand that something is occluding another person's vision – e.g., "Daddy can't see the puppy because there is a chair in his line of sight" (see Flavell et al. 1978; Moll/Tomasello 2006). Early acquisition of visual perspective-taking skills is perhaps not surprising, given that attending to other people's line of gaze plays a key role in children's learning of language (Brooks/Meltzoff 2015): young children need to know what Mom and Dad are looking at to figure out what the words their parents utter refer to. By kindergarten, at age 4 or 5, most children can "construct" what someone else with a different vantage point sees – e.g., "I can see that the other kid is Daniel, but Mama doesn't know it, because she can only see the back of his head" (see Flavell et al. 1981).

Around 3 years of age, children enter a "magical" age, when they are said to start acquiring a "theory of mind." This theory, in short, is an understanding that the contents of other people's minds guide other people's perceptions and behavior, and the contents of other people's minds may differ from one's own, resulting in sometimes predictable differences in beliefs and desires (Wellman 1990). So, a 4-year-old can start to wrap her head around the idea that "Mama *thinks* we are having chicken for dinner because that's what Papa told her this morning, but *really* we're having pizza because it's Mama's birthday!" This developmental milestone can contribute to new heights of deviousness, too (Talwar/Lee 2008), such as, "If I put my brother's shoes next to the muddy footprints that *I* made on the carpet, everyone will think he tracked in the mud, not me."

3 Seeing and Believing

The fact that evidence of visual perspective taking emerges earlier in children than evidence of conceptual perspective taking has been used to suggest that visual perspective taking is a skill upon which conceptual perspective is built (see Hamilton et al. 2009). Although this ordering could in part be an artifact introduced by the fact that current measures of conceptual perspective taking require verbal skills that young children haven't yet acquired, visual perspective taking does seem intuitively simpler in some ways than conceptual perspective taking. What people visually "see" seems more rooted in the physical properties of the objects – that is, there is an external referent they can attend to in order to gain

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information about what another person can see. If, for example, someone is facing us as we stand across from them, then it seems highly likely that their left arm will appear on the right side for us. Consistent with this, the most predictable and determined cases of visual perspective taking may be when someone else's visual perspective is altered from our own by 180 degrees – e.g., something exactly defined as opposite to our own. Indeed, there is some suggestion that the cognitive process used in perspective taking may be somewhat different in this case than when the angle is different (Cavallo et al. 2017; Erle/Topolinski 2017; see also Surtees et al. 2013).

In contrast, when it comes to conceptual perspective taking, what the other person could be "seeing" is less determined by physical cues in the "real world" like light and angles and may largely be the product of integrating a wide possible range of mental constructs stored or even created in the head of the perspective taker (e.g., Hodges et al. 2018; Lewis et al. 2012). If in the last election, someone voted conservative and we voted liberal, then guessing that their views on gay marriage will be (politically) "on the right" of ours is perhaps a good place to start, but is far from certain. They may be to the political right in terms of fiscal issues, but maybe not on social ones. Or, they may be generally more socially conservative, but because of their sexual orientation, they may be pro-gay marriage and hold other pro-gay views that even exceed the average liberal.

These examples highlight another potentially important difference between visual and conceptual perspective taking: when taking visual perspectives, we can acknowledge that things "look different from here" but there is a sense that there is some objective reality out there: "the dress really is black and blue, even if it looks gold and white to you" (e.g., see discussion and research about the appearance of the online viral phenomenon of "the dress" by Chetverikov/Ivanchei 2016; and by Wallisch 2017). However, when it comes to conceptual perspective taking – for example, trying to see how an interaction could have looked like flirting to a co-worker, or to understand how much a homebuyer values hardwood floors, there is likely no "objective reality" about an external referent to consult. And although there is fascinating research on how non-visual variables can impact what people literally visually see (e.g., Proffitt et al. 1995) or remember seeing (e.g., Loftus/Palmer 1974), it would seem that individual "perspectives" on social matters have the potential to be shaped by – and constructed from – a wider range of variables than individual visual perspectives.

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4 Anchors and Effort

At minimum, visual perspective taking provides a useful analogy for conceptual perspective taking, and possibly more (Erle/Topolinski 2015). Erle/Topolinski (2017) have identified several shared characteristics of visual and conceptual perspective taking. Both forms of perspective taking involve recognizing that a target person has the capability of inner mental states and that the target's mental states can differ from those of the perceiver. Both forms also create some experience of "self-other overlap" of the perceiver with the target of perspective taking. Research into both visual and conceptual perspective taking has also demonstrated a strong egocentric bias: people automatically adopt their own perspective as a default, and even when they are attempting to take another perspective, suppressing the self's perspective is hard to do (e.g., Epley et al. 2004; Samson et al. 2010; Todd et al. 2017; Todd et al. 2015). Thus, both forms of perspective taking involve adjusting away from the self's egocentric default perspective (Epley et al. 2004). Just as we *adjust* for the fact that our friend sitting next to us has a view that is not obstructed by the tall man's hat, and can then in our minds imagine what the scenery must look like to her, we can also *adjust* for the fact that another friend didn't know that our neighbors divorced and then in our minds imagine what the friend must have thought when she saw the former wife kissing someone else.

Arriving at someone else's perspective is generally thought to require effort (Epley et al. 2004; Keysar et al. 1998; Lin et al. 2010; Sabbagh/Taylor 2000; Todd et al. 2017), although there is debate about whether visual perspective taking may sometimes occur relatively automatically (e.g., Apperly/Butterfill 2009; Furlanetto et al. 2016; Heyes 2014; Qureshi et al. 2010; Samson et al. 2010; Santiesteban et al. 2014; Santiesteban et al. 2017; Surtees et al. 2016; Todd et al. 2017; Zhao et al. 2015). Within the conceptual perspective-taking realm, in support of the idea that taking a different perspective requires cognitive effort, several studies have demonstrated that perspective taking is impaired when done under increasing cognitive load (e.g., Chambers/Davis 2012; Epley et al. 2004; Lin et al. 2010). There is further evidence from cognitive psychologists and neuroscientists that perspective taking is cognitively taxing, both in terms of how it takes cognitive capacity away from other tasks and also in terms of engaging parts of the brain associated with effortful thinking (e.g., Santiesteban et al. 2017; van der Meer et al. 2011).

Researchers have theorized about the *possibility* of automatic (or at least *more* automatic) conceptual perspective taking occurring (Hodges/Wegner 1997; see also Baldwin/Holmes 1987; Taylor et al. 2003). Just as other complex but

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frequently executed behaviors (such as driving a car or playing a musical piece) can become automatic (Logan 1988; Shiffrin/Schneider 1984), it seems theoretically possible that people who often consider a particular person's perspective over time (e.g., a family member or close friend) may find themselves automatically incorporating that other person's perspective (e.g., sizing up a menu based on a romantic partner's food preferences; turning down a social invitation without being consciously aware of summoning one's child's perspective on the event).

To further complicate matters, perspective taking is experimentally manipulated in the lab in most empirical studies – i.e., it is something experimenters instruct participants to do. Thus, even if effortless (or less effortful) perspective taking occurs spontaneously "in the wild," we are likely not catching it in the lab. There are some exceptions, with a few researchers studying spontaneous perspective taking (e.g., Batson et al. 2007; Furlanetto et al. 2013; Gehlbach et al. 2012; Gerace et al. 2013). There are also researchers who construe perspective-taking tendencies along a continuum of individual differences, e.g., the perspective-taking subscale of Mark Davis's Interpersonal Reactivity Index (IRI) (Davis 1980; Davis 1983).

Other mechanisms involved in perspective taking could also become automated. For example, there is evidence that we may rely on stereotypes of a person's group when we take their perspective (e.g., see Lewis et al. 2012); and use of a highly accessible stereotype in conceptual perspective taking could look like automatic perspective taking. However, the sources and number of variables that could be considered when engaging in conceptual perspective taking seem potentially more numerous and less determined than in the case of visual perspective taking. The more an instance of perspective taking requires taking a particular person's conceptual perspective in a particular context, the more idiosyncratic the exercise and thus the less likely it is to be automatic. Thus, outside of a few contexts with a few close individuals, conceptual perspective often requires some cognitive work, and in some cases, quite considerable cognitive work.

The cognitive work of perspective taking involves two important jobs. The first of these is that perspective taking makes people consider *more* information and *other* information than is available from their default "self" perspective. Perspective taking leads people to see things a little (or a lot) differently than they normally do. Of course, there are no guarantees that simply considering more information will make people understand other perspectives better or that considering other information will make them behave more prosocially (we'll give some counterexamples later). Yet the possibilities seem ripe, given that a second frequent job of perspective taking – one closely intertwined with the first job – is to cause us to put ourselves in the place of the person whose perspective we are taking as a method to help construct that other person's perspective. Involving

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the self tends to bring along a slew of "self-favoring" biases identified by social psychologists. People generally behave in ways that promote self-interest and view the self's behavior in a positive light (e.g., Alicke et al. 1995; Kennedy/Pronin 2008; Tavris/Aronson 2007; Weinstein/Klein 1995). If we imagine the self in another person's place, it seems probable that we might view that other person more favorably, too.

For example, imagine taking the perspective of another automobile driver who is backing out of a particular driveway. You know that when *you* back out of this driveway, it's hard to see the road because of all the bushes, so you might be more understanding of why the other driver is inching out so slowly (see e.g., Herzog 1994). Or, when another researcher doesn't recognize you at a conference, you may think about times when you didn't recognize someone and knew that *you* weren't purposefully ignoring that person. In line with work by Galinsky/Moskowitz (2000), perspective taking also helps us to go beyond our stereotypes of the other groups (considering more and different information). When we connect someone else's perspective to our own, we attribute our own reasons for acting to others (putting the self in someone else's place) and there is a good chance we will bring our more charitable self-favoring interpretations of our own behavior over to our interpretations of their behavior.

The process of perspective taking isn't accomplished by simply "plopping" the self in the place of another person. Instead, perspective taking has been described as an "anchoring and adjustment" process (Epley et al. 2004), akin to that used in judgment and decision making (Tversky/Kahneman 1974). People *anchor* on the self, and then *adjust* away from the self to account for differences between the self and the person whose perspective is being taken. Just as Tversky/Kahneman (1974) note that adjustment away from an anchor is often insufficient, in Epley et al.'s (2004) perspective-taking account, adjustment away from the self-anchor is also likely insufficient, resulting in an overly self-flavored outcome.

The self isn't the only anchor people use when taking the perspective of another person: They may also anchor on their stereotypes of the group to which the other person belongs (Lewis et al. 2012), particularly if they perceive the other person as being unlike themselves (Ames 2004). However, using the self as the default anchor is defensible, as it is a highly accessible reference point (Catrambone et al. 1996; Christian et al. 2014; Hodges 2005) and in the absence of other information, projecting from the self leads to better estimates of others than ignoring the self (Dawes 1989; Hoch 1987; Krueger 1998).

Using the self as an anchor in perspective taking leads to acknowledging some similarities or at least parallels between us and the target of perspective taking. To use an extreme example, suppose you are asked to put yourself in the

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place of someone robbing a cash machine. No matter how law-abiding and honest you are, and no matter how much you think, “I would *never* rob a cash machine,” the mere act of trying to imagine yourself in the position of someone who *has* probably makes you think just a little about how your own life of crime might be. As another example, when people say things like, “I can’t imagine why she’s being so stubborn about this!”, the truth is that they are probably actually doing exactly that: imagining themselves in her place. Granted, that imagining might include thoughts such as, “This is a ridiculous point of view and preposterous position to maintain,” but nevertheless, there has been some attempt to overlap the self with the other person.

Social psychologists have been able to measure this phenomenon, showing that perspective taking reliably increases perceived *overlap* between self and other (Davis et al. 1996; Galinsky/Moskowitz 2000; Myers/Hodges 2012). Many studies of perspective taking have shown that post-perspective taking, people perceive themselves as more similar to the other person; describe themselves in more similar terms; and choose graphical representations of themselves and the other person that literally show greater overlap (Laurent/Myers 2011; Maner et al. 2002; Myers/Hodges 2012; Myers et al. 2014). Perspective taking rarely (if ever) produces the sense that the self and the other person occupy the *exact* same space, but the act of perspective taking seems to highlight the extent to which the self and the other person are perceived as overlapping in space. If that overlap is not extensive, the perspective taker may conclude that the self and the other have very different points of view (e.g., a mother taking her adolescent child’s perspective about the merits of engaging in some risky behavior). However, even if there is a great distance between two perspectives, there seems to be a powerful effect on interpersonal outcomes when the relationship between perspectives is located on the same map.

5 Alignment

We think that what happens during perspective taking can be understood by drawing on the concept of *alignability* in comparisons that was developed by cognitive psychologists Gentner/Markman (1994). Gentner/Markman’s work was developed to describe how people arrive at judgments of similarity and difference – largely when comparing objects, not perspectives. However, Gentner/Markman made the important observation that in order to discuss how similar (*or* different) two things were, those things had to first be aligned on some dimension of comparison to give meaning to the comparison.

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We think alignment is also important in the act of perspective taking, when the alignment that takes place prior to putting ourselves in someone else's place also gives meaning to the comparison. For example, in the case of visual perspective, the two people's vantage points could be aligned: "Xuan's further to the right than me, so maybe she can't see the image in corner of the screen." In this example, the visual perspectives are aligned along a left-right axis in space. Conceptual perspectives can be aligned, too: "Rob's kids are younger than mine, so I bet he doesn't see school redistricting as such a big problem." Here, the two perspectives are aligned along the dimension of "age of offspring."

Which dimension perspectives are aligned on depends on context (as illustrated in the examples above). The comparison between our own and someone else's perspective could involve multiple dimensions ("Well, she'll probably be more enthusiastic about the new carrot-themed restaurant than me, because first, she's vegan, and second, she owns stock in carrot futures"). However, having more dimensions for alignment doesn't assure more similarity and can, in fact, emphasize greater difference. German speakers use the expression "to compare apples and pears" and English speakers say "that's like apples and oranges" as a way to indicate how *different* two things are. The expressions work in their respective languages because we can align two fruits (an apple and a pear, or an apple and an orange) on many dimensions that yield differences: their taste, their color, their shape, how they ripen, etc. It is because of these many alignable dimensions that we feel comfortable making a judgment about their similarity or lack thereof. The expression, "That's like apples and chairs!" as a way to express how different two things are hasn't caught on in either German or English – not because these two objects aren't different from each other, but because in most contexts, they would be hard to align in comparison. In the end, we feel comfortable saying two things are different or similar when we can see how they stand in relationship to each other by lining them up on one or more dimensions.

When we put ourselves in someone else's place, we are also trying to find some dimension of alignability, with the potential to then map how much or little overlap there is with the self. When we put ourselves in a bank robber's place, we may come to the conclusion that we would *not* rob a bank machine under any circumstances. However, we have still lined ourselves up on some shared continuum with the bank robber, albeit with different landing positions on that dimension (perhaps criminal tendencies, morality, or fear of reprisal). Aligning the self and other appears to play a key role in extending "self-benefits" and self-favoring biases to the other person, which ultimately may lie at heart of much of the perspective-induced prosocial behavior observed by social psychologists over the years.

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6 When Perspective Taking Doesn't Help Because Perspective Taking Doesn't Happen

Taking all this background about perspective taking into account, we can start to predict when perspective taking may not lead to prosocial outcomes, and when it may even "backfire" and make people less prosocial. A very basic starting point is that perspective taking sometimes fails to produce prosocial outcomes in cases where people simply *won't* try to take someone else's perspective, or else they have abandoned or avoided perspective taking. People have to be convinced to perspective take, given the cognitive effort it generally entails. People also may resist taking another person's perspective for reasons other than cognitive effort. First, people may refuse to take another person's perspective as a way to denote that the other person is in an entirely different category. If perspective taking involves alignment (as we outline above), then potential perspective takers may not be willing to accept the prospect of *any* overlap between that person and the self: there is no point of meaningful alignment between the self and some entirely different "subspecies." It's like apples and chairs. Additionally, the perspective taker may reject the possibility of alignment and comparison with someone else as a way to deny the humanity of the other person. This leaves unscathed potentially important moral considerations for the perspective taker about what it means to be human – and can also keep at bay any threat to the perspective taker's *own* humanity that might arise when comparing oneself to unsavory elements.

Taking an enemy's or competitor's perspective may be a step down a slippery slope. At some level, humans may be aware – or at least wary – that taking their enemy's perspective may cause the enemy to seem more reasonable and less blameworthy, which may sound desirable at some level, but also may threaten important group-defining beliefs and cherished identities. For example, for Zionist Israelis, taking the perspective of a Palestinian settler's claim on the land may threaten their basic beliefs about the establishment of a Jewish homeland, and thus the Zionists may simply not engage in taking Palestinian perspectives. Or, although we've earlier suggested that most people can make themselves take the perspective of a bank robber, we suspect that some people would firmly resist when asked to take the perspective of a more extreme criminal – like a brutal mass murderer. Refusing to contemplate his perspective may not only be a way to hold the line against feeling any sympathy towards him, but it also may deny him legitimacy as a fellow human.

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Even in non-adversarial conditions, when people may care about or like the person whose perspective they are asked or motivated to take, there may be times when they resist perspective taking. As already noted, there are cognitive costs to perspective taking, but there are also other potential costs. For example, suppose people try to imagine the perspective of an asylum seeker from Guatemala, whose child is taken from them at the border and placed in detention, while they are sent back to Guatemala. Or they try to take the perspective of one of the thousands of Syrian refugees, currently living in a cold, muddy camp, desperately seeking somewhere that they won't be bombed, so they can earn money for food and their children can go to school. If people can compellingly imagine these scenarios, they are probably seeing some fairly disturbing images in their mind's eye. The images may be so aversive that people discontinue perspective taking. Even if they soldier on, they may be in for *more* distress. Perhaps they become keenly aware of the contrast between their own (relatively) comfortable existence and what these other people are experiencing, and then think, "I must do something to help. I must give money." However, then they realize that to do much good, the costs would be high: "I need to give *all* my money to Doctors Without Borders *and* quit my job to go volunteer in a refugee camp, *and* host 3 refugees in my tiny home." If the refugee's perspective has really successfully been taken, it might be hard to deny that these are all things that would help the refugee.

To consider another example which is not as dramatic and dire, but perhaps depressingly familiar, suppose an academic dean is asked to meet with a group of female faculty who point out that they get paid substantially less than the male faculty in the department. The dean (perhaps a woman herself, maybe not) takes the group's perspective, and perceives that the situation looks a lot like gender bias. But now, what is the dean going to do? The salary differential might be quite substantial, and yet the money budgeted to the department for salary raises might be quite small. Fixing the gender bias might require using *all* the money the dean has for raises each year for the next 10 years, meaning the dean will have no money for other raises (e.g., none to give to the person who gets a competitive offer from another university). Feeling the female faculty's pain more keenly after taking their perspective makes their problem now also the dean's problem, and the dean's desire to solve the problem becomes more self-serving. But the dean might have rather not acquired these feelings about this problem, which no doubt joins a number of other pressing priorities on the dean's desk.

In the refugee and faculty examples given above, perspective takers have already incurred the "baseline" cost of perspective taking in terms of exerting cognitive effort. After they have expended the effort to construct another perspective, they now also see the target of perspective taking's plight in a new way – one that

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has some degree of overlap with the self and thus to some degree makes acting on the other person's behalf and desires somewhat self-serving. But acting on the other's behalf may now incur more material and social costs. Enough experiences like this with high enough costs, and the perspective takers may avoid future situations that could cause them to take certain people's perspectives to begin with: perhaps turning off the news when there are stories about refugees, or finding that their calendar seems really full when a group of female faculty ask to meet with them.

When people are aware of the potential costs of perspective taking, they may take preemptive precautions so that perspective taking never occurs at all, and any potential benefits of perspective taking are circumvented altogether. For example, Shaw et al. (1994) demonstrated that people who are aware that they may be moved to provide costly assistance to another person in need will choose to avoid hearing a compelling account of that person's need – something the authors labelled empathy avoidance, rather than perspective-taking avoidance. (See also recent work suggesting that trying to maintain an objective view of another person – often the directions given to "control" condition participants in studies that manipulate perspective taking – will inhibit feelings for the other person; McAuliffe et al. 2018.) Empirical methods for capturing someone in the process of avoiding a perspective may be more challenging to execute. As we noted earlier in this chapter, self-reports of perspective-taking failure ("I can't imagine what she was thinking…") often indicate an abortive attempt. The pattern of outcome variables for someone avoiding a perspective might look very similar to the results for someone who took the perspective but found it odious or threatening – and we wouldn't know which of these events had occurred.

7 When Perspective Taking Backfires

When people *do* try to take the perspective of clear enemies or salient outgroups, conditions are perhaps most ripe for backfiring. Taking their perspective seems to highlight the animosity and differences, especially when the perspective taker has little other information about the target of perspective taking. The point of alignment is likely to be the dimension which defines the groups, sides, and battle lines, so that alignment serves to emphasize just how much the perspective taker and target of perspective differ. For example, Tarrant et al. (2012) found that when people who were highly identified with their ingroup were asked to take the perspective of an outgroup member, they actually attributed *more*, not fewer stereotypic traits to the outgroup members – that is, the gap between groups got

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bigger. Targets who clearly fit a negative stereotype of an outgroup may also be stereotyped more when people are asked to take their perspective (Skorinko/Sinclair 2013). In another example of when perspective taking highlights differences, Okimoto/Wenzel (2011) asked research participants to take perspective of a lab partner who had previously been inconsiderate to them. When that earlier inconsiderate behavior was ambiguous (i.e., it was unclear if the partner really meant to be malicious or not), perspective taking showed the more usual prosocial effects and led to participants forgiving the lab partner. However, when the inconsiderate behavior was unambiguous (i.e., the partner definitely intended to be malicious), the research participants asked to take the partner's perspective became vengeful, not forgiving (see also Lucas et al. 2016).

Even without perspective taking occurring across entrenched differences, things can still go awry. There is no guarantee that people will accurately "get" the other person when they try to take their perspective. We don't really have any access to how other people "see" the world – we can't get inside their heads. This, of course, is the ancient "other minds problem." To some extent, we are forced to construct, make up, and imagine how things look to them. A lot depends on how the other person's perspective is constructed – and some construction projects may lead to backfiring.

As mentioned earlier, one powerful perspective construction tool is the self – we can simulate how things would look to us in the same circumstances (e.g., Ames 2004; Epley et al. 2004). However, there are limits to how successful this simulation is. Maybe we've never been in a similar situation and we don't have the knowledge to simulate or imagine how things would be. Even if we have been in a similar situation, some things are easier to conjure up than others. For example, thinking again about bank robbers, we may all be quite familiar with a desire to have more money. However, we may not be able to imagine the feelings of being so addicted to a drug that we'd be willing to break the law to steal money to buy it.

Van Boven/Loewenstein (2005) have persuasively demonstrated that even if we try, it's hard to imagine physiological needs or visceral emotions of others if we aren't currently feeling the same way. For example, without experiencing intense feelings such as imminent embarrassment, it is hard to really "get" the perspective of other people who are experiencing those feelings. In one study (see Van Boven et al. 2013), university students were asked whether they thought their classmates would be willing to perform a solo dance in front of their class to Rick James' 1980s rhythm and blues hit "Super Freak" for a small sum of money. Those who had previously been given the choice themselves ("Would you be willing to dance to the song right now for $5?") did a better job of estimating their classmates'

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behavior (not surprisingly, actually choosing to dance was not a very popular choice!).

Other times we *think* we have succeeded in putting ourselves in another person's place, but we fail. In another sobering example from Van Boven's lab, Silverman et al. (2015) gave normally-sighted individuals a chance at taking the perspective of people who were permanently blind. They blindfolded participants and had them do a series of everyday tasks, such as sorting coins, pouring a glass of water from a pitcher, and navigating their way around the offices in a building. Normally sighted people found these tasks challenging to do while blindfolded. They found it so difficult, in fact, that the experience made them evaluate blind people as *less* capable than participants not given the experience. Blindfolded participants took the perspective of blind people, but relied too much on the powerful difficulties they personally experienced as they struggled to pour water and count coins. They failed to accurately put themselves in the place of people who were habitually blind and thus had adapted to their disability (see also Nario-Redmond et al. 2017). Even if we've shared real (not simulated) life experiences that match others' experiences, we *still* may miss the mark in trying to nail their perspective. In a study in which participants tried to guess what new mothers were thinking, participants who themselves were also new mothers were no more accurate than women who were currently pregnant or never pregnant women (Hodges et al. 2010).

Stereotypes and schemas are another source of input for constructing someone else's perspective: what would someone else from this person's group (e.g., nationality or occupation) be thinking? What would the average person in this situation (e.g., witnessing a car accident, meeting their future sister-in-law) be thinking? These stereotypes and schemas may bring to mind information that also causes perspective taking to backfire. For example, in a series of studies, Mooijman and Stern (2016) asked heterosexual participants to take the perspective of a gay male couple. When doing so, a not uncommon place they went in their heads was to think about gay sex. For conservative participants who found gay sex repellant, the more they thought about gay sex while perspective taking, the less their attitudes towards gays improved after perspective taking. If, however, similar participants were specifically sent in a different direction during their perspective taking and told to "think about the gay couple grocery shopping" – that is, if they were given another schema – then perspective taking led to relatively more positive attitudes toward gays. Even if perspective taking does not evoke ideas that are *repellant*, if perspective taking involves considering ideas that are merely incongruent with the perspective takers' values, their attitudes

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are less likely to move towards those of the perspective taking target (Catapano et al. 2019).

Even when people are really motivated to build bridges with members of distinct outgroups, they may encounter unpleasant content that can cause perspective taking to backfire when they try to see the world through the eyes of an outgroup member. Jacquie Vorauer and her collaborators (e.g., Vorauer/Sasaki 2009; 2014; Vorauer et al. 2009) have studied ethnic majority members in Canada (mostly White Canadians, descended from Europeans) and minority Native Canadians – "First Nations" indigenous Canadians descended from the people already in North America when Europeans first came. Vorauer's research group has found that perspective-taking majority group members might be in for an unpleasant surprise: if they succeed in accurately constructing how the minority member sees the world, and they know the minority group has a negative view of their group (e.g., thinks they are racist, elitist, etc.), then taking the minority group member's perspective reminds them of the unflattering image that the minority holds of them. Instead of making them feel closer to the minority group member, taking the minority group perspective makes perspective takers feel wary, embarrassed, and/or uncomfortable about how the specific minority group member and the minority group more generally may view them. What's more, once the perspective takers feel this discomfort, the minority group member may sense it in their interactions. Perspective taking has thus served to highlight that the minority group has negative views of the perspective taker's own group (see also Berthold et al. 2013).

Context may also result in perspective taking highlighting threatening information, particularly contexts that involve competing self-interests (see Epley et al. 2006; Pierce et al. 2013). Imagine two roommates, and one slice of delicious cake. So that both can have some, the roommates decide to share the cake. One of them cuts the cake and serves the other half a slice. Now, suppose the cake "receiver" takes the perspective of the cake cutter. The receiver imagines herself in the cutter's role, and thinks what she would do – and knows that she would cut the cake unequally and save the big portion for herself! The "receiver" has been successful in putting herself in the other person's place, but it has provided her with a negative (and not necessarily accurate) view of the cutter. This view may in turn affect her own future behavior (e.g., "Oh – remember that time she robbed me of cake – so I need to bump up how much she owes me for her half of this bar tab"). Perspective takers in zero sum negotiations see their own self-interest reflected back at them when they imagine the person across the table, or as Epley et al. (2006) put it, "Looking into the mind of a competitor highlights self-interested motives and leads people to behave more self-interestedly in return."

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Even outside of competitive contexts, perspective taking may fall short when perspective takers with negative self-concepts project those negative characteristics on to perspective-taking targets. Including others in the self results in the extension of self-favoring perceptions only if the self is viewed positively (see Todd/Burgmer 2013).

8 Perspective Taking and Polarization

As we near the end of this chapter, we turn to real-life political events currently unfolding in the U.S. at the end of the "twenty-teens" decade, as a way to illustrate and summarize our main points. American politics have been described of late as highly polarized (e.g., Neal 2020), to the point of creating uncivility, rancor, and even dysfunction. Bi-partisan cooperation among national legislators gets described in wistful, nostalgic terms. Political disagreements are now perceived as "Trump-ing" (pun intended…) all the other connections that in the past kept people with different views on speaking terms. Although there is some evidence that today's polarization may not necessarily be that unusual (Van Boven/Sherman 2018; Westfall et al. 2015), there is a perception that things are currently at a polarization fever pitch (e.g., Balz 2018). Although people with differing views can't necessarily be expected to reach the *same* position via perspective taking, in the past, the idea was that perspective taking at least allowed them to appreciate why others held different views (e.g., see Hodges et al. 2018). The cause of this perceived unbridgeable gap between people has been attributed to the rise of social media communities (e.g., Bail et al. 2018) that allow people to surround themselves with like-minded others and avoid any exchanges with those whose views differ. Indeed, some researchers suggest that this sequestration is occurring not just in the virtual world, but the physical world as well, with people literally moving to neighborhoods that share their world views (Motyl et al. 2014). In other words, the possible points of alignment that underpin perspective taking (e.g., "we care about the same things in this community"; "our children go to school together"; and "we all live here") are vanishing. At the same time, others have suggested that polarization is not the simple result of being exposed to only one viewpoint (Bail et al. 2018). Instead, consistent with some of the ideas we've discussed in this chapter, sometimes the act of thinking about another perspective can push groups apart.

It is our perception that science has been newly caught in the crossfire of this polarization. Although science has never been immune to political influence, it used to be viewed as something that at least in theory operated largely separately

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from and outside of politics. Scientific discovery often served as a neutral ground that brought people together – in wonder and pride (think, for example, of the moon landing, or the mapping of the human genome). However, like the polar ice caps, science's neutrality appears to be shrinking.

Science's new part in polarization is likely at least in part due to the election of Donald Trump as U.S. president. Many of Trump's visible actions in office have suggested an executive chief who is at best unsupportive of science. His budgets have included large proposed funding cuts (although not all of them realized) to U.S. government agencies that historically have provided support to science programs and scientists (Ledford et al. 2019). More widely broadcast is his derision of climate change, as he has publicly mocked the position held by the vast majority of scientists that a threatening form of climate change is occurring (see Scientific consensus: Earth's climate is warming, 2019). More than before, it seems that scientific positions are classed as matters of political belief, rather than as determined or even influenced by data, research, or widely agreed upon "scientific facts." Unfortunately, implicit portrayals of science as something one can be for or against (like a football team) means previously neutral science can – with so many other forces – fuel polarization.

As a conclusion to this chapter, here is what we think may be happening when politically polarized Americans try to take each other's perspectives. Several of our specific examples pertain to how perspective taking and polarization may affect perceptions and understanding of science. The first three items below address an unwillingness or resistance towards perspective taking. The last four address how perspective taking may "backfire" – when people seek out conversations and Facebook friendships with others who voted differently or when people actively try to consume media from the "other side" but nonetheless find themselves even more estranged and less understanding of the other point of view.

1. People on different sides won't dignify the other side as having a perspective to take. For example, while some people in the U.S. merely don't like Trump (to various degrees), others have found his behavior and attitudes toward women repulsive (e.g., the infamous "grab them by the…" that was caught on tape) and find other Trump comments – both via Twitter and other media – to reveal a deep racism. Others have gone as far as to compare his xenophobic and nationalist proclamations to Hitler. Such extremely negative views may make potential perspective takers unwilling to dignify Trump as even having a "perspective." Trump's apparent disregard for the longstanding "rules" of science makes it even easier for people who are pro-science to dismiss him as not having a perspective to take.

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2. Perspective taking is cognitively taxing. Partisans on both sides have busy 21st century lives with multiple demands on their cognitive resources. Resources for trying to understand how the other side feels may lose out to challenging projects at work, juggling one's carpool schedule, and attending to an ailing spouse or relationship. The fact that the political divide is being portrayed as extreme and unbridgeable (something we realize we are contributing to with this chapter!) makes the cognitive task of trying to understand the other side seem even more daunting, perhaps inflating the estimates of just how much cognitive work it will be, and thus discouraging people from attempting it. Understanding "the other side" becomes all the more fraught when the other side represents a different position on something studied by science. For example, most laypeople – including the vast majority of those who believe climate change is happening – are not experts in climate science. Acquiring the background, knowledge, and skills to really understand the science behind their own position, let alone a competing position, would be daunting indeed.

3. Potential perspective takers may be wary of how perspective taking could make them sympathetic to personally costly beliefs. Someone opposed to the use of carbon fuels may not want to see an opponent's perspective on how declining coal mining has gutted small towns and eliminated jobs, because it could result in him finding himself shifting views in favor of actions that will result in poorer air quality and mine-ravaged landscapes. A conservative voter may not want to see a liberal's point that a new tax plan could hurt many people in the lower and middle classes, because the conservative may be talking herself out of a lucrative tax cut. In these examples, even when there might be accessible data that could inform a perspective, people may resist engaging with it, in order to avoid possible being persuaded by it.

4. People use incorrect or too extreme stereotypes, or they may inaccurately perceive key aspects of the other side when attempting to take their perspective. For example, more American Republicans (the more conservative of the two major U.S. parties) believe in climate change than is popularly thought by more liberal Democrats (Scherer et al. 2015; Van Boven et al. 2018; Van Boven/Sherman 2018). And for a number of scientific issues other than climate change, the Republicans and the more liberal Democrats scored equally in terms of how much they agreed with scientific consensus on the issues (e.g., McPhetres/Pennycook 2020), although both sides may deride the other side as ignorant or misinformed.

5. Taking the other side's perspective exposes perspective takers to ideas that they consider disgusting or immoral. Perspective-taking conservatives may have to contemplate transgender people who make them uncomfortable. Perspective-

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taking liberals may have to contemplate oil pipelines in wilderness areas that make them uncomfortable.

6. *Taking the other side's perspective exposes perspective takers to negative portrayals of their own side.* When conservatives and liberals in the U.S. expose themselves to media associated with the other side, conservatives may see themselves portrayed as unflatteringly stupid, plodding, and anti-science (e.g., "flat earthers"); liberals may see themselves portrayed as elitist "nerds," who care more about bad things that scientists say will happen in the future than in having compassion for the economic and social struggles some Americans face in the present.

7. *Taking the other side's perspective in an adversarial or zero-sum situation leads to casting aspersions on their tactics, which in turn causes the perspective taker to adopt similar tactics in defense.* Both sides, when contemplating the other side, may think about how the other side might be willing to stretch the truth, even lie, or otherwise finagle things in order to make their point or get their way. Contemplating this behavior on the other side (without any necessary evidence for it – the contemplation just makes it possible) can make parallel questionable or dishonorable practices on one's own side seem more justifiable or even "fair." If they take the other side's perspective, only to have that highlight how the other side isn't likely to treat them well, it's likely to lead to more provocation, not reconciliation.

The current tension and polarization in the U.S. are certainly not the first time that groups have had trouble seeing each other's perspective, so the problem isn't new. Somehow, Americans (and people in many other countries) made it through the tumultuous and divided late 1960s and early 1970s, when fights over the Vietnam War and civil rights for ethnic minorities and women flared. Exactly how these conflicts eased, however, and the extent to which perspective taking helped or hurt, is not clear. Is there hope for us now? We will end by speculating about some strategies that might help. Testing these strategies may be ripe for future research.

First, we think that perspective taking is more likely to be successful in creating understanding and cooperation when people interact with each other as individuals, rather than as members of opposing factions. Group identities highlight group level stereotypes and antagonisms. When taking an outgroup member's perspective, it's easy to align the comparison along the dimension that distinguishes between the two groups, which guarantees that a certain level of distance will be found. In contrast, if the other person is represented by characteristics that don't rely only on group membership, there are potentially many more dimensions to align (e.g., "He loves bowling, I like it"; "He has a three-year-

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old, I have a 10-year-old"; "He is from further south than I am"). Thus, for example, creating a website that specifically is designed to facilitate interactions between liberals and conservative seems efficient, but may in the long run be less effective than getting diverse people to talk to each other when they are not defined by their politics or group membership. Getting people to talk to each other this way will be an ambitious, uncharted challenge.

In a related vein, we think that perspective taking that occurs in face-to-face conversations is likely to be more successful than perspective taking that occurs outside of personal interactions. Not only has recent work by Schroeder and colleagues (e.g., Schroeder/Epley 2016; Schroeder et al. 2017) demonstrated the humanizing importance of hearing another person's voice when we disagree with them, but also during face-to-face conversations, a number of norms generally apply, along the lines of politeness, pleasantness, and listening and exchanging ideas. Right around the time of Trump's presidential inauguration in the U.S. in 2017, one of the authors of this chapter sat next to a man on a plane who held views on Trump different from her own. Later in the year, she sat next to a man on a train in Germany whose position on Middle Eastern immigrants seeking refuge was different from her own. In neither case did a fight break out – voices were never raised. In fact, in both cases, the conversations were congenial and engaging. She found herself engaging in a lot of perspective taking and left with greater appreciation and understanding for their position. The conversations didn't result in a change in her own position or voting behavior, or – she suspects – her seatmates', but the conversation did cause her to see the other side as more reasonable, and also called her attention to different experiences and assumptions on both sides. It was probably also important that all the travelers in these examples were by themselves, not with groups. In neither case was it the author's role, nor that of her seatmates, to "represent" a particular position. Instead, they were essentially "randomly assigned" to seats, which fits with our suggestion above that interactions that occur for reasons other than explicitly exchanging ideas across group lines may be more likely to lead to prosocial perspective-taking outcomes.

Finally, in a cynical way to end a somewhat cynical chapter, it may be that things getting worse first will help them to ultimately get better. Larger crises that span both sides of the political divide – as scary and disruptive as they may be – may provide the silver lining of obscuring the challenges of perspective taking across ideological gaps. Although political polarization in the U.S. is challenging, Americans have other challenges: an estimated 115 people die each day in the U.S. of opioid overdose (e.g., see Opioid Overdose Crisis 2020). Many American communities are dealing with the aftermath of record-breaking hurricanes and

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deadly wildfires (whether the residents think these events are the result of climate change or not!). People may be more likely to find themselves taking the perspective of someone who has lost a spouse or house than thinking about someone's political perspective, allowing them perhaps to align on dimensions that return us to the kind of perspective taking associated with increases in compassion and prosocial behavior.

References

Alicke, M. D., Klotz, M. L., Breitenbecher, D. L., Yurak, T. J., & Vredenburg, D. S. (1995). Personal Contact, Individuation, and the Better-Than-Average Effect. *Journal of Personality and Social Psychology*, 68(5), 804–825. DOI: 10.1037/0022-3514.68.5.804.

Apperly, I. A. & Butterfill, S. A. (2009). Do Humans Have Two Systems to Track Beliefs and Belief-like States? *Psychological Review*, 116(4), 953–970. DOI: 10.1037/a0016923.

Ames, D. R. (2004). Inside the Mind Reader's Tool Kit: Projection and Stereotyping in Mental State Inference. *Journal of Personality and Social Psychology*, 87(3), 340–353. DOI: 10.1037/0022-3514.87.3.340.

Aron, A., Aron, E. N., Tudor, M., & Nelson, G. (1991). Close Relationships as Including Other in the Self. *Journal of Personality and Social Psychology*, 60(2), 241–253. DOI: 10.1037/0022-3514.60.2.241.

Bail, C. A., Argyle, L. P., Brown, T. W., Bumpus, J. P., Haohan, C., Fallin Hunzaker, M. B., Lee, J., Mann, M., Merhout, F., & Volfovsky, A. (2018). Exposure to Opposing Views on Social Media can Increase Political Polarization. *Proceedings of the National Academy of Science*, 115(37), 9216–9221. DOI: 10.1073/pnas.1804840115.

Baldwin, M. W. & Holmes, J. G. (1987). Salient Private Audiences and Awareness of the Self. *Journal of Personality and Social Psychology*, 52(6), 1087–1098.

Balz, D. (2018). A Split America Reasserts its Divisions in the Midterm Elections. *Washington Post*, November 6, 2018. https://www.washingtonpost.com/politics/a-split-america-reassert-its-divisions-in-the-midterm-elections/2018/11/06/31475b7c-dfa9-11e8-b3f0-62607289efee_story.html.

Batson, C. D. (1987). Prosocial Motivation: Is it Ever Truly Altruistic? *Advances in Experimental Social Psychology* (Ed. L. Berkowitz). New York. NY: Academic Press, 65–122.

Batson, C. D., Chang, J., Orr, R., & Rowland, J. (2002). Empathy, Attitudes and Action: Can Feeling for a Member of a Stigmatized Group Motivate One to Help the Group. *Personality and Social Psychology Bulletin*, 28(12), 1656–1666. DOI: 10.1177/014616702237647.

Batson, C. D., Eklund, J. H., Chermok, V. L., Hoyt, J. L., & Ortiz, B. G. (2007). An Additional Antecedent of Empathic Concern: Valuing the Welfare of the Person in Need. *Journal of Personality and Social Psychology*, 93(1), 65–74. DOI: 10.1037/0022-3514.93.1.65.

Batson, C. D., Lishner, D. A., Carpenter, A., Dulin, L., Harjusola-Webb, S., Stocks, E. L., Gale, S., Hassan, O., & Sampat, B. (2003). '…As You Would Have Them Do Unto You': Does Imagining Yourself in the Other's Place Stimulate Moral Action? *Personality and Social Psychology Bulletin*, 29(9), 1190–1201. DOI: 10.1177/0146167203254600.

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Batson, C. D., Polycarpou, M. P., Harmon-Jones, E., Imhoff, H. J., Mitchener, E. C., Bednar, L. L., Klein, T. R., & Highberger, L. (1997). Empathy and Attitudes: Can Feeling for a Member of a Stigmatized Group Improve Feelings Toward the Group? *Journal of Personality and Social Psychology*, 72(1), 105–118. DOI: 10.1037//0022-3514.72.1.105.

Berthold, A., Leicht, C., Methner, N., & Gaum, P. (2013). Seeing the World With the Eyes of the Outgroup – The Impact of Perspective Taking on the Prototypicality of the Ingroup Relative to the Outgroup. *Journal of Experimental Social Psychology*, 49(6), 1034–1041. DOI: 10.1016/j.jesp.2013.07.007.

Brooks, R. & Meltzoff, A. N. (2015). Connecting the Dots From Infancy to Childhood: A Longitudinal Study Connecting Gaze Following, Language, and Explicit Theory of Mind. *Journal of Experimental Child Psychology*, 130, 67–68. DOI: 10.1016/j.jecp.2014.09.010.

Catapano, R., Tormala, Z. L., & Rucker, D. D. (2019). Perspective Taking and Self-Persuasion: Why 'Putting Yourself in Their Shoes' Reduces Openness to Attitude Change. *Personality and Social Psychology Bulletin*, 30(3), 424–435. DOI: 10.1177/0956797618822697.

Catrambone, R., Beike, D., & Niedenthal, P. (1996). Is the Self-Concept a Habitual Referent in Judgments of Similarity? *Psychological Science*, 7(3), 158–163. DOI: 10.1111/j.1467-9280.1996.tb00349.x.

Cavallo, A., Ansuini, C., Capozzi, F., Tversky, B., & Becchio, C. (2017). When Far Becomes Near: Perspective Taking Induces Social Remapping of Spatial Relations. *Psychological Science*, 28(1), 69–79. DOI: 10.1177/0956797616672464

Chambers, J. R. & Davis, M. H. (2012). The Role of the Self in Perspective-Taking and Empathy: Ease of Self-Simulation as a Heuristic for Inferring Empathic Feelings. *Social Cognition*, 30(2), 153–180. DOI: 10.1521/soco.2012.30.2.153.

Chetverikov, A. & Ivanchei, I. (2016). Seeing "The Dress" in the Right Light: Perceived Colors and Inferred Light Sources. *Perception*, 45(8), 910–930. DOI: 10.1177/0301006616643664.

Christian, C., Lee, I.-C., & Hodges, S. D. (2014). From East to West: Accessibility and Bias in Self-Other Comparative Judgments. *Personality and Social Psychology Bulletin*, 40(11), 1391–1405. DOI: 10.1177/0146167214549318.

Coke, J. S., Batson, C. D., & McDavis K. (1978). Empathic Mediation of Helping: A Two-Stage Model. *Journal of Personality and Social Psychology*, 36(7), 752–766.

Davis, M. H. (1980). A Multidimensional Approach to Individual Differences in Empathy. *JSAS Catalog of Selected Documents in Psychology*, 10, 85.

Davis, M. H. (1983). Measuring Individual Differences in Empathy: Evidence for a Multidimensional Approach. *Journal of Personality and Social Psychology*, 44(1), 113–126.

Davis, M. H., Conklin, L., Smith, A., & Luce, C. (1996). Effect of Perspective Taking on the Cognitive Representation of Persons: A Merging of Self and Other. *Journal of Personality and Social Psychology*, 70(4), 713–726.

Dawes, R. M. (1989). Statistical Criteria for Establishing a Truly False Consensus Effect. *Journal of Experimental Social Psychology*, 25(1), 1–17.

Epley, N., Caruso, E. M., & Bazerman, M. H. (2006). When Perspective Taking Increases Taking: Reactive Egoism in Social Interaction. *Journal of Personality and Social Psychology*, 91(5), 872–889. DOI: 10.1037/0022-3514.91.5.872.

Epley, N., Keysar, B., Van Boven, L., & Gilovich, T. (2004). Perspective Taking as Egocentric Anchoring and Adjustment. *Journal of Personality and Social Psychology*, 87(3), 327–339. DOI: 10.1037/0022-3514.87.3.327.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Erle, T. M. & Topolinski, S. (2015). Spatial and Empathic Perspective-Taking Correlate on a Dispositional Level. *Social Cognition*, 33(3), 187–210. DOI: 10.1521/soco.2015.33.3.187.
Erle, T. M. & Topolinski, S. (2017). The Grounded Nature of Psychological Perspective-Taking. *Journal of Personality and Social Psychology*, 112(5), 683–695. DOI: 10.1037/pspa0000081.
Flavell, J. H., Everett, B. A., Croft, K., & Flavell, E. R. (1981). Young Children's Knowledge about Visual Perception: Further Evidence for the Level 1-Level 2 Distinction. *Developmental Psychology*, 17(1), 99–103.
Flavell, J. H., Shipstead, S. G., & Croft, K. (1978). Young Children's Knowledge about Visual Perception: Hiding Objects From Others. *Child Development*, 49(4), 1208–1211.
Furlanetto, T., Becchio, C., Samson, D., & Apperly, I. (2016). Altercentric Interference in Level 1 Visual Perspective Taking Reflects the Ascription of Mental States, Not Submentalizing. *Journal of Experimental Psychology: Human Perception and Performance*, 42(2), 158–163. DOI: 10.1037/xhp0000138.
Furlanetto, T., Cavallo, A., Manera, V., Tversky, B., & Becchio, C. (2013). Through Your Eyes: Incongruence of Gaze and Action Increases Spontaneous Perspective Taking. *Frontiers in Human Neuroscience*, 7, ID 455. DOI: 10.3389/fnhum.2013.00455.
Galinsky, A. D., & Ku, G. (2004). The Effects of Perspective-Taking on Prejudice: The Moderating Role of Self-Evaluation. *Personality and Social Psychology Bulletin*, 30(5), 594–604. DOI: 10.1177/0146167203262802.
Galinsky, A. D., Ku, G., & Wang, C. S. (2005). Perspective-Taking and Self-Other Overlap: Fostering Social Bonds and Facilitating Social Coordination. *Group Processes and Intergroup Relations*, 8, 109–124. DOI: 10.1177/1368430205051060.
Galinsky, A. D., Maddux, W. W., Gilin, D., & White, J. B. (2008). Why it Pays to Get Inside the Head of Your Opponent: The Differential Effects of Perspective Taking and Empathy in Negotiations. *Psychological Science*, 19(4), 378–384. DOI: 10.1111/j.1467-9280.2008.02096.x.
Galinsky, A. D. & Moskowitz, G. B. (2000). Perspective-Taking: Decreasing Stereotype Expression, Stereotype Accessibility, and In-Group Favoritism. *Journal of Personality and Social Psychology*, 78(4), 708–724. DOI: 10.1037//0022-3514.78.4.708.
Gehlbach, H., Brinkworth, M. E., & Wang, M.-T. (2012). The Social Perspective Taking Process: What Motivates Individuals to Take Another's Perspective? *Teachers College Record*, 114(1), 1–26.
Gentner, D. & Markman, A. B. (1994). Structural Alignment in Comparison: No Difference Without Similarity. *Psychological Science*, 5(3), 152–158.
Gerace, A., Day, A., Casey, S., & Mohr, P. (2013). An Exploratory Investigation of the Process of Perspective Taking in Interpersonal Situations. Journal of Relationships Research, 4, e6. DOI: 10.1017/jrr.2013.6
Goldstein, N. J. & Cialdini, R. B. (2007). The Spyglass Self: A Model of Vicarious Self-Perception. *Journal of Personality and Social Psychology*, 92(3), 402–417. DOI: 10.1037/0022-3514.92.3.402.
Hamilton, A. F. de C., Brindley, R., & Frith, U. (2009). Visual Perspective Taking Impairment in Children with Autistic Spectrum Disorder. Cognition, 113(1), 37–44.
Herzog, T. A. (1994). Automobile Driving as Seen by the Actor, the Active Observer, and the Passive Observer. *Journal of Applied Social Psychology*, 24(23), 2057–2074. DOI: 10.1111/j.1559-1816.1994.tb00574.x.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Heyes, C. (2014). Submentalizing: I am not really reading your mind. *Perspectives on Psychological Science*, 9(2), 131–143. DOI: 10.1177/1745691613518076.
Hoch, S. J. (1987). Perceived Consensus and Predictive Accuracy: The Pros and Cons of Projection. *Journal of Personality and Social Psychology*, 53(2), 221–234. DOI: 10.1037/0022-3514.53.2.221.
Hodges, S. D. (2005). Feature Matching in Social Comparisons. *The Self in Social Perception* (Eds. M. Alicke, D. Dunning, & J. Krueger). Philadelphia, PA: Psychology Press, 131–153.
Hodges, S. D., Clark, B., & Myers, M. W. (2011). Better Living Through Perspective Taking. *Positive Psychology as a Mechanism for Social Change* (Ed. R. Biswas-Diener). Dordrecht: Springer Press, 193–218.
Hodges, S. D., Denning, K. R., & Lieber, S. (2018). Perspective Taking: Motivation and Impediment to Shared Reality. *Current Opinion in Psychology*, 23, 104–108. DOI: 10.1016/j.copsyc.2018.02.007.
Hodges, S. D., Kiel, K. J., Kramer, A. D. I., Veach, D., & Villanueva, R. B. (2010). Giving Birth to Empathy: The Effects of Similar Experience on Empathic Accuracy, Empathic Concern, and Perceived Empathy. *Personality and Social Psychology Bulletin*, 36(3), 398–409. DOI: 10.1177/0146167209350326.
Hodges, S. D., & Wegner, D. M. (1997). Automatic and Controlled Empathy. *Empathic Accuracy* (Ed. W. J. Ickes). New York, NY: Guilford, 311–339.
Keysar, B., Barr, D. J., & Horton, W. S. (1998). The Egocentric Basis of Language Use: Insights from a Processing Approach. *Current Directions in Psychological Science*, 7(2), 46–50.
Kennedy, K. A. & Pronin E. (2008). When Disagreement Gets Ugly: Perceptions of Bias and the Escalation of Conflict. *Personality and Social Psychology Bulletin*, 34(6), 833–848. DOI: 10.1177/0146167208315158.
Krueger, J. (1998). On the Perception of Social Consensus. *Advances in Experimental Social Psychology* (Ed. M. P. Zanna). San Diego, CA: Academic Press, 163–240.
Ku, G., Wang, C. S., & Galinsky, A. D. (2015). The Promise and Perversity of Perspective-Taking in Organizations. *Research in Organizational Behavior*, 35, 79–102. DOI: 10.1016/j.riob.2015.07.003.
Laurent, S. M. & Myers, M. W. (2011). I Know You're Me, but Who am I? Perspective Taking and Seeing the Other in the Self. *Journal of Experimental Social Psychology*, 47(6), 1316–1319. DOI: 10.1016/j.jesp.2011.05.018.
Ledford, H., Reardon, S., Rodriguez Mega, E., Tollefson, J., & Witze, A. (2019). Trump Seeks Big Cuts to Science Funding — Again. *Nature*, March 11, 2019. https://www.nature.com/articles/d41586-019-00719-4.
Lewis, K. L., Hodges, S. D., Laurent, S. M., Srivastava, S., & Biancarosa, G. (2012). Reading Between the Minds: The Use of Stereotypes in Empathic Accuracy. *Psychological Science*, 23(9), 1040–1046. DOI: 10.1177/0956797612439719.
Lin, S., Keysar, B. & Epley, N. (2010). Reflexively Mindblind: Using Theory of Mind to Interpret Behavior Requires Effortful Attention. *Journal of Experimental Social Psychology*, 46(3), 551–556. DOI: 10.1016/j.jesp.2009.12.019.
Loftus, E. F. & Palmer, J. C. (1974). Reconstruction of Automobile Destruction: An Example of the Interaction Between Language and Memory. *Journal of Verbal Learning and Verbal Behavior*, 13(5), 585–589.
Logan, G. D. (1988). Toward an Instance Theory of Automatization. *Psychological Review*, 95(4), 492–527.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Lucas, B. J., Galinsky, A. D., & Murnighan, K. J. (2016). An Intention-Based Account of Perspective-Taking: Why Perspective-Taking Can Both Decrease and Increase Moral Condemnation. *Personality and Social Psychology Bulletin*, 42(11), 1480–1489. DOI: 10.1177/0146167216664057.

Maner, J. K., Luce, C. L., Neuberg, S. L., Cialdini, R. B., Brown, S., & Sagarin, B. J. (2002). The Effects of Perspective Taking on Motivations for Helping: Still No Evidence for Altruism. *Personality and Social Psychology Bulletin*, 28(11), 1601–1610. DOI: 10.1177/014616702237586.

McAuliffe, W. H. B., Forster, D. E., Philippe, J., & McCullough, M. E. (2018). Digital Altruists: Resolving Key Questions about the Empathy–Altruism Hypothesis in an Internet Sample. *Emotion*, 18(4), 493–506. DOI: 10.1037/emo0000375.

McPhetres, J. & Pennycook, G. (2019). Science Beliefs, Political Ideology, and Cognitive Sophistication. November 19, 2019. DOI: 10.31219/osf.io/ad9v7.

Moll, H. & Tomasello, M. (2006). Level I Perspective-Taking at 24 Months of Age. *British Journal of Developmental Psychology*, 24(3), 603–613. DOI: 10.1348/026151005X55370.

Mooijman, M., & Stern, C. (2016). When Perspective Taking Creates a Motivational Threat: The Case of Conservatism, Same-Sex Sexual Behavior, and Anti-Gay Attitudes. *Personality and Social Psychology Bulletin*, 42(6), 738–754. DOI: 10.1177/0146167216636633.

Motyl, M., Iyer, R., Oishi, S., Trawalter, S., & Nosek, B. A. (2014). How Ideological Migration Geographically Segregates Groups. *Journal of Experimental Social Psychology*, 51(1), 1–14. DOI: 10.31234/osf.io/25myb.

Myers, M. W. & Hodges, S. D. (2012). The Structure of Self-Other Overlap and its Relationship to Perspective Taking. *Personal Relationships*, 19(4), 663–679. DOI: 10.1111/j.1475-6811.2011.01382.x.

Myers, M. W., Laurent, S. M., & Hodges, S. D. (2014). Perspective Taking Instructions and Self-Other Overlap: Different Motives for Helping. *Motivation and Emotion*, 38(2), 224–234. DOI: 10.1007/s11031-013-9377-y.

Nario-Redmond, M. R., Gospodinov, D., & Cobb, A. (2017). Crip for a Day: The Unintended Negative Consequences of Disability Simulations. *Rehabilitation Psychology*, 62(3), 324–333. DOI: 10.1037/rep0000127.

Neal, Z. P. (2020). A Sign of the Times? Weak and Strong Polarization in the U. S. Congress, 1973–2016. *Social Networks*, 60, 103–112. DOI: 10.1016/j.socnet.2018.07.007.

Okimoto, T. G. & Wenzel, M. (2011). The Other Side of Perspective Taking: Transgression Ambiguity and Victims' Revenge Against Their Offender. *Social Psychological and Personality Science*, 2(4), 373–378. DOI: 10.1177/1948550610393032.

Opioid Overdose Crisis (2020). *National Institute on Drug Abuse*, May 27, 2020. https://www.drugabuse.gov/drugs-abuse/opioids/opioid-overdose-crisis.

Pierce, J. R., Kilduff, G. J., Galinsky, A. D., & Sivanathan, N. (2013). From Glue to Gasoline: How Competition Turns Perspective Takers Unethical. *Psychological Science*, 24(10), 1986–1994. DOI: 10.1177/0956797613482144.

Proffitt, D. R., Bhalla, M., Gossweiler, R., & Midgett, J. (1995). Perceiving Geographical Slant. *Psychonomic Bulletin and Review*, 2(10), 409–428. DOI: 10.3758/BF03210980.

Qureshi, A. W., Apperly, I. A., & Samson, A. (2010). Executive Function is Necessary for Perspective Selection, not Level-1 Visual Perspective Calculation: Evidence from a Dual-Task Study of Adults. *Cognition*, 117(2), 230–236. DOI: 10.1016/j.cognition.2010.08.003.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Sabbagh, M. A. & Taylor, M. (2000). Neural Correlates of the Theory-of-Mind Reasoning: An Event-Related Potential Study. *Psychological Science*, 11(1), 46–50. DOI: 10.1111/1467-9280.00213.
Samson, D., Apperly, I.A., Braithwaite, J. J., Andrews, B. J., & Bodley Scott, S. E. (2010). Seeing it Their Way: Evidence for Rapid and Involuntary Computation of What Other People See. *Journal of Experimental Psychology: Human Perception and Performance*, 36(5), 1255–1266. DOI: 10.1037/a0018729.
Santiesteban, I., Catmur, C., Hopkins, S. C., Bird, G., & Heyes, C. (2014). Avatars and Arrows: Implicit Mentalizing or Domain-General Processing? *Journal of Experimental Psychology: Human Perception and Performance*, 40(3), 929–937. DOI: 10.1037/a0035175.
Santiesteban, I., Kaur, S., Bird, G., & Catmur, C. (2017). Attentional Processes, Not Implicit Mentalizing, Mediate Performance in a Perspective-Taking Task: Evidence from Stimulation of the Temporoparietal Junction. *NeuroImage*, 155, 305–311. DOI: 10.1016/j.neuroimage.2017.04.055.
Sassenrath, C., Hodges, S. D., & Pfattheicher, S. (2016). It's All About the Self: When Perspective Taking Backfires. *Current Directions in Psychological Science*, 25(6), 405–410. DOI: 10.1177/0963721416659253.
Scherer, A. M., Windschitl, P. D., & Graham, J. (2015). An Ideological House of Mirrors: Political Stereotypes as Exaggerations of Motivated Social Cognition Differences. *Social Psychological and Personality Science*, 6(2), 201–209. DOI: 10.1177/1948550614549385.
Schroeder, J. & Epley, N. (2016). Mistaking Minds and Machines: How Speech Affects Dehumanization and Anthropomorphism. *Journal of Experimental Psychology: General*, 145(11), 1427–1437. DOI: 10.1037/xge0000214.
Schroeder, J., Kardas, M., & Epley, N. (2017). The Humanizing Voice: Speech Reveals, and Text Conceals, a More Thoughtful Mind in the Midst of Disagreement. *Psychological Science*, 28(12), 1745–1762. DOI: 10.1177/0956797617713798.
Scientific Consensus: Earth's Climate is Warming (2019). *NASA*. https://climate.nasa.gov/scientific-consensus/.
Shaw, L. L., Batson, C. D., & Todd, M. R. (1994). Empathy Avoidance: Forestalling Feeling for Another in Order to Escape the Motivational Consequences. *Journal of Personality and Social Psychology*, 67(5), 879–887.
Shiffrin, R. M. & Schneider, W. (1984). Automatic and Controlled Processing Revisited. *Psychological Review*, 91(2), 269–276.
Silverman, A. M., Gwinn, J. D., & Van Boven, L. (2015). Stumbling in their Shoes: Disability Simulations Reduce Judged Capabilities of Disabled People. *Social Psychological and Personality Science*, 6(4), 464–471. DOI: 10.1177/1948550614559650.
Skorinko, J. L. & Sinclair, S. A. (2013). Perspective Taking Can Increase Stereotyping: The Role of Apparent Stereotype Confirmation. *Journal of Experimental Social Psychology*, 49(1), 10–18. DOI: 10.1016/j.jesp.2012.07.009.
Surtees, A., Apperly, I., & Samson, D. (2013). The Use of Embodied Self-Rotation for Visual and Spatial Perspective-Taking. *Frontiers in Human Neuroscience*, 7(5), 1–12. DOI: 10.3389/fnhum.2013.00698.
Surtees, A., Apperly, I., & Samson, D. (2016). I've Got Your Number: Spontaneous Perspective-Taking in an Interactive Task. *Cognition*, 150, 43–52. DOI: 10.1016/j.cognition.2016.01.014.
Talwar, V. & Lee, K. (2008). Social and Cognitive Correlates of Children's Lying Behavior. Child Development, 79(4), 866-881.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Tarrant, M., Calitri, R., & Weston, D. (2012). Social Identification Structures the Effects of Perspective Taking. *Psychological Science*, 23(9), 973–978. DOI: 10.1177/0956797612441221.
Tavris, C. & Aronson, E. (2007). *Cognitive Dissonance: The Engine of Self-Justification. Mistakes Were Made (But Not by Me*). Orlando, FL: Harcourt, 361–380.
Taylor, M., Hodges, S. D., & Kohanyi, A. (2003). The Illusion of Independent Agency: Do Adult Fiction Writers Experience Their Characters as Having Minds of Their Own? *Imagination, Cognition and Personality*, 22(4), 361–380. DOI: 10.2190/FTG3-Q9T0-7U26-5Q5X.
Todd., A. R. & Burgmer, P. (2013). Perspective Taking and Automatic Intergroup Evaluation Change: Testing an Associative Self-Anchoring Account. *Journal of Personality and Social Psychology*, 104(5), 786–802. DOI: 10.1037/a0031999.
Todd, A. R., Cameron, C. D., & Simpson, A. J. (2017). Dissociating Processes Underlying Level-1 Visual Perspective Taking in Adults. *Cognition*, 159, 97–101. DOI: 10.1016/j.cognition.2016.11.010.
Todd, A. R., Forstmann, M., Burgmer, P., Wood Brooks, A., & Galinsky, A. D. (2015). Anxious and Egocentric: How Specific Emotions Influence Perspective Taking. *Journal of Experimental Psychology*, 144(2), 374–391. DOI: 10.1037/xge0000048.
Tversky, A. & Kahneman, D. (1974). Judgment Under Uncertainty: Heuristics and Biases. *Science*, 185(4157), 1124–1130.
Van Boven, L., Ehret, P. J., & Sherman, D. K. (2018). Psychological Barriers to Bipartisan Public Support for Climate Policy. *Perspectives on Psychological Science*, 13(4), 492–507. DOI: 10.1177/1745691617748966.
Van Boven, L. & Loewenstein, G. (2005). Empathy Gaps in Emotional Perspective Taking. *Other Minds: How Humans Bridge the Divide Between Self and Others* (Eds. B. F. Malle, & S. D. Hodges). New York, NY: Guilford Press, 284–297.
Van Boven, L., Loewenstein, G., Dunning, D., & Nordgren, L. F. (2013). Changing Places: A Dual Judgment Model of Empathy Gaps in Emotional Perspective Taking. *Advances in Experimental Social Psychology* (Eds. J. M. Olson, & M. P. Zanna). San Diego, CA: Elsevier Academic, 117–171.
Van Boven, L. & Sherman, D. (2018). Actually, Republicans Do Believe in Climate Change. *The New York Times*, July 28, 2018. https://www.nytimes.com/2018/07/28/opinion/sunday/republicans-climate-change.html.
van der Meer, L., Groenewold, N. A., Nolen, W. A., Pijnenborg, M., & Aleman, A. (2011). Inhibit Yourself and Understand the Other: Neural Basis of Distinct Processes Underlying Theory of Mind. *NeuroImage*, 56(4), 2364–2374. DOI: 10.1016/j.neuroimage.2011.03.053.
Verhofstadt, L. L., Buysse, A., Ickes, W., Davis, M., & Devoldre, I. (2008). Support Provision in Marriage: The Role of Emotional Similarity and Empathic Accuracy. *Emotion*, 8(6), 792–802. DOI: 10.1037/a0013976.
Vorauer, J. D., Martens, V., & Sasaki, S. J. (2009). When Trying to Understand Detracts from Trying to Behave: Effects of Perspective Taking in Intergroup Interaction. *Journal of Personality and Social Psychology*, 96(4), 811–827. DOI: 10.1037/a0013411.
Vorauer, J. D. & Sasaki, S. J. (2009). Helpful Only in the Abstract: Ironic Effects of Empathy in Intergroup Interaction. *Psychological Science*, 20(2), 191–197. DOI: 10.1111/j.1467-9280.2009.02265.x.
Vorauer, J. D. & Sasaki, S. J. (2014). Distinct Effects of Imagine-Other Versus Imagine-Self Perspective-Taking on Prejudice Reduction. *Social Cognition*, 32(2), 130–147. DOI: 10.1521/soco.2014.32.2.130.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Wallisch, P. (2017). Illumination Assumptions Account for Individual Differences in the Perceptual Interpretation of a Profoundly Ambiguous Stimulus in the Color Domain: 'The Dress'. *Journal of Vision*, 17(4), ID 5. DOI: 10.1167/17.4.5.

Weinstein, N. D. & Klein, W. (1995). Resistance of Personal Risk Perceptions to Debiasing Interventions. *Health Psychology*, 14(2), 132–140. DOI: 10.1037//0278-6133.14.2.132.

Wellman, H. M. (1990). *The Child's Theory of Mind*. Cambridge, MA: MIT Press.

Westfall, J., Van Boven, L., Chambers, J. R., & Judd, C. M. (2015). Perceiving Political Polarization in the United States: Party Identity Strength and Attitude Extremity Exacerbate the Perceived Partisan Divide. *Perspectives on Psychological Science*, 10(2), 145–158. DOI: 10.1177/1745691615569849.

Zhao, X., Cusimano, C., & Malle, B. F. (2015). In Search of Triggering Conditions for Spontaneous Visual Perspective Taking. *Proceedings of the 37th Annual Conference of the Cognitive Science Society*, 2811–2816.

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Markus Gottschling

Creating a Rhetorical Situation

Kevin Esvelt, Gene Drive and the Call for Open and Responsive Science

1 Introduction

In a letter to the science communication community from 2017 the scientists-cum-science communicators Joseph Roche and Nicola Davis lamented a recent development that, in their words, could signal "a sea change in the relationship between science and society" (Roche/Davis 2017). According to their analysis, science had increasingly come under criticism from (populist) politics as well as the public. Roche/Davis diagnosed poor communication to be one of the principal reasons why science was losing its status as the driving force of progress. They suggested overcoming this deficiency by giving scientists a more powerful part in public communication. Accordingly, they primed their letter to address a crucial question: "Should the science communication community play a role in political activism?" (Roche/Davis 2017)

In their letter, their answer to the question is a resounding "yes." However, looking at it from the viewpoint of a rhetorician, whether the question should be answered in the affirmative also depends on an adequate answer to a second, related question: *How* can science communicators engagingly and persuasively communicate scientific discourse – that is to say their own scientific issues, topics, and concerns – to the public as well as to politicians? Possible answers affect the core of the relationship between science and the public – and nowhere is this better observed than in genetic engineering.

Genetic engineering is a scientific field where research is advancing at an incredible pace with amazing scientific breakthroughs over the last 20 years, from the completion of the Human Genome Project in 2003, over the discovery and use of precise genetic engineering with the so-called CRISPR/Cas9 system (henceforth CRISPR) in early 2010 (cf. Lander 2015), and on to the application of CRISPR to create the first genetically engineered human babies in late 2018. The will to communicate such breakthroughs from the part of the scientific community is complemented by a "legitimation discourse" over the utility and usefulness of a

https://doi.org/10.1515/9783110676310-003

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scientific or technological discovery (Weingart 2005).[1] Scientific methods and processes – especially if they appear to be particularly complex, opaque, and unintelligible – have come under scrutiny from the public. Sometimes this is due to the fact that the interdisciplinary nature of today's science makes it hard to get a grasp on its methods – so that ultimately the public needs to trust what scientists are doing; and sometimes the reason for the public's scrutiny is a clear breach of the very same trust invested in science and scientists, a disregard for ethical, as well as scientific and even legal standards. A case in point is the political and public turmoil geneticist He Jiankui faced in 2019 after he used CRISPR to edit the genome of twin human babies.

By examining the communicational achievements of evolutionary engineer Kevin Esvelt, this chapter will examine how scientists use rhetorically focused science communication to influence public debates. Or, more precisely, how they try to create such debates as rhetorical situations. Specifically, the chapter will argue that Esvelt is using the re- and precontextualization of scientific discourse to improve the climate of public trust and to put science communication – and the legitimation discourse between science and the public as a whole – on new, radically transparent footing. To contextualize the analysis of his communicational acts, however, we will first take a closer look at how, why, and for what purpose science communication is carried out – and why rhetoric can help creating science communication that better caters to its audiences.

2 Challenges of Science Communication

There are central, interconnected tasks and challenges to the way scientists communicate their insights and their research to the public. That science is generally in need to be communicated to the public is not disputed anymore. However, the role of the communicator is in rapid and encompassing transformation. Historically, this task fell to the media which received information from the communication departments of research institutes and universities (cf. Weingart 2005), rarely entailing "more than a press release through their institution's public relations division, and possibly a follow-up interview with a journalist" (Liang et al. 2014).

However, at its heart, science faces a conundrum in its relationship with the public: according to Scheufele (2014), the very "nature of modern science" – its accelerated pace, steadily rising complexity and interdisciplinarity of research

1 Translations from German in this chapter are mine.

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fields, and even scientific methodology as such – makes science communication a challenging task. At the same time, while the reasons and ideological backgrounds for this development are manifold, the public seems to increasingly doubt scientific methods and insights (cf. Melo-Martin/Intemann 2018; Rutjens et al. 2018). Consequently, the successful communication of scientific insights is a necessary and complex act of mediation between the laboratory and the living room. Scientists along with science managers and policy makers seem to agree that there is a strong need for the "public acceptance of scientific research" (cf. Liang et al. 2014) and building public trust has become the main objective of science communication.

This insight has led to an evidence-based theory as well as more sophisticated practice of science communication (cf., for example, Jamieson et al. 2017; Leßmöllmann et al. 2019). Casting off the ignorance at the root of the so-called deficit model – according to which science communication should be concerned "with increasing levels of scientific understanding among various lay publics" (Scheufele 2014) – research on science communication has developed new models for better communication. The path of science communication is currently leading away from aiming at "Public Understanding of Science and Humanities" (PUSH) toward "Public Engagement with Science and Technology" (PEST) – and thus to a much stronger involvement of the public (cf. Broks 2017). However, as theory and practice of science communication have evolved, its old foundations have collapsed. Structural problems in the 'traditional' way science is communicated have begun to show and communication departments of scientific institutions have to deal with a "crumbling science-public-infrastructure" (Scheufele 2013). However, it is precisely this development that offers scientists themselves the opportunity to contribute to the public discourse as communicators.

What Bucher (2019) has described as processes of medialization of science broadened the scope of science communicators: enriching the communication through visualization, reaching new audiences through popularization, and transforming monologic into dialogic communication through digitalization. More and more scientists from all disciplines are embracing the role as communicators of the scientific discourses they partake in, especially on social media (cf. Collins et al. 2016; Geier/Gottschling 2019). As a consequence, the market for guidebooks to science communication flourishes (see, for example, Amsen 2018; 2020; Dean 2009; Olson 2009). Such advice can, of course, only be heuristic in nature and cannot guarantee successful communication in detail – but its very existence shows that scientists recognized the need for further training in the field of science communication. Still, only a fraction of scientists of all disciplines

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and levels actively engages in science communication. The reasons for this are threefold.

For one, fear of the "Sagan Effect" – named after the astrophysicist and extremely successful communicator of science – still looms. In 1991, Carl Sagan was purportedly denied access to the National Academy of Sciences because he was considered a brilliant popularizer of science, but nothing *more* (cf. Liang et al. 2014; Martinez-Conde 2016; Shugart/Racianello 2015). Although the reputation of scientists visible in the public sphere has improved somewhat over the last 30 years, "the perception that popular, visible scientists are worse academics than those scientists who do not engage in public discourse" (Martinez-Conde 2016) is still lingering, especially *within* the scientific community. Secondly, as Shugart/Racianello (2015) point out, institutional incentives are missing: "Public outreach activities are not counted toward the tenure decisions at many universities."[2] Nevertheless, thirdly, missing resources and a lack of encouragement by science managers may hinder science communication and outreach activities. Especially at graduate and postgraduate level, young scientists are being trained in communicating their insights within the scientific community first and foremost. However, as Scheufele (2013) remarks, "the very same conventions and skill sets that are invaluable" for peer-reviewed journals and funding proposals become "potential liabilities" in the public sphere.

Coincidentally, as Scheufele (2014) suggests, the "modern nature of science" makes it hard for the media and the public alike to truly understand what science is doing exactly. The emergence of extremely specialized and complex interdisciplinary fields triggers a series of problems such as "(i) the scientific complexity of emerging disciplinary fields of research, (ii) the pace of innovation in some of those fields, and (iii) the nature of public debates that accompany different applications" of such technologies. As a consequence, the former president of the German Research Foundation (DFG), Peter Strohschneider, observes a kind of cognitive aloofness in science when it comes to mediating between the hyperspecialized sciences and the public: "If you do mathematics in seven-dimensional spaces, how can you create a general closeness to what you are mathematically interested in as a problem?" (Korbmann 2017) Thus, it would be of crucial importance

2 Recently, there has been some, if small development here in Germany, at the institutional level. In 2019, Federal Minister of Education and Research Anja Karliczek has declared science communication to be an integral part of research funding: "This is intended to create incentives for researchers and research institutions and to make science communication an integral part of science." (BMBF 2019)

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that the interdisciplinary scientists who are spearheading research, could address the public in an engaging and reception-oriented manner.

For it is precisely these complex and converging fields that force scientists into the role of public actors. According to Scheufele (2014) the acceleration of scientific insights produces ethical, moral, legal, or political issues "at a rate that outstrips our capacity to think through and appropriately respond." Not only science as a field, but also each individual scientist is asked to face these challenges in consultation rounds, interviews, committees, and podcasts – or at least to support the democratic institutions in finding solutions. This is especially true for disciplines fraught with repercussions, such as genetic engineering. Here, communicating science equals debating the consequences of scientific developments. These discussions often are less about the scientific facts themselves and more about political decisions – and thereby they become inherently rhetorical.

When scientists participate in these debates, they act, or at least seem to act rhetorically as science advocates or political activists. Which confronts them with serious questions such as that put forward by Roche/Davis (2017): should they even play an active role in political activism? Is taking part in these discussions, debates, and decision-making processes still science communication and not political opinion-making? Is this form of science advocacy suitable for 'serious' scientists? As there are no general answers to these questions, an unsettledness has become visible in the field of science communication.

In their letter, Roche/Davis (2017) – along with other scientists – are arguing for more participation and political activism (see also, for example, Broks 2017; Nerlich/McLeod 2016). Entering the rhetorical arena of public communication by choice, but often rather tentatively and cautiously, and only rarely with an entertainer's self-confidence, scientists acting as science communicators must adapt to the different values, mindsets, and needs of their diverse audiences. By analyzing the communicational attempts of one of these scientists, this chapter will also trace what belongs to successful deliberative science communication. To understand what communicative measures evolutionary engineer Kevin Esvelt takes as a science communicator, a brief glance is needed at how to conceptualize and then analyze the communication of scientific discourse to a lay audience.

3 Recontextualizing Scientific Discourse

To foster interaction with the public, science communication is to rhetorically transform complex scientific discourses in such a way that the intended audience can not only understand them but can engage confidently with scientific discourse

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in processes of democratic decision making. These processes are inherently rhetorical and should, as such, be described through the concept of the “rhetorical situation” as conceptualized by Bitzer (1968). According to Bitzer, a rhetorical situation consists of “a complex of persons, events, objects, and relations presenting an actual or potential exigence which can be completely or partially removed” through discourse. Or, in short, a rhetorical situation is marked by an exigence, an audience, and constraints.

Within the paradigm of science communication, rhetorical situations in this sense especially occur when scientific findings lead to the need for political and social action. The rhetorical shift toward engaging the audience – from the transfer of facts to partaking in or even shaping debates and discussions – can be retraced especially well in topics like climate change (cf. Schäfer/Bonfadelli 2017). With this and other structurally related topics, the particular rhetorical exigence which Bitzer (1968) also described as “imperfection marked by urgency” is leading to the creation of a rhetorical situation that urges scientists and researchers into the political realm. Speaking out on such topics, they are acting as advocates for scientific discourse.

Science communication then must make sure that scientific discourse travels from one communicative situation – that of internal communication of scientific exchange – to another: public and political deliberation. A theoretical framework frequently used to describe this shift is that of the *popularization* of scientific discourse. However, as Liebert (2019) points out, the term “can be rather assigned to the deficit model” of science communication – implying an effortless way of communicating science by just making oneself understandable. This chapter, rather than relying on the term popularization, wants to conceptualize the successful communication of scientific knowledge in a rhetorical situation as the “recontextualization” of scientific discourse: a “dynamic transfer-and-transformation of something from one discourse [...] to another” (Linell 1998a) with communicative consequences not only for the audience but also for the communicators.

Linell states, that because “discourses and their contexts presuppose and imply each other” (Linell 1998b), the recontextualization of discourse does more than serving the purpose of tapping into the audiences’ background knowledge. Instead, recontextualization aims at activating the audiences’ concrete contextual resources, their passions and hobbies, their political beliefs and values, etc. Thus, as Calsamiglia/van Dijk (2004) point out, recontextualization means more than just reformulating discourse. Recontextualization, then, can be understood as a form of what Bell (1984) dubbed “audience design” and what has even previously been called “recipient design” (Sacks et al. 1974). According to Thieme (2010), audience design comprises “the stylistic features by which speakers

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design their utterances for particular audiences as well as design audiences by means of their utterances." So, when communicators use recontextualization to design or position their audiences, they try to "imagine and situate different audience constituents" in order to activate shared knowledge and values between them. Thus, the communicator and the audience need a common ground on which knowledge can be conveyed and exchanged (cf. Clark 1996). If the audience can link what the communicator explains to their own system of knowledge, understanding, and belief, communication has a chance of being effective. Or, as Clark/Brennan (1993) put it: "Grounding is essential to communication. Once we have formulated a message, we must do more than just send it off. We need to assure ourselves that it has been understood as we intended it to be."

Closer to the realm of science communication, to recontextualize also means more than just to explain. On the one hand, recontextualization is, according to Bauman/Briggs (1990) "an act of control" which never is neutral. As Oddo (2013) explains, the act of recontextualization "entails the power to appropriate a text, the ability to redefine it, and the authority to claim the recontextualization as legitimate." On the other hand, in order to successfully perform recontextualization as an act of control, speakers must adapt the discourse "to the appropriateness conditions" (Calsamiglia/van Dijk 2004) of the situation in which it is placed. This links recontextualization to Bitzer's (1968) three constituents of the rhetorical situation – exigence, audience, and constraints – as well as to Liebert's (2019) functional determinants of science popularization. The latter include actors, addressees, and knowledge needs as well as communicative goals such as entertainment, legitimacy, or beauty.

Focusing onto the specifics of science communication, recontextualization is related to what Hyland (2010) calls creating "proximity." The recontextualization of scientific discourse, according to Hyland, "offers different ways of understanding academic practices." Establishing proximity with the intended audience allows communicators to exercise control through "rhetorical features which display both authority as an expert and a personal position towards issues in an unfolding text" (Hyland 2010). Hyland identifies these features as textual organization and argument structures, the scientist's credibility and stance, as well as reader engagement. With conscious decisions for each of those features, Hyland argues, science communicators let the audience not only connect and engage with the topic, but also tell them something about themselves as well as their perspective on the audience. Consequently, the recontextualization of scientific discourse can be understood as positioning science as a communicative activity and involving the audience in the communication.

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Drawing on Hyland's proximity features, Luzón (2013) divides the rhetorical strategies for recontextualizing scientific discourse into two parts: firstly, strategies to tailor information, such as explanation, paraphrases, metaphors, examples form daily life or the use of visuals; and secondly, strategies to engage the audience, such as references to popular lore, self-disclosure, questions, or humor. Mattiello (2017) draws on Luzón to count the "adjustment of information to the readers' knowledge and information needs" and the "employment of linguistic features typical of personal, informal, and dialogic interaction" among the main categories of recontextualization. In addition, however, she elevates one of Luzón's sub-items to a main category: the "use of explicit and personal expressions of evaluation."

We will encounter all three of Mattiello's categories in the following analysis. However, based on the results of Calsamiglia/van Dijk, special attention will be paid to the use of metaphors in the process of recontextualizing discourse around genetic engineering. Their findings show a close connection between "structures of meaning and of knowledge in the discursive act of explanation" (Calsamiglia/van Dijk 2004). Categories such as *Localization*, *Composition*, *Size*, *Number*, *Appearance*, and *Functions* seem to be more than just semantic categories, but to belong to a "basic knowledge schema." Through recontextualization, these categories are metaphorized to be more accessible – working with an example from genetics themselves, Calsamiglia/van Dijk are able to show this accessibility for the conceptual metaphor "genome is a text" and its use in science journalism. We will come across this metaphor again when we now turn to Kevin Esvelt's recontextualization of the scientific discourse around CRISPR technology and gene drives.

4 Gene Drives on the Horizon

In the last few years, in the light of a revolutionary breakthrough in genome editing that is the discovery and subsequent development of CRISPR, we have been witnessing the emergence of another rhetorical situation in science discourse and science communication, which has already shown the potential to dominate or even alter the science-public-relation and the state of science communication even in its earliest stages of public discussion. The complex CRISPR method has become the central process of genetic engineering since its discovery and application in the early 2010s. In order to make it as easy as possible to understand, the following explanation by award-winning science journalist Michael Specter (2015) is used:

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> CRISPR has two components. The first is essentially a cellular scalpel that cuts DNA. The other consists of RNA, the molecule most often used to transmit biological information throughout the genome. It serves as a guide, leading the scalpel on a search past thousands of genes until it finds and fixes itself to the precise string of nucleotides it needs to cut [...]. With CRISPR, scientists can change, delete, and replace genes in any animal, including us.

With CRISPR, Specter (2015) writes, "scientists will be able to rewrite the fundamental code of life, with consequences for future generations that we may never be able to anticipate." For this very reason, CRISPR is particularly in need of public explanation via the means of recontextualization.

At the forefront of CRISPR research as well as its recontextualization in communication to the public is Kevin Esvelt. Esvelt is an assistant professor, head of the *Sculpting Evolution* research group and, by his own account, less of a geneticist than an "evolutionary engineer" – an ambitious role that fits the institution he is researching at: the Media Lab of the Massachusetts Institute for Technology (MIT), a science location that, in the words of its founder Nicholas Negroponte (1995), long considered itself a "salon des refusés," a band of outsider scientists. Accordingly, Esvelt's science agenda seems rather extraordinary: he is focused on how to change the environment through designing the evolution of specific organisms. His main achievement is to stabilize the CRISPR system in organisms with the help of a so-called gene drive – and thus facilitate genetic modification of entire populations. As this chapter wants to analyze Esvelt's efforts in science communication, it is perhaps best fitting to use his own words from his research group's website:

> In 2013, Esvelt was the first to identify the potential for CRISPR "gene drive" systems to alter wild populations of organisms. Recognizing the implications of an advance that could enable individual scientists to alter the shared environment, he and his colleagues chose to break with scientific tradition by revealing their findings and calling for open discussion and safeguards before they demonstrated the technology in the laboratory. (Esvelt 2020a)

For the will to communicate both, his discovery and transparency, Esvelt came into the focus of the media and the public: as a speaker at town hall meetings, TEDx conferences and other science communication events, as an expert in podcasts such as *Radiolab* or as the subject of a portrait in *The New Yorker* magazine, as well as other magazines and newspapers. In 2016, science journal *Nature* included him in the "10 People Who Mattered This Year" list (cf. Ledford 2016), and at the beginning of 2020, he was one of the "50 people who will shape the coming decade" (cf. Williams 2020) according to online magazine *Inverse*.

The following pages will mainly draw from three of his presentations, although I will offer some additional analysis from other texts by or about Esvelt.

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The three main examples are Esvelt's talk at the *TEDxCambridge* conference in June 2016,[3] his short talk at MIT's 30th anniversary celebration – titled *Mind, Magic and Mischief* – in 2015, and an interview he gave in the podcast Radiolab in 2017, which was published as part of the show entitled *Update: Crispr*. In order to describe how Esvelt recontextualizes the scientific discourse around CRISPR and gene drives, this article will trace how Esvelt creates proximity: how he tailors information, engages his audience as well as positions himself within scientific discourse.

Setting. First, one needs to consider the backdrop of the general communication situation, the setting of each of the three examples. At the recurring *TEDxCambridge* conference on June 6, 2016 at the Boston Opera House, Esvelt delivers one of a total of six lectures in front of 2500 guests. The other speakers included a neuroscientist, a chef, and a philosopher. Most of the topics presented at the conference over the years were of a scientific nature. The name of the conference refers to the universities Harvard and MIT; the audience can be assumed to be scientifically educated or at least interested. On stage, supported by a digital slide presentation, Esvelt (2016a) talks about whether and how "Openly Engineering Our Ecosystems" is possible and feasible. A topic he takes more than 22 minutes of his time for – and thus significantly exceeds the intended length of a TED talk.[4]

At the *Mind, Magic and Mischief* symposium on the occasion of MIT's thirtieth birthday, Esvelt's presentation is shorter, only 8 minutes long. Held at the Kresge Auditorium of MIT in front of an audience of about 1000 students, professors, and alumni, it is safe to assume that the audience was either academically trained or at least interested in science. The event, according to the official announcement "celebrated the Media Lab's roots as a *salon des refusés*, engaging a distinguished roster of speakers who presented on themes emblematic of the Lab history: creative, contrarian, and counterintuitive, with humanitarian, artistic, scientific, and social purposes." (Ito 2016) Within this setting, Esvelt then talks about the extent to which CRISPR and gene drives can give science an upgrade. In doing so, he refers to a talk by a previous speaker at the symposium, thusly linking.

3 In the words of the TED organization, "TEDx is a grassroots initiative, created in the spirit of TED's overall mission to research and discover 'ideas worth spreading.' TEDx brings the spirit of TED to local communities around the globe through TEDx events. […] These events are not controlled by TED, but event organizers agree to abide by our format, and are offered guidelines for curation, speaker coaching, event organizing and more." (TEDx Program 2020) To find out more about the characteristics of TED talks, see Martijn Wacker's chapter in this volume.

4 Despite an explicit statement to the contrary in the TEDx rules – "[a]ny talk exceeding 18 minutes […] may not be published to the TEDx YouTube Channel" (TEDx Rules 2020) – the video of Esvelt's talk can be found on the YouTube channel in question.

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The setting of a podcast, in turn, differs significantly from that of live presentations. And in the case of the science podcast *Radiolab*, also produced by WNYC Studios and broadcast as a radio show on NPR, this is particularly true. *Radiolab's* broadcasts deal mostly with scientific topics, merging elements of monologue lectures with classic dialogical interviews. It integrates elements of the reportage, field recordings, and other sound bites. Characteristic for the show are overlays of voices and fast edits, which can be disorienting but give the show speed and depth – and which are well received by the audience. After all, the format has been running for 18 years now.[5] In a February 2017 episode on CRISPR, hosts Jad Abumrad and Robert Krulwich, along with producer Molly Webster, interviewed Esvelt. While this interview takes up only a few minutes in the 50-minute show, some of Esvelt's statements are placed as snippets at the beginning of the show and thus carry particular weight. Why this part of Esvelt's interview is placed at the beginning of the show will be discussed later.

Structure and Argumentation. Looking at the structure and course of the argumentation in the analysis examples, it quickly becomes apparent that Esvelt's presentations at *TEDxCambridge* and MIT are structurally similar but vary in linguistic and metaphorical respects. With introductions and conclusions as a frame, Esvelt divides the main parts of the lectures into three larger sub-sections: first, he talks about the CRISPR method, its possibilities and its limitations; then he goes into his specific field of research, gene drive, and explains its mechanism and possibilities; in a final step, he takes an argumentative turn towards the status of science: Esvelt pleads for a transformation of the culture of science towards open and responsive science. While the argumentative structure of the lectures is similar, they differ in their emphasis: While Esvelt gives each part of the MIT lecture about the same amount of speaking time, in the *TEDxCambridge* lecture he spends more than twice as much time on the topics 'gene drive' as well as 'open and responsive science' as on CRISPR. When he has more speech time, one can cautiously conclude from these examples, he seems to focus on gene drive technology and the argumentative turn towards open and responsive science. This conclusion, of course, correlates with the arrangement of his arguments, since CRISPR is, as it were, the foundation of his argumentation at the beginning of the lecture's main part, and then the narrative tension is developed over the significance of gene drives to the culture of science.

5 The listener numbers and the exact audience of Radiolab cannot be represented with certainty, so this chapter refrains from doing so for the benefit of setting analysis. For more on *Radiolab* as science communication, see Thomas Susanka's contribution to this volume.

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In the case of the *Radiolab* podcast, the structure is naturally different since it is not Kevin Esvelt but the makers of the program who have dramaturgical control. What is more: they use these excerpts from Esvelt's interview as a teaser at the beginning of the program. With that, they carry out an argumentative shift from the possibilities of gene drives to the consequences of research for the public. The podcast ends with Esvelt's interview segment, giving it the greatest argumentative weight. Here too, through interviews with other scientists, the description of the possibilities of CRISPR and gene drive technology are offered first, before Esvelt adds a layer that addresses another level of the topic. How he addresses this other level – and why he does so – can be complemented by an analysis of Esvelt's use metaphors and audience design.

Metaphors. The recontextualization of the scientific discourse around genetic engineering has frequently become the subject of scientific analysis (cf. the already discussed Calsamiglia/van Dijk 2004); in recent years, the metaphors used by science communication have come to the fore, particularly in the case of CRISPR. In a study focusing on how such metaphors are used, O'Keefe and colleagues argued that CRISPR-communication to the public should focus on three points: "(1) the ethical complexity of the technology; (2) an accurate description of the technology, how it works, and how it can be used; and (3) what is known and unknown about its potential consequences" (O'Keefe et al. 2015). The authors conclude that the metaphors that are used about CRISPR belong to the field of "editing." These metaphors are of course only a variation of the "genome is a text" metaphors (Calsamiglia/van Dijk 2004), and, as O'Keefe and Colleagues point out, they lack the third of their criteria in particular. Consequently, the authors suggest that the "limitations of these metaphors", if left unchanged and uncommented, "will have a ripple effect across the public, political, and scientific commons and the decisions made within them." Here the public, political, and scientific-cultural dimension of science communication discussed above becomes visible. It will also play a central role in Esvelt's recontextualizations.

O'Keefe et al. are in any case correct regarding the frequency of "editing" metaphors in popular science explanations of CRISPR. For example, this present article has integrated such metaphors by citing Michael Specter's explanation above. To recall: CRISPR, according to Specter (2015), is used to "change, delete, and replace genes." Against this backdrop, it is not surprising that Kevin Esvelt makes extensive use of metaphors from the nexus of "editing": at *TEDx*, for example, he talks about how CRISPR can be used to write. "If biology is written in the language of DNA – and it is –, CRISPR is our pencil" (Esvelt 2016a). A gene drive, with which it is possible to firmly anchor the CRISPR system in the cell and

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thus also to implement genetic changes in subsequent generations, is explained by Esvelt using the metaphor of a pencil to write, erase and rewrite.

> Introduced into the cell, [would be] not just your edited DNA sequence but also the instructions for making and using the pencil. So CRISPR will erase the original sequence and write in the new one, plus the instructions for making and using the pencil. Once one copy goes in, it will produce the pencil and use it to erase the other copy of the original version and write in the new one. So now the organism has two copies. (Esvelt 2016a)

In the MIT talk, given about half a year before *TEDxCambridge*, Esvelt omits the specific image of the pencil and symbolizes CRISPR editing through the metaphor of a copied cassette:

> They would have the CRISPR-system which would be programmed to again cut the wild version of the gene and copy the cassette over again. So, all of those offspring would inherit it. And editing would happen again going from one to two copies in every generation down through the generations until all of the population has been edited. (Esvelt 2015, 4:21)

Also, in the *Radiolab* interview, Esvelt uses the "editing" metaphor as a basis to explain how gene drives work, this time illustrated not by a pencil but by scissors:

> Instead of just snip the DNA and insert the gene that we want, we also insert the genes that encode the CRISPR system and tell it to make that particular change. […] In the offspring without any human assistance, CRISPR will cut the original version and copy over the change. That gene does the work that I used to do in the lab, on its own inside the baby. […] Like I set it on autopilot. (Abumrad/Krulwich 2017)

However, in the case of gene drives, he complements the image of editing with that of the autopilot – and thus manages to give the automation of the gene drive procedure an amazingly consequential focus: "This is something that spreads indefinitely." (Abumrad/Krulwich 2017) Accordingly, the connotations here are suddenly no longer exclusively positive; in the podcast the following reaction from producer Molly Webster can be heard a short time later:

> I just think that sounds terrifying. Honestly, I just keep thinking of it's like, oh, we've just hit over a domino and then walked away and aren't watching where the rest of them are falling. (Abumrad/Krulwich 2017)

This question is more cue than problem for Esvelt. He uses his answer to shift the argument, again, towards the possible consequences of gene drive research: "I'm very glad you think that way. It took me one full day to reach that point." And here, after more than two-thirds of the podcast, the same passage that was already played to the listeners at the beginning comes up again:

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> Kevin Esvelt: I'm very glad you think that way. It took me one full day to reach that point. Initially I was elated. Let me tell you, there is nothing like the sheer elation of discovery. And I think, this is the end of malaria, this is the end of everything else mosquitoes spread. Wait a minute, tick spread Lyme disease, we can probably get rid of that too. I thought.
> Robert Krulwich: So in the morning, you're like, woo hoo.
> Molly Webster: You're singing to the turtles in the park.
> Kevin Esvelt: Pretty much. I give myself a full day of being [woo hoo]. And then I started thinking, but, but, but, but what if something goes wrong? (Abumrad/Krulwich 2017)

Esvelt here contrasts scientific progress, the "sheer elation of discovery" with a clear "but" repeated several times. The consequences, which according to O'Keefe and colleagues do not belong to the usual metaphors for CRISPR communication, are contrasted by Esvelt in the *Radiolab* podcast by means of the autopilot metaphor and the repeated objection by the "but" to the editing.

Also, in the TEDx presentation, Esvelt asks the same rhetorical question to the audience: "What if something goes wrong?" (Esvelt 2016a) The question about possible consequences brings out the ambivalence of using CRISPR and gene drive. In Esvelt's words, "a pencil is a pencil" and possible mistakes can be corrected by CRISPR combined with a gene drive. But Esvelt emphasizes the casual character of such an application by repeatedly using the verb "tinker": All too careless tinkering, Esvelt says, can lead to serious consequences, the ecological risks are quite real. And with that, Esvelt combines his explanations with his audience design to fully recontextualize CRISPR and gene drive technology for the audience.

Audience Design. At *TEDxCambridge*, against the visual background of a picture of the earth taken from space, Esvelt begins his lecture with the story of a slowly sinking world ship whose ecology seems almost irreparably damaged. As a contrast, he asks his audience to "imagine a world" (Esvelt 2016a) in which these problems are solved. But of course Esvelt is not a dreamer à la John Lennon, but a scientist, so it's not just a matter of imagination – these dreams actually could come true with CRISPR and gene drive: "Overall, gene drive is a way to solve ecological problems using biology not bulldozers." The mood of his talk is tailored to the setting of TED and its audience, as TED conveys a passionate belief "in the power of ideas to change attitudes, lives and ultimately the world." (About: Our Organization 2020) Accordingly, Esvelt's use of pathos and storytelling is exactly what an audience would expect from *TED* – he shows his mastery of what in rhetoric theory is called *aptum* (appropriateness). Accordingly, at Media Lab's 30th anniversary, he adapts to the situation. To match the event's theme of "Mind, Magic and Mischief," he links CRISPR to a magic trick and explains gene drive with an analogy to open source software. In the *Radiolab* podcast, his grasp of aptum is demonstrated through the story of his personal eureka moment,

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which is told with the intention to bring him closer to the audience: As he tells the hosts, the idea to develop gene drives came to him during a walk in Boston's Emerald Necklace Park.

In his presentations Esvelt also tries to work with those examples from his research area that are probably best known to the audience from their own experience: The first example he uses to explain the advantages of gene drives is malaria – and thus, compared to other diseases such as Zika or Chikungunya, the illness that is most accessible to the knowledge and imagination of the audience. After all, malaria is the most common infectious disease in the world, affecting around 200 million people every year. The fact that in his explanation he later switches to Lyme disease is due both to his research subject and to local factors: For he explicitly evokes a very specific image – children infected with Lyme disease – that promises to be highly effective for his argument, especially in his lectures in Boston:

> Well here in New England, the iconic image of American childhood – that of kids running freely through the woods – is increasingly threatened by the prevalence of Lyme disease and other tick-borne pathogens. If you could invent the technology to prevent tick-borne disease and let the kids run free again, would you do it? (Esvelt 2016a)

Contrary to first appearances, this is not a rhetorical question. It involves the audience: not necessarily in Esvelt's research process, but in the scientific and political decision-making processes that accompany this research. For the question is embedded in two inquiries that concretely activate the audience. Right before the quoted passage, he asks for a show of hands to find out who has already been bitten by ticks, and then he asks the audience again how they answer to his question about the technology that can prevent tick-borne disease. Both times, his reaction suggests, most of the hands go up. Esvelt frequently uses such questions and surveys, especially at *TEDx*, thus linking the rhetorically appropriate addressing of the audience with a central question of his research: How can research work on such a sensitive technology as gene drives, what is allowed for science, what is not? The questions that he asks the audience in his lectures are the same questions that he had to ask the public for his research.

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5 From Recontextualization to Precontextualization

Since 2016, Esvelt and other researchers have been working on a pilot project to genetically modify the wild mouse population on islands such as Nantucket and Martha's Vineyard to eradicate Lyme disease in limited, easily controlled environments. Long before a gene drive vaccine was ready, Esvelt attended town hall meetings on both islands to set an example for a *different* way of doing science. "He set up a governance plans [sic] for the residents to oversee the project, should they decide to let it go ahead. He explained his strategy, asked for opinions, and – crucially – listened to the responses." This is how the journalist Ed Yong describes Esvelt's approach in a portrait for *The Atlantic* (Yong 2017) – one of several articles published by renowned newspapers and magazines that reported on Esvelt and his evidently quite unusual strategy (see, for example, Ducharme 2016; Grolle 2016; Harmon 2016; Specter 2017; Zimmer 2017).

Ultimately, Esvelt wants to be able to do research on CRISPR and gene drives. His approach, however, is not only to conduct studies and collect funding; instead he recognizes the need to conduct science – in his own field of evolutionary engineering, but also beyond it – more openly in order to be able to persuasively influence political decisions. The recontextualization of CRISPR research, the establishment of proximity and connectivity thus serves a rhetorical purpose: the establishment of a discussion about benefits and risks, *a priori* of possible research consequences.

It is evident in all his public appearances that Esvelt also wants to take the time to discuss such possible consequences of his own research. His big objection – "but, but, but, but what if something goes wrong?" – already was addressed above in relation to the *Radiolab* podcast. At *TEDx*, he explores such objection in greater length:

> And right now, there is nothing stopping me or any other scientist from building any gene drive system that we want. Imagine a well-meaning scientist who wants to solve an ecological problem. They want to spur on the ecologist to run those tests to make sure that it's a good idea, so they build a gene drive system in the laboratory. They're confident that it it's a good idea. We'd certainly find out if any of their gene drive organisms escaped into the wild. It only takes one. Oops, they might say. Terribly sorry, I didn't mean to unleash a technology that could ultimately impact the lives of billions of people. I mean, I know our ancestors fought and died for the right to self-governance, but it was an honest mistake. You'd forgive them, I'm sure. You're compassionate, remember? You wouldn't let a single mistake by a single scientist seriously damage your trust in science, and it certainly won't prompt

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> you or anyone else to impose harsh restrictions on what scientists can do, would it? Because we're trying to fix the sinking world ship here, right? (Esvelt 2016a)

With a strong pinch of irony, Esvelt sweetens the bitter truth for the audience: there are no guardrails, no regulations, no stop rules for gene drive research. The consequences that Esvelt foresees are that if something goes wrong, it would not only have potentially catastrophic ecological consequences. Public confidence would be permanently damaged; it would unleash public debates and political discussions about how far research should go. The rules that would then be imposed, Esvelt says, would be stricter than anything research is currently imposing on itself. With the case of the babies genetically modified by He Jiankui this vision of the future has in part already become reality. He's case has led to exactly those political discussions, social debates, and scientific regulations that Esvelt outlined (cf. Dickenson/Darnovsky 2019).

However, Esvelt does not consider individual researchers to be the culprits, but rather the entire scientific culture. Science has been communicating in the same way for about 200 years, by publishing in journals, he complains in his talk at MIT: "That is to say despite the tremendous advantages in communication technologies that we have now; despite the fact that science would be much more efficient and reliable if done more like open source software, we don't do it that way." And even though he is aware that this is difficult – "it's hard to change systems and it's even harder to change cultures", Esvelt (2015) remarks – he wants to change this for his own peer group. As he tells Specter (2017): "in the laboratory we don't even tell each other what we're doing. There is very little openness. That is going to have to change."

Esvelt wants to be the driving force for a fundamental structural change, an advocate for building trust, reaching out toward the public as well as within the scientific community. Thus, he demands to communicate and research gene drive in the most open and transparent way possible. As he writes on the website of his research group, for him "gene drive research is an ideal test case" for an open and responsive science, and it "offers a way out" of the prisoner's dilemma that current research – at least from his point of view – poses:

> Conducting gene drive experiments behind closed doors risks affecting the shared environment and the lives of others without their knowledge or consent. It denies other scientists and interested citizens the opportunity to voice suggestions or concerns that could improve safety and accelerate progress. (Esvelt 2020b)

There have been numerous initiatives to open the sciences, create transparency, and open access – especially with the shift in EU funding to so-called Responsible Research and Innovation (RRI) initiatives (cf. Broks 2017). With these demands,

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Esvelt nevertheless finds himself in an outsider position – or at least he considers himself to be in one. Accordingly, in the *TEDx* talk (cf. Esvelt 2016a) he suggests that he has been "professionally punished" for disclosing his own research results – and so it seems only understandable that he is pursuing the *refusé's* path of promoting science communication through lectures, interviews, as well as political and not least media influence.

However, his external science communication complements communication efforts aimed at his peers using the traditional channels of scientific discourse. For example, Esvelt has published letters and op-eds in the major journals *Nature* and *Science*, in which he advocates for more confidence-building measures for the public.

> Openness and collective oversight would reduce the risk of an accident involving gene drive, and may mitigate the backlash from such a disaster, while accelerating – not impeding – discovery. Journals, funders, policy-makers, and holders of intellectual property should work to ensure that all gene drive research is open from the proposal stage onward. (Esvelt 2017)

With these op-eds and letters (see also Esvelt 2016b; Esvelt 2016c), it becomes even clearer that Esvelt's communication is directed at deliberating future events – right at this moment. Whereas with the public, in order to make it understood how his research works, he saw the need to recontextualize the scientific discourse in establishing two possible future outcomes – saving the world vs. regulating science – Esvelt deploys what Oddo (2013) calls "precontextualization." Oddo bases his understanding of precontextualization on a notion of recontextualization in that it is rhetorical in a very political and power-related sense. If this act of control is aimed at a future event, it becomes precontextualization.

> Precontextualization occurs any time a text introduces or predicts elements of a semiotic event which is yet to unfold. However, precontextualization not only entails describing future discourse. It also entails providing a context for that discourse, and requires that speakers position an upcoming rhetorical event within and among other semiotic representations of the present, past, and future. (Oddo 2013)

So, through precontextualization, the future becomes the groundwork for an argumentation in the present; it is used to establish the plausibility of current actions regarding future events – and thus to establish the latter as persuasive frameworks for today's discourse. According to Oddo, "speakers may shift from epistemically modalized representations of what will happen at some distant future moment to deontically modalized exhortations of what must happen now." (Oddo 2013) And this is exactly what Esvelt is doing: in shifting his argument from

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the recontextualization of CRISPR and gene drive research to its precontextualization, he is issuing a call for action.

For as soon as gene drives were released into the wild – whether by an unfortunate mistake or as a fraudulent research measure – a major public and political debate about the social or ecological consequences would be inevitable. This would create a rhetorical situation in which the urgent problem would be how to deal with transgression through research. In order to prevent this rhetorical situation, Esvelt establishes a horror scenario which would, at least from today's perspective, probably entail to restrict the freedom of research drastically. Then, in another twist, he contrasts this horror scenario with another option: open and responsive science as a research utopia. By precontextualizing both scenarios, Esvelt tries to channel a future debate about results toward creating a current debate about research itself and thereby prevent that "something will go wrong" in the first place.

From the viewpoint of rhetorical theory, this approach is, of course, not comprehensible with Bitzer's understanding of the rhetorical situation. Bitzer conceptualized rhetorical situations as discursive events that emerge when the time is right. For this reason, reference should be made here to Richard E. Vatz's understanding of rhetorical situations, which precisely fits Esvelt's actions. Vatz understands rhetoric more as "creation of reality or salience rather than a reflector of reality" (Vatz 1973); accordingly, rhetorical situations arise when rhetors successfully create salience of a topic within an audience. And this is exactly what Esvelt tries to do: he fears the outcome of a future rhetorical situation, so by precontextualizing that future situation, he tries to create another rhetorical situation in the present, which has a different outcome. In order to prevent harsh restrictions on gene drive research in the future, he tries to create salience for a discussion about communication within science, about public trust, and about safeguarding principles in research. In this alternative rhetorical situation, politicians, scientists, stakeholders, and the public should exchange opinions and arguments, even before research has yielded any insights.

6 Conclusion

From the perspective of rhetorical theory applied to science communication, Kevin Esvelt's approach is promising. Yet, one question remains: How successful is his communicational work? How successful are recontextualization and precontextualization? To what extent does he actually manage to create a rhetorical situation? The answer is ambivalent. On the one hand, his approach has met a

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great deal of interest, especially among the 'traditional' media – as the science of science communication also noted (cf. Brossard et al. 2019). Regarding Esvelt's intervention against a gene drive field trial in New Zealand, Brossard and colleagues note that Esvelt's approach sometimes leads to the fact that only his own, occasionally too narrow view is represented in the media – and that other scientists are not heard. He has understood the logic of media and is using it for his own agenda. It is precisely the call for open and responsive science, the example of transparency, that seems to make his research particularly newsworthy – as Esvelt readily admits: "We got New York Times coverage on a project on which no one has even touched a pipette yet [...]. To some extent, that's a reflection of the fact that I don't think people usually do this." (Ducharme 2016) However, the criticism voiced by Brossard and colleagues also indicates that Esvelt's project, which included the creation of an online community for the exchange of open research, has not necessarily been successful so far. The online platform appears to be quite inanimate, and apart from older results of his own research group, nothing is to be found there. Similarly, his New England islands project yielded mixed results. The citizens of Nantucket and Martha's Vineyard, according to Brossard and colleagues (2019) "said no to gene drive (but might ultimately say yes to more conventional genetic engineering that does not automatically spread throughout an entire population)."

If one tries to generalize Esvelt's communication measures regarding the connection between science communication and rhetoric, science communication can – and for that matter, should – not only be used to introduce scientific discourses to solve pre-existing rhetorical situations. Rather, science communication can also be used to create rhetorical situations in the first place. When scientific institutions as well as individuals acting from within science address the public, they are not only interested in passing on facts, but also in participating in public discourse. Therefore, as deliberative instances, they should also have a rhetorical effect. The analysis of Kevin Esvelt's re- and precontextualizations of CRISPR and gene drive research demonstrates one way of how such influence can work. CRISPR and gene drives in particular can contribute to a paradigm shift that allows scientists and scientific institutions to become politically – and that means rhetorically – active.

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References

About: Our Organization (2020). *TED*. https://www.ted.com/about/our-organization.
Abumrad, J. & Krulwich, R. (2017). Update: CRISPR. *Radiolab*. WNYC Studios, February 24, 2017. https://www.wnycstudios.org/podcasts/radiolab/articles/update-crispr.
Amsen, E. (2018). *From Science to SciComm. A Guide for Scientists Interested in a Science Communication Career*. Self-published.
Amsen, E. (2020). *SciComm for Researchers. A Guide for Scientists Who Want to Communicate Their Work to New Audiences*. Self-published.
Bauman, R. & Briggs, C. L. (1990). Poetics and Performance as Critical Perspectives on Language and Social Life. *Annual Review of Anthropology*, 19, 59–88.
Bell, A. (1984). Language Style as Audience Design. *Language in Society*, 13(2), 145–204.
Bitzer, L. F. (1968). The Rhetorical Situation. *Philosophy & Rhetoric*, 1(1), 1–14.
Broks, P. (2017). Science Communication: Process, Power and Politics. *Journal of Science Communication*, 16(4), C02. DOI: 10.22323/2.16040302.
Brossard, D., Belluck, P., Gould, F., & Wirz, C. D. (2019). Promises and Perils of Gene Drives: Navigating the Communication of Complex, Post-normal Science. *PNAS*, 116(16), 7692–7697. DOI: 10.1073/pnas.1805874115.
Bucher, H.-J. (2019). The Contribution of Media Studies to the Understanding of Science Communication. *Science Communication* (Eds. A. Leßmöllmann, M. Dascal, & T. Gloning). Boston/Berlin: De Gruyter Mouton, 51–76. DOI: 10.1515/9783110255522-003.
BMBF (Bundesministerium für Bildung und Forschung) (2019). *Grundsatzpapier des Bundesministeriums für Bildung und Forschung zur Wissenschaftskommunikation*. Berlin: n.p.
Calsamiglia, H. & van Dijk, T. (2004). Popularization Discourse and Knowledge About the Genome. *Discourse & Society*, 15(4), 369–389. DOI: 10.1177/ 0957926504043705.
Clark, H. H. (1996). *Using Language.* Cambridge, UK: Cambridge University Press.
Clark, H. H., & Brennan, S. E. (1993). Grounding in Communication. *Perspectives on Socially Shared Cognition* (Eds. L. B. Resnick, J. M. Levine, & S. D. Teasley). Washington, DC: American Psychological Association, 127–149.
Collins, K., Shiffman, D., & Rock, J. (2016). How Are Scientists Using Social Media in the Workplace? *PLoS ONE*, 11(10), e0162680. DOI: 10.1371/journal.pone.0162680.
Dean, C. (2009). *Am I Making Myself Clear? A Scientist's Guide to Talking to the Public*. Cambridge, MA/London: Harvard University Press.
Dickenson, D. & Darnovsky, M. (2019). Did a Permissive Scientific Culture Encourage the 'CRISPR Babies' Experiment? *Nat Biotechnol*, 37, 355–357. DOI: 10.1038/s41587-019-0077-3.
Ducharme, J. (2016). An MIT Biologist Is Taking the Secrecy Out of Scientific Research. *Boston Magazine*, June 21, 2016. https://www.bostonmagazine.com/health/2016/06/21/kevin-esvelt-lyme-disease/.
Esvelt, K. M. (2015). ML30: Kevin Esvelt. *ML 30: Mind, Magic, Mischief*. https://youtu.be/w0TomBjQtcs.
Esvelt, K. M. (2016a). Openly Engineering Our Ecosystems. *TEDxCambridge*. https://youtu.be/eoRqivhO6NM.
Esvelt, K. M. (2016b). Gene Editing Can Drive Science to Openness. *Nature*, 534, 153. DOI: 10.1038/534153a.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Esvelt, K. M. (2016c). Strategies for Responsible Gene Editing. *Project Syndicate*, January 25, 2016. https://www.project-syndicate.org/commentary/crispr-gene-drive-editing-rules-by-kevin-m--esvelt-2016-01.

Esvelt, K. M. (2017). Precaution: Open Gene Drive Research. *Science*, 355, February 10, 2017, 589–590. DOI: 10.1126/science.aal5325.

Esvelt, K. M. (2020a) Kevin M. Esvelt, Ph.D. http://www.sculptingevolution.org/kevin-m-esvelt.

Esvelt, K. M. (2020b). Sharing Research Plans. http://www.sculptingevolution.org/proposals.

Geier, A. & Gottschling, M. (2019). Wissenschaftskommunikation auf Twitter? Eine Chance für die Geisteswissenschaften! *Mitteilungen des Deutschen Germanistenverbandes*, 66(3), 282–291. DOI: 10.14220/mdge.2019.66.3.282.

Grolle, J. (2016). Bildhauer des Lebens. *Der Spiegel*, 10, 106–108.

Harmon, A. (2016). Fighting Lyme Disease in the Genes of Nantucket's Mice. *The New York Times*, June 7, 2016. https://www.nytimes.com/2016/06/08/science/ticks-lyme-disease-mice-nantucket.html.

Hyland, K. (2010). Constructing Proximity: Relating to Readers in Popular and Professional Science. *Journal of English for Academic Purposes*, 9, 116–127. DOI: 10.1016/j.jeap.2010.02.003.

Ito, J. (2016). *MIT Media Lab, Reports to the President 2015–2016*. http://web.mit.edu/annualreports/pres16/2016.03.05.pdf.

Jamieson, K. H., Kahan, Dan M., & Scheufele, D. A. (Eds.) (2017). *The Oxford Handbook of the Science of Science Communication*. New York, NY: Oxford University Press.

Korbmann, R. (2017). "Wir haben dramatische Vermittlungsprobleme". Teil 2 des "Wissenschaft kommuniziert"-Gesprächs mit DFG-Präsident Prof. Dr. Peter Strohschneider. *Wissenschaft kommuniziert*, February 7, 2017. https://wissenschaftkommuniziert.wordpress.com/2017/02/07/wir-haben-dramatische-vermittlungsprobleme/.

Lander, E. S. (2016). The Heroes of CRISPR. *Cell*, 164(1–2), 18–28. DOI: 10.1016/j.cell.2015.12.041.

Leßmöllmann, A., Dascal, M., & Gloning, T. (Eds.) (2019). *Science Communication*. Boston, MA/Berlin: De Gruyter Mouton.

Liang, X., Su, L. Y.-F., Yeo, S. K., Scheufele, D. A., Brossard, D., Xenos, M., Nealey, P., & Corley E. A. (2014). Building Buzz: (Scientists) Communicating Science in New Media Environments. *Journalism & Mass Communication Quarterly*, 91(4), 772–791. DOI: 10.1177/1077699014550092.

Liebert, W.-A. (2019). Communicative Strategies of Popularization of Science (Including Science Exhibitions, Museums, Magazines). *Science Communication* (Eds. A. Leßmöllmann, M. Dascal, & T. Gloning). Boston, MA/Berlin: De Gruyter Mouton, 399–416. DOI: 10.1515/9783110255522-019.

Linell, P. (1998a). *Approaching Dialogue: Talk, Interaction and Contexts in Dialogical Perspectives*. Amsterdam, Philadelphia, PA: John Benjamins.

Linell, P. (1998b). Discourse Across Boundaries: On Recontextualizations and the Blending of Voices in Professional Discourse. *Text*, 18(2), 143–157. DOI: 10.1515/text.1.1998.18.2.143.

Luzón, M. J. (2013). Public Communication of Science in Blogs: Recontextualizing Scientific Discourse for a Diversified Audience. *Written Communication*, 30(4), 428–457. DOI: 10.1177/0741088313493610.

Martinez-Conde, S. (2016). Has Contemporary Academia Outgrown the Carl Sagan Effect? *The Journal of Neuroscience*, 36(7), 2077–2082. DOI: 10.1523/JNEUROSCI.0086-16.2016.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Mattiello, E. (2017). The Popularisation of Science via TED Talks. *International Journal of Language Studies*, 11(4), 77–106.
Melo-Martín, I. & Intemann, K. (2018). *The Fight Against Doubt: How to Bridge the Gap Between Scientists and the Public*. New York, NY: Oxford University Press.
Negroponte, N. P. (1995). *Being Digital*. New York, NY: Alfred A. Knopf.
Ledford, H. (2016). Nature's 10: Kevin Esvelt. CRISPR Cautionary. *Nature*, 540, 513.
Nerlich, B. & McLeod, C. (2016). The Dilemma of Raising Awareness "Responsibly". *EMBO reports*, 17(4), 481–485. DOI: 10.15252/embr.201541853.
O'Keefe, M., Perrault, S., Halpern, J., Ikemoto, L., & Yarborough, M. (2015). "Editing" Genes: A Case Study About How Language Matters in Bioethics. *The American Journal of Bioethics*, 15(12), 3–10. DOI: 10.1080/15265161.2015.1103804.
Oddo, J. (2013): Precontextualization and the Rhetoric of Futurity: Foretelling Colin Powell's UN address on NBC News. *Discourse & Communication*, 7(1), 25–53. DOI: 10.1177/1750481312466480.
Olson, R. (2009). *Don't Be Such a Scientist*. Washington, DC: Island Press.
Roche, J. & Davis, N. (2017). Should the Science Communication Community Play a Role in Political Activism? *Journal of Science Communication* 16(1), L01. DOI: 10.22323/2.16010101.
Rutjens, B.T., Sutton R. M., & van der Lee, R. (2018). Not All Skepticism Is Equal: Exploring the Ideological Antecedents of Science Acceptance and Rejection. *Personality and Social Psychology Bulletin*, 44(3), 384–405. DOI: 10.1177/0146167217741314.
Sacks, H., Schlegloff, E., & Jefferson, G. (1974). A Simplest Systematics for the Organization of Turn-taking in Conversation. *Language*, 50(4), 696–735.
Schäfer, M. S. & Bonfadelli, H. (2017). Umwelt- und Klimawandelkommunikation. *Forschungsfeld Wissenschaftskommunikation* (Eds. H. Bonfadelli, B. Fähnrich, C. Lüthje, J. Milde, M. Rhomberg, & M. S. Schäfer). Wiesbaden: Springer VS, 315–338. DOI: 10.1007/978-3-658-12898-2_17.
Scheufele, D. A. (2013). Communicating Science in Social Settings. *PNAS*, 110 (Supplement 3), 14040–14047. DOI: 10.1073/pnas.1213275110.
Scheufele, D. A. (2014). Science Communication as Political Communication. *PNAS*, 111 (Supplement 4), 13585–13592. DOI: 10.1073/pnas.1317516111.
Shugart, E. C. & Racianello, V. R. (2015). Scientists: Engage the Public! *mBio*, 6(6), e01989-15. DOI: 10.1128/mBio.01989-15.
Specter, M. (2015). The Gene Hackers. *The New Yorker*, November 16, 2015. https://www.newyorker.com/magazine/2015/11/16/the-gene-hackers.
Specter, M. (2017). Rewriting the Code of Life. *The New Yorker*, January 2, 2017. https://www.newyorker.com/magazine/2017/01/02/rewriting-the-code-of-life.
TEDx Program (2020). *TED*. https://www.ted.com/about/programs-initiatives/tedx-program.
TEDx Rules (2020). *TED*. https://www.ted.com/participate/organize-a-local-tedx-event/before-you-start/tedx-rules.
Thieme, K. (2010). Constitutive Rhetoric as an Aspect of Audience Design: The Public Texts of Canadian Suffragists. *Written Communication*, 27(1), 36–56. DOI: 10.1177/0741088309353505.
Vatz, R. E. (1973). The Myth of the Rhetorical Situation. *Philosophy & Rhetoric*, 6(3), 154–161.
Weingart, P. (2005). *Die Wissenschaft der Öffentlichkeit*. Weilerswist: Velbrück Wissenschaft.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Williams, C. (2020) Inverse Future 50: Gene Drives Could Stop the World's Oldest Problems. Kevin Esvelt Wants to Make Sure They Don't Start Any. *Inverse*, January 4, 2020. https://www.inverse.com/science/kevin-esvelt-interview.

Yong, E. (2017). One Man's Plan to Make Sure Gene Editing Doesn't Go Haywire. *The Atlantic*, July 11, 2017. https://www.theatlantic.com/science/archive/2017/07/a-scientists-plan-to-protect-the-world-by-changing-how-science-is-done/532962/.

Zimmer, C. (2017). 'Gene Drives' Are Too Risky for Field Trials, Scientists Say. *New York Times*, November 16, 2017. https://www.nytimes.com/2017/11/16/science/gene-drives-crispr.html.

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Sophia Hatzisavvidou

Communicating Sustainability

Shifting Context, Altering Content?

1 Introduction

The term *sustainability* has acquired a prominent status in public discourse today. Indeed, it has taken the form of a principle of action that everybody abides by. We want to sustain the rainforests, the oceans, the cities, and our lives in them, even space. And by "we" I mean scientists, policy makers, international organizations, local communities, as well as individual citizens. The idea of leading more sustainable lives, for example through consuming sustainably produced food and drinks, is widely supported. The term sustainability and its derivatives seem to have earned their place in public discourse, especially among those who want to advance an environmental-friendly or green profile. Responsible development is sustainable development. Indeed, Connelly et al. (2012) suggest that we can consider the impact of the idea of sustainable development as a victory for green thinking. To live sustainably is common sense.

However, this has not always been the case. In this paper, I explore the evolution of sustainability thinking from a rhetorical perspective. Before setting out the aims of my scrutiny, it is important to make two clarifications: I am not concerned with providing a working definition of sustainability or with comparing the different perceptions of sustainability among those who support and advance it; neither am I interested in reconsidering the contested (Connelly 2007; Jacobs 1999) or paradoxical (Redclift 2007) nature of the concept and thus in repeating arguments made elsewhere. Rather, I am interested in probing the evolution of the term in public discourse in the last twenty years in order to illuminate two things: first, the effect of rhetorical context on the emergence and establishment of certain concepts in public life; and second, the normative and ideological nuances of these diverse uses. As a rhetorician, my concern is with the qualitative transformations that certain technical or scientific terms undergo when they enter the field of political communication; as a political theorist, I am interested in how these transformations enable such concepts to become central to policy planning, goal setting, and strategy deployment, and, therefore, to become an integral part of what we call our common good.

https://doi.org/10.1515/9783110676310-004

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To achieve these aims, I selected a sample of scientific outputs and UK policy documents. The task of studying them from a rhetorical perspective entails attentiveness to a diversity of elements that comprise these texts, but also of elements that precede, and exceed the text. Therefore, a rhetorical analysis differs from a textual analysis that studies concepts in their specific context in order to track alterations in meaning. As McGee (1990) argues, the object of study of critical rhetoric (what he calls “fragment”) ultimately is not a finished text, but a set of facts, events, texts, discourse, and stylized expressions that participate in explaining the importance or influence of the artifice under scrutiny and expose its meaning. The study of “fragments” is the study of the integrated complex of text and context.

I treat both categories of documents studied for this paper as a form of intervention that aims to achieve persuasion. From the one hand, scientific articles seek to persuade the scientific community and the public that a given technique, method, or process can advance our knowledge and understanding of the world; on the other, policy documents seek to set and forge common purposes, as well as justify and advance the need for collective action. Each set of documents comes with the particularities that the genre (or type) it belongs to dictates. Scientific articles are especially suited for the purpose pursued here for at least three reasons, as Gross et al. (2002) argue: first, journal articles have become the canonical form for the communication of original scientific results; second, articles are more manageable and amenable to rigorous scrutiny compared to books or other forms of academic communications; third, they are meant for public scrutiny by definition. At the same time, attempts to organize and coordinate human co-existence in the context of political communities have resulted to the production of international and national documents that aim to standardize common goals, principles of action, and mechanisms of implementation. These “fragments” integrate facts, values, ideologies, and visions for collective action and, therefore, are of particular interest as exemplars of rhetorical interventions that shape the terms of human co-existence.

Sustainability thinking has evolved primarily in the two domains of human action studied here, namely the production of scientific knowledge and the formation of political common sense and, therefore, of what constitutes shared knowledge within the context of a given society. The concept of sustainability has become a commonplace in social and political discourse, following a process that projected it as a common goal to be pursued by a relatively cohesive social and political body. One of my purposes is to scrutinize how arguments advanced in policy documents resonate with ideas formed and argued for in scientific articles and eventually the extent in which policy discourse integrates,

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reflects, relies on, or is inspired by scientific discourse. However, this is not a case of examining whether science informed policy; rather, the assumption is that a more complex relation is in place, one which ultimately results to the co-production of social knowledge. The creation and integration of ideas that become common sense is the product of both scientific and political thinking. If sustainability today is common sense, this is not only because it was argued for in a persuasive way by certain agents of political discourse; it is also because it gained credibility by drawing on the authority – what in rhetoric is called *ethos* – of science.

2 Rhetorical Analysis

The concept of rhetoric has negative connotations in popular discourse, frequently invoked within the "speech versus action" binary where at best it is associated with the pejorative meaning of the task of speaking in the absence of any practical outcomes and at worst it is linked to intentional deception. However, as a method of studying the constitution of social and political reality rhetoric is a critical research process that enables one to attend to the dynamic and complex grid of discourse, agency, and structure. Following Aristotle's first attempt to offer a systematic study of this process, a flourishing discipline has emerged which spans across the diverse domains of human activity and provides insights on the interaction between the physical and social world. One of the virtues that this method of analyzing public discourse brings is that it combines the theoretical rigorousness of social and political thought with the empirical attentiveness to old and new problems in order to provide informed insight into the human endeavor to inspire, govern, prosper, survive. Furthermore, since the most fundamental function of rhetoric is, according to Burke (1969) "the use of words by human agents to form attitudes or to induce actions in other human agents," the study of rhetoric enables us to scrutinize how these formations and inductions take place through the use of persuasive language.

One of the virtues that rhetoric brings to the analysis of political discourse is that it calls our attention to arguments – and, therefore, to purposeful forms of discursive interventions that aim to have an effect on an audience. When studying arguments rhetoricians study their invention, arrangement, and style, as well as the contexts in which such interventions emerge and which they seek to inform and transform. Rhetorical analysis shows how rhetoric is not only instrumental but can also be constitutive of social and political change, creating new meanings and perceptions (Hatzisavvidou 2017). By analyzing rhetorical

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arguments, we also analyze the strategies and so the ideas and beliefs of political actors; furthermore, by examining the contests between rival positions we can better understand the arguments used in the constitution of political identities and affiliations, thus creating shared realities.

An emerging theme in science communication is the role of "narratives" in shaping public's understanding on sustainability issues (Goggin 2009). Narratives of course contribute significantly to the way we understand events and facts and how we relate to them; however, persuasion begins well before the arrangement of arguments and, therefore, before the creation of narratives. According to Cicero, the first canon of rhetoric is invention: in order to make a persuasive argument, one must first invent what is persuasive within a given context and guide the audience from familiar ideas, perceptions, or beliefs to new ones. This process, though, is not the sole work of the agent of persuasive discourse; rather, invention is a collective process in the sense that it draws on concepts and ideas from a wider tradition or context within which the rhetor is situated and which constrains but does not dictate or proscribe practice (Jasinski 1997). Furthermore, because political actors try to reach out for audiences that lie outside their own systems of belief or "traditions," the process of invention of political arguments is a highly creative task that entails synthesizing different forms of knowledge and techniques of appeal.

A classical system that is particularly useful at the stage of invention is *stasis*. This system can help to define the parameters that are pertinent to a given condition through a series of related questions and hence invent the arguments more relevant to it. In my project, the stasis system can be used to analyze the force and quality of arguments as they move from a disciplinary context to that of political life. First developed by Hermagoras and then refined by Cicero and Hermogenes of Tarsus, this system consists of three (or more) tiers at which different questions about an issue can be asked. These are: conjecture, definition, cause/effect, value, action. Fahnestock/Secor (1988) propose that the tool of stasis not only generates questions relevant to an issue, but it also determines the order in which they are asked; stasis describes the logic inherent in the development of an issue. However, the usefulness of stasis is not exhausted in its being an invention technique; rather, "staseis can also be used as probes for the analysis of audience," as well as for the creation of audiences and responses to them (Fahnestock/Secor 1988). This is so because arguments, as they are moved in the tiers of stasis, operate as orientating tools for the audiences that are called to use their knowledge, values or convictions in order to arrive to judgement within a given context. Evidently, when someone makes an argument in

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front of an audience that doesn't share or recognize the value of the chosen stasis then her attempt to persuasion becomes more challenging.

The analysis of Fahnestock/Secor is particularly relevant to the task pursued here. It demonstrates not only the analytical power of the stasis system, but also that the very context (e.g., discipline) within which an argument emerges or is employed defines the tiers of stasis within which the argument moves. Our concern here, though, is how stasis theory can be used to analyze the force and quality of arguments not in different disciplinary contexts, but rather as they move from a disciplinary context to that of politics. What is distinct about this field of human action is that it is essentially characterized not merely by the existence of values and beliefs but of profound disagreement on their role in planning collective action; in other words, political life is distinct in the sense that it is riven by dispute about different courses of action (Finlayson 2007). Ultimately, these disputes are not merely informed by scientific arguments, but they also call for the production or invention of new ones. The study of invention, of the very first stage that conditions persuasion, facilitates the study of the mechanisms that participate in the creation of a political argument; in other words, it helps us "to interpret not just the internal coherence of a discourse but the way that speech is assembled in response to specific situations" (Martin 2014). It helps us to attend to strategic interventions that aim to rhetorically construct or reinterpret a given situation.

It is the strategic function of rhetoric in the field of politics that brings to our attention the importance of the social context and rhetoric's relation to it. Since the aim of rhetoric is persuasion within a particular circumstance or set of conditions, the agent of persuasion must know the nature of the parameters that define this context. In a frequently cited article in which he inquires into the nature of the rhetorical situation, Bitzer (1968) argues that a persuasive intervention is called into existence as a response to an "exigence," that is an "imperfection marked by urgency"; however, a specific audience to be addressed, as well as a set of constraints that affect judgement, are also constitutive of the function of "rhetorical situation." Consigny further refines this argument, suggesting that although the situation invites rhetorical intervention, it is the agent of persuasion and the way she engages with the particular circumstances that defines the function of the rhetorical act. Consigny (1974) proposes that the classic category of commonplaces or topics is determinant of the function of rhetoric: both as a means to invent or discover argument and as the realm within which the rhetor thinks and acts, *topos* "allows the rhetor to become engaged in particular situations in a creative way." Therefore, what makes a situation rhetorical is that it remains susceptible to reconceptualization and redefinition

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through the use of rhetorical strategies, or “creative combination of established narrative frames with projectile-like ideas that shift perspectives on a situation” (Martin 2014).

Martin helps us understand how rhetorical strategies can be incorporated into analyzing political life. He suggests a generic approach to the study of analysis of rhetorical political strategies and he identifies three distinct moments of rhetorical intervention: context, arguments, and effect. For the purposes of Martin’s (2014) analytical scheme, which he develops as a method for analyzing political speeches, the rhetorical context “refers to the immediate conditions giving rise to a speech occasion.” Nonetheless, a rhetorical context is, indeed, a much broader category, one that is not “just an aggregate of immediate variables (e.g., audience, rhetor, medium, topic obstacles, setting, etc.), nor is it exclusively the producer of pressing exigencies,” but rather it encompasses various rhetorical acts that orchestrate traditions “far more enduring than any immediate political scene” (Poirot 2014). Therefore, for a project that aims to study not merely certain instances of political speech but also their fusion with other elements for the creation of political common sense, the idea of context encompasses systems of beliefs and knowledge that precede and inform such speeches.

Despite its associations with archaic, and perhaps obsolete, terms rhetorical analysis is a critical methodology that is not exhausted to the traditional schemes and mechanisms it has inherited from the Ancients. It enriches its methodological weaponry with concepts or techniques that it borrows from other disciplines, eventually blending them with its own strengths and incorporating them to achieve not the objective representation of reality but a more critical and creative study of it. This is for example the case with genealogy. A rhetorical genealogy examines how certain concepts participate in arguments and public debates about a given topic at specific times and places, assuming thus a continuity and persistence that call for our attention (Walsh 2013). The assumption of continuity, however, does not foreclose the possibility of transformation; rather, it affirms the dynamic relation between the world and language. Therefore, a genealogical approach considers the transformation of concepts as inextricably linked with social and political change, sometimes driving them and sometimes following from the necessity to invent new concepts in order to envision new futures.

This is the approach that I pursue here. Rather than tracking the origins and evolutions of the concept sustainability in order to provide a critical historiography of it, I explore the resonances between scientific and political thinking and map their co-evolution. Since I do not aspire to provide an exhaustive rec-

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ord of the uses of the concept in these two modes of exploring and re-creating the world, I have focused my analysis on instances that I treat not as authoritative but rather as exemplary of the interplay between knowledge systems, policy needs, ideological persuasions, and power aspirations. Invention provided me with the tools that enabled me to study the evolution of arguments for sustainability. For example, the use of stasis theory allowed me to attend to discourses on sustainability as interventions within particular occasions or contexts and thus to highlight the importance of the latter in the process of creating and amplifying commonplaces, that is common points of reference that can forge common action. It is due to the problematic nature of this process, I argue, that rhetorical analysis proves a highly relevant methodological tool to the study the politics of the environment; Rhetorical analysis is useful not because it reveals supposedly hidden linkages between terminological selections and normative commitments, but because it takes as its starting point the constructed and, therefore, contested nature of concepts and their definitions, calling for their critical examination in order to illuminate a deeper understanding of existing problems.

I argue that using the canon of invention we can identify and analyze the emergence of scientific and political arguments, but also track the invention of scientific disciplines, policy goals, as well as co-produced bodies of knowledge. Whereas the "creation of knowledge," which the German language more concretely and effectively grasps as *Wissenschaft*, is usually seen as taking place in a terrain of objectivity and neutrality achieved through peer review, the context of political action is radically different. Indeed, the formation of political judgement takes place in a contested context where beliefs, emotions, and personal interests are part of the process of negotiating different positions and choices. However, there is no direct, linear relation between scientific and political arguments, in the sense that the former dictate the latter; as rhetorical political analysis helps us see, although certain argumentative patterns may be replicated, the creation of social and political "common sense" is a far more complex process.

3 Scientific Beginnings

Rhetoricians have not been inattentive to the evolution and usages of sustainability. Indeed, they have highlighted effectively the diverse and contested ways in which the concept of sustainability is employed in different spatial and temporal contexts by agents who employ it in order to promote or prevent action. In

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a landmark study that critically analyzes the rhetoric of sustainability, Peterson (1997) unpacks the tensions inherent in the concept and demonstrates how despite its diverse interpretations it becomes a commonplace for advocates of the environment. Myers/Macnaghten (1998) offer a comparative analysis of arguments for sustainability and sustainable development in leaflets used in relevant campaigns and in everyday talk about the environment; their analysis evidences the great discrepancy between policy and everyday rhetoric of sustainability. Stevens (2006) attends to the different rhetorical enactments of sustainability in view of showing how activist or community-based rhetoric participates forcefully in the production and reconfiguration of the concept's social meaning. In a collection of papers edited by Goggin (2009) contributors analyze how practices of sustainability in different geographical contexts contribute to the conceptual construction, enactment, and reformulation of the concept. Finally, more recently Katz-Rosene (2017) demonstrates how the rhetoric of sustainability is now used in combination with the rhetoric of corporate responsibility to justify the materialization of projects such as the production of Synthetic Crude Oil and has thus become a new ecological rhetorical strategy in the hands of corporations. It is to this literature that my project seeks to contribute. Unlike the majority of these works, though, this paper is not focused on a particular case study. Rather, its aim is to offer a more substantial discussion of the rhetorical invention of sustainability, as well as of the transmutations that the concept has undergone, especially as it shifts context of use.

Although the idea of sustainability seems to be implicit in various old philosophies and world views that are concerned with the harmonious symbiosis of humans with their natural environments (Mebratu 1998) the actual term itself is the outcome of scientific reflection on how to overcome the problem of resources management on a finite planet. It was more precisely conceived in the context of forestry as "sustained-yield forest management" in 18th century Europe and its invocation in this context was intended to avoid any disruption associated with timber shortage and eventually to maximize the social value of forests (Sample/Sedjo 1996). It was also in the form of this principle that the term was introduced in the US by Conservationists who saw the destruction of natural resources such as forests as wasteful and advocated the need for their conservation (Dresner 2008). Also known as "wise use," this idea was based upon technical studies that suggested that forest ecosystems can naturally regenerate themselves if an optimal amount of resources is taken from them (Whitehead 2013). Evidently, the logic of this conservationist argument is premised on two assumptions: first, that natural systems have a form of agency that allows them to reproduce themselves, but nonetheless they can be subject to

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scientific observation and quantification, as well as exploitation to fuel economic growth; and second, that human beings cannot merely co-exist with natural environments but indeed have a distinct place in them as their active guardians so that growth can be safeguarded. The logic of sustainability originally affirms natural resources as an object that needs to be sustained so that human needs can be met without disruption.

The concept, then, has environmental, ecological, economic, as well as social resonances. More precisely, it entails "the existence of the ecological conditions necessary to support human life at a specified level of well-being through future generations" (Lélé 1991). According to Lélé, it was the realization that no idea of ecological sustainability can be meaningful unless certain social and political factors are materialized that sparked the invention of the term "sustainable development." This brought together concerns with regard to social and economic change or development and to issues of natural resources management; as we will see, it more particularly bridged the pledges for environmental protection with concerns over economic development, particularly of less advanced countries. Although sustainability was first presented as a major issue in a polemic book entitled *Blueprint for Survival* published in 1972 in which the authors associated it with the problem of infinite growth by finite resources (Kidd 1992), ultimately the term would be employed on a major scale in the form of "sustainable development" .

Following a call by the General Assembly of the United Nations, the World Commission on Environment and Development (WCED) presented in 1987 the document that popularized the term "sustainable development," *Our Common Future*. Its authors defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," identifying thus the horizon of sustainability thinking as that of human needs (World Commission on Environment and Development 1987). Affirming the limitations "imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities," the report suggested that in order to create possibilities for "a new era of economic growth" improvements to both technology and social organization were needed. Consequently, *Our Common Future*, with its prioritization of growth, conceptualized sustainability in economic terms and linked it to market mechanisms and intensified technological advancement.

The Brundtland report – as it is also known after the Commission's chairman and prime minister of Norway – attempted to present environmental themes as a global problem. As Peterson (1997) observes, the report did so by

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employing the language of common interests, according to which "environmental issues represent a framework in which developed and developing countries have common interests." A unique feature introduced by this report, then, was that it advanced sustainability as a goal to be pursued jointly across different countries through the achievement of particular goals which can be scientifically defined and measured. Yet, and despite setting a common purpose around the conservation and responsible use of natural resources, the Brundtland report reflected problems created by the attempt to articulate a principle in objective, scientific terms which is then to be pursued as a social goal advocated and defended by employing ethical and political arguments (Peterson 1997). This is directly related to the spirit that underlies the report and which is a presupposed existence of "a conflict-free social climate wherein scientists can evaluate the sustainability of development and agriculture practices, propose 'more sustainable' alternatives, then preside over their introduction" (Peterson 1997). Ultimately, *Our Common Future* would pave the way for a new, upgraded social and political role for science, which was based on a narrow understanding of its functions and role in public life.

Peterson's work remains the landmark study on sustainability from a rhetorical perspective. Her analysis provides not only an informed discussion into the emergence of the concept of sustainable development, as well as an extensive summary of some of the most insightful criticisms against this idea, but also an invaluable account of how rhetorical criticism can contribute constructively to the task of addressing the causes of these criticisms. Although the scope of this paper is far more limited than the one pursued in her book, the analysis attempted here resonates with the spirit of Peterson's work and her contention that rhetoric can help us probe the use of terminologies across various social domains in order to re-pose questions and address tensions that remain unresolved. It is these questions and tensions that the remaining part of this paper scrutinizes, by bringing together the scientific, ethical, and political arguments in the discourse on sustainability as it evolved in the last 20 years.

4 Scientific Arguments for Sustainability

The introduction of the term sustainability in the terrain of international governance did not significantly alter the content of the term. Originally coined to refer to processes that would ensure the optimal satisfaction of human needs in natural resources, sustainability was subsequently introduced in the domain of politics as an argument for managing natural resources in a way that would

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continue to serve the needs of human society intergenerationally. This argument took the form of a policy goal to be achieved jointly by developed and developing countries. International documents produced in the following years, such as the Rio declaration in 1992 which explicitly recognized sustainable development as a global challenge, drew upon the rationale of the Brundtland report, linking environmental protection with economic growth and development.

The second major step towards the integration of sustainability to policy planning was in 1992. The United Nations Conference on Environment and Development – also known as Rio Summit – in 1992 produced *Agenda 21*, a document that identified a set of plans aimed at achieving sustainable development, setting the blueprint for sustainability in the 21st century. *Agenda 21* specifically advocated that "[o]ne role of the sciences should be to provide information to better enable formulation and selection of environment and development policies in the decision-making process"; therefore, it stated that "[s]cientific knowledge should be applied to articulate and support the goals of sustainable development, through scientific assessments of current conditions and future prospects for the Earth system" (UNCED 1992). *Agenda 21* also called national governments to integrate sustainability in their national strategies. Following this and other international meetings in the 1990s national governments, political parties, and other political agents started to incorporate the concept of sustainability in their vocabulary and actions. At the same time the discussions in these meetings, which among other things aimed to assess the role of science in the achievement of the goal of sustainable development, resulted to a number of initiatives for the establishment of new research centers and sources of funding were unveiled (Clarke 2002).

Evidently this international call for a more active role of science in shaping the extant goals of sustainable development impacted on the production of relevant knowledge. Two leading academic journals in the field, *Sustainable Development* and the *International Journal of Sustainable Development and World Ecology* were introduced in 1993 and 1994 respectively, marking the intensification of attempts to create interdisciplinary venues for deepening understanding of sustainability and its various aspects. The articles published in the first years reflect the need to address the issue of sustainability both on a local and global level and give a sense of the direction of knowledge at the time. These works are indicative of the state of knowledge in the mid-1990s, as well as of the mood with regard to sustainable development in academia. Reading a selection of articles published in these journals during this time can enlighten our understanding of these issues.

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In order to examine them closely in a more systematic way, I have selected and studied ten well referenced articles using the stasis system, a device that helps establish types of questions about an issue, which can then be used to evaluate and arrange arguments. I have opted for the system proposed by Fahnestock/Secor (1988), which involves five questions: fact, definition, cause, value, and action. As the analysis shows, all authors of these articles spent some time discussing the meaning of sustainable development as well as the importance of integrating this principle into certain aspects of policy making, such as urban planning. The most interesting similarity, though, is that all authors dwell primarily on the fifth level of argument, namely action. This allows us to assume that the audiences of these journals had already accepted the value of sustainable development as a principle of organization or policy planning and the emphasis was now on how to concretely use technological expertise to inform practice. Nonetheless, this example also demonstrates the different receptions of the idea of sustainable development: whereas some authors unproblematically accept the driving role that the concept can provide, others also point to the tensions and challenges that the plurality of interpretations of the concepts creates. In any case, there seems to be an agreement on the role of sustainability as a driver for positive action for resolving environmental issues.

This optimism with regard to the role of science and technological progress in addressing environmental and social problems did not have universal appeal. As early as in 1993 it was argued that in its attempts to address the global environmental and developmental crisis UNCED came up with solutions that "marginalize rival interpretations of [the crisis's] origins and thereby block the discovery of possible ways forward" primarily through an overemphasis on the capacity of "respectable knowledge" to allocate responsibility and remediate action (Thomas 1993).

The privileging of "respectable knowledge" remained at the center of international attempts to respond to the environmental crisis. In her Presidential Address at the Annual Meeting of the American Association of the Advancement of Science in 1997, Lubchenco (1998) suggested that, considering the fast-paced changes of the world and our knowledge about it, a new social contract was needed between science and society, one that "would more adequately address the problems of the coming century," that would "recognize the extent of human domination of the planet," and that would "harness the full power of the scientific enterprise in discovering new knowledge, in communicating existing and new understanding to the public and to policy-makers, and in helping society move toward a more sustainable biosphere."

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The discipline of "sustainability science" emerged gradually as it was becoming evident that the complexity of the challenge of "sustainable development" required a different way of thinking. In 1999 the National Research Council in the US published *Our Common Journey*, a collaborative report in which sustainability was affirmed as being defined by "the joint objectives of meeting human needs while preserving life support systems and reducing hunger and poverty" (National Research Council 1999). Crucially, the report acknowledged the need to develop "a useful 'sustainability science'," a task that would "require novel approaches for research linking the natural and social sciences, and studying adaptive management and policy; for technology development and diffusion, to provide the most useful and needed tools for navigating the choices; and for institutions, to overcome barriers and find new funding mechanisms" (National Research Council 1999). Eventually, sustainability science was officially established in 2001 at the Global Change Open Science Conference which was organized in Amsterdam by the International Council for Science (ICSU) and which resulted to the production of the Amsterdam Declaration on Earth System Science. The aim of this new discipline would be "to understand the fundamental character of interactions between nature and society," an understanding that would "encompass the interaction of global processes with the ecological and social characteristics of particular places and sectors" and that would, therefore, "integrate the effects of key processes across the full range of scales from local to global"; this would enable the cooperation between different social actors despite uncertainty and limited information and would demand the combination of "different ways of knowing and learning" (Kates et al. 2001).

Initially, sustainability science was not seen as an autonomous field of research or discipline, but rather as "a vibrant arena that is bringing together scholarship and practice, global and local perspectives from north and south, and disciplines across the natural and social sciences, engineering, and medicine" (Clark/Dickson 2003). Gradually, it developed into a dynamic field of study with its own academic journals (e.g., *Sustainability Science*, *Sustainability: Science, Practice, Policy*), its own societies (e.g., *International Society for Sustainability Science*), as well as its own research programs and centers in major academic institutions. As a result, an important bibliography emerged that aimed to respond to the call for a rigorous discipline that would contribute to the achievement of the sustainable development goals, in a way that would be practical, timely, and "glocal." According to Kajikawa et al. (2014), in 2000 there were about 14,000 papers on sustainability issues, ranging from research clusters such as environmental systems to health; in 2015 the number rocketed

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to over 135,000 papers. The emergence of this new thriving discipline, then, coincided with the recognition that scientists should contribute substantially to decision-making processes and, therefore, with the raise of specific expectations with regard to their social role – a new ethos for the sustainability scientist.

In the launching issue of the journal *Sustainability Science* its editors addressed the tension inherent in the evolution of sustainability from a scientific concept into “a key issue facing twenty-first century society” (Takeuchi/Komiyama 2006). As they comment, “the idea of sustainable development increasingly seems to be linked to political agendas, raising concerns about the solidity of its analytical basis,” therefore an effort to clarify the underpinnings of this emerging discipline was paramount. Komiyama/Takeuchi endeavored to provide these clarifications and they consequently argued that in addition to such problems as that of inter-generational equity, which is emphasized in the concept of sustainable development, they adopt a systemic approach to sustainability at three levels, namely global, social, and human. These three systems, they argue, “are crucial to the coexistence of human beings and the environment, and it is our view that the current crisis of sustainability can be analyzed in terms of the breakdown of these systems and the linkages among them” (Takeuchi/Komiyama 2006). From the perspective of sustainability science, then, sustainability is seen as the mediating factor between human beings and their environment; it is also seen as applying on a complex system that refers to natural/global systems (the geosphere, atmosphere, hydrosphere, and biosphere), human-made/social systems (the political, economic, industrial, and other structures that provide the societal base for a fulfilling human existence), and human systems (the sum total of factors affecting the survival of individual human beings and that are influenced by disease, illness, and inequities). At the same time, sustainability is seen as being in crisis, caused by numerous factors and fundamentally by the industrialization that followed the industrial revolution, the rapid economic growth it fostered, and eventually “the burgeoning consumption of fossil fuels and other nonrenewable resources” (Takeuchi/Komiyama 2006). Considering the complexity and interconnectedness of the problems associated with the sustainability crisis, a critical task of science is the creation of a new platform of knowledge, as well as a new way of structuring knowledge, which requires also the cooperation among researchers, industry, and the general public. As they argue, “only when society at large is inspired to act on the basis of their research and conclusions can sustainability scientists lay the foundation for construction of a sustainable society” (Takeuchi/Komi-

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yama 2006). The emphasis on the joint nature of the task of implementing the sustainable society is one of the commonplaces in arguments for sustainability.

In scientific discourse the idea of sustainability evolved from a conservative technical term that was associated with resource management practices that would maintain or facilitate the balance of nature into an integrative concept that refers to a policy goal for the achievement of which the contribution of science is indispensable. What's more, this conceptual evolution also marked the emergence of a new scientific discipline, one in which sustainability functions as a guiding principle of action that links human societies to the natural environment.

5 Sustainability in Policy Discourse

The question that remains to be examined is whether the substantive context of the term sustainability changes with its introduction into national policies. Here, I am taking on the example of the UK.

As mentioned in the previous section, Agenda 21 called national governments to integrate sustainability in their national strategies. The UK government first introduced a national Environmental Strategy in 1990 in a document entitled This Common Inheritance, which according to Connelly et al. (2012) was more a summary of existing plans and less a plan for change. The Government Panel on Sustainable Development was set up in January 1994 to provide independent advice to the Government on issues related to the UK Sustainable Development Strategy, including issues from the Agenda 21 such as climate change, biodiversity, and forestry. A year later the UK Round Table on Sustainable Development was launched to facilitate discussion especially between people who have a range of different viewpoints and a variety of responsibilities. However, despite the flurry of governmental activity which resulted among other things in the production of several environmental White Papers, the actual policy impact was ultimately limited (Dryzek et al. 2003).

The government of Tony Blair was elected in 1997 having pledged during the election campaign to place the environment "at the heart of policy-making" in an integrated way by making "every government department a 'green' department" (Labour Party 1997). The Party's election manifesto (under the banner "New Labour because Britain deserves better") made the case for "the protection of the environment" as an intergenerational issue: "No one can escape unhealthy water, polluted air or adverse climate change. And just as these problems affect us all, so we must act together to tackle them. No responsible gov-

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ernment can afford to take risks with the future: the cost is too high. So it is our duty to act now." The manifesto associated sustainable development with the development of "an effective and integrated transport policy at national, regional and local level that will provide genuine choice to meet people's transport needs" (Labour Party 1997). Effectively, the election of the Labour Party renewed hopes for the implementation of the sustainable development agenda (Connelly et al. 2012).

In 1999 the Labour government introduced the White Paper *A Better Quality of Life – Strategy for Sustainable Development for the United Kingdom* (HM Government 1999). The format of the paper featured a clear layout: a foreword signed by Tony Blair, followed by an executive summary of the content and 10 chapters. The foreword explicitly connected development with economic growth and progress and introduced a more holistic approach to the economy, environment and society, but it framed it in highly ethical and ideological terms: "delivering the best possible quality of life for us all means more than concentrating solely on economic growth." This was the premise that called for the integration of sustainable development into governmental policies through the introduction of specific performance indicators. The government had "a strategy for making sustainable development a reality." It also set specific objectives, future priorities, as well as ten guiding principles, including respect of environmental limits and the use of scientific knowledge. Ideologically, the strategy outlined in the document was characteristic of a center-left party, emphasizing social justice. However, as Connelly et al. (2012, 315) observe, it remained unclear which of the ten guiding principles set out in the White Paper would take priority where there were conflicts. As a policy document produced by a center-left Government, the White Paper (1999) brought together seemingly non-matching terms, such as "environmental equality" and "social exclusion," "social progress" and "environmental protection," "prosperity" and "fairer society." Sustainable development, the White Paper argued, must be integrated into governmental policies because this could help "delivering the best possible quality of life for all."

Stasis system can help us unravel the logical emergence of arguments for sustainable development in the 1999 White Paper. In order to justify the need to take action, and, therefore, the very reason behind its production, the Paper begins with the establishment of facts and, therefore, with conjectural argument. We need sustainable development because "the need for development is as great as ever, but future development cannot simply follow the model of the past." The problem, then, is that there is a "need for change": we need to change the way we plan our economic activities, from production to consump-

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tion, the way we build our habitats, as well as the way we use energy resources. But at the same time there is the need to maintain "high and stable levels of economic growth and employment, so that everyone can share in high living standards and greater job opportunities"; sustainability is inextricably linked to growth. Having established that there is an issue that must be addressed, the next argument is made at the stasis of definition, in order to clarify the meaning of the term to the public. Although it quoted the Brundtland report to define sustainable development, the Paper also gave its own definition in terms that the public could perhaps grasp easier: "a better quality of life for everyone, now and for generations to come." To strengthen even more the case for sustainability, the Paper also employs arguments at the value stasis. The achievement of the objectives associated with sustainable development will, arguably, result among other things to a more competitive economy, reduction of social exclusion, a more efficient transport system, as well as a better quality of life in urban centers. Expectedly, the bulk of the Paper evidently focuses on arguments at the stasis of action, setting out governmental policies that take into account ten principles which reflect themes of the Agenda 21, without nonetheless setting particular timelines for action. Nonetheless, the Paper ends with the promise of the government to review it after five years.

Blair's government introduced a revised strategy for sustainable development in 2005 entitled Securing the Future (HM Government 2005). The document had a similar format to the A Better Quality of Life White Paper, opening with a foreword signed by Tony Blair, followed by an executive summary and seven chapters. The foreword explicitly connected the two publications and provided the reasons that dictated the need for a new strategy: the devolution to Scotland and Wales and the local and regional governments, as well as the World Summit on Sustainable Development in 2002. Blair used his ethos to explain the importance of sustainable development: it is about securing "a future that is fairer, where we can all live within our environmental limits." This is a matter of choices, he argued, adding that "development, growth, and prosperity need not and should not be in conflict with sustainability." The prevalence of climate change became now a crucial matter, one that the scientific community has agreed upon as being the result of human activity. This suggested a shift in terms of stasis system, since the debate could now move from conjectural arguments (whether there is a problem) to the stasis of action (how to deal with it). The promotion of sustainable (also described as "new" and "modern") ways of living, working, producing, and travelling, was presented as providing not only a response to the environmental problem, but also the opportunity "to achieve wider benefits to human health and well being [sic]." In a sense, Secur-

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ing the Future extends the argument of the 1999 White Paper: sustainability is about securing a better quality of life on every level, from transportation to major public services; it is about creating “sustainable communities,” but also tackle “environmental inequalities”; and it is about acting now to secure the future. The goal of sustainable development is thus summarized as the goal “to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations.”

The new strategy focused around:

– five principles – with a more explicit focus on environmental limits;
– four agreed priorities – sustainable consumption and production, climate change, natural resource protection and sustainable communities; and
– a new indicator set, which is more outcome focused, with commitments to look at new indicators such as wellbeing.

In this paper we also notice that sustainable ways of living, working, producing, and travelling are also referred to as “new” and “modern” and, therefore, in congruence with New Labour ideology. The use of the rhetorical figure of metalepsis (whereby we replace a term with a different one creating a far-fetched logical connection) here is a tactical move that aimed to make these transformations sound attractive and desirable. Such transformations were presented as providing not only a response to the environmental problem, but also the opportunity “to achieve wider benefits to human health and wellbeing.”

The use of the perspective of “choice” in the document is particularly interesting. This is developed in Chapter 2, where it is argued that the implementation of the vision of sustainable development is premised on the making of “different choices” by “governments, businesses, public sector, voluntary and community organizations, communities and families.” Evidently, the argument goes, changes are brought about when behaviors change, therefore, “Government will focus on measures to enable and encourage behavior change, measures to engage people, and ways in which the Government can lead by example.” To facilitate or encourage such behavior change the Government introduced “Community Action 2020 – Together We Can,” aiming to help people “to get involved by providing skills training, improved access to funding and mentors,” along with other initiatives such as “a deliberative forum to look at what it would take to help people live more sustainable lifestyles” and “new commitments to support education and training in sustainable development.” In this spirit, Blair’s Government identified as a key problem the need “to deliver new products and services with lower environmental impacts” and pledged

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to a strategy that would address the issue through actions such as “influencing consumption patterns” and “support for innovation to bring through new products, materials and services.” Overall, the realization of “the vision of sustainable communities across England” to deliver the aim of sustainable development was adopted as the key aspect of the Government’s strategy.

In summary, sustainability policy discourse in the UK under Labour is underpinned by the particular ideological commitments of the government. At the same time, tracking the evolution of sustainability policy discourse allows us to gain a deeper understanding of how this discourse shifts to adjust to ideological and political changes.

6 Conclusion

The use of tools from the tradition of rhetoric helps us to identify linkages between scientific thought, policy design, and the creation of political and social common sense. Sustainability thinking emerged as a key concept in international governance and then was evolved into a central concept of policy aiming to address issues of social and economic development and to create the green state. Stasis system shows how different questions that are deemed closed in specific contexts need to be revisited when the production of new knowledge calls into question existing understandings or creates new ones.

In this paper, I began to explore the entanglements of scientific and political knowledge with regard to the issue of sustainability. The example of the UK Labour Party is interesting because it serves as a case where science-informed-policy was adopted as a way to design a modern environmental state that would be able to materialize the vision of a “green future” by way of promoting “new, modern, sustainable ways of living, working, producing and travelling.” It is an exemplar of creating connections between scientific developments and social conditions that people can affiliate with.

In the case of the UK, the argument for sustainable development became entwined with the ideological discourse of the center-left political space that New Labour represented and more precisely of the New Labour ideology. It is by linking directly this argument with a particular interpretation of social and economic progress that sustainable development in the UK was presented and communicated as a means to growth and modernization.

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References

Bitzer, L. F. (1968). The Rhetorical Situation. *Philosophy & Rhetoric*, 1(1), 1–14.

Burke, K. (1969). *A Rhetoric of Motives*. Berkeley, CA: University of California Press.

Clark, W. C. & Dickson, N. M. (2003). Sustainability Science: The Emerging Research Program. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), 8086–8091. DOI: 10.1073/pnas.1231333100.

Clarke, T. (2002). Now We're Talking. *Nature*, 420, 733–734. DOI: 10.1038/420733a.

Connelly, J., Smith, G., Benson, D., & Saunders, C. (2012). *Politics and the Environment* (3rd ed.). New York, NY/London: Routledge.

Connelly, S. (2007). Mapping Sustainable Development as a Contested Concept. *Local Environment*, 12(3), 259–278. DOI: 10.1080/13549830601183289.

Consigny, S. (1974). Rhetoric and Its Situations. *Philosophy & Rhetoric*, 7(3), 175–186.

Dobson, A. (1999). *Fairness and Futurity: Essays on Environmental Sustainability and Social Justice*. Oxford: Oxford University Press.

Dresner, S. (2008). *The Principles of Sustainability* (2nd ed.). London/Sterling, VA: Earthscan.

Dryzek, J. S., Downes, D., & Hunold. C. (2003). *Green States and Social Movements: Environmentalism in the United States, United Kingdom, Germany, and Norway*. Oxford: Oxford University Press.

Fahnestock, J. & Secor, M. (1988). The Stases in Scientific and Literary Argument. *Written Communication*, 5(4), 427–443.

Finlayson, A. (2007). From Beliefs to Arguments: Interpretive Methodology and Rhetorical Political Analysis. *British Journal of Politics and International Relations*, 9(4), 545–563. DOI: 10.1111/j.1467-856X.2007.00269.x.

Goggin, P. (Ed.) (2009). *Rhetorics, Literacies, and Narratives of Sustainability*. New York, NY: Routledge.

Gross, A. G., Harmon, J. E., & Reidy, M. (2002). *Communicating Science: The Scientific Article from the 17th Century to the Present*. Oxford: Oxford University Press.

Hatzisavvidou, S. (2017). Disputatious Rhetoric and Political Change: The Case of the Greek Anti-Mining Movement. *Political Studies*, 65(1), 215–230. DOI: 10.1177/0032321715624425.

HM Government. (1999). A Better Quality of Life – Strategy for Sustainable Development for the United Kingdom. *The National Archives*. http://webarchive.nationalarchives.gov.uk/20070925095336/http://www.sustainable-development.gov.uk/publications/uk-strategy99/index.htm.

HM Government. (2005). Securing the Future: Delivering UK Sustainable Development Strategy. *The National Archives.* https://webarchive.nationalarchives.gov.uk/20130506184153/https://www.gov.uk/government/publications/securing-the-future-delivering-uk-sustainable-development-strategy.

Jacobs, M. (1999). Sustainable Development as a Contested Concept. *Fairness and Futurity. Essays on Environmental Sustainability and Social Justice* (Ed. A. Dobson). Oxford: Oxford University Press, 21–45.

Jasinski, J. (1997). Instrumentalism, Contextualism, and Interpretation in Rhetorical Criticism. *Rhetorical Hermeneutics: Invention and Interpretation in the Age of Science* (Ed. A. Gross, & W. Keith). Albany, NY: State University of New York, 195–224.

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Kajikawa, Y., Tacoa, F., & Yamaguchi, K. (2014). Sustainability Science: The Changing Landscape of Sustainability Research. *Sustainability Science*, 9(4), 431–438. DOI: 10.1007/s11625-014-0244-x.
Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B., Dickson, N. M., Faucheux, S., Gallopin, G. C., Grubler, A., Huntley, B., Jager, J., Jodha, N. S., Kasperson, R. E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., O'Riordan, T., Svedin, U. (2001). Environment and Development: Sustainability Science. *Science*, 292, 641–642. DOI: 10.1126/science.1059386.
Katz-Rosene, R. M. (2017). From Narrative of Promise to Rhetoric of Sustainability : A Genealogy of Oil Sands. *Environmental Communication*, 11 (3), 401–414. DOI: 10.1080/17524032.2016.1253597.
Kidd, C. V. (1992). The Evolution of Sustainability. *Journal of Agricultural and Environmental Ethics*, 5(1), 1–26.
Labour Party (1997). Manifesto. *Archive of Labour Party Manifestos*. http://labour-party.org.uk/manifestos/1997/1997-labour-manifesto.shtml.
Lélé, S. M. (1991). Sustainable Development: A Critical Review. *World Development*, 19(6), 607–621. DOI: 10.1016/0305-750X(91)90197-P.
Lubchenco, J. (1998). Entering the Century of the Environment: A New Social Contract for Science. *Science*, 279(5350), 491–497. DOI: 10.1126/science.279.5350.491.
Martin, J. (2014). *Politics and Rhetoric: A Critical Introduction*. London: Routledge.
McGee, M. C. (1990). Text, Context, and the Fragmentation of Contemporary Culture. *Western Journal of Speech Communication*, 54(3), 274–89.
Mebratu, D. (1998). Sustainability and Sustainable Development: Historical and Conceptual Review. *Environmental Impact Assessment Review*, 18(6), 493–520. DOI: 10.1016/S0195-9255(98)00019-5.
Myers, G. & Macnaghten, P. (1998). Rhetorics of Environmental Sustainability: Commonplaces and Places. *Environment and Planning A*, 30(2), 333–353. DOI: 10.1068/a300333.
National Research Council. (1999). *Our Common Journey: A Transition Toward Sustainability*. Washington, D.C.: National Academies Press. DOI: 10.17226/9690.
Peterson, T. R. (1997). *Sharing the Earth: The Rhetoric of Sustainable Development*. Columbia, SC: University of South Carolina Press.
Poirot, K. (2014). *A Question of Sex: Feminism, Rhetoric, and Differences That Matter*. Amherst, MA: University of Massachusetts Press.
Redclift, M. (2007). Sustainable Development (1987–2005), An Oxymoron Comes of Age. *Sustainable Development*, 13, 212–27. DOI: 10.1002/sd.281.
Sample, V. A. & Sedjo, R. A. (1996). Sustainability in Forest Management: An Evolving Concept. *International Advances in Economic Research*, 2(2), 165–173. DOI: 10.1007/BF02295056.
Stevens, S. (2006). Activist Rhetorics and the Struggle for Meaning : The Case of "Sustainability" in the Reticulate Public Sphere. *Rhetoric Review*, 25(3), 297–315. DOI: 10.1207/s15327981rr2503_4.
Takeuchi, K. & Komiyama, H. (2006). Sustainability Science: Building a New Discipline. *Sustainability Science*, 1(1), 1–6. DOI: 10.1007/s11625-006-0007-4.
Thomas, C. (1993). Beyond UNCED: An Introduction. *Environmental Politics*, 2(4), 1–27.
UNCED (United Nations Conference on Environment and Development) (1992). *Agenda 21*. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Walsh, L. (2013). *Scientists as Prophets: A Rhetorical Genealogy*. Oxford: Oxford University Press.
Whitehead, M. (2013). Sustainability. *Introducing Human Geographies* (Eds. P. Cloke, M. Goodwin, & P. Crang) (3rd ed.). Abingdon: Routledge, 448–460.
WCED (World Commission on Environment and Development) (1987). *Our Common Future*. http://www.un-documents.net/our-common-future.pdf.

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Part II: **Narratives and Stories**

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Martijn Wackers

Memorable Stories in Science and Popular Science

How Speakers Use Anecdotes in Research Presentations and TED Talks

1 Introduction

Being memorable, or making sure the central message or key points of the presentation will be remembered by the audience, is a purpose speakers in various presentation situations pursue. This purpose is not easily achieved when the main message is based on complex knowledge. For example, in case of scholars, condensing months or years of study into a twenty-minute conference talk that should drive home key conclusions of the research can be quite a challenge; when confronted with a mixed and broad audience instead of fellow scholars, the task seems even more daunting.

In the popular online presentation genre of TED talks, speakers appear to deal with complex scientific or technological topics in a way that is considered compelling and entertaining to a wide audience. Initially organized as a one-time conference on Technology, Entertainment, and Design in 1984, TED developed itself into a popular global concept: in 2012, the organization celebrated the one-billionth view of the online conference talks and local TEDx conferences are organized around the world (TED 2017). TED talks, in which speakers ideally offer the audience an "idea worth spreading," are often seen as a successful way of science popularization (Sugimoto et al. 2013; Scotto di Carlo 2014a). According to Scotto di Carlo (2014a), what sets TED talks about scientific content apart from "traditional" science communication is the fact that scientists are in direct contact with their audience, without a "mediator" (e.g., a science journalist or spokesperson) in between.

However, the format of TED talks has also raised more than a few eyebrows – especially the talks with a scientific character. According to Romanelli et al. (2014) "several authors have criticized TED for flattening or dumbing down ideas so they fit into a preconceived, convenient format that is primarily designed to entertain." Criticists point to the dangers of oversimplifying complex knowledge, which could lead to a false sense of comprehension. In the lion's den, on the stage of *TEDxSan Diego*, professor of visual arts Benjamin Bratton did not

https://doi.org/10.1515/9783110676310-005

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beat around the bush in criticizing the TED format: “This is beyond popularisation. This is taking something with value and substance and coring it out so that it can be swallowed without chewing” (Bratton 2013). In short, speakers need to recontextualize the knowledge their presentation is grounded on in order to get the message across to the audience, and in doing so can be applauded for making it more accessible and at the same time be criticized for oversimplifying it.

At the crossroads of accessibility and oversimplification seems to be the narrative. According to Dahlstrom (2014) stories and anecdotes are considered to be unreliable and even manipulative within scientific communities, whereas in a context of science communication to a broader, non-expert audience they are more important and appear to be more effective regarding comprehension. He sketches how narratives are often contrasted with logical-scientific arguments, for example concerning generalizability and dependency on context; narratives derive meaning from context, whereas logical-scientific arguments are ideally context-free.

A popular-scientific public speaking situation, in which scholars aim to make complex knowledge more accessible to a wider audience, implies a more nuanced relation between narratives and logical-scientific arguments: for such audience, scientific knowledge can derive meaning from context via narratives. Scholars can use types of narratives such as anecdotes as vehicles to recontextualize supposedly context-free, complex subject matter. In anecdotes, scientific information can be linked to concrete situations the audience can visualize and relate to; this way, the audience is provided with a (new) context to interpret scientific knowledge.

Often considered a speech genre with the purpose to popularize science, TED talks exemplify the apparent contrast between logical-scientific arguments and narratives. Scotto di Carlo (2014a) observes that where “typical scientific dissemination uses highly scientific and technical language, presented in a logical, rational and objective way, from an authoritative and institutional perspective, TED uses a horizontal approach, presenting its talks using accessible language, presented in a rhetorical, human and subjective way, from a communal and local perspective.” Therefore, stories are important ingredients in TED talks with a scientific character. A TED speaker often “shares a personal journey of insight and realisation, its triumphs and tribulations” (Bratton 2013) and the TED format “maximizes storyboarding and highlights passion for the subject” (Romanelli et al. 2014). Personal stories and anecdotes are important rhetorical tools to mediate proximity: they can emphasize common ground, closing the gap between audience and speaker (Scotto di Carlo 2014a). Perhaps not surprisingly, a personal story or experience was the prime opening technique in the

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corpus of 84 TED talks Scotto di Carlo (2014a) investigated. She considers sharing personal stories and experiences as an important credibility-enhancing strategy in TED talks (Scotto di Carlo 2014b).

The qualities of a story to make complex knowledge more accessible and establish proximity between audience and speaker could explain why narratives are often advised as a rhetorical strategy to influence audience information retention, the extent to which the audience remembers information from a presentation. The anecdote, as a specific type of narrative, is found to be one of the most frequently advised retention techniques in English-language public speaking textbooks. From a corpus analysis of 40 English-language textbooks from the period 1980 to 2009, it appeared that in half of the textbooks the anecdote was regularly advised as a strategy to influence information retention (Wackers et al. 2016).

The overview of retention advice from modern public speaking textbooks is insightful, but at the same time it reveals two problems. First, textbooks only provide few examples and details about the use of rhetorical techniques in real-life presentations. Second, only few studies have focused on the effect of rhetorical techniques or choices on audience information retention in the specific communicative situation of a presentation or speech (Wackers et al. 2016). Some indicated positive retention effects of rhetorical strategies such as announcing the concluding part of the talk (Andeweg et al. 2008), including a humoristic element in a lecture (Kaplan/Pascoe 1977), and using concise sentences as titles on PowerPoint slides compared to single words or short phrases (Alley et al. 2006). To the contrary, in an experiment by Andeweg/De Haan (2009), the use of explicit transition sentences did not cause an increase in information retention. Although narratives are often associated with increasing recall (Dahlstrom 2014), to date no studies into the retention effect of anecdotes in a specific presentation situation are known.

To gain more insight into the possible effect of the anecdote on audience information retention, first it is needed to map how this presumed retention technique is used in speech and presentation practice. A previous study on the use of structural retention techniques (such as the summary) in research presentations and political speeches showed a range of varieties in length and the extent to which the key points were repeated or elaborated on (Wackers et al. 2016). Similarly, narratives and anecdotes could appear in various forms, possibly dependent of presentation genre and context. A more detailed overview of anecdote use would provide more insight into how anecdote characteristics could possibly influence audience information retention.

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Scotto di Carlo (2014b) already provided some more specific insights into the varieties in use of personal stories by TED speakers. She discerns “Who I am” stories, emphasizing the speaker’s identity and credibility, and “Why I am here” stories, aimed at supporting the motivation and purpose for the speaker to give the talk. However, it is not entirely clear how the “personal story” or “anecdote” is operationalized in Scotto di Carlo’s qualitative analysis – possibly because it is one of many strategies analyzed. Furthermore, she analyzed a single presentation genre (TED talks) and focused explicitly on the function of establishing proximity – not on retention.

The current research is narrowed down to the specific narrative type *anecdote* and intends to provide a working definition for this retention technique. This way, the technique anecdote is operationalized in order to analyze speech and presentation texts. Furthermore, next to the genre of TED talks, the research takes a “reference genre” of research presentations into account.

In doing so, this paper presents an exploration of how the anecdote, an apparent retention technique, is used in TED talks and research presentations. To this end, the use of anecdotes was analyzed in a corpus of 16 of the most popular online TED talks and a corpus of 16 research presentations at the scientific VIOT conference held in 2008 at the Vrije Universiteit Amsterdam. This is the triennial conference of the Dutch-Flemish society for research into (applied) communication (VIOT), attended by scholars who work in the field of, e.g., rhetoric and argumentation studies.

The results of this rhetorical analysis can be interpreted from various perspectives. First of all, it provides an insight into the actual application of anecdotes in presentations, possibly indicating variations of anecdote use and specifying anecdote features that could influence retention. Secondly, it could shed more light on the role of narratives in science popularization, as the corpus of TED talks can be contrasted with the research presentations. The presentations in both corpora are predominantly knowledge-based but differ in main purpose of the speaker and composition of the audience.

The paper is structured as follows. Section 2 discusses retention advice on the anecdote in public speaking textbooks and explains how the technique can be related to the concept of information retention in memory psychology. Section 3 puts forward the characteristics of the two corpora of research presentations and TED talks that were analyzed and presents the method of analysis in more detail – for instance, by providing a definition of the anecdote and the textual, linguistic, and stylistic characteristics to detect anecdotes in the two analyzed speech corpora. Section 4 covers the results: the frequency of anecdote use in both corpora and a more detailed discussion of anecdote varieties

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based on corpus examples. In section 5, these results will be related to the main purpose and discussed from a genre, retention, and popularization perspective.

2 Anecdote: Retention Advice and Possible Effect

Although the anecdote is frequently linked to retention in public speaking textbooks (Wackers et al. 2016), the route from implementation of the technique to audience information retention remains rather obscure. First, section 2.1 presents an overview of how the anecdote is advised as a retention technique and what characteristics public speaking textbooks attribute to it. Secondly, section 2.2 reviews the possible memorable qualities of the anecdote in a cognitive psychological and empirical context.

2.1 Anecdote: Retention Advice and Characteristics

The anecdote is mentioned as a retention technique in half of the 40 English-language textbooks investigated on retention advice in Wackers et al. (2016).[1] Atkinson (2004) illustrates this strong position of the anecdote as a retention technique:

> However, of all the techniques described in earlier chapters, the one that really comes into its own in social and duty speeches is the anecdote. A well-chosen story that represents some key characteristic of a person can be so effective that it is often the only thing that anyone ever remembers about such speeches.

Just as Atkinson refers to the anecdote as a "well-chosen story," other textbook authors discern similar characteristics they link to a possible retention effect. Key characteristics that are frequently found are: narrative elements, vividness, brevity, relevance, and humor.

Narrative elements. Textbook advisors often present the anecdote as a type of memorable story. Witt/Fetherling (2009) for example state that stories can

1 Public speaking textbooks can be characterized as books aiming to provide an overview of advice on preparing and performing an effective presentation. Most works aim at a broad audience of readers interested in public speaking, but more specifically at novice speakers. Most textbooks analyzed did not seem to be geared towards a specific application context, such as communication education. For a more detailed description of the composition of the textbook corpus, see Wackers et al. (2016).

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influence retention, as they "offer an overview over a large amount of information, so that it is coherent and easy to remember." A story usually comprises narrative elements such as a main character, time, place, temporal organization of events and a termination, or coda (Labov 2003). In textbooks, some of these elements are discussed in relation to retention, such as the choice of a main character. For example, according to Urech (1998) and Booher (2003) the main character could well be the speaker or someone close to the speaker, as personal anecdotes help the audience identify with the story and make the speech memorable. In contrast, some authors cited by Andeweg/De Jong (2006) argue the anecdote should deal with well-known people "such as Nero, Wellington, Churchill and of course President Kennedy."

Vividness. In their investigation of the anecdote as an introductory technique, Andeweg/De Jong (2006) found that some textbooks advise the speaker to make the story lively and build suspense. This vividness of the story is also related to the anecdote's retention effect. Booher (2003) describes these qualities of the anecdote vividly when she advises to "add anecdotes to touch all five senses":

> The setting creates the visual. Dialogue engages the ear. And if you can add details that help listeners smell, taste, and feel the atmosphere, you have increased your chances dramatically that they will remember your story and the point it illustrates.

This characteristic of an anecdote resembles classical-rhetorical concepts such as *evidentia* or *enérgeia*: the use of vivifying words and figures to bring a scene before the audience's mind's eye (Fahnestock 2011).

Brevity. Five textbook authors mention that an anecdote should be a short, uninterrupted story. This characteristic distinguishes the anecdote from a story or narrative element that is spun out over an entire speech. The notion of brevity is subject to interpretation, though: where Linkletter (1980) sees possibilities for several two-minute anecdotes in a fifteen-minute speech, Atkinson (2004) warns anecdotes that last longer than a minute run the risk of becoming "shaggy dog stories."

Relevance. An anecdote is not just a story on its own, separate from the rest of the speech, according to quite some textbook advisors. It should be relevant and clearly be linked to the central idea(s) of the presentation or speech or "illustrate key messages" (Atkinson 2004). Krusche (1986) also refers to the link between the anecdote and the speech's content: "[anecdotes] will be remembered better by the audience, also in connection with the actual speech." This need for clarifying the relevance shows similarities with the classical-rhetorical narrative form *chreia*, which often took the form of an anecdote that was ex-

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panded on and concluded with a deed or "pithy saying" (Fahnestock 2011). Atkins/Finlayson (2013) note the chreia usually has a (moral) message, therewith resembling a parable, but differs from the parable in that it is rooted in reality – just as the anecdote.

Humor. Finally, anecdotes are often considered to be humorous. Ehninger et al. (1978) state that "humorous anecdotes [...] all may serve effectively to illuminate your central idea in an entertaining and memorable way" – a quote that suggests non-humorous anecdotes might not be memorable or that anecdotes are humorous by default. Atkinson (2004) suggests there is a link between humorous anecdotes and long-term memory:

> [...] if you illustrate a key point with an example or anecdote that makes an audience laugh, the laughter not only implies agreement with the point, but also increases the chances of it being remembered in the longer term.

In short, modern public speaking textbook advisors frequently describe the anecdote as a technique to influence retention, and in some cases attribute specific characteristics to this retention function. Although this overview of retention advice is insightful, it also reveals two problems. First, textbooks only provide few examples and details about the use of the anecdote in real-life presentations. Only incidentally an exemplary anecdote is described. Next to that, not all authors describe the anecdote and its characteristics in a detailed way, and those that do are not in agreement on the elements an anecdote can comprise. Second, textbooks hardly refer to scientific sources to support retention claims of specific anecdote characteristics, which makes it difficult to assess the value of the retention claims made.

2.2 Possible Retention Effect of Anecdotes: Elaboration and Narrative Elements

How could the use of an anecdote lead to information retention in the long-term memory? Cognitive memory research and empirical studies into narrative elements offer some points of reference to answer that question. [2]

2 This article by no means intends to provide an exhaustive overview of memory research. Human memory is a complex system investigated in many research disciplines. The theory is used here to obtain insight into how the retention process could work when a presentation or a speech is given.

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Cognitive memory research shows that the way information is processed, interpreted or filtered determines for a large part whether it will be stored for a longer period and can be retrieved after a while (Baddeley et al. 2009). *Attention* is an important condition for the susceptibility to store and retrieve information. Subsequently, once information is taken in, it is first 'encoded' (Baddeley et al. 2009; Craik 2007). This process can be compared to the task of organizing possessions when moving into a new house; labelling items and boxes in order to locate them upon arrival in the new residence. Important encoding principles are (1) *organization*, how information is structured, (2) *visualization*, whether an image or picture is present or can be created mentally, and (3) *elaboration*, the extent to which information can be linked to or associated with existing knowledge in the memory (Baddeley et al. 2009; Zimbardo et al. 2005).

Narratives such as an anecdote could stimulate the encoding processes of elaboration and visualization by linking to existing knowledge and painting a mental picture of a series of events. Dahlstrom (2014) states that narratives are "often associated with increased recall" and suggests that they can positively contribute to long-term memory storage. In a public speaking context, a study by Andeweg/De Jong (2006) already implied the anecdote can increase attention of an audience. They compared its use as an introductory technique in informative presentations to two other opening strategies; although recall was not explicitly measured, the anecdote received a high score on drawing attention (*captivation*), scored average on comprehensibility, and lowest on credibility.

Furthermore, research into persuasion via narratives in texts suggests that linguistic and stylistic variations in anecdotes could influence elaborative encoding and retention, for example via the notions of *identification*, *transportation*, and *absorption*. Although these studies are focused on persuasive effects in texts, the results could indicate influential retention factors in public speaking situations.

First of all, identification, known as an influential rhetorical concept (cf. Burke 1973), can play an important part in the persuasive effect of narratives. Several studies have shown that the extent to which a reader can identify with the main character can influence persuasion positively (De Graaf et al. 2012; Hoeken et al. 2016). Drivers for narrative persuasion via identification are the perspective used in the story (e.g., a first-person or a third-person perspective) and the similarity the reader experiences with the character. A higher perceived similarity with the main character can mediate persuasion, just as a first-person perspective can be more effective than a third-person perspective (De Graaf et al. 2016; Hoeken et al. 2016).

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Secondly, closely related to identification are the notions of transportation and absorption: a reader can be transported into a story and experience the emotions and events as if he or she were in the shoes of the main character (Green/Donahue 2009). Craftsmanship in style and the quality of the story can lead to a higher "transportability" of a story (Green/Donahue 2009).

3 Rhetorical Analysis: Corpora and Method

Section 2 made clear that public speaking advisors connect the anecdote to information retention, and it discussed theories to clarify how a retention effect might be established. A follow-up question is whether this advice has found its way to speech-making practice, and if so, in what form. As a first step towards finding out, a corpus of popular online TED talks and a corpus of presentations by scholars held at the VIOT conference of the Dutch-Flemish Society for scholars in the field of (applied) communication studies were analyzed.[3] This section details the composition of both corpora (TED talks and research presentations) in section 3.1, followed by an explanation of the method of analysis, based on an operationalization of the anecdote and its characteristics, in section 3.2.

3.1 Corpus Construction

To map the typical use of anecdotes in TED talks and research presentations, two corpora of 16 speeches and presentations each were constructed. These two corpora were chosen for two reasons. First of all, as they represent different genres, the analysis of the presentations could show whether the use of anecdotes as a retention technique could be genre dependent. For example, the two genres differ in the extent to which the presentations are prepared. TED talks generally are rehearsed various times, whereas research presentations at conferences are usually only rehearsed a few times or even not at all (cf. Romanelli et al. 2014, who compare TED talks and academic lectures). With this in mind, speakers in the TED corpus seem more likely to be qualified as "professional speakers," whereas the scholars in the Research Presentations corpus could be more easily seen as "speaking professionals." Would this difference be reflected

3 Many thanks to Brigitte Hertz for sharing the corpus of research presentations and to Lisanne Mijnders and Nanouk Bel, Master students Rhetoric and Argumentation at Leiden University, for their support in analyzing the research presentations and TED talks.

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in the way anecdotes are applied? Secondly, although the corpora differ in genre, scholars are involved as speakers in both corpora. This presents an opportunity to review whether narratives such as an anecdote are a typical science popularization technique.

Table 1 provides an overview of the corpora based on six characteristics. The first three (context, audience composition, and main purpose) give insight into the rhetorical situation in which the presentations within each corpus were held; related to Bitzer (1968), these three characteristics indicate how the audience and constraints such as the occasion of the presentation (context) might influence the rhetor (here: the scholar or TED speaker) and how the exigence of the situation is experienced by both rhetor and audience. The second three characteristics (source text, mean number of words, and total length) provide information on the nature of the presentation texts. The various characteristics of the corpora will be specified and elaborated on in the remainder of this section.

Tab. 1: Overview of the most important characteristics of the analyzed presentation corpora.

Corpus characteristics	**TED corpus (n=16)**	**Research Presentations corpus (n=16)**
Context	Most popular TED talks online, April 1, 2015; held at various TEDx conferences	Dutch-Flemish conference on applied linguistics and rhetoric in 2008
Audience composition	Mixed/broad	Colleagues/experts
Main purpose	To inspire	To inform
Source text	Text published online on www.ted.com	Transcriptions of video recordings
Mean words (sd)	2861 (901)	3419 (402)
Total length in words	45.768	54.704

Context. The TED corpus consists of the sixteen most popular (most viewed) talks online on TED.com, as measured on April 1st, 2015. The popularity of the talks is an indicator of a positive reception, although we did not study to what extent viewers appreciated the talks. It also suggests that these talks are prepared well. Six out of the sixteen TED talks were presented by scientists; the

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remaining speakers were popular science writers, authors of fiction, and advisors or consultants.[4]

The Research Presentations corpus consists of sixteen research presentations held at the triennial VIOT conference for Dutch and Flemish communication scientists, rhetoricians and argumentation theorists. The presentations fit into a fixed format of about twenty minutes, followed by a short discussion. The composition of this corpus has also been described by Hertz (2015).

Audience. The audience composition can be characterized differently for both corpora. TED talks are generally held in front of an engaged, interested audience (Romanelli et al. 2014) that bought a ticket or was invited to the event. The audience can be mixed in background (expertise, profession, education, etc.). The audience for the research presentations are usually fellow scholars, experts in the same discipline as the speaker or a field closely related. The audience composition could prompt speakers to select rhetorical techniques they seem suited for their specific audience and occasion.

Main purpose. Following from the difference in audience composition, the main purpose of the corpora differs as well. The TED talks are aimed at inspiring the (broader) audience. As the TED organization states, their mission is to "spread ideas," make them "accessible," and to "spark conversation" (TED 2017). The research presentations are mainly aimed at informing about recent research. Scientific conferences are places to share knowledge, and be informed of recent research developments in a particular field.

It is important to point out that we signal a difference in *main* purpose, as a mixture of secondary purposes can be ascribed to the presentations in both corpora as well. For instance, a TED speaker might need to persuade the audience of the urgency of the issue addressed in the speech and a scholar could feel the need to persuade fellow researchers of certain research method's effectiveness. It is plausible that retention is a secondary purpose for speakers in both corpora. Both to inspire and inform an audience, a certain extent of information seems indispensable.

Source text. Of both corpora only the speech or presentation text was used. As the analysis was aimed at linguistic and stylistic features of anecdotes, delivery aspects (gestures, voice, expression) were not taken into account. Therefore,

4 The selection of TED talks was initially made with the purpose to compare the use of the anecdote as a possible retention technique in two different presentation genres. This explains why the TED corpus does not contain talks given by scientists only. With this in mind, we still feel that this corpus selection offers opportunities to touch upon the role of anecdotes in (science) popularization.

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video recordings were not used. For the same reason, the (PowerPoint) slides and visual aids used were not analyzed. The nature of the text sources varies somewhat. The texts of the presentations in the TED corpus were obtained from TED.com. These speech texts are transcriptions of the videos, but they are slightly edited to make them easily readable. The texts in the Research Presentations corpus were exact transcriptions from video recordings, which means they contain conversational cues such as gap fillers ("eh…") and mispronunciations or mistakes.

Length (mean and total number of words). The research presentations are longer than the TED talks and do not vary much in length. This is due to the fixed format of the research conference: a presentation of about twenty minutes, followed by a short discussion. The discussions after the research presentations were not taken into account in this analysis. The TED talks are a bit shorter than the research presentations. The standard deviation of the speech length is higher, as the length of the TED talks is more flexible. The maximum length of a TED talk is about eighteen minutes, but some are shorter (nine / twelve / fifteen minutes).

Despite the differences between the corpora, we believe the texts are suitable for the analysis described in this study, since the emphasis of this study is on a rhetorical technique that is likely to reveal itself in a presentation or speech text – the anecdote. At the same time, it should be noted that some factors that could possibly amplify a retention effect, such as visual aids and delivery by the presenter, were not analyzed.

3.2 Method of Analysis: Labelling and Reliability

To be able to discern anecdotes in the presentation texts, labelling instructions were developed which contains a working definition of the anecdote. To reliably detect the technique in the analyzed materials, the definition was operationalized by determining indicators (recognizable text features). The definition and characteristics applied in this study are based on the analysis of textbook advice and the sources and research into the anecdote, narratives, and question figures discussed in section 2. Table 2 gives an overview of the definition and characteristics of the anecdote as used in this analysis.

Table 2 shows that anecdote characteristics such as *relevance* and *humor* are not part of the labelling instructions. These features are not easily operationalized in a text and could require a more in-depth, content analysis of the entire speech. However, *relevance* is considered when interpreting possible (retention) effects and variety in use of anecdote in section 4.

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Tab. 2: Overview of the definition and characteristics of the anecdote as used in this analysis.

Working definition	**Characteristics / indicators (recognizable text features for labelling)**
An anecdote is a short story that:	The text marked as anecdote:
is brief	is not interrupted by another part of the speech
contains one or more story characters	contains one or more story characters, for example marked by (a change in) the story perspective in the text (e.g., from general information or 'they' to an 'I' / first-person perspective)
is a narrative with a story development from beginning to end	contains elements of narrative structure, such as orientation, a sequence of events, and a wrap-up

Apart from the definition and characteristics described in table 2, several other labelling agreements were made to systematize the analysis by different raters. For instance, examples of text signals to recognize the techniques (e.g., the transition to another perspective in the speech text) and the exact starting and ending point of text that was to be coded were recorded in the instruction.

The speech and presentation texts from both corpora were systematically coded via the data analysis software Atlas.ti. Two researchers independently analyzed four speeches from both corpora (eight in total), using the labelling instructions. This analysis showed a substantial inter-rater reliability between the raters (κ=.69, $p<.001$).

4 Results: Frequency and Examples of Anecdote Use

How do TED speakers and researchers apply anecdotes in their presentations? This section discusses the results of the rhetorical analysis. First, quantitative results will be presented to show possible trends in similarities or differences in frequency of use by the two groups of speakers investigated in section 4.1. After that, section 4.2 will zoom in on examples of the use of the anecdote and questions by TED speakers and scholars, to show stylistic and linguistic variance and to interpret the use of the anecdotes in light of possible information retention.

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4.1 Frequency of Anecdote in TED Talks and Research Presentations

Table 3 shows the frequency of the anecdote within the two corpora and the average anecdote length.

Tab. 3: Frequency of anecdote use in TED corpus and Research Presentations corpus expressed in the total occurrence, average per presentation/speech. Furthermore, the average anecdote length (standard deviation in parentheses) and the total number of words used in anecdotes as a percentage of the total corpus length are shown.

Anecdote frequency	TED talks (n=16)	Research presentations (n=16)
Total number	22	5
Average per presentation (sd)	1,4 (1,7)	0,3 (0,6)
Average anecdote length in words (sd)	256 (195)	103 (47)
Total words used in anecdotes in percent of total number of words in corpus	8,2%*	1,1%*

* $p<.05$ ($F(2, 27.09) = 4.50$)

Compared to the research presentations, over four times as many anecdotes are used in the TED talks. This difference is not significant, though, which might be explained by the unequal distribution of anecdotes over the various TED speakers: the twenty-two anecdotes are used by nine of the sixteen TED speakers. In two TED talks the speakers attain as many as five anecdotes in a speech (Ken Robinson and Mary Roach), whereas seven speakers do not apply any anecdotes. The six scientists in the TED corpus together account for four anecdotes.

On average, the anecdotes in the TED corpus are longer than those in the research presentations. About 8 percent of the number of words in an average talk from the TED corpus are part of an anecdote; in the Research Presentations corpus that is just over 1 percent ($p<.05$). Such a difference in length suggests that TED speakers take more time to elaborate an anecdote and might be more able to exploit anecdote characteristics as listed in section 2.2. However, table 3 also shows the anecdote length in the TED corpus fluctuates quite a bit; within the TED corpus itself, the anecdote comes in various tastes and sizes. All in all, the researchers seem to take the brevity criterion of the anecdote seriously, whereas the TED speakers use more words to shape their narrative.

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4.2 Typical Anecdote Use in TED Talks and Research Presentations

The quantities of the techniques per corpus can indicate trends, similarities, and differences, but they do not provide any insight into the stylistic and linguistic features of the examples used. To map the variety in use of the anecdote and assess possible retention effects, this section zooms in on the actual use by the TED speakers and researchers analyzed. To this end, in this section examples of anecdotes from both corpora will be reviewed on anecdote characteristics discussed in 2.2*: narrative elements*, *vividness*, and *relevance*.[5]

Anecdotes in TED Talks Contain More Narrative Elements

In both the TED talks and the research presentations, the main character in the anecdotes usually is the speaker, hence the anecdotes are often told from a first-person perspective. The following two examples illustrate this use of first-person perspective, which could be a condition for the audience to identify with the story and main character.

> (1) So at the end of my first year at Harvard, a student who had not talked in class the entire semester, who I had said, "Look, you've gotta participate or else you're going to fail", came into my office. I really didn't know her at all. She came in totally defeated, and she said, "I'm not supposed to be here".
> And that was the moment for me. Because two things happened. One was that I realized, oh my gosh, I don't feel like that anymore. I don't feel that anymore, but she does, and I get that feeling. And the second was, she is supposed to be here! Like, she can fake it, she can become it. So I was like, "Yes, you are! You are supposed to be here! And tomorrow you're going to fake it, you're going to make yourself powerful, and, you know" – [Applause] "And you're going to go into the classroom, and you are going to give the best comment ever." You know? And she gave the best comment ever, and people turned around and were like, oh my God, I didn't even notice her sitting there. [Laughter]
> She comes back to me months later, and I realized that she had not just faked it till she made it, she had actually faked it till she became it. So she had changed. And so I want to say to you, don't fake it till you make it. Fake it till you become it. Do it enough until you actually become it and internalize. (Cuddy 2012, TED corpus)

5 Two characteristics are not taken into account in this section: *brevity* is already touched upon in 4.1; *humor* was considered to be a complex phenomenon that would require a more thorough analysis taking humor theories into account.

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(2) Standardizing always happens for a number of reasons and most of these reasons have nothing to do with language but all with economy. For example that cost-saving element, the clear brand image they want to show, the fact that they control the communication activity are all important things the marketing people keep themselves occupied with. To illustrate this: this morning on the train to Amsterdam I stopped at the familiar train stations, you'll know them. At the first station in Roosendaal I see this Coca Cola advertisement with the well-known Santa Claus and the perfectly understandable message "Merry Christmas". So Coca Cola does not need to adapt its message, they keep it nice and standard. (Research presentation #4 [translation: MW]. Topic: visual rhetoric. Conference was held around Christmas time.)

In both examples, the speaker is the main character in the anecdote. However, example 1 is longer and more detailed than example 2, which means the audience has more time to familiarize with the "I-person." The audience gets to know more about the main character in example 1, which is Cuddy herself in her position as a lecturer and scholar in social psychology. She explains her emotions and the motivation for her actions in the situation described in the anecdote; e.g., "One was that I realized, oh my gosh, I don't feel like that anymore. I don't feel that anymore, but she does, and I get that feeling." Moreover, example 1, the TED talk, contains a second character the audience might recognize or familiarize with – the student. Interestingly enough, in the story Cuddy identifies herself with the student – Cuddy recognizes the student's situation; she realizes she once was in a similar position as the student, but she has moved on since. The story describes the student going through a similar process Cuddy experienced before, which adds an extra layer to the identification process.

Example 2 contains a clear change to a first-person perspective: the advertising principle of standardizing is illustrated with a personal story ("this morning… I stopped…"). The anecdote text itself provides little detail on the main character, which gives the audience less opportunity to get acquainted with the speaker. However, considering the presentation context of example 2, the audience as colleagues or fellow researchers might already experience a higher perceived similarity in the first place. Still, based on the anecdote text itself, example 1 contains more features that could incite identification and transportation processes with the audience.

Regarding other narrative elements, the two examples show a difference as well. Example 1 shows a narrative development: there is a point of departure, with Cuddy's student feeling insecure and "defeated," culminating into a final situation in which she is more powerful and secure. This is combined with an indication of time: in between the "end of my first year at Harvard" and "months later," the student's transformation has taken place. The location is

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also mentioned, albeit not described in detail: Harvard, Cuddy's office, and the classroom.

In example 2, an indication of time is given as well ("this morning"). It also mentions a location the audience can easily imagine: a train, and a railway station in The Netherlands. However, example 2 hardly contains a narrative development: the main character stops at several train stations and at one particular train station his attention is drawn to an advertisement. The story development in example 1, therefore, lends itself more to an audience experience of absorption or transportation.

It is not always clear whether an exemplifying or narrative-like fragment of a presentation text can be determined as an anecdote based on characteristics such as story perspective and narrative elements, as example 3 shows:

> (3) Behavior predicts behavior. Everyone who takes the elevator to the office in the morning will probably know the phenomenon that in the rare occasion you need to be on another floor, nine out of ten times you still get off on your own floor by accident. Or just the fact that whenever I am in the elevator, I automatically push that button, okay, in the Erasmus building it is outside of the elevator, that button of the floor I normally go to (mild laughter), because only seeing these buttons already evokes the response "eight", and there you are again, whereas you actually had to go to, well, the fifth. After a few weeks, a habit has been ingrained. (Research presentation #16 [translation: MW]. Topic: message design to influence behavior.)

Compared to examples 1 and 2, it is more difficult to distinguish a main character in this example. The fragment does not contain a first-person perspective, but a more general "everyone" in the first sentence and a second-person perspective ("you") afterwards. This could obstruct an audience from perceiving similarity with a main character, although audience members might recognize themselves in the situation portrayed. The narrative development is less clear than in the previous example; it can be argued however that this short story shows some sort of development from an opening scene to a new or changed situation. Still, clear temporal indicators are absent, and the story is not that detailed. It could be deemed as an example of a more abstract anecdote, which meets (some of) the criteria set in section 3 more implicitly. It also illustrates the challenges raters come across when trying to detect anecdotes in a presentation text.

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Anecdotes in TED Corpus Are More Vivid

The anecdotes in the TED corpus contain more stylistic and linguistic elements that make them more vivid. Examples 3 and 4 illustrate differences in vividness between the two corpora.

> (4) So, I'll start with this: a couple years ago, an event planner called me because I was going to do a speaking event. And she called, and she said, "I'm really struggling with how to write about you on the little flyer." And I thought, "Well, what's the struggle?" And she said, "Well, I saw you speak, and I'm going to call you a researcher, I think, but I'm afraid if I call you a researcher, no one will come, because they'll think you're boring and irrelevant". [Laughter] And I was like, "Okay". And she said, "But the thing I liked about your talk is you're a storyteller. So I think what I'll do is just call you a storyteller." And of course, the academic, insecure part of me was like, "You're going to call me a what?" And she said, "I'm going to call you a storyteller." And I was like, "Why not magic pixie?" [Laughter] I was like, "Let me think about this for a second." I tried to call deep on my courage. And I thought, you know, I am a storyteller. I'm a qualitative researcher. I collect stories; that's what I do. And maybe stories are just data with a soul. And maybe I'm just a storyteller. And so I said, "You know what? Why don't you just say I'm a researcher-storyteller." And she went, "Ha ha. There's no such thing." (Laughter)
> So I'm a researcher-storyteller, and I'm going to talk to you today – we're talking about expanding perception – and so I want to talk to you and tell some stories about a piece of my research that fundamentally expanded my perception and really actually changed the way that I live and love and work and parent. (Brown 2010, TED corpus)

> (5) And I think it is a beautiful sequence of turns. I showed it to my students once and I told them I [eeh] had printed this and hung it over my desk, because to me it was a kind of little poem, a poetic chord, in fact [mild laughter], and they looked very puzzled and surprised, as if to say: "she is completely professionally deformed". But I think it is a very beautiful [eeh] [eeh], beautiful little poem, actually. Well, I added that I have also hung the the ordinary pictures of my kids over my desk [laughter], and then I slowly started to turn into a normal [eeh] person again [laughter]. But it is a [eeh], yeah, sequence of turns that is needed to eventually mutually reach such a, yeah, mutual understanding. (Research presentation #10 [translation: MW]. Topic: conversational analysis.)

Example 4 shows an anecdote in a TED talk by Brené Brown, research professor at the University of Houston Graduate College of Social Work and well-known author. In her talk, she recounts a telephone conversation she had. She uses direct speech, which could increase proximity: the audience might experience the anecdote as if overhearing the conversation. Brown uses an informal style register, close to everyday conversation, with phrases such as "I was like…", and "and she went…". In example 5, from the Research Presentations corpus, the speaker describes a conversation she, as a lecturer, had with her students. Although some of the descriptions in this anecdote are quite detailed and set

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the scene, such as the "puzzled and surprised" looks of the students, she rather uses indirect speech to describe her conversation with the students ("I told them…", and "I added that…"). This could make the audience feel less directly involved, compared to Brown's anecdote.

Overall, the TED corpus contains anecdotes that seem more closely related to the concepts of evidentia and enérgeia, in which a situation is depicted vividly to the audience's mind's eye (see section 2.1). This is illustrated by example 6, a fragment of an anecdote by novelist Elizabeth Gilbert (a "non-scientist" in the TED corpus).

> (6) I had this encounter recently where I met the extraordinary American poet Ruth Stone, who's now in her 90s, but she's been a poet her entire life and she told me that when she was growing up in rural Virginia, she would be out working in the fields, and she said she would feel and hear a poem coming at her from over the landscape. And she said it was like a thunderous train of air. And it would come barreling down at her over the landscape. And she felt it coming, because it would shake the earth under her feet. She knew that she had only one thing to do at that point, and that was to, in her words, "run like hell." And she would run like hell to the house and she would be getting chased by this poem, and the whole deal was that she had to get to a piece of paper and a pencil fast enough so that when it thundered through her, she could collect it and grab it on the page. (Gilbert 2009, TED corpus)

Here, Gilbert paints a scene with words, using metaphors and imagery to try and make the audience part of the dramatic situation. She carefully chooses words that express emotions, experiences, and movement. Such linguistic and stylistic features are in line with the "craftsmanship and style" Green/Donahue (2009) relate to enhanced transportation into the narrative.

TED Corpus: Relevance More Explicitly Emphasized

Relevance is another anecdote characteristic often related to effectiveness and enhanced retention. An anecdote should be clearly embedded in the speech or even be explicitly connected to the speech purpose or its main message. Presentations in the TED corpus appear to emphasize the anecdote's relevance more explicitly.

Examples 2 and 5 from the Research Presentations corpus both end with a final sentence that more or less expresses the relevance of the anecdote. In example 2, first the relevance is stressed by the announcement "to illustrate this" and the final sentence ties the advertisement example to the principle of standardization. In example 4 the final sentence could be interpreted as the anecdote

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illustrating this concept of mutual understanding, although the anecdote itself is more about the researcher's admiration of the sequence of turns and the awkward yet funny situation that followed in class. For both example 2 and 4, the concepts illustrated do not seem to be key points but rather sub-points of the presentation.

To the contrary, the anecdotes in the TED talks often seem to illustrate key concepts or even the presentation's purpose, and the speaker usually emphasizes the link between anecdote and key point explicitly. In example 1, Cuddy uses the anecdote to stress the key message of her talk and explicitly stresses its importance by addressing the audience: "And so I want to say to you, don't fake it till you make it. Fake it till you become it." Brown (example 4) links the anecdote about being a "researcher-storyteller" in the beginning of her talk to the purpose statement: "so I'm a researcher-storyteller, and I'm going to talk to you today [...] and so I want to talk to you and tell some stories about...". From an audience retention perspective, it is valuable to see that anecdotes are rather explicitly linked to purpose statements and key messages, but are also used to illustrate what appear to be sub-points of the presentation.

5 Discussion and Conclusion

This paper presented an exploration of how the anecdote, an apparent retention technique, is used in TED talks and research presentation. Generally, this exploration has provided insights into practical anecdote use, using a working definition of the technique to be able to distil anecdotal fragments from the presentation texts with a substantial interrater agreement. Overall, the analysis has shown a wide variety in anecdote use in both corpora. Using the textbook advice on anecdote as a reference, the anecdotes applied in practice do not necessarily contain all the characteristics attributed to anecdotes – just as not all advisors agree on which criteria an anecdote should fulfil. Some anecdotes, found in the TED corpus, "tick all the boxes" in an elaborate way, others only contain a few less detailed anecdotal features (mostly found in research presentations).

This section discusses the main impressions of this exploration, organized into anchor points of this paper: a comparison of anecdote use between the corpora, the link to information retention, and science popularization. It is wrapped up discussing limitations and future research.

Comparison of anecdote use in corpora. Quantitatively, the TED speakers used more and longer anecdotes than the scholars in the research presenta-

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tions. Compared to the Research Presentations corpus, the TED corpus contained a significantly higher number of words spent on anecdotes expressed in the percentage of the total length of the corpus.

Upon closer inspection, the (relatively) longer anecdotes in the TED corpus were found to contain typical anecdote characteristics more elaborately and explicitly than the anecdotes in the research presentations. Although most anecdotes in both corpora contained a main character and were often told from a first-person perspective, which might increase the audience's perceived similarity and thus identification with the main character, the emotions and thoughts of the main characters in the TED anecdotes were more expanded on.

Furthermore, the TED anecdotes contained more detailed narrative elements such as temporal indicators, location, story development (a change in the initial situation), and explicit wrap-up or transition. Next to that, the TED anecdotes seemed to contain a more vivid style, suggesting to the audience that they are almost witnessing the situation portrayed in the story. The more detailed narrative elements and the vivid style are indicators for an audience to be transported into the story.

Finally, the TED anecdotes contained a more explicit connection to key points of the overall presentation, sometimes even the presentation's purpose. Although the anecdotes of the scholars were linked to the speech content as well, their relevance seemed to be less explicitly marked.

Genre differences could offer explanations for the described variety in anecdote use. TED speakers could be qualified as professional speakers compared to the scholars (speaking professionals), especially when the presentation's occasion is taken into account. The TED talks could potentially be viewed by a large (online) audience, which increases the need for a thorough, intensive preparation of the overall presentation. The purpose to inspire could lead to a focus on narrative techniques such as the anecdote, as opposed to the more informative purpose of the scholars.

Retention. The TED anecdotes contained more elaborate narrative elements that might increase identification and transportation with the audience. That way, the TED anecdotes could stimulate encoding processes such as elaboration, association, and (perhaps to a lesser extent) visualization, which can influence retention on a longer term. Moreover, the rather explicit connection of the anecdote to a relevant key point could make the audience attentive to the structure and organization of the speech – another indicator of possible retention.

The research presentation anecdotes seem less elaborate and detailed, and stress the anecdote's position and relevance within the overall presentation to a

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lesser extent. A previous study showed scholars might prefer structural retention techniques closely related to the encoding principle of organization, such as an explicit summary and announcement of the conclusion (Wackers et al. 2016). The choice for specific retention techniques might therefore be genre-dependent: in the mainly informative presentations to fellow scholars, researchers might favor organization strategies over elaboration techniques.

Science popularization. Scientists in the TED corpus used more elaborative and "rich" anecdotes than the scholars from the Research Presentations corpus. This observation corresponds with the impression that scientists view narratives as an effective rhetorical strategy in more popularizing presentations for a broader audience and more logical-scientific arguments in scientific talks to an audience of peers (cf. Dahlstrom 2014). This way, the anecdote is one of the narrative strategies scholars use to recontextualize often complex knowledge for a wider audience. The scholars in the TED corpus had carefully crafted their anecdotes, keeping their audience in mind – a rhetorically conscious approach, which intriguingly could also contribute to the critical impressions of "storifying science" and oversimplifying complex content as voiced by, for example, Bratton (2013). Interestingly, Brené Brown's anecdote (example 4) seems to pinpoint this duality: she feels she is a "researcher-storyteller," to which her conversation partner replies that "there is no such thing" – a statement Browns anecdote ironically refutes.

Limitations. This exploration only took two collections of presentations into account. The research presentations were from a specific area in humanities and social sciences, and a specific cultural background (Dutch-Flemish). More scientific disciplines should be taken into account to paint a more complete picture of anecdote use in research presentations, just as an analysis of various TED talk categories could provide a clearer overview of that specific presentation genre. Finally, not all talks in the TED corpus were given by scientists. To be more precise on the role of narratives in TED talks regarding popularization, it could be insightful to compare TED talks and research presentations given by the same scholars.

Future research. The exploration of anecdote use offers a point of departure and focus for future (retention) research into anecdotes. First of all, the analysis has pointed to specific anecdote features that could influence audience retention and reception. Future studies could focus on effects of these characteristics, for instance by comparing presentation variants with and without anecdotes in an experimental setup in which recall is measured. Such an approach could indicate to what extent anecdotes in presentations indeed affect audience in-

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formation retention and, if so, how anecdote features such as narrative elements, vivid language, and relevance are of influence.

Another promising perspective could be reception research of actual presentations, aimed at unravelling audience response to anecdotes. Genre differences could be taken into account here as well, for instance: would TED audiences indeed value narratives more than an audience of a research presentation? Still, more explorations of presentation practice in various genres are needed to pinpoint variations in application of rhetorical retention techniques, to be able to formulate hypotheses on possible effects. Results of such studies could contribute to more precise, evidence-based public speaking advice on retention techniques. All in all, this study has written the opening lines of the story of anecdote retention research. A story that no doubt will be elaborated on.

References

Alley, M., Scheiber, M., Ramsdell, K., & Muffo, J. (2006). How the Design of Headlines in Presentation Slides Affects Audience Retention. *Technical Communication,* 53(2), 225–234.

Andeweg, B. & de Haan, C. (2009). Overgangszinnen in een Powerpointpresentatie. *Studies in taalbeheersing 3* (Eds. W. Spooren, M. Onrust, & J. Sanders). Assen: Van Gorcum, 17–29.

Andeweg, B. & de Jong, J. (2004). *De eerste minuten. Attentum, benevolum en docilem parare in de inleiding van toespraken*. PhD thesis Nijmegen University. The Hague: Sdu Publishers.

Andeweg, B. & de Jong, J. (2006). Start With a Story. Theory Versus Practice of the Anecdote as Speech Introduction Technique. *The Map and the Landscape. Norms and Practices in Genre* (Eds. P. Gillaerts & P. Shaw). Bern: Peter Lang, 169–196.

Andeweg, B., de Jong, J., & Wackers, M. (2008). The End is Near. Effects of Announcing the Closure of a Speech. *Proceedings of the Professional Communication Conference IPCC*, IEEE International, Montreal. DOI: 10.1109/IPCC.2008.4610194.

Atkins, J. & Finlayson, A. (2013). '... A 40-Year-Old Black Man Made the Point to Me': Everyday Knowledge and the Performance of Leadership in Contemporary British Politics. *Political Studies*, 61(1),161–177. DOI: 10.1111/j.1467-9248.2012.00953.x.

Atkinson, M. (2004). *Lend Me Your Ears. All You Need to Know About Making Speeches and Presentations*. London: Random House.

Baddeley, A., Eysenck, M. W., & Anderson, M. C. (2009). *Memory*. Hove: Psychology Press.

Bitzer, L. F. (1968). The Rhetorical Situation. *Philosophy & Rhetoric*, 1(1), 1–14.

Booher, D. (2003). *Speaking with Confidence. Powerful Presentations that Inform, Inspire, and Persuade*. New York, NY: McGraw-Hill.

Bratton, B. (2003). We Need to Talk About TED. *Guardian*, December 30, 2013.

Brown, B. (2010). The Power of Vulnerability. *TEDxHouston*, June, 2010. https://www.ted.com/talks/brene_brown_the_power_of_vulnerability/transcript.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Burke, K. (1973). The Rhetorical Situation. *Communication: Ethical and Moral Issues* (Ed. L. Thayer). New York, NY: Gordon & Breach, 263–275.

Craik, F. I. M. (2007). Encoding: A Cognitive Perspective. *Science of Memory: Concepts* (Eds. H. L. Roediger III, Y. Dudai, & S. M. Fitzpatrick). New York, NY: Oxford University Press, 129–135.

Cuddy, A. (2012). Your Body Language May Shape Who You are. *TEDGlobal*, June, 2012. https://www.ted.com/talks/amy_cuddy_your_body_language_may_shape_who_you_are/transcript?language=en.

Dahlstrom, M. F. (2014). Using Narratives and Storytelling to Communicate Science With Non-expert Audiences. *Proceedings of the National Academy of Sciences*, 111, 13614–13620. DOI: 10.173/pnas.13206455111.

De Graaf, A., Hoeken, H., Sanders, J., & Beentjes J. W. J. (2012). Identification as a Mechanism for Narrative Persuasion. *Communication Research*, 39(6), 802–823. DOI: 10.1177/0093650211408594.

De Graaf, A., Sanders, J., & Hoeken, H. (2016). Characteristics of Narrative Interventions and Health Effects: A Review of the Content, Form, and Context of Narratives in Health-Related Narrative Persuasion Research. *Review of Communication Research*, 4, 88–131. DOI:10.12840/issn.2255-4165.2016.04.01.011.

Ehninger, D., Monroe, A. H., & Gronbeck, B. E. (1978). *Principles and Types of Speech Communication* (8th ed.). Glenview: Scott Foresman.

Fahnestock, J. (2011). *Rhetorical Style. The Uses of Language in Persuasion*. New York: Oxford University Press.

Gilbert, E. (2009). Your Elusive Creative Genius. *TED2009*, February, 2009. https://www.ted.com/talks/elizabeth_gilbert_your_elusive_creative_genius/transcript.

Green, M. C. & Donahue, J. K. (2009). Simulated Worlds: Transportation Into Narratives. *Handbook of Imagination and Mental Simulation* (Eds. K. D. Markman, W. M.P. Klein, & J. A. Suhr). New York, NY: Taylor and Francis, 241–254.

Hertz, B. (2015). *Spotlight on the Presenter. A Study Into Presentations of Conference Papers With PowerPoint.* PhD thesis Wageningen University.

History of TED. (2017). *TED*. https://www.ted.com/about/our-organization/history-of-ted.

Hoeken, H., Kolthoff, M., & Sanders, J. (2016). Story Perspective and Character Similarity as Drivers of Identification and Narrative Persuasion. *Human Communication Research*, 42, 292–311. DOI: 10.1111/hcre.12076.

Kaplan, R. M. & Pascoe, G. C. (1977). Humorous Lectures and Humorous Examples: Some Effects Upon Comprehension and Retention. *Journal of Educational Psychology*, 69(1), 61–65.

Krusche, H. (1986). *Neem het woord. Zelfverzekerd spreken in het openbaar* (2nd ed.). Baarn: Bigot/Van Rossum.

Labov, W. (2003). Uncovering the Event Structure of Narrative. *Georgetown University Round Table 2001* (Eds. D. Tannen, & J. E. Alatis). Washington, DC: Georgetown University Press, 63–83.

Linkletter, A. (1980). *Public Speaking for Private People*. Indianapolis, IN/ New York, NY: The Bobbs-Merrill Company Inc.

Osborn, M. & Osborn, S. (1997). *Public Speaking* (3rd ed.). Boston, MA: Houghton Mifflin.

Romanelli, F., Cain, J., & McNamara, P. J. (2014). Should TED Talks Be Teaching Us Something? *American Journal of Pharmaceutical Education*, 78(6), 113. DOI: 10.5688/ajpe786113.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Scotto di Carlo, G. (2014a). The Role of Proximity in Online Popularizations: The Case of TED Talks. *Discourse Studies*, 16(5), 591–606. DOI: 10.1177/1461445614538565.
Scotto di Carlo, G. (2014b). Ethos in TED Talks: The Role of Credibility in Popularised Texts. *Facta Universitatis*, *Series*: *Linguistics and Literature*, 12(2), 81–91.
Sugimoto, C. R., Telwall, M., Larivière, V., Tsou, A., Mongeon, P., & Macaluso, B. (2013). Scientists Popularizing Science: Characteristics and Impact of TED Talk Presenters. *PLOS One*, 8(4), 1–7. DOI: 10.1371/journal.pone.0062403.
Urech, E. (1998). *Speaking Globally. Effective Presentations Across International and Cultural Boundaries*. Dover: Kogan Page.
Wackers, M., de Jong, J., & Andeweg, B. (2016). Structure Strategies for a Memorable Speech: The Use of Rhetorical Retention Techniques by Scholars and Politicians. *Rhetoric, Knowledge and the Public Sphere* (Eds. A. Kampka, & K. Molek-Kozakowska). Bern: Peter Lang, 75–92.
Witt, C. & Fetherling, D. (2009). *Real Leaders Don't Do Powerpoint*. New York: Crown Business.
Zimbardo, P. G., Weber, A. L., & Johnson, R. L. (2005). *Psychologie. Een inleiding* (5th ed.) Amsterdam: Pearson Education Benelux.

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Thomas Susanka

Questions and Dialogue in Science Communication

The Rhetoricity of Complex Stories in *Radiolab*

1 Introduction

Public engagement with science is commonly identified as a primary goal of science communication (cf. Bauer 2017). The critical term *engagement* overtly aims at inducing action in the audience that points at the rhetorical dimension of science communication. However, many forms of science communication assign the role of a more or less passive recipient to the audience. Presentations, for example, have become an immensely popular form of science communication, as is evidenced by events such as a TEDx talk in Bueons Aires with up to 10,000 attendees (Reissman 2014). But presenters at such events rarely have the chance to interact with the audience – and by the same token, it is virtually impossible for the audience to intervene, e.g., to ask questions about the science and hence solidify their engagement with it.

This restriction can be best described with Bitzer's concept of constraints in rhetorical situations (Bitzer 1968). For Bitzer, situations, i.e., the "complex of persons, events, objects, and relations" (Bitzer 1968), are the determining forces a speaker has to deal with in order to be a successful communicator.[1] Most importantly, situations imply social rights about who may speak and who is required to remain silent. Hence, we could say that a critical situational constraint of presentations is the enforcement of a unidirectional monologue or soliloquy by the speaker and a consequential muting of the audience – at least for a period of time. To be sure: without this constraint, presentations would not be possible and could not be effective.

We find similar situational constraints in other popular forms of science communication: most notably written texts such as articles in newspapers and magazines, films and videos, YouTube-channels, or auditive formats such as radio shows or podcasts. We may venture to think that these forms of communication may mute the audience but by the same token enable the individual con-

1 Knape pursues a similar idea with the concept of 'situative resistance' (Knape 2013).

https://doi.org/10.1515/9783110676310-006

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strual of knowledge as a quiet and individual mental activity. But, of course, Socrates famously claimed in *The Symposion*, that wisdom cannot be poured like water from a full vessel into an empty cup, but instead requires, as maintained in the *The Republic,* active participation on the side of the one aspiring to attain knowledge (Allen 2006). That is of course why he favored the interactivity of dialogue, reflecting a conception of knowledge that is also held by contemporary educational researchers – most notably in the *Cognitive Theory of Inquiry Teaching* developed by Collins (1981).

Hence, a crucial question for successful science communication seems to be how to ensure participatory engagement on side of the audience in light of severe situational constraints that mute the audience and confine it to passivity. In this paper, I would like to inquire into the challenges of science communication imposed by a muted audience. In doing so, I will examine the case of the widely popular US-American radio show and podcast *Radiolab*. By means of an exemplary rhetorical analysis, this explorative paper aims at uncovering rhetorical techniques and devices applicable throughout a wider range in science communication.

2 Radiolab

Radiolab is an experimental radio show and has been on the air since 2002 on over 550 radio stations in the United States. It focuses on a variety of topics, yet a large bulk of the content is related to science – and *Radiolab* is remarkably successful in featuring these topics. According to their hosting radio station WNYC, the show has around 1,3 million weekly listeners and 7 million monthly on-demand-listens, i.e., for example by people listening to podcasts (New York Public Radio 2017). The show is not only very popular, but also claims to be successful in reaching its (partial) communicative goal of science communication, as a listener-survey of 2009 commissioned by WNYC suggests (Flagg 2009).[2] This survey reports some remarkable numbers:

> 91% of listeners could keep up with and follow the presentation of topics.
> 77% felt the show affected the way they think about choices.
> 76% said the process of science is clear when discussed on the show.
> 68% agreed the show increased awareness of the influence of science on our lives.

2 As a commissioned survey, its results need to be taken with a grain of salt, of course. However, the survey's method generally adheres to accepted standards of empirical research.

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> 59% thought the show raised their awareness of scientific methods and processes.
> 29% were familiar and 42% were unfamiliar with most of the information in the show. (Flagg 2009)

The numbers suggest that the show is quite good at explaining complex issues. Also, listeners follow the program and actively engage with the topics – indeed, from the perspective of science communication research, the show appears to be immensely effective. We still may make note of one caveat: the reported numbers refer to the self-assessment of the audience and hence do not necessarily report reality or actual behavior. But especially with regard to the goal "engaging with science topics," self-reported data seems to be a reliable indicator of the effectiveness of the show. How does the staff behind *Radiolab* achieve this? How does the show work?

3 A Complex Dialogue

On their website, we can find the following self-description which gives us some cues about the working principles of *Radiolab*: *Radiolab* is "[a] show about curiosity. Where sound illuminates ideas, and the boundaries blur between science, philosophy, and human experience" (Radiolab 2020).

To start with, sound-design plays an important role in the show's concept as can already be observed in the tonal complexity of the introductory sound clip that is played at the beginning of each episode. While the complex sound-design is elementary for the show, this short sound clip also points at a key-characteristic of the overall approach to science communication of the program: There's a polyphony of voices and we can observe a conversational dialogue style that is marked by elements of question and response.

Let's see how this manifests itself in the entire show. In order to do so, I would like to briefly walk through an exemplary episode, aiming to uncover some basic principles underlying it. This exemplary analysis focuses on the episode "From tree to shining tree" (Abumrad/Krulwich 2016) that first aired in July 2016.[3]

3 To be clear: this is not designed to be a structural analysis of the entirety of all *Radiolab* episodes which would require much more extensive research. Rather, the exemplary analysis of the episode aims at uncovering underlying communicative principles that may also hold in other *Radiolab* episodes and may also be relevant in other contexts of science communication.

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After the already mentioned introductory sound clip, the episode starts off with the two hosts, Jad Abumrad and Robert Krulwich, introducing themselves and the show. Here, they directly address the audience of the program, basically saying “Hello and welcome.” Afterwards, they engage in an informal conversation where they talk to each other and directly address the audience as well.

After this initial chat, the hosts engage with the topic of the episode. This is also the moment when each of them takes up a role or function for the rest of the episode: Robert Krulwich assumes the role of the narrator and begins to tell a story to the other host, Jad Abumrad, who assumes the role of the listener, functioning as a step-in audience or virtual audience, as we may call it. From this moment on, the audience in front of the radio is no longer directly addressed but is made to overhear a dialogue, where one host functions as a figure of identification for the listeners. This moment is flagged with conventional markers for storytelling by the narrator, such as “This story [...] begins with a woman” (Abumrad/Krulwich 2016) and by setting the scene for a story as in “I'd like to begin by building a tall, dark, dense green forest making towering trees to your left” (Abumrad/Krulwich 2016). In the meantime, the host that functions as a virtual audience, Jad Abumrad, highlights his role by being an active listener, constantly interacting with the storyteller by means of prosodic sounds and interjections.

In a next step, the dialogue becomes more complex as the narrator Robert Krulwich introduces additional audio-material to advance the story. In this material, he engages in another conversation, where he talks with the central figure of the show: the professor Suzanne Simard, who herself tells him her story. The web of dialogue gets more complex as they take turns in telling the story together and boundaries begin to blur as the role of the narrator Robert Krulwich shifts between that of a storyteller and that of an interviewer.

From a rhetorical perspective, what happens at the beginning of the episode is a quite typical case of narration, where techniques of vividness are employed to depict an event, all in preparation of the argumentation – the explanation of the science (Kemmann 1996). In this case, we learn about how Suzanne Simard initially became interested in the roots of trees as a child. This narration prepares the explanation of her research about how trees of different species in a forest exchange nutriments and even communicate with each other by means of a giant web created by a fungus attached to their roots.

The basic framework of storytelling is maintained during the episode, yet as we move along, more time is spent on explaining the scientific discoveries of Simard. The already complex dialogue of three participants is extended as more and more people join this virtual conversation. We may call it “virtual” as the

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dialogue is, of course, a construct of the editing room. The narrator Robert Krulwich introduces further interviewees and we also have an additional reporter/producer, Latif Nasser, join the conversation later on. He again brings in even further interview-sequences. Hence, in this exemplary *Radiolab* episode, science is explained by means of complex polyphony. Even more, it is not merely a large group of people talking but these interview-snippets and their background sounds also take us on an auditive journey to different locations.[4]

To preliminarily conclude, we can say that in this episode, *Radiolab* communicates science by interweaving stories and explanations into a complex form of dialogue. Given that the production of such an episode requires a huge amount of editing, we may step back and ask: Why? Why would one create such complex polyphony in order to communicate science? In doing so, *Radiolab* seems to make use of several communicative techniques at the same time. In a next step, I would like to take a closer look at them and see how they potentially contribute to successful science communication.

3.1 Storytelling

Most obviously, *Radiolab* uses storytelling and there is already ample research on how science communication to non-experts can profit from forms of storytelling. Concerning the effectiveness of storytelling in science communication, Michael Dahlstrom concludes in a paper investigating research of the last 40 years:

> Narratives offer increased comprehension, interest, and engagement. Nonexperts get most of their science information from mass media content, which is itself already biased toward narrative formats. Narratives are also intrinsically persuasive, which offers science communicators tactics for persuading otherwise resistant audiences, although such use also raises ethical considerations. (Dahlstrom 2014)

Dahlstrom (2014) opposes storytelling to "[l]ogical-scientific communication," which "is context-free in that it deals with the understanding of facts that retain their meaning independently from their surrounding units of information" (Dahlstrom 2014). In contrast, "narrative communication is context-dependent because it derives its meaning from the ongoing cause-and-effect structure of the temporal events of which it is comprised" (Dahlstrom 2014).

4 Technically, this points to the fact that what we are hearing is not a pure form of storytelling, but a blended form that also features elements of reportage and radio play.

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In this sense, storytelling can be seen as a technique of recontextualizing scientific facts that also makes them, as Dahlstrom argues, intrinsically persuasive. Dahlstrom does not refer to rhetorical literature, yet the persuasive character of the narration preceding a logical argumentation is of course well known to rhetorical theory since antiquity (Knape 2013). Hence, from a rhetorical perspective, I would like to append to Dahlstrom's argument that stories also become persuasive by focusing on human agents, highlighting their competencies, motivations, and their personal integrity. Hence, recontextualization of scientific facts by storytelling can take place by focusing on scientists as persons and on their research activity, grounding their persuasiveness in the *ethos* of the scientist, one of the three means of persuasion known to rhetoric since Aristotle's first treatise of the art (Robling 1994).

3.2 Overhearing Dialogue

Storytelling and the staging of the *ethos* of scientists certainly play a critical role in the success of *Radiolab*, yet, we may well ask why listeners are only overhearing these stories instead of having them directly narrated to them – which would at first glance seem to be a much more effective way of engaging with the audience. What kind of benefit may there be in overhearing a story told to someone else?

Experimental research in the effectiveness of tutoring has investigated how learning from watching videos can be effective. Amongst others, several studies support the effectiveness of so-called *vicarious learning* (cf. Chi et al. 2008; Craig et al. 2004; Driscoll 2003; Muldner et al. 2011). That means that students seem to learn better when they observe a dialogue of a tutor and a tutee than when they have a monologue directed at them in a video.

Chi et al. (2008) argue that the success of this vicarious learning essentially depends on the level of engagement that is triggered by overhearing dialogue. Hence, vicarious learning becomes the more successful, the more the observed tutee is involved, which, Chi et al. (2008) argue also emphasizes the effectiveness of peer-learning. Similarly, *Radiolab* seems to build upon the effects of vicarious learning.

Driscoll et al. (2003) also report significant effects of overhearing dialogue and conclude that these results are in favor of Gernsbacher's *structure building framework* (Gernsbacher 1990; 1997), "because the questions asked by the virtual tutee [...] were designed to support those [causal] relations" (Driscoll et al. 2003). Overhearing dialogue seems to be particularly effective in the construal of knowledge when the overheard conversation features sequences of questions-

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and-answers. When we take a closer look at an excerpt of the *Radiolab* episode, we can see how questions provide the underlying framework of the explanation:

> Robert Krulwich: Let me just back up for a second so that you could, you can, to set the scene for me.
> Jad A[bumrad]: Yeah.
> Robert Krulwich: When you go into a forest, you see a tree, a tall tree. So what is [sic] the tree do?
> Jad A[bumrad]: What's its job?
> Robert Krulwich: What's its job? It's [sic] soaks in sunshine takes the CO2 out of the air, carbon dioxide, which has of course carbon, C, in it.
> Jad A[bumrad]: The oxygen.
> Robert Krulwich: Yeah. And it keeps the C.
> Suzanne Simard: Carbon, which is science speak for food,
> Robert Krulwich: It turns that carbon into sugar, which it uses to make its trunk and its branches. Anything thick you see on a tree is just basically air made stuff.
> Jad A[bumrad]: Carbon and sugar are the same thing?
> Robert Krulwich: Yeah. You can think of the carbon is [sic] basically the sugar that builds the tree. However, if that's [sic] all they had was carbon.
> Roy Halling: It'd only be this tall.
> Robert Krulwich: Oh, that's Roy, again, he's holding his hand maybe a foot off the ground.
> Robert Krulwich: It would be a teeny tree?
> Roy Halling: It would be smaller.
> Robert Krulwich: So if all a tree could do is get carbon from the air, you'd have a tree the size of a tulip. A floppy tulip. Huh. A tree needs something else. And what a tree needs are minerals.
> Jennifer [Frazier]: Minerals from the soil. Very similar to the sorts of vitamins and minerals that humans need.
> Robert Krulwich: What kind of minerals does a tree need?
> Suzanne Simard: Like nitrogen and phosphorous.
> Jennifer [Frazier]: Magnesium.
> Suzanne Simard: Potassium and calcium and,
> Jennifer [Frazier]: Copper.
> Jad A[bumrad]: Why? What do these do for the tree?
> Robert Krulwich: Like can a tree stand up straight without minerals or can,
> Suzanne Simard: It can't. No.
> Robert Krulwich: It can't? (Abumrad/Krulwich 2016)

Research indicates the effectiveness of overheard dialogue and in *Radiolab*, stories are told and explanations are given by means of a complex dialogue. Questions constitute the driving force behind this dialogue and it seems as if asking questions accounts for the effectiveness of the program.

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3.3 Questions

Questions are a powerful communicative device and rhetorical theory knows of numerous functions that questions can fulfill in discourse (Schöpsdau 1996; Veit 1996).[5] As an effective communicative device, the rhetorical system assigns to questions a critical role during the argumentation. Yet the most important function of questions in rhetoric is in the process of the invention, i.e., during the exploration of the topic by the orator in preparation of the rhetorical act (Veit 1996). And indeed, questions play an integral role in any form of explorative inquiry and knowledge acquisition. Hence, building on Rickert (1928), Zillober (1972) defines that a question

> is a sentence, that expresses incomplete knowledge (ontological) or that voices a hypothesis (logical), for which the inquirer expects a concluding answer or a decision about its truthfulness from another person or from himself. That is why an act of judgment will not provide knowledge as long it does not answer a question. (Zillober 1972, quoting Rickert 1928, my translation)[6]

Rickert claims that questions are epistemological as they constitute a necessary prerequisite for the construal of knowledge. In *Truth and Method*, Hans-Georg Gadamer pursues a similar argument, when he claims that

> [k]nowledge is dialectical from the ground up. Only a person who has questions can have knowledge, but questions include the antithesis of yes and no, of being like this and being like that. (Gadamer 1975)

While Rickert's and Gadamer's primary focus was, of course, philosophy and not scientific knowledge, we still find this perspective on knowledge reflected in the so-called scientific method, i.e., the circulatory process of formulating hypotheses and the empirical testing of predictions that eventually lead to what is often flatly referred to as "scientific facts." Given that the epistemological status of hypotheses is by definition undefined by being neither verified nor falsified, hypotheses necessarily entail their underlying questions, too. Hence any scien-

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5 Accordingly, we could analyze the questions in *Radiolab* with regard to their potential rhetorical function such as aesthetic, logical-argumentative, didactical-structuring, or emotional as documented by Schöpsdau (1996).

6 The original reads: "Frage. Sie ist ein Satz, der eine unvollständige Erkenntnis (ontologisch) oder eine Annahme (logisch) zum Ausdruck bringt, deren abschließende Antwort oder Wahrheitsentscheidung der Fragende entweder von einer anderen Person, dem Gefragten, erwartet oder selbst herbeizuführen versucht. Daher leistet der Urteilsakt 'nichts für die Erkenntnis, wenn er nicht auf eine Frage antwortet'." (Zillober 1972, quoting Rickert 1928)

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tific hypothesis "a is x" necessarily entails the question "Is it true, that a is x?" – which, again, "includes the antithesis of yes and no, of being like this and being like that." Consequently, no collection of empirical data, no set of information can give cause for knowledge, if no question is being raised about them at some point. Accordingly, we may venture to postulate: Scientific evidence can only come into existence through the formulation of questions.

Questions provide the initial context for scientific activity, yet science aims for decontextualized insights and consequently the initial questions are often, as Dahlstrom (2014) maintains, lost in logical-scientific communication, that "aims to provide abstract truths that remain valid across a specified range of situations" (Dahlstrom 2014). Yet addressees of science communication need not only the answers – but the questions, too. They will provide them with the necessary context for the construal of knowledge. This becomes even more profound as the questions are neither self-evident nor easily accessible, as Gadamer maintains: "There is no such thing as a method of learning to ask questions, of learning to see what is questionable" (Gadamer 1975).[7]

4 Conclusion

The initial question of this paper was how science communicators can overcome the challenges of situational constraints, in particular that of a muted audience. How can communicators induce engagement with scientific topics in their audience despite their situational enforced passivity? Taking a closer look at *Radiolab,* an explorative analysis has identified three central communicative devices that seem to account for the show's success and that also hint at more fundamental principles of effective science communication: 1. storytelling, 2. overhearing dialogue or vicarious learning, and 3. the use of questions and response. In the case of the *Radiolab* episode, the three techniques are fused together: Stories of science are told and explanations are given in form of a complex dialogue where figures of identification regularly interrupt the process of science communication only to advance it by asking questions in lieu of the audience. In short: we overhear a dialogue where stories are told by using question and response as a rhetorical device for multiple effects.

7 Speaking with Charles Sanders Peirce, we could maintain that questions are in essence abductive.

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What follows for science communication in general? The use of storytelling as an effective tool to recontextualize knowledge is already well researched and acknowledged. As for overhearing dialogue: especially in times where long-distance learning is in desperate need for new, diverse, and effective methods, educators and science communicators should engage more with the possibilities of vicarious learning, which still seems to be only a rarely employed method. Finally, it seems to me, a key result of this paper is to highlight the role of questions in science communication and their potential – again – to recontextualize knowledge. Questions provide the necessary context for facts and hence are crucial in the construal of knowledge. The strategic use of questions in science communication may be critical to its success as questions spark interest and curiosity and actively engage the audience in a quest for answers.

It is often maintained that a central goal of science communication should be to raise the audience's engagement with scientific topics. Questions, to my mind, are a critical device in raising this engagement: Indeed, we might even argue that engaging with scientific topics is – after all – nothing else but pursuing questions. Science communication should provide these questions and help people raise questions themselves.

References

Abumrad, J. & Krulwich, R. (2016). From Tree to Shining Tree. *Radiolab*. WNYC Studios, July 30, 2016. https://www.wnycstudios.org/podcasts/radiolab/articles/from-tree-to-shining-tree.

Allen, R. E. (2006). *Plato: The Republic*. New Haven, CT: Yale University Press.

Bauer, M. W. (2017). Kritische Beobachtungen zur Geschichte der Wissenschaftskommunikation. *Forschungsfeld Wissenschaftskommunikation* (Eds. H. Bonfadelli, B. Fähnrich, C. Lüthje, J. Milde, M. Rhomberg, & M. Schäfer). Wiesbaden: VS Verlag für Sozialwissenschaften.

Bitzer, L. F. (1968). The Rhetorical Situation. *Philosophy & Rhetoric*, 1(1), 1–14.

Chi, M. T. H., Roy, M., & Hausmann, R. G. M. (2008). Observing Tutorial Dialogues Collaboratively: Insights About Human Tutoring Effectiveness from Vicarious Learning. *Cognitive Science*, 32(2), 301–341. DOI: 10.1080/03640210701863396.

Collins, A. & Stevens, A. L. (1981). *A Cognitive Theory of Interactive Teaching*. Cambridge, MA: Bolt Beranek and Newman.

Craig, S., Driscoll, D., & Gholson, B. (2004). Constructing Knowledge from Dialog in an Intelligent Tutoring System: Interactive Learning, Vicarious Learning, and Pedagogical Agents. *Journal of Educational Multimedia and Hypermedia*, 13(2), 163–183.

Dahlstrom, M. F. (2014). Using Narratives and Storytelling to Communicate Science With Non-expert Audiences. *PNAS*, 111 (Supplement 4), 13614–13620. DOI: 10.1073/pnas.1320645111.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Driscoll, D. M. (2003). Vicarious Learning: Effects of Overhearing Dialog and Monologue-Like Discourse in a Virtual Tutoring Session. *Journal of Educational Computing Research*, 29(4), 431–450.

Flagg, B. N. (2009). Listeners' Evaluation of Radiolab Program: Choice. Research Report No. 09-009. *Report for WNYC*, March 19th, 2009. https://www.informalscience.org/sites/default/files/Radiolab_Choice_Evaluation.pdf.

Gadamer, H.-G. (1975). *Truth and Method*. New York, NY: Seabury Press.

Gernsbacher, M. A. (1990). *Language Comprehension as Structure Building*. Hillsdale, NJ: Erlbaum.

Gernsbacher, M. A. (1997). Two Decades of Structure Building. *Discourse Processes*, 23, 265–304.

Kemmann, A. (1996). Evidentia. *Historisches Wörterbuch der Rhetorik. Bd. 3* (Ed. G. Ueding). Tübingen: Niemeyer, 33–47.

Knape, J. (2013). *Modern Rhetoric in Culture, Arts and Media. 13 Essays*. Berlin/New York, NY: De Gruyter.

Muldner, K., Dybvig, K., Lam, R., & Chi, M. (2011). Learning by Observing Tutorial Dialogue Versus Monologue Collaboratively or Alone. *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*. Austin, TX: Cognitive Science Society, 1340–1346.

New York Public Radio (2017). *Media Kit*, Q4, 2017. https://static1.squarespace.com/static/53ff2c53e4b0e1f6ca3c017d/t/5aafc4e388251bc59a8f334d/1521468646084/Media+Kit+Q4+2017.pdf.

Radiolab (2020). *KLCC*. https://www.klcc.org/programs/radiolab.

Reissman, H. (2014). A 10,000-person TEDx Event Unfolds in Buenos Aires. *TED Blog*, December 3, 2014. https://blog.ted.com/a-10000-person-tedx-event-unfolds-in-buenos-aires/.

Rickert, H. (1928). *Der Gegenstand der Erkenntnis*. Tübingen: Mohr.

Robling, F.-H. (1994). Ethos. *Historisches Wörterbuch der Rhetorik. Bd. 2* (Ed. G. Ueding). Tübingen: Niemeyer, 1516–1543.

Schöpsdau, K. (1996). Frage, rhetorische. *Historisches Wörterbuch der Rhetorik. Bd. 3* (Ed. G. Ueding). Tübingen: Niemeyer, 445–454.

Veit, W. (1996). Frage. *Historisches Wörterbuch der Rhetorik. Bd. 3* (Ed. G. Ueding). Tübingen: Niemeyer, 420–445.

Zillober, K. (1972). Frage. *Historisches Wörterbuch der Philosophie. Bd. 2* (Eds. J. Ritter, K. Gründer, & G. Gabriel). Basel: Schwabe, 1059.

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Kristin Raabe

Scientists on the Hero's Journey

Storytelling in Different Communicative Situations

1 Introduction – The National Institute for Science Communication

Science is an integral part of our culture and helps set the course for the future development of our society. Our vision at the National Institute for Science Communication (NaWik, "Nationales Institut für Wissenschaftskommunikation" in German) is to firmly embed science in our society. This includes educating the public about scientific issues as well as fostering a well-informed public debate on scientific topics. To achieve this, scientists reach out to the public and enter a conversation with society about their projects, findings, and hypotheses. In this way, they grant insights into their research area and research processes. In addition to communicators and journalists, they are thus among the key actors in science communication.

NaWik's goal is to help as many researchers as possible communicate their objectives, methods, findings, and the challenges they encounter to various sectors of society in a way that is comprehensible and fosters productive dialogues. For that purpose, NaWik Lecturers like myself train scientists to communicate their intentions, findings, and issues to a wider audience and engage with society for a dialog.

NaWik seminars are one- or two-day long attendance courses. Participants work in small groups with emphasis on hands-on-exercises and a high level of practical relevance. We teach the participants to think in terms of target audiences, be mindful of their own communication goals, and to master practical communicative techniques.

In order to reach out to different target audiences in different communicative situations, scientists have to recontextualize their knowledge. Whether an astrophysicist is about to give a talk in front of an amateur astronomy club or planning a guided tour around a radio telescope with a group of ten-year-old school children is a totally different task and requires an adaptive communication strategy. In both situations, storytelling can be very helpful when it comes to engaging the respective target audience. But not every story works for every target audience. How a story can be adapted to a specific communicative situa-

https://doi.org/10.1515/9783110676310-007

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tion will be shown and illustrated by examples from our courses in the following chapter.

2 Why Scientists Don't Like to Engage in Storytelling and Why They Definitely Should

"I'm a scientist, not a storyteller," this sentence – usually spoken with a glimmer of indignation – comes up regularly in the communication trainings I conduct for scientists. The self-concept of a scientist does not seem to conciliate with being a storyteller. This is understandable: science is based on facts, figures, numbers, objectivity, hard evidence, and reason, whereas stories depend on emotion, contain speculative or even fictitious elements, and are shaped by the subjective perspective of the main character. Apart from those obvious irreconcilable differences, the scientists in my workshops show great passion, they give insights in previously unknown worlds, they tell me about mysteries that need to be unraveled and about fascinating ideas. Aren't those the perfect ingredients for a captivating story?

Why so many scientists seem to have problems with storytelling might become clearer if you look at a dispute that was published in *Nature Methods* in (Krzywinski/Cairo 2013). Two visualization experts, Martin Krzywinski and Alberto Cairo, asked readers not to present all the data and information in one figure, but to rather deliver the information step by step with one figure for each step so that the figures could tell a small story. I personally wouldn't call a succession of diagrams, graphs, and other figures a story, but nevertheless this approach was strongly opposed by a young biologist called Yarden Katz, whose reply to Cairo/Krzywinski's (2013) article was published a couple of weeks later (Katz 2013). He writes, "If we project the features of great storytellers onto a scientist, the result is a portrait of a scientist far from ideal. Great storytellers embellish and conceal information to evoke a response in their audience. Inconvenient truths are swept away, and marginalities are spun to make a point more spectacular. A storyteller would plot the data in the way most persuasive rather than most informative." To me it seems that storytelling in Katz's opinion is almost the same as scientific misconduct, but he does not deliver any proof for this theory. Scientists who oversell their results, journalists who taper a science story to the level that it becomes untrue, and press officers who conceal unwanted or possibly unpopular information have always been part of the field of science communication and, sadly, probably always will be. But in most of

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those cases, no real storytelling approach was used in the communication efforts involved. On the contrary, polished research results usually don't make a good story. A factual and captivating science story is not just about the successes in research, it is more about the failures and obstacles that had to be overcome before the victory could be achieved. It is the throwbacks, the flawed theories that didn't work out, and the failed experiments that are needed for a thrilling story. Nothing is more boring than the sentence most press releases, at least in Germany, start with: "Scientist of the XY institute have found out that…". Suspense can only build when victory does not come easy. And sometimes not even a victory is needed, a story about failure alone can be equally compelling. By identifying and speaking about the many obstacles, a science story offers a great opportunity for science communicators: a real understanding of the rocky process of scientific inquiry can develop within the audience.

Another reason why science communicators should rely more often on storytelling approaches than they currently do is the impact that stories have on their audience. Uri Hasson, Paul J. Zak, and other neuroscientists and psychologists were able to demonstrate in their research that we humans are hardwired for storytelling. Storytelling is our way of forming connections between certain events and of giving meaning to the proceedings around us. If we listen to a story, large parts of our brain are activated (Zak 2015), which is probably why we get hooked on stories. So much of our brain is occupied with processing the story that not many resources are left that can be used to distract us from the story. Proof that stories deliver the intended message better than just pure information comes from a study Hasson and his team were conducting at Princeton University. They measured the brain activity of storytellers and listeners at the same time using EEG-electrodes and magnetic resonance imaging (Hasson et al. 2012; Regev et al. 2013). The two brains showed the exact same pattern of brain activity as if they were coupled. The coupling did not just occur in the brain areas for listening and processing language, it appeared in the frontal and parietal cortex, where deeper thinking, reflection, and creativity are located. A story's message should be processed in those parts of the brain. This phenomenon, which Hasson calls "Neural Entrainment," occurs only when stories are told and not when information is simply verbally transmitted. Stories are not just the ideal way of transmitting a certain message, they also cause people to care and to act (Zak 2015).

Despite all the positive impact stories have on their audience, they are not used very often as a tool in science communication. A storytelling approach is probably most common in health communication, whereas you can rarely find it in mathematics. One reason for the success of storytelling in health communi-

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cation might be that it can easily be done by simply using a patient's case as material for a story. Another reason might be that politicians, doctors and other stakeholders in our health care system have a vital interest in successful health communication because it can save lives and reduce medical expenses. A good example for a successful health communication story with a very unusual main character and some fictional elements comes from Northern Europe with the story of Karius and Bactus (Egner 1976). The story has been used for decades to educate kindergarten children in proper dental care. The main characters are Karius and Bactus who are two small "tooth trolls" that live inside cavities in the teeth of a boy named Jens. Karius and Bactus have a very good life there, especially when Jens eats white bread with syrup and fails to brush his teeth afterwards. Eventually, their homes are destroyed by a dentist and they are rinsed out of Jens' mouth. The story was written and illustrated by Norwegian author Thorbjørn Egner in 1949; at the same time the tools for proper dental care – soft toothbrushes and fluoride toothpaste – became available. At least in Northern Europe, the story of Karius and Bactus became extremely popular, not just through the children's book, but also through audiobooks and an animated puppet film. Although preschool teachers still use the story of Karius and Bactus, it was criticized a lot (e.g., Buschmann 2018) because the children empathized with the cute tooth trolls Karius and Bactus. Especially dentists feared they might reject dental care and refuse to visit them. Then again, would this story still be read to children by preschool teachers and parents if the children would react in such a way? The Danish literary scholar Marianne Børch believes that it might have been the unusual perspective of the Karius and Bactus story that has made it so successful. "The unwanted solidarity with the bacteria here is disconcerting, but we also get to think in a way that might bring about new insights – and some of these sudden impulses or leaps might be so cognitively disruptive as to open new, arguably creative, avenues of thought" (Børch 2010). Would the same story being told from a dentist's perspective be of any interest to children? The decades-long success of Karius and Bactus is definitely a great example of how the choice of a main character shapes a story.

3 How to Find a Science Story

The story of Karius and Bactus uses fictional elements to transmit information about dental healthcare. Through this story, the children learn that sweets can cause cavities and that proper dental care and regular visits to the dentist might prevent most of the damage to their teeth. Most science topics don't need such

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fictitious elements. If you have a science topic, the first challenge is to find your story within all the information. Then the question arises: what really is a story? A simple but very usable definition could – at least up until 2019 – be found on Wikipedia: "A narrative or story is a report of connected events, real or imaginary, presented in a sequence of written or spoken words, or still or moving images, or both."

More simply put, you have to find a connection between certain events and then you arrange the story. With a science topic, it could mean that the results of a first experiment might inspire the scientist to try another experiment that again produces an interesting result, which leads to further experiments and results. Each result might bring the researcher closer to the final solution of a problem. If that information can be properly arranged, you can probably find a story in every science topic.

The approach of the literary scholar and author Gustav Freytag isn't much more complex. He published his drama theory, *Die Technik des Dramas* (*Freytag's Technique of the Drama*), in 1863. Because there was a high demand for theater plays in the 19th century, it made sense to look out for ways to produce them as fast and efficient as possible. Freytag was probably one of the first who saw drama theory as a blueprint or recipe for constructing stories. His simple approach is still very popular and widely used among screenwriters, playwriters and novelists. According to Freytag, a drama is divided into five parts, or acts, which some refer to as a dramatic arc: exposition, rising action, climax, falling action, and dénouement (conclusion). Freytag's Pyramid can help writers organize their thoughts and ideas when describing the main conflict of the drama, the rising action, the climax and the falling action (Freytag 2012). Although Freytag's analysis of dramatic structure is based on five-act plays, it can be applied (sometimes in a modified manner) to short stories, films and storytelling for different media. Here is a more detailed outline of his five-act structure:

1. Exposition: The main character and the world he or she lives in is being introduced.
2. Rising Action: A conflict or a problem is presented that needs to be solved during the following acts.
3. Climax: This is the turning point of the whole story. The final confrontation between the hero and his or her opponents takes place and the hero might fail or win.
4. Falling Action: After the final confrontation, the action subsides.
5. Conclusion: At the end, a solution has been found. The hero might have won or lost his battle and either gets his reward or is punished.

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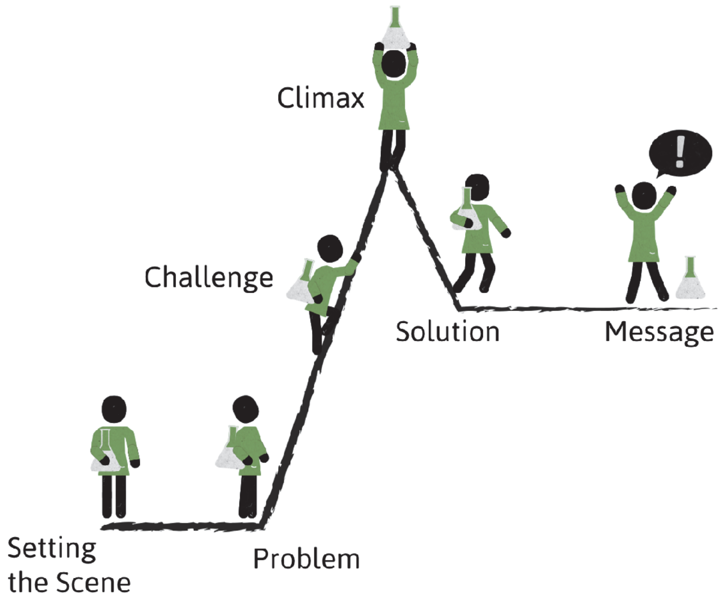

Fig. 1: Freytag's five-act structure – slightly modified – the way it is used in NaWik-communication trainings (©NaWik).

The participants in my communication trainings at NaWik are asked to present their research topic by using this scheme. Usually, it is at this point when I hear the sentence that I was quoting at the beginning: "I'm a scientist, not a story-teller." However, the resistance vanishes once they recognize how interesting the stories of the others are.

A very specific template for a story was found by Joseph Campbell (1904–1987) after he had analyzed myths, legends, and fairy tales from all over the world. He published his results in 1949 in his book The Hero with a Thousand Faces. Every fairy tale, legend or saga Campbell investigated followed the same narrative pattern. This pattern is called the Hero's Journey:

> A hero ventures forth from the world of common day into a region of supernatural wonder: fabulous forces are there encountered and a decisive victory is won: the hero comes back from this mysterious adventure with the power to bestow boons on his fellow man. (Campbell 1949)

Campbell's version of the Hero's Journey contains 17 stages and caught the attention of George Lucas (Seastrom 2015). Lucas consciously used the Hero's Journey as a template for his screenplays for the *Star Wars* movies. Campbell

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and Lucas first met in person in 1984 after the biologist and Nobel laureate Barbara McClintock introduced them (Baxter 1999). Nowadays, the Hero's Journey is widely used by screenwriters. It can be identified in every Hollywood blockbuster – *Pretty Woman*, *Harry Potter*, *James Bond*, etc. Most of the time, the screenwriters use a shorter version of the Hero's Journey with just 12 stages, as published by Christopher Vogler in 1998 in his book *The Writer's Journey*.

Fig. 2: Vogler's version of the Hero's Journey (© NaWik).

Figure 2 illustrates Vogler's version of the Hero's Journey.

1. The Ordinary World: the hero is seen in their everyday life.
2. The Call to Adventure: the initiating incident of the story.
3. Refusal of the Call: the hero experiences some hesitation to answer the call.
4. Meeting with the Mentor: the hero gains the supplies, knowledge, and confidence needed to commence the adventure.
5. Crossing the First Threshold: the hero commits wholeheartedly to the adventure.
6. Tests, Allies, and Enemies: the hero explores the special world, faces trial, and makes friends and enemies.
7. Approach to the Innermost Cave: the hero nears the center of the story and the special world.
8. The Ordeal: the hero faces the greatest challenge yet and experiences death and rebirth.
9. Reward: the hero experiences the consequences of surviving death.

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10. The Road back: the hero returns to the ordinary world or continues to an ultimate destination.
11. The Resurrection: the hero experiences a final moment of death and rebirth so they are pure when they reenter the ordinary world.
12. Return with the Elixir: the hero returns with something to improve the ordinary world.

It is not as difficult as you might think to apply this template to any science topic. Researchers constantly seek answers in special "unknown" worlds: particle physics, microscopic cells, the universe or nanotechnology for example. Most of them have a mentor who supports their work and their ideas. In order to answer scientific questions, they have to solve mysteries, pass tests, and collaborate with colleagues. Only then might they be able to refute their opponents' arguments. If they came this far, they might have an epiphany that leads them to their last experiment. This experiment might finally deliver the answers they seek and enable them to find a solution to a problem in the ordinary world. The stages of the Hero's Journey are there, but science communicators have to carve them out in the narrative they create.

As inspiring as the Hero's Journey might be, it is not something that is easy to apply for storytelling beginners. Participants in my storytelling workshops usually find it hard to work with this template. It takes time and experience to get to know all the different chapters of the Hero's Journey with its hidden corners and surprising twists and turns.

Many TV Journalists who have to come up with a narrative within a very short time limit use a different method to find their story. The documentary filmmaker and lecturer for documentary dramaturgy, Gregor A. Heussen, has trained more than one generation of TV journalists and has created a mind map for developing a storyline for a documentary (Heussen 2016).

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Tab. 1: Gregor A. Heussen's "Mind Map for TV Journalists."

Topic	Brief summary of the topic and the most important research results.
Main Character	A person, a group, an animal, a plant, a microbe, an object, an institution, an idea.
– Attributes	What attributes would describe the main character in this narrative?
– Challenge	What kind of obstacles must the main character conquer?
– Motive	What is the motive for the main characters actions?
– Change	How does the main character change during the whole narrative?
Supporting Characters	Who is helping or fighting the main character?
Narrative Pattern	Being born, crossing a boundary, conquering death, solving a mystery, etc.
Emotional Goal	What kind of emotions should the audience feel at the end of the film?
Argumentative Goal	Which opinion, knowledge or argument should the audience understand at the end of the film?

With this mind map, the main character is the anchor of the whole creative process of developing a narrative and everything else revolves around him or her. It doesn't necessarily have to be a person: it can be a group, an animal, a plant, a microbe, an object, an institution or even an idea. Many scientific topics offer more than one possible main character. Are the doctor, the patient, or the bacteria causing the disease the best main characters? Even particles, lab rats, research institutes or 3D printers are possible main characters in science stories. Usually, a certain amount of personalization is needed for a nonhuman main character: Which main character is the most ideal depends, to a large extent, on the communicative situation in which the story will be told. As a rough guide you could say, most of the time, the main character with the biggest challenge is the best. Remember that motives, attributes, and changes should be taken into consideration when the choice for a particular main character is made. The more the main character changes throughout their narrative journey, the more interesting they are.

In many communicative situations, the author aims at a specific argumentative goal. Maybe the audience should be convinced to eat less red meat, or the readers should understand the meaning of neutrinos. It is crucial that the author of a science story knows his or her argumentative goal and that the story line of the chosen main character is supporting that goal. The choice of the main

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character shapes the whole narrative, as is shown in the example of Karius and Bactus. As important as the argumentative goal is the emotional goal. Sometimes an author simply wants to raise excitement for a specific scientific topic, incite worry about an environmental problem or arouse fear in their audience. Usually the emotional goal is achieved if the main character feels those emotions at the end of the story. If the main character is happy at the end, the audience will be too; if the main character is sad, the audience might cry.

Certain narrative patterns occur in many different stories: being born, crossing a boundary, or conquering death are some examples. In many science stories, unravelling a mystery is a suitable narrative pattern. It is important to be aware of those patterns and to carve them out throughout the whole narrative. You can do that for example by spending enough time and effort on illustrating the scientific question at the beginning of the story, also explaining how difficult it is to answer and why no one has been able to solve it until now.

I use Heussen's mind map a lot for my work as a science journalist, no matter if I am working on a TV documentary, a radio report or a magazine article. I usually try out several possible main characters and after many years in this field, I'm still sometimes surprised how much the stories change with each main character and which one turns out to be the best for my argumentative and emotional goals.

4 Storytelling in Different Communicative Situations

Which character will make the best main character strongly depends on the communicative situation in which the story will be told. This is why before any decision on the storyline is made the whole communicative situation should be analyzed.

Each brick of the NaWik-Arrow shown in Figure 3 points to a certain question that should be answered before a science communicator starts communicating.

- Aim: – Why am I doing this?
- Audience – Who am I addressing?
- Medium – Where am I communicating?
- Style – How do I impart my topic?
- Topic – What is the content of my communication?

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Fig. 3: The National Institute for Science Communication has developed the NaWik-Arrow as a helpful tool for researchers when preparing for any kind of communication. It is also helpful for this kind of analysis in storytelling (© NaWik).

In order to demonstrate how a certain communicative situation might call for a particular story with a specific main character, I have chosen a real-life science topic that I regularly use in NaWik communication trainings. I found it within five minutes of scrolling through recent press releases. This is a brief summary of the content of this press release: The research project was a collaboration between a PhD student in botany and a physicist at a university hospital. Together they were able to create 3D magnetic resonance images of the fibers inside a dragon tree that were under pressure because the trunk and the branches were twisted for this experiment. With this new information, engineers might be able to develop stronger but lighter materials for bicycles.

I needed more information for my story than was outlined in the press release, so I called the scientists who were involved in this project. I asked them about the obstacles and their motivation, which lead to some interesting information about how the collaboration between a botanist and a physicist originally started. It was a fortunate coincidence: the botanist, Linnea, wanted to figure out how the mechanical properties of the fibers inside the dragon tree branches are working because these small plants can survive hurricanes and extreme pressure in their natural habitats. The problem was that Linnea was studying slices from dragon tree branches under a microscope and was not gathering much information, so she told her housemate Nils, a physicist, about her struggles. He was working on new Magnetic Resonance Imaging techniques and came up with the idea that Linnea might investigate the fibers with this technology. The next day, they went to Nils' Institute and tried to get an image of a

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dragon tree branch, but unfortunately the results were not very promising. Nils' group leader was informed about the problem and came up with the idea to try a Magnetic Resonance Tomography (MRT) scanner especially developed for small laboratory animals at the university hospital. At the university hospital, a physicist named Jochen was running this special MRT. He hesitated to help when Linnea asked him to get images from the dragon tree fibers because he was already overworked and wasn't convinced, he could do it, but he finally gave it a try. The first results were not very encouraging, because dragon trees do not contain much water, making it hard to get high-resolution images. However, Jochen did not give up and was eventually able to help Linnea with her research project.

So, there were three possible main characters:

1. Linnea, Botanist University of Freiburg
2. Jochen, Physicist University Hospital Freiburg
3. Dracaena Marginata, the dragon tree

All three of them can be the perfect main characters depending on the specific communicative situation. In one of my storytelling workshops, I formed three groups and asked each group to come up with a story about this research project for a specific communicative situation. The three communicative situations were:

Communicative Situation for group 1. Children (ages 7–8) from an elementary school are visiting the Institute for Botany of the University of Freiburg. They will get a guided tour through the greenhouse and the labs. The teacher wants them to learn something about an actual research project.

Communicative Situation for group 2. An article about the research project for the university magazine.

Communicative Situation for group 3. A short video (5') about the research project for the German science show *Quarks & Co*, a monothematic show planning a special about the opportunities recent advances with imaging technologies offer for researchers and patients.

All three groups where asked to use the NaWik-Arrow to think about the communicative situation. Table 2 shows the results of group 1:

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Tab. 2: Results of Group 1 working with the NaWik-Arrow.

Aim – Why am I doing this?	To raise interest in science, specifically in botany.
Audience – Who am I addressing?	Children aged 7–8.
Medium – Where am I communicating?	Interactive tour and presentation at lab and greenhouse of the botanical institute.
Style – How do I impart my topic?	Entertaining, humorous.
Topic – What is the content of my communication?	Botany and the work at the institute.

Group 1 decided to go for Drago, the Dragon Tree as the main character for their story.

Tab. 3: Results of Group 1 working with Heussen's mind map.

Main Character	Drago, the Dragon Tree
– Attributes	Small, with a hidden strength, lives in Linnea's living room.
– Challenges	Surviving strong winds of his home country Madagascar and surviving children and pet attacks at Linnea's living room.
– Motive	Wants to grow and become a big tree like the ones he can see outside the window.
– Change	From feeling small and weak to feeling strong and happy.
Supporting Characters	Linnea and Jochen are helping Drago to find his inner strength.
Narrative Pattern	Being more than it seems. Disclosing a secret.
Emotional Goal	Happiness.
Argumentative Goal	How much we can learn from plants. How interesting science can be.

And here is the beginning of the story group 1 came up with – you can easily identify some elements of the Hero's Journey in it:

> Drago lives a quiet life in Linnea's living room (*ordinary world*). From his place at the window, he can see a big tree with branches 10 times bigger than any part of Drago. Then a huge storm comes, and the big tree loses some of his branches. *Poor big tree*, Drago thinks. Then children come over and play in the living room. Linnea puts Drago on the top of the big bookshelf, but a ball hits the shelf and Drago falls down to the floor. Guess

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> what! His plant pot broke but nothing happened to Drago. Linnea (*mentor*) wants to find out why Drago can be so small but so strong at the same time, so she brings Drago into her lab (*crossing the threshold*, *entering the special world*) [...].

Drago is the perfect main character for children because they can relate to him and empathize with his feeling of being small and unimportant. Nonetheless, those attributes are not suitable for other communicative situations. If a science communicator would have to communicate the same topic to an adult audience, he or she probably would have chosen a different main character – as did group 2 in my workshop. Here are their reflections of the NaWik-Arrow:

Tab. 4: Results of Group 2 working with the NaWik-Arrow.

Aim – Why am I doing this?	For the reputation of the University of Freiburg.
Audience – Who am I addressing?	Students, employees, scientists, journalists, visitors and donors of the University of Freiburg.
Medium – Where am I communicating?	Article for the university magazine and its website.
Style – How do I impart my topic?	Inspirational, lively but also factual.
Topic – What is the content of my communication?	Interesting research cooperation between botanist and physicists.

In this case, the group chose the young PhD student Linnea to be the main character.

Tab. 5: Results of Group 2 working with Heussen's mind map.

Main Character	Linnea
– Attributes	Curious, intelligent, open minded, ambitious, thinks outside the box.
– Challenges	Does not get any interesting results with conventional methods, first experiments with MRI fail, at first Jochen is not interested in collaborating with her.
– Motive	Wants to understand the mechanics of the dragon tree fibers in order to help other scientists to develop new materials for bicycles.
– Change	From desperation about not getting any usable results with the conventional methods to being really excited about the results she gets with the MRI scanning technology.

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Supporting Characters	Jochen and a friend are helping her.
Narrative Pattern	Unravel a mystery. Entering new worlds.
Emotional Goal	Excitement about the interesting research that is being done at the University of Freiburg.
Argumentative Goal	Unexpected research collaborations can be extremely beneficial for both sides.

Here is a rough outline of the storyline of group 2:

> Linnea wants to solve the mystery of why the dragon tree can be light and strong. If she found out how the dragon tree does it, she could probably help other scientists to develop new materials and they could build better bicycles. No matter what she tries in her lab (*her ordinary world, tests*), nothing works. She talks to a friend (*mentor*) about her problems. He is a physicist who is developing high-resolution MRI systems. Together they experiment in his lab (*the special world*), but his MRI system does not work on plants (*tests, allies*). But he has another friend who runs an experimental MRI system at the University hospital [...].

If you want to motivate and inspire other PhD students, Linnea is the perfect main character. She has large goals for her research and doesn't give up, despite all the obstacles she is facing. By being open minded and giving an unusual experiment a try, she is finally successful. With her as a main character, you motivate students, impress donors, and spark visitors' interests in the research that's being done at the University of Freiburg.

However, even Linnea is not the ideal main character for every situation. For a journalist working for a German TV science show planning a special about imaging technologies, the choice would be different. Here is an analysis of this communicative situation with the NaWik-Arrow done by group 3:

Tab. 6: Results of Group 3 working with the NaWik-Arrow.

Aim – Why am I doing this?	Introducing the audience to the exciting world of new imaging technologies.
Audience – Who am I addressing?	A wide range of people (ages 14–80), who have a special interest in new developments in science.
Medium – Where am I communicating?	Video (5 minutes long) for the popular science show *Quarks & Co*, which will be airing a special on new imaging technologies.
Style – How am I communicating?	Inspirational, lively but also factual.

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Topic – What is the content of my communication?	New magnetic imaging technologies can allow insights into living plants and deliver results that might revolutionize other research fields.

For this communicative situation, the focus of the intended story has shifted from the dragon tree and its fibers, to the technology that was used for these experiments. Therefore, it makes complete sense that group 3 chose the physicist to be their main character.

Tab. 7: Results of Group 3 working with Heussen's mind map.

Main Character	Jochen, physicist at the University Hospital
– Attributes	Intelligent, tenacious.
– Challenges	Dragon trees do not contain much water, which makes it very hard to get high resolution imaging results from them. Also, Jochen works at the university hospital, taking MRI scans of laboratory animals. He doesn't have much time for the experiments with the dragon tree.
– Motive	Wants to help Linnea because he likes her.
– Change	From expressing doubt to being very enthusiastic about the whole project.
Supporting Characters	Linnea is inspiring him.
Narrative Pattern	Unravel a mystery. Entering new worlds.
Emotional Goal	Fascination and excitement about the unexpected possibilities this new imaging technology is offering.
Argumentative Goal	MRI technology can be applied in many unexpected ways (i.e. in botany) and might offer insights that could revolutionize a lot of research areas.

The final story of group 3 starts like this:

> Jochen is working at the University Hospital, where he is primarily scanning laboratory animals or tissue (*Jochen's ordinary world*) with a specialized MRI system. Linnea, a botanist (*mentor* or *ally*) approaches him and asks him if he could help her by scanning a dragon tree (call for adventure). First, he is very skeptical *(refusal of the call*). A plant? However, he tries (*the special world of plants*) but the results were not very encouraging. The fibers of the dragon tree do not contain much water, which makes it a lot harder to get high resolution images (*tests*, *obstacles*). Nevertheless, Jochen wants to accept the challenge […].

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If you compare the three stories, you can easily find out what makes each story interesting and possibly captivating. The first story wants to spark children's interest, so it utilizes an unusual perspective of Drago, the Dragon Tree, who lives in a world where he doesn't feel he belongs until his hidden power is discovered. His character has some similarities with Harry Potter. Like the neglected child who lives in the cupboard under the stairs, Drago watches the world from his bookshelf and has no direct access to sunlight and wind, unaware of his powers. Seeing Drago invigorated and happy because he has discovered his hidden strengths brings the audience a lot of satisfaction.

In the second and third story, which are definitely the more conventional science stories, the tension arises because the main characters are not successful from the beginning. Their first experiments fail, and they have to be tenacious, using unconventional approaches in order to be successful. Both stories would not have been even remotely interesting if the main characters would have been successful from the start. In that way, a storytelling approach in science communication is far more realistic than most other forms of science communication. The work of a real-life scientist is marked by failure, frustration, long working hours and sometimes even difficult struggles with colleagues who favor an opposing theory. The public has a right to hear those stories too. Real-life science stories open up opportunities to present a scientist as relatable and believable because he or she – like everybody else – fails from time to time.

5 Conclusion

Science communicators – whether they are scientists themselves, press officers or journalists – can find their story by utilizing the toolbox of screenwriters and filmmakers. For beginners, Heussen's (2016) Mind Map is probably the easiest way of creating a story. But a communicator with more experience could take advantage of a 12-step scheme like in Christopher Vogler's version in *The Hero's Journey*, which might inspire a more complex science story. In any case, the choice of the main character is extremely important, as it is the perspective of this character that shapes the whole narrative. The reservations that many scientists have towards storytelling are unfounded, because most of the time, science stories deliver a more realistic account of the hard and rocky process of scientific inquiry than a more conventional form of science communication usually does. Especially today, when trust in science is declining and conspiracy theories, fake news and alternative facts are on the rise, science stories have

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the potential to present a scientist in a relatable and believable way. We cannot afford to lose the opportunities a storytelling approach in science communication offers.

References

Baxter, J. (1999). *George Lucas: A Biography*. Hammersmith, London: Harper Collins.
Børch, M. (2010). The Semantics of Originality as Indicator of the Cultural Paradigm Shift From Medieval to Modern. *Origins as a Paradigm in the Sciences and in the Humanities* (Ed. P. Spinozzi, & A. Zironi). Göttingen: V&R Unipress, 243–256.
Buschmann, C. (2018). Rote Karte für Imagekiller von Zahnpflege und Zahnärzten. *Landesarbeitsgemeinschaft Jugendzahnpflege in Hessen (LAGH)*. https://www.lagh.de/fileadmin/user_upload/LAGH/Patenschaftsteams/LAGH_-_IB021_Rote_Karte_2018_01_low.pdf.
Campbell, J. (1949). *The Hero with a Thousand Faces*. Princeton, NJ: Princeton University Press.
Dreier, W. (2016). Deriving Inspiration from the Dragon Tree. *Press Release by Albert-Ludwigs-Universität Freiburg im Breisgau*, September 8, 2016. https://idw-online.de/de/news?print=1&id=658736.
Egner, T. (1986). *Karius and Baktus*. Bloomington, MN: Skandisk Inc.
Freytag, G. (2012). *Die Technik des Dramas* (2nd ed.). Darmstadt: Autorenhaus Verlag.
Hasson, U., Ghazanfar, A. A., Galantucci, B., Garrod, S., Keysers, C. (2012). Brain-to-Brain Coupling: Mechanism for Creating and Sharing a Social World. *Trends in Cognitive Science*, 16(2), 114–121. DOI: 10.1016/j.tics.2011.12.007.
Heussen, G. A. (2016). *Checkliste – Das Exposé*. https://gregor-a-heussen.de/werkzeuge/arbeitsvorlagen/.
Katz, Y. (2013). Against Storytelling of Scientific Results. *Nature Methods*, 10, 1045. DOI: 10.1038/nmeth.2699.
Könneker, C. (2012). *Wissenschaft kommunizieren. Ein Handbuch mit vielen praktischen Beispielen*. Weinheim: Wiley-VCH.
Krzywinski, M. & Cairo, A. (2013). Relate Your Data to the World Around Them Using the Age-Old Custom of Telling a Story. *Nature Methods,* 10(8), 371.
Regev, M., Honey, C., & Hasson, U. (2013). Modality-Selective and Modality-Invariant Neural Responses to Spoken and Written Narratives. *Journal of Neuroscience,* 33(40), 15978–15988. DOI: 10.1523/JNEUROSCI.1580-13.2013.
Seastrom, L. O. (2015). Mythic Discovery Within the Inner Reaches of Outer Space: Joseph Campbell Meets George Lucas Part I. *Star Wars Website*, October 22, 2015. http://www.starwars.com/news/mythic-discovery-within-the-inner-reaches-of-outer-space-joseph-campbell-meets-george-lucas-part-i.
Vogler, C. (2007). *The Writer's Journey: Mythic Structure for Writers* (3rd ed.). Studio City, CA: Michael Wiese Production.
Zak, P. J. (2015). Why Inspiring Stories Make Us React: The Neuroscience of Narrative. *Cerebrum*, 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4445577/.

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Part III: **Education and Knowledge Transfer**

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Nina Janich

Science Revisited

The Representation of Scientific Knowledge and Ignorance in the German *Kinder-Uni* Books

1 Introduction

Out of the plethora of media and texts that exist for children, one particular communicative format is especially interesting in relation to the recontextualization of scientific knowledge, the issue on which this collection is focused, namely, the Children's University (in German and here henceforth *Kinder-Uni*). The activities and materials provided by universities to give children access to the results of science and research in the form of a special program of events are by now widespread and extremely popular in Germany. The following analysis does not refer to the actual lectures, however. Instead, the *Kinder-Uni* is represented here by a successful German non-fiction series of books containing the lectures delivered as part of the first German *Kinder-Uni* (University of Tübingen) and revised and edited by local Tübingen journalists Ulrich Janssen and Ulla Steuernagel. The result is three high-quality volumes of non-fiction published between 2003 and 2005 by Deutsche Verlagsanstalt and illustrated by renowned children's book illustrator Klaus Ensikat; the books have since been translated into many languages and have received various children's literature awards. The *Kinder-Uni* books do not simply convey knowledge, then: they do so explicitly in the context of the scientific research and teaching on which they draw. Accordingly, all three books in the series carry the subtitle: "Researchers explain the mysteries of the world." The various chapters – all of which contain the question word *why* in their heading – are based on authentic lectures actually delivered by various scientists as part of the first pioneering *Kinder-Uni* at Tübingen. These scientists are introduced individually in the books, with each serving as a kind of "expert mentor" for each chapter. In addition, a glossary included in the first volume contains a list of key terms of so-called "university language." The entries listed are not really to be understood as definitions, however; their purpose is rather to provide an introduction to the particularities of university life and thus to establish the "academic" context of the non-fiction book.

https://doi.org/10.1515/9783110676310-008

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The three books are therefore extremely well suited to analyzing the ways scientific knowledge is recontextualized for children.[1] This essay pursues the following questions:
1. What kind of knowledge is at issue here – and to what extent is this knowledge recontextualized as “scientific” (in the broader sense of the German word *wissenschaftlich*)?
2. To what extent are ignorance, doubt, and controversy discussed – are they addressed as a topic at all?
3. What image of science does the book project?

The following analysis can be regarded as a qualitative search for processes of recontextualization, one that promises to provide information about how *Wissenschaftlichkeit*, the character of science, is conveyed to children and about what kind of image of science today emerges for them in the process.

2 Methods

In order to answer the questions posed at the start of this essay, I shall apply various analytic steps to the topic-based chapters of the three *Kinder-Uni* books. Where necessary, I shall also refer to the three introductions to these volumes, to the sections in the appendix where the professors are introduced and to the aforementioned glossary contained in the first volume. The aim is to look for any basic figures of discourse which are woven into the texts and which, taken

1 The following essay issues from the research project “Linguistic Strategies of Knowledge and Scientific Transfer in Text Types and Media Genres for Children” (2013–2017) backed by the German Research Foundation (DFG). This project has involved examining various media and genres in terms of their specific multimodal procedures of knowledge transfer (e.g., non-fiction works for children, Children’s University lectures and children’s TV programs about science and knowledge). The context is an extra-curricular one throughout; in other words, it is not about school textbooks or learning materials but rather about formats accessed by children of their own accord and in their spare time. The research questions explored in the project relate to the linguistic and visual techniques and strategies employed to provide children with knowledge – especially scientific knowledge – and are thus concerned with a description of the genre of communicative formats aimed at conveying knowledge to children. Also of interest is the kind of scientific knowledge addressed in such formats per se and what image of science emerges from the way it is represented. Additionally at issue, then, is the recontextualization of science in a context involving a target group that is fairly unusual for science communication, namely, children.

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together, convey an impression of how scientific knowledge is recontextualized for children here:

> Basic figures of discourse order the content-related elements of texts. In some instances, they cause them to appear at certain points in the discourse, determining the internal structure of the discourse – which need not necessarily be identical to the thematic structure of the texts in which they appear. They form a "grid", which itself can again exert influence as a basic structure of transdiscursive epistemic associations. (Busse 2000)[2]

The aim is to reconstruct these basic figures of discourse across different linguistic categories. I shall be looking especially for

1. lexical patterns: e.g., references to *scientist/researcher/professor* and to locations, instruments, and processes of scientific work and research, possibly also rhetorical figures which constitute a semantic framing of scientific results,
2. syntactic patterns: e.g., mode and negation to identify the degree of validity of scientific knowledge,
3. textual patterns: e.g., isotopies (i.e. the recurrence of semantic patterns, for example the pattern "scientific"), temporal connectives to identify the chronology of epistemic processes,
4. argumentative patterns: e.g., presuppositions (e.g., "what is known"), speech acts (e.g., what are scientists doing when they talk), causal connectives to describe scientifically justifiable associations.

These categories are derived in part from the various ontological possibilities for referring to science as a professional praxis (e.g., references to working locations, methods, instruments, research practices; cf. also Janich 2018) and in part also from linguistic studies on the way scientific knowledge and ignorance is expressed linguistically in texts (cf. e.g., Janich/Simmerling 2015; Janich 2015; 2016).

3 Knowledge Recontextualized as "Scientific"

First of all, it is striking that all the chapter headings in all three books are phrased as "why" questions. This form of question is a standard design criterion in many other non-fiction children's books, to be sure, but in the *Kinder-Uni*

2 Translations from German in this chapter by K. Cross.

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books the question plays a significant and consistent role as a pattern of recontextualization: the purpose of these questions is not only to structure the volumes at the macro (chapter) and the micro level (internal structure of the chapters); rather, asking questions and searching for answers are also postulated as a feature of science per se at a meta level:

(1) Questions and answers that have been compiled, discovered, investigated, discarded, asked anew, dropped and augmented here. (Vol. 1/Introduction)[3]

(2) Questions posed at the Tübingen Eberhard Karls University and answered by Tübingen academics. (Vol. 3/Preface)

Surprisingly, though, the type of question addressed here is characterized in different ways from one book to the next, so that between volume 1 and volume 3 a kind of rhetorical climax arises with regard to the importance of asking questions:

(3) At the children's university, real professors answered questions posed by children. Adults were also curious to hear the answers, because often enough they themselves hadn't been able to supply them. In the hustle and bustle of our daily lives, who indeed knows how to explain, off the top of their head, why people have to die? Who can say exactly why there are rich and poor people, why volcanoes are so hot, or why the dinosaurs became extinct? Who, if not such professors? (Vol. 1/Introduction)

(4) Children like dinosaurs. Children like volcanoes. And children like jokes. And when someone comes along and explains why the dinosaurs became extinct or why volcanoes spit fire, and tells a lot of jokes besides, the chances are that children are going to like it. But what about when it comes to Greek art, sculptures or vases? Or the mysterious "self" over which philosophers have wracked their brains? Or the structure of a plant? Isn't that a bit too alien to children's worlds? Not at all. In Tübingen the children weren't put off by any of the difficult topics. (Vol. 2/Preface)

(5) Whoever heard of such questions? At least, whoever heard of them until the children's universities arrived, overwhelming the whole state and then neighboring states with questions that otherwise might never have been posed in public – but that really deserved to be answered by an expert for once. (Vol. 3/Introduction)

In the first volume, then, the focus is still on the questions asked by children and to which they themselves are curious to know the answers. Here, science is

3 All the extracts quoted in this essay are from the three *Kinder-Uni* books and are translations of the first editions published in German. The original texts can be looked up in the corresponding German editions.

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conceptualized merely as an especially good source of information (*real professors answered questions posed by children … Who can say exactly … Who, if not such professors?*). The second volume – or "second semester" – clearly introduces, in addition to these children's questions, the kinds of questions scientists ask themselves. Due to the popularity of the *Kinder-Uni* it is assumed that children will be interested in these kinds of questions as well (*Isn't that a bit too alien to children's worlds? Not at all. The children in Tübingen were not at all put off by the trickier subjects.*). Finally, the third volume, or "third semester," is about questions which even the scientists only asked themselves upon having been quizzed by children – questions, then, which would never have been asked in public without the *Kinder-Uni*. The *Kinder-Uni* seems thus to be completely integrated into the process of knowledge acquisition, as it not only answers questions but also – like science itself – consistently prompts new questions.

Yet it is not just the questions that are important, of course – so, too, are the answers. They represent scientific knowledge because they are the outcomes of research processes:

> (6) Scientists have investigated why castles were so important for knights. (Vol. 3/Why did knights build castles?)

> (7) Researchers have discovered that birds are highly adaptable where language is concerned. (Vol. 3/Why do we tell stories?)

> (8) And just how they do that is something that scientists have tried to find out for centuries. (Vol. 2/Why do plants grow?)

There are two aspects to this research process. First, knowledge is recontextualized explicitly and quite matter-of-factly as expert and scientific knowledge by means of isotopic networks that are woven throughout the texts and refer lexically and semantically to typical sites of scientific work (*laboratory, desk, expedition/trip*), to scientific instruments and methods (*experiment, field study, method, model, theory, invention, latest equipment, electron microscope*), and to more general procedures of scientific endeavor and research (*research, solve problems, try to find out, discover, dig, observe, study sources, measure, analyze, work out, check, prove, explain, produce/construct*):

> (9) But he had shown how it was possible to find out about nature's mysteries: by conducting experiments. (Vol. 3/Why do thunder and lightning happen?)

The scientists themselves also appear in the texts in form of multifarious chains of reference, that is, they are repeatedly referred to in highly varied lexical forms:

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scientists, researchers, scholars, medical doctors, physicians, mathematicians, archaeologists or *language researchers, whom we also call linguists*.

Second, scientific research is conceptualized through metaphors while also being portrayed as a matter of solving mysteries, going on adventures or even treasure hunts – whether to make it more exciting for the children (see examples 10 and 11) or perhaps because scientists themselves see their research this way (see examples 12 and 13):

(10) Almost everywhere, professors are laying out their treasure trove of knowledge for children, letting it sparkle like so many crown jewels. (Vol. 3/Preface)

(11) By chance, we've just stumbled upon one of the most exciting features of the numerical realm. (Vol. 3/Why can't mathematicians count?)

(12) The end of the dinosaurs is one of science's greatest mysteries. Countless dinosaur researchers have wracked their brains for years without being able to solve it. (Vol. 1/Why did the dinosaurs die out?)

(13) In their search for interesting stones they go on many expeditions and can lead a pretty adventurous life. (Vol. 1/Appendix: Scientist as a Profession)

Finally, the knowledge presented here is recontextualized as scientific by being framed terminologically. All the chapters contain repeated explanations of scientific terms; thus, the reformulation, explanation, and/or definition of scientific terms can be regarded as a dominant basic figure of discourse. It shows that science speaks a different, special language (e.g., *or as the scientists say*):

(14) *Identity* (from identitas, the Latin word for 'essential unity') is what constitutes a human being's personality, what distinguishes him or her from all other human beings. (Vol. 3/Why do we tell stories?, margin note)

(15) Scientists call this technique, which bats have mastered perfectly, echolocation. (Vol. 3/Why do bats see with their ears?)

(16) The term given by scientists to this group of reptiles is archosaurs. (Vol. 1/Why did the dinosaurs die out?)

From time to time, however, there are also (unnecessarily stereotyped) accounts of what characterizes scientific language:

(17) **Technical jargon** [the German term *Fachchinesisch* carries a negative connotation:] – this question is no joke. What is the following in technical jargon: "People don't laugh in the same way or about the same things in different parts of the world"? Answer: "The hypothesis of the universality of laughter can be falsified via the evidence of a range of mo-

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tives and modalities of the process." And what's that in translation please? (1/Why do we laugh at jokes?, margin note).

(18) We would love to explain how Fermat's problem was solved. But unfortunately, the solution wouldn't fit in this book. (Vol. 3/ Why can't mathematicians count?, margin note)

One sign of an addressee-specific strategy of recontextualization is that the scientists presented here have purportedly endeavoured to impart their knowledge in an especially easy-to-understand way. The presupposition conveyed here in clichéd fashion is that, rather than being taken for granted, the comprehensibility of science is a special feature of the *Kinder-Uni* – despite the scientists being portrayed just as much in their general role as teachers (especially when the professors are introduced as individuals):

(19) The professors reflected longer than usual on how best to communicate their knowledge, how to present it most vividly, without thereby losing sight of the relevant 'why' question. That demanded a quite different approach than when they were addressing students or colleagues in their own fields. It sometimes also presented the lecturers with unforeseen challenges. (Vol. 1/Introduction).

(20) Gregor Markl [mineralogist] doesn't look like a typical professor. He wears jeans and a T-shirt, just like his students, is usually in a good mood, and speaks completely normally. Only in his moments of forgetfulness does he seem like a real professor. (Vol. 1/Appendix: profession of scientist)

The knowledge conveyed in the books is thus conceptualized as an outcome of scientific research and as part of science. This is achieved using various lexical resources (such as isotopic networks, lexically varied references, and metaphors) as well as basic figures of discourse such as the question-answer schema and the paraphrases and definitions of scientific terms. In the next section we shall look at the extent to which this knowledge might contain certain gaps and what role scientific ignorance and controversies play in the books as indications of conflicting evidence. The point of interest behind this question – given that the process of generating scientific knowledge is not without ruptures and conflicts but indeed is characterized by discussion, eristic communication, and skepticism (cf. e.g., Ehlich 1993; Merton 1973; Weinrich 2006) – is how authentically this is portrayed for the books' child readers.

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4 The Question of Authenticity: The Research Process and the Role of Ignorance and Controversy

What is conveyed very clearly in all the chapters of the three volumes is that scientific knowledge is the outcome of a *long-term* process of research. The books contain numerous references to gaps in knowledge that once did or still do exist and to the fact that nowadays we possess more, better, and more certain knowledge than we did in times past. The linguistic resources used to convey this are, first, lexical antitheses between *now* and *today* along with contrasting references to earlier ages (*in Benjamin Franklin's time; the scholars of the 16th century*) and, second, temporal information about periods during which attempts have been (or still are being) made to solve a certain problem (*three thousand years after; for three hundred years*):

> (21) In Benjamin Franklin's time, no-one could have known why a body takes on an electrical charge through friction, since back then the atomic model used by today's scientists to explain the structure of matter was unknown. (Vol. 3/Why do thunder and lightning happen?)

> (22) Even so, three thousand years after this Egyptian pharaoh lived, it still remains unclear how much of our linguistic capacity or grammar is inborn and how much is learnt. [...] We now know that language is not simply controlled by one part of the human brain. (Vol. 3/Why do we tell stories?)

> (23) And just how they do that is something that scientists have tried to find out for centuries. [...] There is now no doubt that life teems in all parts of plants. [...] Researchers know much more about the inner life of plants, but even they haven't yet managed to see right down to the smallest molecules. (Vol. 2/Why do plants grow?)

These examples demonstrate not only that science repeatedly and successfully sets out to explain the world, to solve mysteries, and to answer questions (*today we know, we know now, there is now no doubt, researchers know much more about*) but also that this research process is constantly and unsurprisingly accompanied by the realization that knowledge gaps and uncertainties exist (*it still remains unclear, but even they haven't yet managed to see right down to, scientists suspect, most scientists believe, however*) and that the problems at hand are highly complex (*the world's cleverest mathematicians tried to solve Fermat's problem*). It is also made clear in many of the chapters that the research process is fundamentally open-ended, a circumstance for which very

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different reasons are offered: limited opportunities (example 24), limits to what is possible (examples 25 and 26) and even limits to what is permissible (example 27):

> (24) Hard luck for the archaeologists that grave robbers often got there first [...] Chance is the archaeologist's constant companion. It can ruin even the best-laid plans. (Vol. 2/Why are Greek statues naked?)

> (25) Even so, we still have to assume that life has also developed in other solar systems and distant galaxies, even if we will probably never know of it. (Vol. 2/Why don't the stars fall out of the sky?)

> (26) Do we even know how many languages are spoken across the world? We can only guess, since we can't simply count languages like apples and pears. Even just distinguishing between a dialect and a language is a complex business. (Vol. 3/Why do we tell stories?)

> (27) Now we can finally answer our question about whether we are allowed to clone human beings. We are not allowed to. Cloning is too complicated and risky to try it out on human beings [...] No-one knows how someone would cope with the knowledge that they were a copy. (Vol. 2/Why are we not allowed to clone humans?)

On the one hand, science is represented in very realistic terms as a search for better and better explanatory knowledge, a search that at times is laborious and not always successful; on the other hand, the processes of knowledge acquisition associated with this search appear – despite all uncertainties – as a linear progression through time, with no mention of any great ruptures or controversies. Scientific eristic, a core element of scientific discourse (cf. Ehlich 1993; Weinrich 2006), is visible only in very isolated cases that are treated in humorous (example 28) or ironic, marginalizing terms (example 29):

> (28) The children weren't short of answers either, and the professors showed them a great deal of collegial respect, sometimes stating that the view in question was an "eminently defensible school of thought". [...] The professors proved to be very open and made space for many other experts beside themselves. (Vol. 1/Introduction)

> (29) **The footnotes:** [...] Sometimes in footnotes you can also find longer discussions. Such discussions are called 'asides,' in which the author might, say, develop a bold new theory on the mating habits of bird spiders. Or she might explain to the reader why a certain other scientist's theory about the mating habits of the bird spider is completely wrong. (Vol. 1/Appendix: 'University Language' glossary – here again only as a note in the margin (!))

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Instead of including the process of scientific debate (with its skepticism, doubting, controversies and different schools of thought; cf. e.g., Merton 1973 following Max Weber) in the representation, scientific knowledge for children – when it actually makes an appearance and despite linguistic markers of uncertainty (e.g., with verbs such as *believe, guess, assume*; cf. Janich/Simmerling 2015) – is generally recontextualized as being free of doubt (e.g., *All the world's serious scientists agree on this point.* Vol. 3/Why do thunder and lightning happen?). As a rule, ignorance is (merely) a form of "not yet knowing" or of "not being able to know"; at most it appears as an error or a lack of knowledge from days gone by.

There are no references, then, to different possible positions *within* science; instead, readers are made aware of the difference between scientific and *everyday* knowledge throughout the book. Scientific knowledge appears as relevant to everyday life because it is capable of explaining phenomena in our ordinary everyday world (*that's not all hocus-pocus; it's guided by the most advanced scientific knowledge.*). Yet at the same time it comes across as being remote from our everyday lives – not just because it is dressed up in a different kind of language (cf. section 3) but because it lies beyond our everyday imagination (*we can't touch, beyond our experience*) and thereby takes on a certain aura of wonder and fascination (*sounds pretty crazy, funnily enough, amazing things, DNA is a marvel, it's fantastic*):

(30) Unfortunately we can't touch atoms […] The story about atoms sounds pretty crazy […] and funnily enough we still don't understand it in all its details […]. […] physical theory that goes beyond our experience […]. (Vol. 3/Why do thunder and lightning happen?)

(31) Doctors today can do amazing things […]. Today's doctors are even clairvoyant. No, that's not all hocus-pocus; it's guided by the most advanced scientific knowledge. (Vol. 3/Why can doctors heal people?)

(32) DNA is a marvel. […] Every time we eat an apple or a schnitzel or drink a glass of milk, we get DNA in our bellies. But don't worry: we don't need to be afraid that an apple tree or a pig will grow in our tummies. […] For genetic scientists, it's fantastic that every living being has a DNA code […]. (Vol. 2/Why are we not allowed to clone humans?)

Scientific knowledge is thus attributed the status of "wondrous," fantastic, and incredible; this is taken so far that scientific knowledge can even merge with fiction (cf. *Asterix*, *Red Riding Hood*) without the change of genre ever really being explicitly mentioned:

(33) The Roman Empire, which ruled Europe for hundreds of years (well, except for a village of indomitable Gauls in northern France, of course), collapsed under the onslaught of many invaders. […] The woods were home not only to strange and wild animals […], but

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> also to strange and wild people – outlaws who had been driven out of the villages, and unscrupulous robbers. In the story of Red Riding Hood we can read just how dangerous it was to stray from the path when walking in the woods. (Vol. 3/Why did knights build castles?)

5 The Image of Science

As the two previous sections have shown, science comes off rather well, albeit not entirely without elements of stereotyping (see e.g., section 3 on scientific language). I return here briefly to these stereotypical elements because they exert an influence on the way scientific knowledge is recontextualized in the *Kinder-Uni* books by subtly giving it specific connotations. In the following, then, I briefly address the difference between the chapters on the natural sciences and those on the humanities as well as the stereotypes relating to everyday university life.

It is interesting that the chapters on natural science topics and those on humanities topics differ noticeably (for further detail, cf. Janich 2018). In the natural science chapters, the knowledge explained is often personalized by naming prominent researchers from specific disciplines and by mentioning feats of research and discovery which are attributed to individuals (*Except that the scientists already knew one thing, two researchers then discovered independently of each other*; cf. also examples 9, 21–23). In the humanities chapters, by contrast, it is more as if the (journalist) authors and readers are searching together for answers to the questions posed by thinking them through and exploring plausible explanations (*we need to consider, we have now found, before we search further, let's look*):

> (34) To answer these questions, we need to consider the era in which the castles were built, the Middle Ages. [...] We have now found one reason why the knights built castles: to protect themselves. This is an important reason, but it was not the only one. Before we search further, let's look at how the knights built castles to make sure they were as safe as possible. (Vol. 3/Why did knights build castles?)

While reference is made here to the sources mined by, for example, philologists and historians and to findings made by archaeologists, the process of generating knowledge comes across as far less abstract and the knowledge itself appears much more ambiguous than scientific knowledge. These differences between the experimental natural sciences and the humanities (often proclaimed to be hermeneutics- and text-based sciences) manifest at different levels. First, the humanities scholars quoted are characterized much more prominently as

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teachers and authors who give talks and lectures, who test students and study sources at their desks or write essays and books. In contrast to this, the natural scientists are largely characterized as people who go on expeditions, who conduct exciting experiments and work in laboratories with sophisticated apparatus. As a result of this contrast, it sometimes appears almost dubious as to whether the humanities can even be characterized as a genuine science at all. The following two examples can be taken as representative of many others regarding the contrast portrayed:

> (35) Mineralogists get around a lot. In their quest for interesting stones they undertake lots of expeditions and can lead quite an adventurous life. They travel to Antarctica, to Greenland and to Lofoten. They spend most of their time, though, in the laboratory. Using ultramodern apparatus, the mineralogists cut their stones into wafer-thin slices and look at them under an electron microscope. (Vol. 1/Appendix: Scientist as a Profession)

> (36) A cultural studies researcher actually has quite a cushy job. He can hang around for days on football fields and say that it's for research purposes. That makes him a football researcher. He watches the matches, asks active and former footballers questions, interviews trainers, looks at what goes on in the clubs, reads sportsmen's memoirs, delves into the archives […]. When cultural studies researchers have completed their field work, then it's back to their desks. This is where their essays and books get written. (Vol. 1/Appendix: Scientist as a Profession)

In addition, the humanities chapters are quite explicitly less about science and research than the natural science chapters in terms of the language used. A sample count of expressions containing the morpheme {*forsch-*} (for *Forschung*, "research") and the morpheme complex {*wissenschaft-*} ("science/scientific") in six randomly selected chapters studied in greater detail elicits the following results (which do not include occurrences of the names of specific disciplines or the representatives of these disciplines):

1. Selected humanities chapters:
   - In the chapter "Why do we laugh at jokes?" (Vol. 1) about empirical cultural studies, the words *joke researcher* (*Witzforscher*) and *cultural studies researcher* (*Kulturwissenschaftler*) occur just once each and solely in the passage introducing the chapter's "expert mentor" Hermann Bausinger – i.e., in an extremely focused, marginal part of the text.
   - In the history chapter "Why did knights build castles?" (Vol. 3) the word *researcher* (*Forscher*) occurs twice and the verb *to research* (*erforschen*) likewise occurs twice (once in connection with archaeology); the word *scientist* (*Wissenschaftler*) occurs once and the word *science* (*Wissenschaft*) occurs three times (here, though, solely in relation to the *lack* of science in the Middle Ages!).

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- In the chapter on German literature “Why do we tell stories?” (Vol. 3) the word *researcher* (*Forscher*, also as a compound noun, i.e., *-forscher*) occurs four times: once for *scientists* (*Naturwissenschaftler*) in the context of “the language of birds” and three times specifically in relation to Jacob Grimm and his narrative research; *science* as a compound noun occurs just once in the word *legal science* (*Rechtswissenschaft*) with regard to Grimm’s education.

2. Selected natural science chapters:
   - In the paleontology chapter “Why did the dinosaurs die out?” (Vol. 1) the word *research* (*erforschen*) occurs twice, the word *researcher* (*Forscher*) occurs six times (plus twice for *Dinoforscher*, once for *Naturforscher*, once for *Urzeit-Forscher*, and once for *Saurierforscher*); *scientific* (*wissenschaftlich*) occurs once, *science* (*Wissenschaft*) once and *scientist* (*Wissenschaftler*) 17 times.
   - In the genetics chapter “Why are we not allowed to clone humans?” (Vol. 2) the word *researcher* (*Forscher*) occurs 13 times, the word *research* (*Forschung*) once, and the word *scientist (Wissenschaftler)* seven times.
   - In the physics chapter “Why do thunder and lightning happen?” (Vol. 3) the word *researcher* (*Forscher*) occurs four times, the verb *research* (*erforschen*) once, and the noun *research* (*Erforschung*) once, as well as there being eight words that include *science* as a compound noun.

This shows, therefore, that humanities’ scholars are perceived and represented less self-evidently as scientific researchers than their natural science colleagues.

Despite being published in the 2000s, the books also reinforce the stereotype that science is essentially a male-dominated domain: the “expert mentors” of the chapters are almost all men (Vol. 1: only men, Vol. 2: six men, two women, Vol. 3: seven men, one woman), which may have to do with the professorial staffing structure at the University of Tübingen. In addition, though, even the glossary of “university language” (Vol. 1) speaks almost exclusively in generic male terms (the headwords appear without exception in the male form: *Der Assistent / Der Doktor / Der Hiwi / Der Kommilitone / Der Magister / Der Professor*). Women are mentioned explicitly in the glossary just twice, though at least in especially honorable contexts (namely, in relation to the qualification *Doktor h. c.* and to research grants). No gender-appropriate language is apparent anywhere in the topic-based chapters (probably for reasons of a better comprehensibility).

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Finally, the university is portrayed – again, not least due to the glossary entries – as a world of its own that is not always entirely comprehensible and is filled with strange rituals. For example, the glossary explains phenomena such as *emeritus professorship, reference works, tapping on the table* (a form of applause when a lecture is over), *cum tempore* (the academic quarter of an hour; the glossary states: *In other countries, c.t. would be translated simply as "too late"*) and the *personal study log* as well as the specific academic hierarchies, from undergraduates and doctoral students through to professors. Despite the explanations generally being straightforward and matter-of-fact, the academic world and, in particular, the students do not escape stereotypical attributions:

> (37) If you make the most of vacations and not enough of the semesters, you may end up becoming a long-term student and clocking up so many semesters that the university might even throw you out. (Vol. 1/Appendix: 'University Language' glossary, lemma "semester")

> (38) Refectories are a really good thing because a lot of students don't have enough money or time to cook. Besides, not everything students cook is edible. (Vol. 1/Appendix: 'Universitary Language' glossary, lemma "refectory").

6 Recontextualizing Science – in Both Authentic and Stereotypical Ways

Let us finally turn to the questions posed at the start of this essay:

What kind of knowledge is at issue here – and to what extent is this knowledge recontextualized as scientific? The knowledge conveyed in the *Kinder-Uni* books is knowledge that children are interested in – this at least is implied by the authors in view of the huge popularity of the prior *Kinder-Uni* lectures that formed the basis of the material in the books. At the same time, the subject matter is a very specific set of knowledge: knowledge acquired by experts on the basis of complex, laborious, labor-, and cost-intensive research processes in a specific surrounding, with specific methods and expressed in a specific language. Narrated in this way, research offers answers to questions to do with everyday phenomena (such as the weather, plants, language/stories, humor, volcanoes, dinosaurs, human living, and dying). It is also, however, at some remove from everyday life by virtue of its abstractness (*Why are not allowed to clone humans? Why am I who I am?*) and complexity (including its linguistic complexity) and thus acquires an aura of mystery and wonder.

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To what extent are ignorance, doubt, and controversy discussed? Ignorance and uncertainty do make regular appearances when past or current knowledge gaps are addressed as yet unproven assumptions. They are a perfectly normal part of research in all chapters; it is still not possible even today to find answers to the new questions that repeatedly arise from new insights. The books also address the limits (regarding both methods and ethics) of knowledge. What they lack, though, is to account of controversies, contradictory expert opinions or indeed disputes within the scientific community. Instead, recent knowledge is always better than older knowledge, and both kinds differ markedly from what we are used to know (and in some cases even are able to understand) in our everyday lives. Scientific knowledge is thus recontextualized as a vehicle for overcoming the state of not-yet-knowing – but not as knowledge that in any way involves contemporary disputes.

What image of science does the book project? Overall the representations in the *Kinder-Uni* books are characterized by an optimistic image of uninterrupted progress. This can be seen from the linear progression of scientific successes and accrued knowledge which appears to proceed without any great disruptions. In terms of its knowledge and the cognitive processes on which it is founded, science is characterized – in terms of both its language and its content – by being very distant from the world of non-scientists and therefore also of children. This applies even more to the natural sciences than it does to the humanities. Accordingly, the texts are interwoven not only by the above-mentioned contrasts between *at that time* and *nowadays* but also by those between *scientists* and *us*. At the same time, however, this special nature of scientific research and scientific knowledge is contrasted with the normality of the scientists who act as "expert mentors" for the different chapters. They "speak quite normally," "don't look like scientists at all," they love football or travelling, they are active in local politics, they like baking or making things, and they wear jeans and sports shoes.

Taken together, these findings demonstrate that the books pursue key strategies of popularization such as those found by Niederhauser (1999) in popular science journalism aimed at adults. In terms of content, the scientific knowledge at issue here is represented in a less compact and less complex way. Scientific words are used circumspectly and are very often explained explicitly. Scientific knowledge is recontextualized in consideration of – and indeed by emphasizing – its significance and its relevance to everyday life; at the same time, it is frequently personalized – at least in case of the natural sciences – so that scientific progress comes across as being an outcome of individual or disciplinary feats of discovery. The book series contains many explicit references to the

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characteristics of science – including semantic and lexical reference and recurrence, metaphorical and explicit descriptions of scientific work processes, scientific naming practices and individual research celebrities and their successes. In doing so, it acquires a special status in the field of children's non-fiction in the sense that it attempts to answer questions of interest to children using knowledge explicitly recontextualized as "scientific."

This way, the books do justice to science while also clearly endeavoring to present content that is suitable for children. At the same time, they reinforce common stereotypes of science and scientists by, for example, deploying them in ironic ways and, in highlighting exceptions to the rule, implicitly confirming them.

References

Busse, D. (2000). Historische Diskurssemantik. Ein linguistischer Beitrag zur Analyse gesellschaftlichen Wissens. *Sprache und Literatur in Wissenschaft und Unterricht*, 31(2), 39–53. DOI: 10.30965/25890859-031-02-90000005.

Ehlich, K. (1993). Deutsch als fremde Wissenschaftssprache. *Jahrbuch Deutsch als Fremdsprache*, 19, 13–42.

Janich, N. (2015). Wissenschaftliche Sprachkultur oder: Was wir in Zukunft nicht aufgeben sollten. *Sprache, Universität, Öffentlichkeit. Festschrift Jürgen Schiewe* (Eds. K. S. Roth, J. Spitzmüller, B. Arendt, & J. Kiesendahl). Bremen: Hempen, 109–124.

Janich, N. (2016). Wissenschaft(ssprach)lichkeit – eine Annäherung. Zu Merkmalen und Qualitäten wissenschaftlicher Texte. *Schreibberatung und Schreibtraining in Theorie, Empirie und Praxis* (Ed. S. Ballweg). Frankfurt a. M. et al.: Peter Lang, 65–82.

Janich, N. (2018). Forscher erklären die Rätsel der Welt. Die Darstellung von Natur- und Geisteswissenschaften in den Büchern ‚Die Kinder-Uni'. *Geisteswissenschaften in der Öffentlichkeit. Linguistisch betrachtet* (Eds. M. Luginbühl & J. Schröter). Bern: Peter Lang, 85–105. DOI: 10.3726/b14151.

Janich, N. & Simmerling, A. (2015). Linguistics and Ignorance. *Routledge International Handbook of Ignorance Studies* (Eds. M. Gross & L. McGoey). London/New York, NY: Routledge, 125–137.

Janßen, U. & Steuernagel, U. (2003–2005). *Die Kinder-Uni. Forscher erklären die Rätsel der Welt. Mit Illustrationen von Klaus Ensikat* (Vol. 1 2003. Vol. 2: Zweites Semester 2004. Vol. 3: Drittes Semester 2005). München: DVA.

Merton, R. (1973). Science and Social Order [1938]. *The Sociology of Science. Theoretical and Empirical Investigations* (Ed. R. Merton). Chicago, IL/London: University of Chicago Press, 254–266.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Niederhauser, J. (1999). *Wissenschaftssprache und populärwissenschaftliche Vermittlung*. Tübingen: Gunter Narr.
Weinrich, H. (2006). Sprache und Wissenschaft. *Sprache, das heißt Sprachen. Mit einem vollständigen Schriftenverzeichnis des Autors 1956–2005* (Ed. H. Weinrich). Tübingen: Gunter Narr, 207–220.

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Joachim Kimmerle

How Laypeople Process Health News Articles

Effects on Perception and Participation on the Internet

1 Introduction

Reports of medical advances in the media often raise high expectations in medical laypeople and affected patients regarding the potential of the reported therapies. Many people, however, underestimate the fragility and *tentativeness* of research findings (Bromme/Goldman 2014; Fischhoff/Davis 2014). Tentativeness of research findings means that the reported successes are often contradictory, ethically problematic, or only conditionally generalizable (Flemming et al. 2020). The neurosurgical procedure of *deep brain stimulation*, for example, is indicated for certain forms of Parkinson's disease according to medical guidelines, but its application to other diseases (such as addictions) is still being discussed and is currently under investigation (Bientzle et al. 2020). The problems of scientific tentativeness and the difficulties in clarifying this tentativeness to the public are particularly relevant for deep brain stimulation. The risks and benefits of this procedure are not known in their entirety, and investigations into the diseases for which they can be used therapeutically and which side effects can occur have up to now been insufficient (Kennedy et al. 2011; Schlaepfer et al. 2013). I will use this neurosurgical intervention of deep brain stimulation as an example throughout this chapter.

Media coverage usually picks up on recently published findings for reports on a specific research field. It seems that media reports implicitly assume that findings in scientific publications can be regarded as facts and assured knowledge. Ongoing controversies in the scientific community regarding methodological or theoretical issues are not always adequately considered by journalists (Peters/Dunwoody 2016). Journalistic texts often stand in sharp contrast to the tentativeness of scientific knowledge. In order to generate a realistic picture of research findings for the public, however, it is also necessary to communicate their tentativeness (Kohl et al. 2016). Of course, it is not always possible to discuss the entire background of this tentativeness. Even so, journalistic contributions should aim at addressing this issue, for example, by referring to recent findings as only one step on a long scientific journey toward solving a

https://doi.org/10.1515/9783110676310-009

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problem. A challenge in conveying the tentativeness of scientific knowledge to laypeople is the widespread public image of science as a system that provides "true" information about the world. The question must be asked as to how it is nevertheless possible to make clear and explain the tentativeness of scientific knowledge.

The focus of this chapter is on presenting research that has examined the relationship between the public discourse about scientific research findings on deep brain stimulation and the processing of these findings by laypeople. For this purpose, I will present the findings of a series of empirical laboratory studies as well as of an exploratory field study that dealt with *situational* (i.e., text-based) and *individual* (i.e., participant-based) factors of influence in science journalistic media reports on deep brain stimulation. These studies examined how the two different kinds of factors influenced people's *perception* and cognitive processing of the information, and how they influenced participants' *discussions* in online forums. The focus of these studies was on the critical evaluation by the recipients of the texts, that is, their own recognition of the tentativeness and their own assessment of the findings on deep brain stimulation, as well as on their comments on these findings in online forums. The science journalistic reporting varied with regard to several potential influencing factors. The aim of the investigations was to analyze the relevant influencing factors involved in the process of the participants' evaluation in order to demonstrate how the transfer of knowledge from science to the general public can be improved. The studies included here were conducted by my research group at the Leibniz-Institut für Wissensmedien (Knowledge Media Research Center).

2 Situational and Individual Factors of Influence

Previous research on the transfer of knowledge from science to society had shown, for example, that the transfer of tentative knowledge to the public is only possible to a limited extent (Kienhues et al. 2011; Thomm/Bromme 2012). Nevertheless, the understanding of the tentativeness of research findings is crucial to the formation of public opinion. New medical procedures can only be properly assessed in their viability if the public not only understands the risks and possibilities associated with a particular therapy, but also comprehends how tentative the reported findings can be. Data from different studies can be contradictory, cause-effect relationships may still be completely unproven, and therapy successes with certain patient groups are often not directly transferable

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to others. Thus, the ability of laypeople to properly assess reports about current research results is an important prerequisite for adequate public discussion of new methods and for enabling people to form their opinions.

Journalists whose business is communicating scientific findings to the public are confronted with many challenges if they want to present the tentativeness of these findings adequately (Dentzer 2009). Journalistic presentations seldom allow for providing a complete picture of the complexity of scientific methods, findings, and discussions. In addition, journalists not only have the task of informing their audience, but also of maintaining their interest and entertaining them. The fulfillment of this task of maintaining attention presupposes a certain degree of recipient-oriented simplification (Allan 2011). For this reason, I present in this article empirical investigations into potential factors which influence laypeople's perception and understanding of tentative research findings.

Another relevant feature of current science communication is that newspapers provide *online platforms* where texts presented by science journalists can be discussed publicly (Brants/De Haan 2010; Fahy/Nisbet 2011). This format aggravates the challenges to the transfer of knowledge: Not only is there the problem that laypeople may not at all or inadequately understand the tentativeness of reported medical findings. But in the forum environment, there is the added problem that the journalistic content also competes with texts created by other users, such as comments with their personal opinions or case stories. Internet users often give an individual case story in a web forum, reported by a person concerned, more weight than a scientifically recognized, well-researched finding (Kimmerle et al. 2012). There is also a risk that people will acknowledge and accept short and simple texts more willingly than more complex texts (Scharrer et al. 2012). In particular, the nature of social media environments is to encourage participation in the production of content, and this implicitly calls on media users to comment on contributions. Processes of deep understanding, in contrast, could lose importance as a consequence.

A factor that has been known to be an important prerequisite for critically questioning information is prior content knowledge. For example, people with pertinent background knowledge can quickly reject false claims (Richter et al. 2009). Accordingly, comments from people with prior knowledge of the subject might be particularly relevant when it comes to discussing complex content appropriately in participatory online forums. In addition to prior knowledge, recipients' attitudes play an important role. Even when journalistically edited scientific findings are presented neutrally and objectively, recipients tend to process them in a biased manner – according to their own preferences or per-

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sonal goals (Kimmerle et al. 2017b; Kunda 1990). Recipients process scientific results in a relatively uncritical way, if these results support their own opinion. Recipients are more inclined to scrutinize information more closely that is inconsistent with their preferences, which often leads to rejection of contradictory information (Ditto/Lopez 1992).

Finally, particular personality traits could also have an impact on the perception of scientific information and participation in discussing this information on the internet. Personality aspects that could be relevant in the context of processing scientific information are people's cognitive ability, their scientific literacy, their academic and their general self-efficacy, and their epistemological beliefs. These are the personality aspects taken into account in the studies presented here. Cognitive ability is relevant, as it can be considered a prerequisite for critical thinking – also with respect to critically scrutinizing scientific information (Bailin 2002). Scientific literacy is the ability to understand the principles of scientific research (Bybee/McCrae 2011; Miller 2004). Academic self-efficacy is people's belief about their own competence to work successfully in academic settings (Komarraju/Dial 2014), while general self-efficacy describes someone's belief that she or he could handle critical situations in general (Bandura 1997). The concept of epistemological beliefs refers to people's beliefs about the nature of knowledge (Buehl/Alexander 2001). People with highly developed epistemological beliefs (i.e., persons who think that knowledge does not have a simple structure but instead is complex, and who believe that knowledge can be falsified and is therefore modifiable) are better in selecting appropriate information sources. Epistemological beliefs regarding the nature of medical knowledge are particularly relevant for the selection, processing, and assessment of medical information (Kienhues/Bromme 2012). Prior to the studies presented here, it was an open research question as to what extent these personality aspects play a role in processing health news articles and in discussing scientific information in online forums. Understanding the relevance of the situational and personal factors influencing perception and their interplay is an important precondition for phrasing suggestions for improved knowledge transfer.

In the following paragraphs, I will first present findings regarding the effects of information presentation and personality factors on people's perception and understanding of the tentativeness of medical research findings. After that, I will present studies that dealt with the impact of online articles and existing user comments on people's particular contributions to the discussion of research findings in online forums. Concluding, I will briefly discuss the implications of the studies for science communication research and practice.

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3 Perception: Effects of Presentation and Personality

In an experimental study we examined several factors that have an impact on people's perception of scientific tentativeness of research on deep brain stimulation (Kimmerle et al. 2015). We took into account both how the presentation of scientific information in a journalistic text and how individual factors influenced people's perception. Regarding information presentation, one has to keep in mind that some journalists do not have the ability to handle scientific information adequately (Dunwoody/Griffin 2013), or that they may be inclined to ignore the tentativeness of research findings in order to announce exciting news. As a consequence, science journalists may present findings in a way that appears to be more clear-cut than it actually is. Such an easily understandable information presentation may be problematic as it could result in the development of misconceptions among the recipients (Scharrer et al. 2012).

In the study presented here we considered how the *framing* of information in a journalistic text about research on deep brain stimulation influenced the extent to which people recognized the tentativeness of the research in the text. It is known from previous research that the positive or negative framing of information has an impact on how people process information (Tversky/Kahneman 1981): People evaluate information differently when it is presented in an optimistic instead of a pessimistic way (Clark 2009). Therefore, the assumption was that journalistic editing makes it more possible for readers to recognize the tentativeness of the research results presented in a newspaper text. In addition, we expected that an emphasis on the limited reliability of the research results would also help the readers in identifying the tentativeness.

Regarding individual factors, we examined people's attitudes toward deep brain stimulation and their domain-specific epistemological beliefs (i.e., their beliefs about medicine-related knowledge; see Bientzle et al. 2014; 2019). As explained above, people tend to process information according to their own preferences. Therefore, people's attitude on a topic is quite important when they have to assess a medical treatment without having enough prior knowledge about the topic. We assumed that people with critical attitudes would be better at recognizing the tentativeness of results reported in a newspaper text than people with a positive attitude. Finally, we hypothesized that people with highly developed epistemological beliefs would also be better at recognizing the tentativeness than those with simple epistemological beliefs.

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The participants in this experiment read a newspaper report that presented findings from an exploratory study where deep brain stimulation was applied for the treatment of severe depression. There were four different versions of this article: We manipulated optimistic vs. pessimistic framing as well as strong vs. weak emphasis on the reliability of the research findings (or lack thereof) as written in a newspaper story about deep brain stimulation. We also manipulated people's attitude toward deep brain stimulation – on the basis that they did not possess any prior knowledge and had no previously existing attitude on this topic. We also measured their epistemological beliefs using a questionnaire (Stahl/Bromme 2007).

As expected, we found that participants who read an article in which the research results were framed pessimistically were more able to recognize the tentativeness of the research findings than participants with texts that framed the findings optimistically. Moreover, when the newspaper article emphasized the limited reliability of the findings, participants were more able to recognize tentativeness than with a newspaper report which only weakly emphasized the absence of reliability. This experiment also showed that people who had a positive attitude toward deep brain stimulation in advance perceived a lower level of tentativeness than people with a negative attitude. Finally, we found that people with sophisticated domain-specific epistemological beliefs were better able to understand the tentativeness of the research findings presented in the newspaper article than participants with simple epistemological beliefs.

In two further experiments we used a similar method (Flemming et al. 2015). We found that when individuals perceived a conflict between the research findings reported in a journalistic science article and an introductory text about deep brain stimulation that they had read before, they were better in recognizing the tentativeness of the research findings. We also found that participants with higher levels of general self-efficacy recognized less tentativeness but perceived a higher degree of scientific credibility than participants with lower levels of general self-efficacy. The findings of these studies suggest that a certain level of uncertainty – resulting from contradicting information or from aspects of personality – makes the recognition of scientific tentativeness more likely.

In a final experiment we not only took the perception of scientific tentativeness into account but also examined to what extent people were able to remember information form a journalist article (Feinkohl et al. 2016a). We found that both more sophisticated domain-specific epistemological beliefs and better cognitive abilities were associated with better recall of the contents of a science journalist article about deep brain stimulation. Moreover, persons with sophisticated domain-specific epistemological beliefs were again more able to recog-

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nize the tentativeness of research findings than individuals with simple domain-specific epistemological beliefs.

4 Participation on the Internet: Effects of Online Articles and User Comments

In further empirical studies we took into consideration that in online environments users are potentially not only influenced by journalistic articles, but also by the content provided by other users in an internet forum. Previous research has shown that the particular wording of users' comments in health-related online forums have an impact on how the discussion further develops (Kimmerle et al. 2014; 2017a). Accordingly, we examined in an experiment how laypeople discussed the medical research findings about deep brain stimulation on a web-based forum (Feinkohl et al. 2016b). All of the participants in this study were presented with an online article that described results from research on deep brain stimulation as a therapy for depression. After reading this article, they joined an online forum where they had the opportunity to discuss these research results with other users. The participants were randomly assigned to one of three experimental conditions that varied with respect to the user comments that were already present in the online forum: In one condition, the participants encountered user comments that explicitly addressed the tentativeness of the findings; in the second condition, they encountered user comments that did not go into the problem of tentativeness; in the third condition, there were no user comments at all. The user comments that addressed the tentativeness issue pointed out, for example, that there might be long-term effects of deep brain stimulation, which were unclear based on the case study reported in the article. Other critical comments referred to the potential role of placebo effects or pointed out that there might be alternative explanations for the research findings. Then the participants had the opportunity to write down and post their own comments about the article. Finally, we measured their domain-specific epistemological beliefs, their scientific literacy, and their academic self-efficacy.

We found, once again, that people with more sophisticated epistemological beliefs were better able to recognize the tentativeness of the research findings. In addition, and more importantly here, we found that people's scientific literacy as well as their academic self-efficacy were associated with more elaborate discussions in their own user comments about tentativeness. Moreover, we

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found that when participants encountered user comments in the online forum that had already addressed the tentativeness of the research findings, they selected the tentativeness issue to be a central theme in their own forum posts to a higher degree than when previous comments had not taken the issue of tentativeness into account.

In a similar vein, Flemming et al. (2017b) also considered the comments of web users regarding online articles about deep brain stimulation. We examined in a field study how conflictual information about research findings in online newspaper articles affected laypeople's comments on the respective articles. We gathered comprehensive data from real newspaper articles on the internet by conducting a systematic search with "deep brain stimulation" as the search term, resulting in a full survey of articles that covered a time frame of one year. Only online newspaper articles which were accompanied by user comments were included in the investigation. The user comments were rated by independent raters with regard to their content. We also measured to what extent the online articles confronted their readers with conflictual information on the reliability and validity of the research findings. We found that higher levels of conflictual information in the articles were associated with higher levels of expressed tentativeness in the user comments. The results also yielded a relationship between conflictual information in the online articles and a more negative attitude toward deep brain stimulation expressed in the user posts.

Finally, in an experimental study (Flemming et al. 2017a) we found that both the actual scientific tentativeness of the research findings reported in a health news article as well as the evidence provided in user comments influenced how users perceived scientific tentativeness and addressed it in their own comments: Participants who read an online science journalistic report that contained tentative findings of a study on deep brain stimulation recognized the tentativeness of the research findings to a higher degree and addressed this tentativeness more elaborately when writing their own user comments than participants with an article that reported findings with a lower level of tentativeness. Moreover, when the participants read skeptical user posts that provided empirical or anecdotal evidence for the skepticism before they wrote their own comments, they addressed the tentativeness in the article to a higher degree in their own comments than when they read skeptical user comments that did not provide any evidence or when they did not read any user comments at all.

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5 Conclusion

Communication of scientific knowledge to the general public is becoming increasingly important. This communication has the purpose and obligation of transferring knowledge to society. It is therefore vital that a realistic and appropriate picture of the respective research area is promoted in the public sphere by all those responsible for the communication. However, this objective is countered by obstacles, an important one of which is people's difficulties in dealing with the tentativeness of research results, which I have addressed in this chapter. The empirical findings presented here indicate that it is worthwhile to consider both situational and personal factors that have an impact on laypeople's processing of tentativeness. The findings of the studies reported in this chapter have important implications for the concrete design of science journalistic contributions and press releases regarding research findings in the life sciences. This chapter also sheds light on the dynamics of knowledge exchange in online forums that deal with health news.

Overall, we found that the more critically laypeople evaluate the subject of a journalistic article, the better they understand the tentativeness of the findings it contains. Our findings also imply the reverse, that laypeople tend to be less critical when they have not recognized the tentativeness of an article's information. This can be the case, for example, if the findings are framed in a one-sided positive way in an article or when it contains no conflicting information.

One limitation of the laboratory experiments that I have presented here was that all of them were conducted with samples that largely consisted of university students. It is unclear to what extent these samples are representative of the population as a whole, both in terms of the personal variables we measured and in terms of their ability to process information or reflect critically when reading scientific journal articles. It is assumed that the general population would display larger variances in the variables and abilities we mentioned here. Therefore, it is possible that the effects of personal variables in the present work have even been underestimated. On the other hand, the ability of our participants to identify tentativeness per se compared to the general population was possibly overestimated, which in turn suggests that the influence of situational variables on the identification of tentativeness would be shown to be even higher for non-student participants.

All studies in this chapter were carried out using the example of journalistic articles on the subject of deep brain stimulation. To which extent the findings can be generalized to other topics remains open. It is possible that the perception of tentativeness also depends on the particular subject being dealt with:

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some areas of scientific research report findings that are regarded as more tentative and some fields are perceived as more controversial than others. Personal relevance and personal concern of the respondents could also play a role. Future studies could also investigate how the detection of tentativeness affects laypeople's perception of science with regard to long-term changes in attitudes. Beyond effects on simply understanding a scientific issue, effects on people's concrete behavior are also conceivable. This might, for instance, directly apply to their information search of scientific topics on the internet. The perception of tentativeness may also have an impact on their decision-making behavior related to these topics, for example, with regard to their willingness to undergo certain therapeutic methods (see Eggeling et al. 2020; Kimmerle et al. 2020).

What this chapter presents, provides a basis for further explorations of laypeople's understanding of the tentativeness of scientific findings. The systematic experimental investigation and empirical evidence of situational and personal factors which influence the perception and handling of tentativeness suggest possible starting points for helping laypeople understand scientific information. The most obvious option is that authors of scientific journalistic texts take into account the situational factors that have been identified. Our investigations imply that journalists can help their readers in their perception of tentativeness by addressing the tentativeness of the findings very explicitly in the text, and by avoiding one-sided positive reporting in favor of a balanced presentation of conflicting positions on the respective topic.

References

Allan, S. (2011). Introduction: Science Journalism in a Digital Age. *Journalism*, 12, 771–777. DOI: 10.1177/1464884911412688.

Bailin, S. (2002). Critical Thinking and Science Education. *Science & Education*, 11, 361–375. DOI: 10.1023/A:1016042608621.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. New York, NY: Freeman.

Bientzle, M., Cress, U., & Kimmerle, J. (2014). Epistemological Beliefs and Therapeutic Health Concepts of Physiotherapy Students and Professionals. *BMC Medical Education*, 14, 208. DOI: 10.1186/1472-6920-14-208.

Bientzle, M., Cress, U., & Kimmerle, J. (2019). Development of Domain-Specific Epistemological Beliefs of Physiotherapists: A Longitudinal Study. *BMC Medical Education*, 19, 401. DOI: 10.1186/s12909-019-1844-z.

Bientzle, M., Kimmerle, J., Eggeling, M., Cebi, I., Weiss, D., & Gharabaghi, A. (2020). Evidence-Based Decision Aid for Patients with Parkinson Disease: Protocol for Interview Study, Online Survey, and two Randomized Controlled Trials. *JMIR Research Protocols*, 9, e17482. DOI: 10.2196/17482.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Brants, K. & De Haan, Y. (2010). Taking the Public Seriously: Three Models of Responsiveness in Media and Journalism. *Media, Culture & Society*, 32(3), 411–428. DOI: 10.1177/0163443709361170.
Bromme, R. & Goldman, S. R. (2014). The Public's Bounded Understanding of Science. *Educational Psychologist*, 49, 59–69. DOI: 10.1080/00461520.2014.921572.
Buehl, M. M. & Alexander, P. A. (2001). Beliefs About Academic Knowledge. *Educational Psychology Review*, 13, 385–418. DOI: 10.1023/A:1011917914756.
Bybee, R. & McCrae, B. (2011). Scientific Literacy and Student Attitudes: Perspectives From PISA 2006 Science. *International Journal of Science Education*, 33, 7–26. DOI: 10.1080/09500693.2010.518644.
Clark, D. (2009). *Framing Effects Exposed*. New York, NY: Pearson Education.
Dentzer, S. (2009). Communicating Medical News: Pitfalls of Health Care Journalism. *New England Journal of Medicine*, 360, 1–3. DOI: 10.1056/NEJMp0805753.
Ditto, P. H. & Lopez, D. F. (1992). Motivated Skepticism: Use of Differential Decision Criteria for Preferred and Nonpreferred Conclusions. *Journal of Personality and Social Psychology*, 63, 568–584.
Dunwoody, S. & Griffin R. J. (2013). Statistical Reasoning in Journalism Education. *Science Communication*, 35, 528–538. DOI: 10.1177/1075547012475227.
Eggeling, M., Bientzle, M., Cress, U., Shiozawa, T., & Kimmerle, J. (2020). The Impact of Physicians' Recommendations on Treatment Preference and Attitudes: A Randomized Controlled Experiment on Shared Decision-Making. *Psychology, Health & Medicine*, 25, 259–269. DOI: 10.1080/13548506.2019.1687917.
Fahy, D. & Nisbet, M. C. (2011). The Science Journalist Online: Shifting Roles and Emerging Practices. *Journalism*, 12, 778–793. DOI: 10.1177/1464884911412697.
Feinkohl, I., Flemming, D., Cress, U., & Kimmerle, J. (2016). The Impact of Personality Factors and Preceding User Comments on the Processing of Research Findings on Deep Brain Stimulation: A Randomized Controlled Experiment in a Simulated Online Forum. *Journal of Medical Internet Research*, 18, e59. DOI: 10.2196/jmir.4382.
Feinkohl, I., Flemming, D., Cress, U., & Kimmerle, J. (2016a). The Impact of Epistemological Beliefs and Cognitive Ability on Recall and Critical Evaluation of Scientific Information. *Cognitive Processing*, 17, 213–223. DOI: 10.1007/s10339-015-0748-z.
Fischhoff, B. & Davis, A. L. (2014). Communicating Scientific Uncertainty. *Proceedings of the National Academy of Sciences*, 111, 13664–13671. DOI: 10.1073/pnas.1317504111.
Flemming, D., Cress, U., & Kimmerle, J. (2017a). Processing the Scientific Tentativeness of Medical Research: An Experimental Study on the Effects of Research News and User Comments in Online Media. *Science Communication*, 39, 745–770. DOI: 10.1177/1075547017738091.
Flemming, D., Feinkohl, I., Cress, U., & Kimmerle, J. (2015). Individual Uncertainty and the Uncertainty of Science: The Impact of Perceived Conflict and General Self-Efficacy on the Perception of Tentativeness and Credibility of Scientific Information. *Frontiers in Psychology*, 6, 1859. DOI: 10.3389/fpsyg.2015.01859.
Flemming, D., Feinkohl, I., Cress, U., & Kimmerle, J. (2017b). User Comments About Research Findings: How Conflictual Information in Online Science Journalistic Articles Influences Laypeople's Understanding of Scientific Tentativeness. *Communications*, 42, 465–480. DOI: 10.1177/1075547017738091.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Flemming, D., Kimmerle, J., Cress, U., & Sinatra, G. M. (2020). Research is Tentative, but That's Okay: Overcoming Misconceptions About Scientific Tentativeness Through Refutation Texts. *Discourse Processes*, 57, 17–35. DOI: 10.1080/0163853X.2019.1629805.

Kennedy, S. H., Giacobbe, P., Rizvi, S. J., Placenza, F. M., Nishikawa, Y., Mayberg, H. S., & Lozano, A. M. (2011). Deep Brain Stimulation for Treatment-Resistant Depression: Follow-Up After 3 to 6 Years. *American Journal of Psychiatry*, 168, 502–510. DOI: 10.1176/appi.ajp.2010.10081187.

Kienhues, D. & Bromme, R. (2012). Exploring Laypeople's Epistemic Beliefs About Medicine: A Factor-Analytic Survey Study. *BMC Public Health*, 12, 759. DOI: 10.1186/1471-2458-12-759.

Kienhues, D., Stadtler, M., & Bromme, R. (2011). Dealing With Conflicting or Consistent Medical Information on the Web: When Expert Information Breeds Laypersons' Doubts About Experts. *Learning and Instruction*, 21, 193–204. DOI: 10.1016/j.learninstruc.2010.02.004.

Kimmerle, J., Anikin, A., & Bientzle, M. (2020). The Impact of Perceived Etiology, Treatment Type, and Wording of Treatment Information on the Assessment of Gastritis Treatments. *Frontiers in Public Health*, 8, 35. DOI: 10.3389/fpubh.2020.00035.

Kimmerle, J., Bientzle, M., & Cress, U. (2014). Personal Experiences and Emotionality in Health-Related Knowledge Exchange in Internet Forums: A Randomized Controlled Field Experiment Comparing Responses to Facts vs Personal Experiences. *Journal of Medical Internet Research*, 16, e277. DOI: 10.2196/jmir.3766.

Kimmerle, J., Bientzle, M., & Cress, U. (2017a). 'Scientific Evidence is Very Important for me': The Impact of Behavioral Intention and the Wording of User Inquiries on Replies and Recommendations in a Health-Related Online Forum. *Computers in Human Behavior*, 73, 320–327.

Kimmerle, J., Bientzle, M., Cress, U., Flemming, D., Greving, H., Grapendorf, J., Sassenrath, C., & Sassenberg, K. (2017b). Motivated Processing of Health-Related Information in Online Environments. *Informational Environments: Effects of Use, Effective Designs* (Eds. J. Buder & F. W. Hesse). Cham: Springer International Publishing, 75–96.

Kimmerle, J., Flemming, D., Feinkohl, I., & Cress, U. (2015). How Laypeople Understand the Tentativeness of Medical Research News in the Media: An Experimental Study on the Perception of Information About Deep Brain Stimulation. *Science Communication*, 37, 173–189. DOI: 10.1177/1075547014556541.

Kimmerle, J., Gerbing, K.-K., Cress, U., & Thiel, A. (2012). Exchange of Complementary and Alternative Medical Knowledge in Sport-Related Internet Fora. *Sociology of Sport Journal*, 29, 348–364. DOI: 10.1123/ssj.29.3.348.

Kohl, P. A., Kim, S. Y., Peng, Y., Akin, H., Koh, E. J., Howell, A., & Dunwoody, S. (2016). The Influence of Weight-of-Evidence Strategies on Audience Perceptions of (Un)Certainty When Media Cover Contested Science. *Public Understanding of Science*, 25, 976–991. DOI: 10.1177/0963662515615087.

Komarraju, M. & Dial, C. (2014). Academic Identity, Self-Efficacy, and Self-Esteem Predict Self-Determined Motivation and Goals. *Learning and Individual Differences*, 32, 1–8. DOI: 10.1016/j.lindif.2014.02.004.

Kunda, Z. (1990). The Case for Motivated Reasoning. *Psychological Bulletin*, 108, 480–498.

Miller, J. D. (2004). Public Understanding of, and Attitudes Toward, Scientific Research: What We know and What We Need to Know. *Public Understanding of Science*, 13, 273–294. DOI: 10.1177/0963662504044908.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Peters, H. P. & Dunwoody, S. (2016). Scientific Uncertainty in Media Content: Introduction to This Special Issue”. *Public Understanding of Science*, 25, 893–908. DOI: 10.1177/0963662516670765.
Richter, T., Schroeder, S., & Wöhrmann, B. (2009). You Don’t Have to Believe Everything You Read: Background Knowledge Permits Fast and Efficient Validation of Information. *Journal of Personality and Social Psychology*, 96, 538–558. DOI: 10.1037/a0014038.
Scharrer, L., Bromme, R., Britt, M. A., & Stadtler, M. (2012). The Seduction of Easiness: How Science Depictions Influence Laypeople’s Reliance on Their Own Evaluation of Scientific Information. *Learning and Instruction*, 22, 231–243. DOI: 10.1016/j.learninstruc.2011.11.004.
Schlaepfer, T. E., Bewernick, B. H., Kayser, S., Mädler, B., & Coenen, V. A. (2013). Rapid Effects of Deep Brain Stimulation for Treatment-Resistant Major Depression. *Biological Psychiatry*, 73, 1204–1212. DOI: 10.1016/j.biopsych.2013.01.034.
Stahl, E. & Bromme, R. (2007). The CAEB: An Instrument for Measuring Connotative Aspects of Epistemological Beliefs. *Learning and Instruction*, 17, 773–785. DOI: 10.1016/j.learninstruc.2007.09.016.
Thomm, E. & Bromme, R. (2012). ‘It Should at Least Seem Scientific!’: Textual Features of ‘Scientificness’ and Their Impact on Lay Assessments of Online Information. *Science Education*, 96, 187–211. DOI: 10.1002/sce.20480.
Tversky, A. & Kahneman, D. (1981). The Framing of Decisions and the Psychology of Choice. *Science*, 211, 453–458.

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Christoph Kulgemeyer

Towards a "Culture of Explaining" in Science Teaching

How Pre-Service Physics Teachers' Beliefs Impact the Quality of Their Instructional Explanations

1 Introduction

Teachers – science teachers in particular – need to be good explainers. It is nearly a consensus in science education literature that explaining is one of the most important skills a teacher should possess. For instance, Baird (1988) claims that "explaining is at the core of science education" and Osborne/Patterson (2011) agree: "providing explanations is the bread and butter of the science teacher's existence." Even more, students value well implemented instructional explanations highly (Wilson/Mant 2011a).

In opposition to the literature, explaining does not play a prominent role in science teacher education programs. In contrary, some teacher educators consider explaining to be an old-fashioned, didactical, and, therefore, ineffective approach that contradicts basic assumptions of constructivist learning. Also, teachers themselves do not think highly of instructional explanations. Wilson/Mant (2011b) found that the same teachers who were considered as exemplary and valued for their explaining skills by their students did not consider explaining to be of importance for good teaching themselves.

In this paper, it will be argued why it is a false assumption to see explaining in general as an ineffective classroom practice. Instructional Explanations performed by science teachers are rather undervalued and can contribute to successful teaching and learning when performed in a particular manner. Usually, however, it lacks an appropriate "culture of explaining," which means good explanations as well as a suitable way to integrate them into a learning process.

The focus of the paper will be on science education literature and describing the most prominent notions of explaining that are present in current research. Evidence about the general quality of instruction will be connected with studies on successful instructional explanations to develop a "culture of explaining" that supports learning and classroom practice.

Finally, evidence about the impact of two groups of beliefs – self-efficacy beliefs and beliefs about teaching and learning – on teachers' explaining perfor-

https://doi.org/10.1515/9783110676310-010

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mance will be presented to point out that the common false understanding of explaining as a transmission of knowledge decreases teaching quality.

2 Explaining in Science Education Research

2.1 Scientific Explanations and Science Teaching Explanations

The term *explanation* has been used with very different notions in science education literature. In the tradition of education on the nature of science, the meaning of the term explanation usually follows an idea that is most prominent in the philosophy of science. In this area of research, even though there are many alternatives (e.g., Kitcher 1981), the most important model for physics in particular still is the Hempel-Oppenheim model, also known as the deductive-nomological model or the covering-law model (Hempel/Oppenheim 1948). Interestingly, the core idea of this understanding of explanations does not fundamentally differ between a scientific and an everyday use of the term (McKain 2015). An explanation, in both cases, basically means a link between the occurrence of a phenomenon and an underlying principle. The science education researchers Treagust/Harrison (1999) called this a “scientific explanation.” They, however, distinguish scientific explanations from science *teaching* explanations, which are explanations of a scientific idea to a certain addressee (the so-called explainee), e.g., students. While scientific explanations need to follow the rules of logic to be accepted, science teaching explanations (or instructional explanations in science) have to consider the needs of their addressees at first. It is important to mention that science teaching explanations can also be given by students, for example during cooperative learning (Berger/Hänze 2015). Explaining is not limited to teachers.

The aim of a science teaching explanation is that the explainees *understand* a concept. Therefore, a communicative perspective has to be taken: considering the explainees’ prior knowledge or interests for an explanation is essential for that kind of explanation.

That leads to significant consequences for explaining as a communicative practice in science classrooms. The structure of explanations in science classrooms sometimes differs largely from the structure of scientific explanations. Scientific explanations link a phenomenon to an underlying principle. Thus, explaining means the explanation of the occurrence of a phenomenon by using a principle such as a law. In a communication process, it is quite often the other

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way around. The usual situation in a classroom is that an underlying principle needs explanation. E.g., the normative goal of a lesson might be the explanation of Newton’s third law (a fundamental principle for classical mechanics; some even call it an axiom). The law is given – and explaining, in this case, rather means an illustration of the law with different examples to which the law can be applied. A teacher, therefore, might try to explain Newton’s third law by showing situations where it works – such as explaining why a sprinter accelerates. Indeed, an appropriate science teaching explanation has a lot to do with a suitable choice of examples. Kulgemeyer/Schecker (2013) describe variables of high importance for explaining physics:

1. an appropriate *choice of examples*,
2. an appropriate *choice of language* (e.g., by using technical terms or everyday language),
3. an appropriate use of *representation forms* (such as diagrams or photos), and
4. an appropriate use of the *level of mathematization* (such as formulas or verbal descriptions of equations).

A good explainer is supposed to adapt these four variables to the addressees’ needs and, of course, to do so in a scientifically correct way. Still, to be of use the four variables require concretization. Who would not agree that an appropriate choice of language or examples is important? What does “appropriate” actually mean in this context? It requires a general theory of teaching quality (sometimes also referred to as instructional quality) to operationalize the appropriateness of science teaching explanations.

2.2 What is a Good Instructional Explanation in Science Teaching? – The Quality of Instruction

Kulgemeyer/Schecker (2013) state that appropriate explanations (a) connect to the prior knowledge of the addressees (i.e., the new information is familiar or at least imaginable) and (b) are interesting enough to activate the addressees cognitively. For suitable explaining, it is imperative to keep that in mind. Cognitive activation is one of three basic dimensions that constitute the quality of instruction, next to constructive support and classroom management (Dorfner et al. 2017). Cognitive activation basically means that the students follow the chain of thoughts. Constructive support consists of a teacher’s ability to adapt the content to the learners’ needs but also to support them emotionally. Classroom management means, e.g., an efficient use of time on a task. These three basic

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dimensions need concrete realizations for a situation like explaining (cf. table 1). For other classroom situations (e.g., students experimenting) different realizations would be required.

Tab. 1: Possible realizations for cognitive activation and constructive support in explaining situations (cf. Kulgemeyer 2019).

Basic dimension	Realization in explaining situations (examples)
Cognitive activation	– *Examples* that connect to prior knowledge and that are interesting (e.g., everyday examples). – *An appropriate language level*, which for some people is rather everyday language but for others also a language containing technical terms. – *An appropriate choice of the degree of mathematics*, which might mean formulas for some people but more verbal descriptions of mathematical equations for others. – An appropriate use of graphical illustrations, representation forms or objects that are familiar to the audience and show basic ideas in the explanation.
Constructive support	– A strong connection between representation forms, verbal language, and mathematics that makes it easy to see similarities and build a mental model. – *Frequently diagnosing the understanding*, e.g., by giving tasks or asking to summarize. – Summarizing the most important points. – *Encouraging* the students to participate actively, *praising* success and *showing understanding* for difficulties.
Classroom management	– Establishing a classroom environment that allows the teacher to stay on topic.

2.3 What is a Good Instructional Explanation in Science Teaching? – The Place of Explanations in the Learning Process

Kulgemeyer/Schecker (2013) present a model for explaining physics that has been used in many different studies since then to model the process of explaining and the efficiency of science teaching explanations. Explaining in this sense can be seen as a process that consists of an explanation by an explainer, feedback by an explainee and adaptations the explainer conducts based on the comments (Kulgemeyer/Schecker 2013). An adaptation based on the feedback is

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essential for the success of an explanation (Wittwer/Renkl 2008). In practice, some teachers aim to explain as easy as possible which is not a promising strategy – for students with a high prior knowledge repetitions or multiple examples are more a cognitive load than helpful.

Thus, there is no such a thing as the best explanation for all explainees. Kulgemeyer/Schecker (2009) understand explaining as a constructivist practice: a good explanation does not lead to understanding but rather increases the likelihood that the explainee can construct meaning. Also, in educational psychology, there has been much research on successful explaining and Wittwer/Renkl (2008) present an excellent overview of relevant results and Kulgemeyer (2019) reviewed additional literature from science education and educational psychology.

Tab. 2: A comparison of possible features of successful instructional explanations and common mistakes.

Instructional explanations in science…	
… that are more likely to *fail*.	**… that are more likely to be *successful*.**
Teacher starts with many examples and presents the underlying principle at the end of the explanation.	Teacher starts with the underlying principle and illustrates it with a few fitting and interesting examples.
Teacher considers the clarity of the explanation as most important and does not diagnose the success (that means whether or not the explainee(s) understood).	Teacher diagnoses frequently and uses the results for the adaptation. Prior knowledge and possible misconceptions guide the explanation.
Teacher tries to make matter as simple as possible.	Teacher adapts the explanation to meet the explainee’s needs. That sometimes requires technical terms and formulas and sometimes does not.
Teacher explains clearly and switches to a different topic. He/she values time on task above all.	Teacher explains clearly and takes the time to give tasks in which students need to elaborate the explained topic.
Teacher gives as many examples, repetitions and representation forms as possible.	Teacher avoids cognitive load and diagnoses whether or not an additional example is useful.
Teacher explains a topic of which students already have a high prior knowledge.	Teacher gives learning tasks that require self-explanation on topics that are already familiar.
Teacher gives tasks that require self-explanations for a new and complex topic.	Teacher explains a new and complex topic in an instructional explanation at first followed by tasks to elaborate the new information.

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Table 2 presents a comparison of common mistakes in explaining and strategies that are supposed to be successful based on the results of Kulgemeyer (2019) and Wittwer/Renkl (2008). Successful explaining in science classrooms consists of four basic steps (cf. figure 1):

1. An inquiry of the prior knowledge.
2. A presentation of new knowledge adapted to this prior knowledge following the realizations of cognitive activation, constructive support, and classroom management presented in Table 1 (the teacher's explanation in the narrower sense).
3. An inquiry of the success of explaining (that means the understanding) leading to possible adaptations and a new explanation.
4. An elaboration of the explained topic by the students guided by appropriate learning tasks that require the information from the teacher's explanation. It is time for these kinds of tasks after a "common ground" is reached: the information required for the task is accessible for the students.

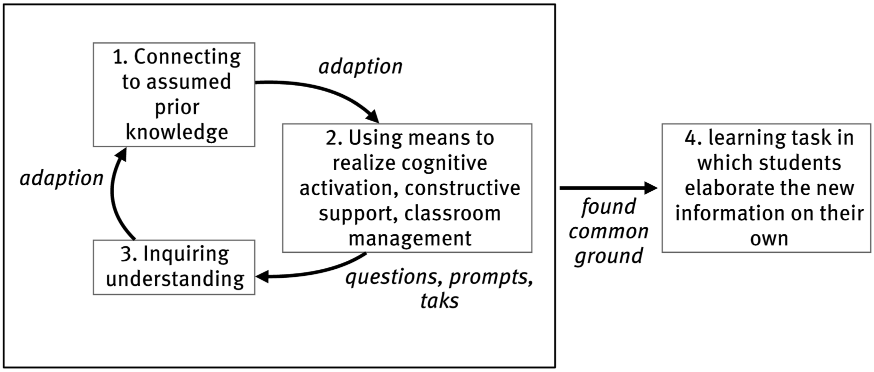

Fig. 1: Possible realization of a successful instructional explanation in science teaching ("culture of explaining").

Applying these four steps in science classrooms is a step towards an appropriate "culture of explaining." The first three steps need to be thought of as a circle: sometimes it is useful to start with step three and sometimes step one would be the starting point. Teacher explanations should, in particular, be used in situations where the new information is too complex to allow self-explaining. It is important to stress that otherwise self-explanations are probably more effective. In this sense and beneath other classroom practices also teacher explanations can be fruitful and contribute to successful teaching and learning. Explaining

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performed as a unidirectional practice in which teachers present the knowledge and quickly turn the attention to different topics, however, is very likely to fail. It is a common mistake to misunderstand instructional explanations that way. Table 2 compares common mistakes and more promising strategies for instructional explanations.

3 Performance-Oriented Testing of Explaining Skills

As described, explaining can be fruitful for science teaching. It is an important skill for science teachers but usually not addressed directly in teacher education. How can we measure explaining skills?

3.1 Performance-Oriented Testing

The usual way to assess teachers’ professional skills is either by using paper-and-pencil tests regarding their (declarative and procedural) professional knowledge or by observing lessons. There have been many studies trying to determine what teachers’ professional knowledge is in the sense of knowledge helping to perform well in specific professional situations (e.g., Keller et al. 2016; Kulgemeyer et al. 2020; Kulgemeyer/Riese (2018). Despite all these studies, there is no empirical evidence for an impact of the knowledge taught during teacher education on instruction quality (Vogelsang 2014). One of the main reasons for this disappointing fact is the measurement itself. Some scholars assume that paper-and-pencil tests fail in predicting procedural knowledge accurately (as they lack prognostic validity for classroom behavior) and call for assessment beyond written tests (Aufschnaiter/Blömeke 2010). Classroom observations seem to be the natural choice for a more authentic assessment. However, there are certain problems with them as well. The effects of professional knowledge on teaching quality might be small or medium, and therefore a large number of observed lessons is needed to determine them. Even more, in a single lesson, the effect is confounded by several context-related variables. Every experienced teacher knows that there are circumstances where even the best skills fail to result in effective learning, e.g., when the prior lesson was exhausting, and the students are simply too tired to learn, or because of some long-lasting difficulties between members of the group that cannot be solved easily. There are a lot of these variables, and in practical research it is impossible to control

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all of them. All the major studies researching the relationship between professional knowledge and instruction quality are limited by the number of lessons they observe (e.g., the COACTIV study: 23 lessons of 23 teachers; see Baumert et al. 2010). A detailed analysis of a whole lesson takes a lot of time and effort. It is nearly impossible to analyze as many lessons as would be needed for every teacher for context effects to cancel each other out.

A possible alternative to the observation of professional practice that has been proposed for the domain of medicine at first is performance-oriented testing (Miller 1990). In such testing formats, authentic behavior under standardized circumstances is required. In medicine, e.g., standardized patients that follow a role description are used (Barrows/Abrahamson 1964). The standardization lies in the equipment the test persons have at their disposal and in the nearly standardized, but still authentic behavior of the patient. It is well-known that this kind of assessment can be conducted reaching high standards of validity, reliability, and objectivity (Walters et al. 2005). Also, for assessing teachers this kind of testing is an alternative at least.

3.2 The Dialogic Explaining Assessment (DEA)

We developed a performance test for teachers' explaining skills called *Dialogic Explaining Assessment* (DEA). It consists of a dialogic explaining situation where a teacher explains a given physics phenomenon to a student. The student, however, follows a role-description by giving standardized prompts and asking standardized questions. These prompts and questions pose challenges to the teachers' explaining skills. These kinds of dialogic explaining situations frequently occur in real teaching, e.g., when a teacher goes from group to group to assist the students in their learning tasks.

A DEA always starts with ten minutes of preparation time after the test person gets the task to explain a given topic to a tenth-grade student, e.g., "Why does a car skid out of a sharp curve on a wet road?". These topics are always explainable using high-school physics from the curriculum. The test person is provided with supporting material, e.g., diagrams and pictures of the situation or the most important formulas. After ten minutes of preparation, the test person is guided into a testing room where one student is waiting. The test person is free to use the given material in any way or to use own materials that have been prepared during the preparation time. During the next ten minutes, the test person needs to explain their topic and is confronted with both the standardized questions and questions that occur during the communication. These ten minutes are videotaped.

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These videos are analyzed using the model on explaining physics (Kulgemeyer/Schecker 2013) mentioned above. It is a category-based analysis with categories that emerged from a qualitative content analysis (Mayring 2000). The basic idea is to focus on the statements of the explainer and to assort categories that either support the cognitive activation or the constructive support – the two basic categories for teaching quality applicable in this dialogic situation. Table 1 shows important aspects that are regarded in the analysis. In the end, a scale from the categories is formed by simply summing up all supportive categories that have been used during the explaining.

Several studies regarding objectivity, reliability, and above all validity have been conducted. For example, it could be shown that the categories can be applied with a high interrater-reliability and that the scale itself has an appropriate internal consistency ($\alpha = .772$). It could also be shown that the measure accurately predicts experts' decision on the higher explanatory quality when comparing two videos. In a German publication, Kulgemeyer/Tomczyszyn (2015) present both the DEA and these studies in detail. Kulgemeyer/Schecker (2013) describe similar studies for a version of the test instrument with high-school students as explainers in English. Kulgemeyer/Riese (2018) used the instrument to analyze the effect of teachers' knowledge on their explanations.

4 The Impact of Beliefs on Explaining Performance

In this section, results of a study that has been conducted in the context of a broader research project will be presented. The project aimed at studying the interdependence of knowledge and performance in physics teacher education (Riese et al. 2015). German teacher education starts from the first semester of university on with courses in content knowledge, pedagogical content knowledge, as well as pedagogics and usually lasts ten semesters. After ten semesters and a master's degree, it takes another 1,5 to 2 years teaching training in practical-oriented institutions outside the university (the so-called "Referendariat") to become a certified teacher. The present section focuses on student teachers from the first phase of teacher education, the academic part at universities.

A group of 109 student teachers from five German universities and all semesters participated in the explaining performance test described above. All of the student teachers took 200 minutes of testing, including tests on content knowledge, pedagogical content knowledge, and explaining performance. They

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were also tested for beliefs, most importantly self-efficacy beliefs and beliefs about teaching and learning, as well as for their general interest in physics, their interest in explaining physics, their perspective taking skills, and various demographics. All the instruments have been researched regarding validity, reliability, and objectivity, e.g., with interview studies and textbook analyzes. The results have been published in detail (Riese et al. 2015).

In the present section, evidence about the impact of two important groups of beliefs on explaining performance will be presented: self-efficacy and beliefs about teaching and learning (cf. Kulgemeyer/Riese 2018). The self-efficacy of teachers has been researched thoroughly; also, many studies have been conducted in science education. Some studies suggest an impact of self-efficacy on teaching performance in general (e.g., Stipek et al. 2001). Self-efficacy has been described with very different notions, beginning with the distinction between self-efficacy and outcome expectancy by Bandura (1977). We accord with Schiefele/Schaffner (2015), who understand self-efficacy as the belief that a teacher can perform high-quality teaching that results in learning even though there are obstacles. Because it is an important concept addressed in teacher education, we were interested in whether or not self-efficacy in explaining situations, in particular, influences the performance quality. Do teachers, who consider themselves to be able to perform high-quality explaining that results in students' understanding show high-quality performance?

The second concept of interest in this section is a group of beliefs about teaching and learning that is also addressed in teacher education on several occasions. As described in section 1, successful explaining is an adaptive practice that follows basic assumptions of constructivism. Still, (mis)understanding science teaching explanations as unidirectional and transmissive is a common mistake. This belief is part of the broader concept "beliefs on teaching and learning." Beliefs about teaching and learning have been described as including many dimensions (Chan/Elliot 2004), but quite often a simple distinction has been used: a constructivist, student-centered point of view on the one hand and a transmissive point of view on the other. It is well-known that a student-centered point of view is more likely to result in effective teaching (e.g., Lygo-Baker/Brouwer 2013), but none of these studies focused on explaining situations. That is interesting because the two "poles" constructivism versus transmission are exactly the common differentiations of explaining situations. The question is: Do teachers with more constructivist beliefs about teaching and learning outperform teachers with more transmissive beliefs regarding the quality of their explaining?

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Path analysis has been used to research these questions. Path analysis is a statistical method to gain insights into relationships that are supposed to be causal. Maximum-likelihood estimation has been used to deal with missing data and manifest values (Kulgemeyer/Riese 2018). The result of a path analysis is a measure for the connection of two variables (the so-called path coefficient) that is usually expressed as a standardized regression coefficient.

Figure 2 shows the results of this analysis. The analysis found a significant influence of both groups of beliefs on the explaining performance, nearly equally strong and combined explaining 23 percent of the variance – which is a major impact. Both beliefs seem to influence how the student teachers acted in explaining situations. The path coefficient of self-efficacy in physics explaining reached $\beta = .34$ ($p < 0.001$) which means that an increase in self-efficacy of one standard deviation results in an increase of .34 standard deviations of the explaining performance. The path coefficient between the belief that explaining is a transmission of knowledge and explaining performance becomes negative: for this sample, therefore, an increase in this belief results in a decrease of explaining performance.

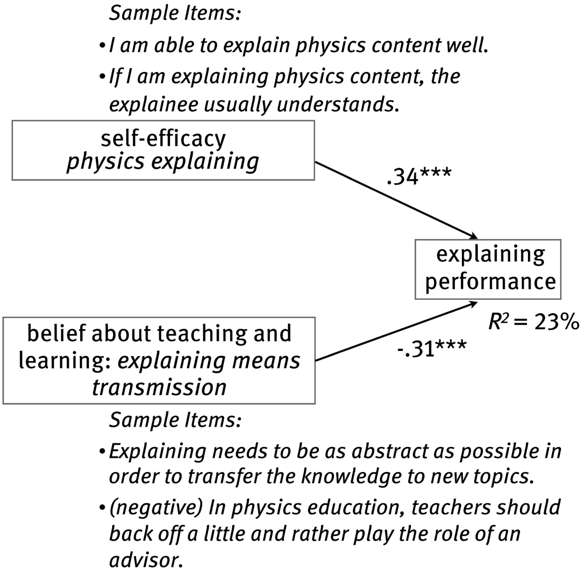

Fig. 2: Path model 1 for explaining performance (Robust Maximum-Likelihood, Full-Information-Maximum-Likelihood-Estimation). CFI=1.0, RMSEA=.00; Path coefficients and explained variance are given.

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That is an important result. It is known that the key to effective explaining is adaptation and interaction between explainer and explainee. The result presented here supports the assumption that beliefs actually influence the actions in explaining situations. Someone holding the belief that explaining is a transmission of knowledge will explain worse, merely because they explain as if it actually was a transmission of knowledge.

That makes explaining a somewhat dangerous practice. It is a widespread misunderstanding that explaining is a practice of which the most important aspect is a clear and logical sound communication that results in understanding. One could say: explaining in a classroom is often misunderstood as the presentation of a scientific explanation but not as a science teaching explanation. Surely, many people who regard explaining to be important believe the same. Still, those people will very likely explain in a worse way than someone holding a more constructivist perspective on explaining. As Geelan (2012) points out, a reason why explaining is missing as a topic from teacher education is the wrong understanding of the term. Still, just ignoring the importance of teacher explanations in teacher education might even help to establish the wrong perspective on the process. In the end, this false belief might turn every situation in science teaching where teacher explanations are required into situations that are ineffective because the explainers act following the dominant transmissive view. Of course, this argumentation needs more empirical backup than the small study presented in this paper.

Regarding the influence of the aspect of self-efficacy we measured, we can say that we actually found the expected impact on explaining quality. That is an interesting result as well. Not only does it show the impact of beliefs on the action, it also shows that people considering themselves as being effective explainers are right in tendency.

We further analyzed this relationship and used an additional variable. We asked the trained students to judge the quality of the previous explainer on a simple Likert scale after each explanation. The resulting number can be interpreted as the students' point of view on the effectiveness of an explainer. So, we have got two judgments: one from the explainer himself and one from the explainee. One could say the two measures represent two important points of view for an explainer: (1) the degree of how much someone considers *themselves* to be a good explainer and (2) the degree of how much *others* consider them to be good explainers. We tried these two measures as predictors for the "objective" explaining quality measured by our test. Figure 3 shows the result of this analysis.

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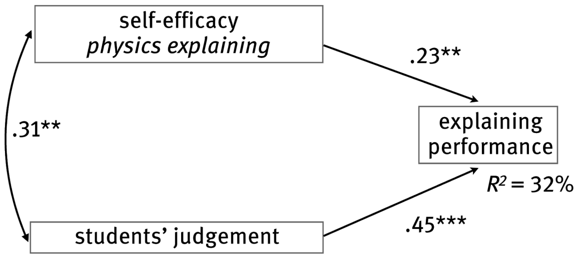

Fig. 3: Path model 2 for explaining performance (Robust Maximum-Likelihood, Full-Information-Maximum-Likelihood-Estimation). CFI=1.0, RMSEA=.00; Path coefficients and explained variance are given.

As we can see, the self-efficacy and the students’ judgment correlate with one another ($r = .31$, $p > .01$). More importantly, however, they can be used as significant predictors for the objective explaining performance. Together they explain 32 percent of the variance in the explaining performance, which is a large effect. What is worth to be highlighted: to find out whether or not someone is a good explainer one should ask them and someone who they already explained to about the quality of the explanations – the result will be a good hint for the objective performance. One could say that self-perception, personal perception and objective performance, in this case, go well together.

All in all, the study shows the importance of beliefs for actual action in explaining situations. It could also stress the importance of an accurate picture of explaining as a constructivist practice, which is a good argument to integrate the training of explaining situations into teacher education. However, it is an open and crucial question if and how the *knowledge* that is addressed in teacher education (most importantly content knowledge, pedagogical content knowledge, and pedagogical knowledge; see Shulman 1987) affects the explaining performance. This knowledge should enable teachers to perform well in various teaching situations, including explaining. Whether or not this is the case and which aspects of this knowledge help the most could be very important results for an evidence-based teacher education program.

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References

Aufschnaiter, C. v. & Blömeke, S. (2010). Professionelle Kompetenz von (angehenden) Lehrkräften erfassen – Desiderata. *Zeitschrift für Didaktik der Naturwissenschaften*, 16, 361–367.

Baird, J. (1988). Teachers in Science Education. *Development and Dilemmas in Science Education* (Ed. P. Fensham). London: Falmer, 55–72.

Bandura, A. (1977). Self-Efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review*, 84, 191–215.

Barrows, H. & Abrahamson, S. (1964). The Programmed Patient: A Technique for Appraising Student Performance in Clinical Neurology. *Journal of Medical Education*, 39(8), 802–805.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., Klusmann, U., Krauss, S., Neubrand, M., & Tsai, Y. M. (2010). Teachers' Mathematical Knowledge, Cognitive Activation in the Classroom, and Student Progress. *American Educational Research Journal*, 47(1), 133–180. DOI: 10.3102/0002831209345157.

Berger, R. & Hänze, M. (2015). Impact of Expert Teaching Quality on Novice Academic Performance in the Jigsaw Cooperative Learning Method. *International Journal of Science Education*, 37(2), 294–320. DOI: 10.1080/09500693.2014.985757.

Dorfner, T., Förtsch, C., & Neuhaus, B. J. (2017). Die methodische und inhaltliche Ausrichtung quantitativer Videostudien zur Unterrichtsqualität im mathematisch-naturwissenschaftlichen Unterricht. Ein Review. *Zeitschrift für Didaktik der Naturwissenschaften*, 23(1), 261–285. DOI: 10.1007/s40573-017-0058-3.

Geelan, D. (2012). Teacher Explanations. *Second International Handbook of Science Education* (Eds. B. Fraser, K. Tobin, & C. McRobbie). Dordrecht: Springer, 987–999.

Hempel, C. & Oppenheim, P. (1948). Studies in the Logic of Explanation. *Philosophy of Science*, 15(2), 135–175.

Keller, M., Neumann, K., & Fischer, H. E. (2016). The Impact of Physics Teachers' Pedagogical Content Knowledge and Motivation on Students' Achievement and Interest. *Journal of Research in Science Teaching*, 54(5), 584–614. DOI: 10.1002/tea.21378.

Kitcher, P. (1981). Explanatory Unification. *Philosophy of Science*, 48(4), 507–531.

Kulgemeyer, C. (2019). Towards a Framework for Effective Instructional Explanations in Science Teaching. *Studies in Science Education*, 54(2), 109–139. DOI: 10.1080/03057267.2018.1598054.

Kulgemeyer, C. & Riese, J. (2018). From Professional Knowledge to Professional Performance: The Impact of CK and PCK on Teaching Quality in Explaining Situations. *Journal of Research in Science Teaching*, 55(10), 1–26. DOI: 10.1002/tea.21457.

Kulgemeyer, C. & Schecker, H. (2009). Kommunikationskompetenz in der Physik: Zur Entwicklung eines domänenspezifischen Kompetenzbegriffs. *Zeitschrift für Didaktik der Naturwissenschaften*, 15, 131–153.

Kulgemeyer, C. & Schecker, H. (2013). Students Explaining Science – Assessment of Science Communication Competence. *Research in Science Education*, 43, 2235–2256. DOI: 10.1007/s11165-013-9354-1.

Kulgemeyer, C. & Tomczyszyn, E. (2015). Physik erklären – Messung der Erklärensfähigkeit angehender Physiklehrkräfte in einer simulierten Unterrichtssituation. *Zeitschrift für Didaktik der Naturwissenschaften*, 21(1), 111–126.

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Kulgemeyer, C., Borowski, A., Buschhüter, D., Enkrott, P., Kempin, M., Reinhold, P., Riese, J., Schecker, H., Schröder, J., & Vogelsang, C. (2020). Professional Knowledge Affects Action-Related Skills: The Development of Preservice Physics Teachers’ Explaining Skills During a Field Experience. *Journal of Research in Science Teaching,* 1–29. DOI: 10.1002/tea.21632.

Mayring, P. (2000). Qualitative Content Analysis. *Forum: Qualitative Social Research*, 1(2). http://www.qualitative-research.net/index.php/fqs/article/view/1089/2385.

McCain, K. (2015). Explanation and the Nature of Scientific Knowledge. *Science & Education*, 24, 827–854. DOI: 10.1007/s11191-015-9775-5.

Miller, G. (1990). The Assessment of Clinical Skills/Competence/Performance. *Academic Medicine*, 65(9), 563–567.

Osborne, J. F. & Patterson, A. (2011). Scientific Argument and Explanation: A Necessary Distinction? *Science Education*, 95(4), 627–638. DOI: 10.1002/sce.20438.

Riese, J., Kulgemeyer, C., Borowski, A., Fischer, H., Gigl, F., Gramzow, Y., Schecker, H., Tomczyszyn, E., & Zander, S. (2015). Modellierung und Messung des Professionswissens in der Lehramtsausbildung Physik. *Beiheft der Zeitschrift für Pädagogik*, 61, 55–79.

Shulman, L. (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Education Review*, 57(1), 1–22.

Stipek, D., Givvin, K., Salmon, J., & MacGyvers, V. (2001). Teachers’ Beliefs and Practices Related to Mathematics Instruction. *Teaching and Teacher Education*, 17, 213–226. DOI: 10.1016/S0742-051X(00)00052-4.

Treagust, D. & Harrison, A. (1999). The Genesis of Effective Science Explanations for the Classroom. *Researching Teaching: Methodologies and Practices for Understanding Pedagogy* (Ed. J. Loughran). Abingdon: Routledge, 28–43.

Van Driel, J. H., Verloop, N., & De Vos, W. (1998). Developing Science Teachers’ Pedagogical Content Knowledge. *Journal of Research in Science Teaching*, 35(6), 673–695.

Vogelsang, C. (2014). *Validierung eines Instruments zur Erfassung der professionellen Handlungskompetenz von Physiklehrkräften – Zusammenhangsanalysen zwischen Lehrerkompetenz und Lehrerperformanz*. Berlin: Logos.

Walters, K., Osborn, D., & Raven, P. (2005). The Development, Validity and Reliability of a Multimodality Objective Structured Clinical Examination in Psychiatry. *Medical Education*, 39, 292–298. DOI: 10.1111/j.1365-2929.2005.02091.x.

Wilson, H. & Mant, J. (2011a). What Makes an Exemplary Teacher of Science? The Pupils’ Perspective. *School Science Review*, 93(342), 121–125.

Wilson, H. & Mant, J. (2011b). What Makes an Exemplary Teacher of Science? The Teachers’ Perspective. *School Science Review*, 93(343), 115–119.

Wittwer, J. & Renkl, A. (2008). Why Instructional Explanations Often Do Not Work: A Framework for Understanding the Effectiveness of Instructional Explanations. *Educational Psychologist*, 43(1), 49–64. DOI: 10.1080/00461520701756420.

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Julia Siebert and Anett Richter

An Opportunity to Induce Bottom-Up Change in Society

Bringing the Transformative Potential of Citizen Science Into the Classroom

1 The Transformative Potential of Citizen Science

1.1 What is Citizen Science?

Citizen science has become a popular term that is understood as the partnership between professional scientists and citizens who share common interests. Citizens engaging in these scientific activities are usually not tied to institutions in the science sector (Bonney et al. 2015; Bonney et al. 2014; Freitag/Pfeffer 2013; Silvertown 2009) and do not require any scientific degree (Bonn et al. 2016). For many civil societies, this form of shared research is not new. Indeed, research by volunteers – both interested laypeople and experts in their fields – has been carried out in numerous fields for centuries (Bonney et al. 2014; Haklay 2013). The current growth of citizen science becomes evident by the increasing number of publications as well as the increasing number of platforms and projects that are allocated to research and built on partnerships between members from science and society (Kullenberg/Kasperowski 2016).

Citizen science projects offer various formats through which they actively involve citizens to generate new knowledge and understanding. The engagement ranges from the short-term collection of data to the intensive use of leisure time to delve deeper into a research topic together with scientists and/or other volunteers, to ask own questions, and to get involved in all phases of the research process – from phrasing research questions to interpreting and communicating results (Bela et al. 2016; Bonn et al. 2016; Bonney et al. 2009; Shirk et al. 2012). From a conceptual perspective it is vital to highlight that all citizen science projects should have a genuine scientific outcome, being carried out as hypothesis-driven science (Shirk et al. 2012). People get a chance to gain hands-on science experience, but at the same time, the outcome should be used to answer research questions, to inform conservation action, management decisions, or environmental policy. Both – the professional scientists and the citizen scientists – should benefit from taking part (Silvertown 2009).

https://doi.org/10.1515/9783110676310-011

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Grounded in the long tradition of volunteering work for science, disciplines such as nature conservation or biodiversity research greatly benefitted from the achievements of amateurs and naturalists and their benchmark findings that ground many of today's principles in ecology and biology (Cooper et al. 2014; Devictor et al. 2012; Theobald et al. 2015). Biological inventories have substantially profited from the voluntary engagement of citizens: the majority of our knowledge on flora and fauna is derived from their work (Bonney et al. 2014; Chandler et al. 2016; Schmeller et al. 2009; Silvertown 2009). The involvement of citizens in mapping biodiversity around the globe has resulted in enormously large datasets that are used by scientists to better understand and predict the future of biodiversity on our planet. However, the societal choices regarding the organism and species groups observed and investigated result in an overall taxonomic bias towards more charismatic taxa, strongly calling for the integration of less iconic and less surveyed species, e.g., through specifically targeted citizen science initiatives (Troudet et al. 2017). One of the novelties in modern citizen science – which may be of great help to address these gaps – is the affordable application of technical advancements such as mobile devices and smart sensors that are used to map, record, analyze, and communicate scientific data and information (Newman et al. 2012; Pimm et al. 2015).

1.2 What Motivates People to Engage in Citizen Science?

The new modes of collaboration between members of society and science enable ways to exchange and generate knowledge and to develop partnerships among and within people sharing a great interest in scientific discovery (Richter et al. 2018). High levels of engagement will also lead to a high level of emotional connectedness and increased learning outcomes within these partnerships (Crall et al. 2013). Studies have shown that personal motivation is key to trigger learning processes (Brossard et al. 2005). Project characteristics like the number of voluntarily engaging participants, their research efforts, the duration of involvement, or the exertion of influence the participants had in the process also strongly shaped the way participants experienced participation (Shirk et al. 2012). Nevertheless, even by contributing observational data participants' knowledge on the ecosystem was improved – sometimes resulting in higher interest in civic processes and possibilities for public engagement (Nerbonne/Nelson 2004; Pattengill-Semmens/Semmens 2003). For participants there are a variety of measures that can affect the success of the participatory experience, e.g. fairness (Cheng et al. 2008; Rowe/Frewer 2005), relevance (Cumming et al. 2008), or trust and credibility (Wulfhorst et al. 2008; Wynne 1992). The thorough con-

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sideration of these dimensions may help to facilitate social learning and long-term engagement (Fernandez-Gimenez et al. 2008; Pahl-Wostl et al. 2008; Tàbara/Pahl-Wostl 2007). In summary, there are manifold reasons for people to engage in citizen science projects – some may be keen on being part of scientific discoveries or help advancing scientific knowledge (Evans et al. 2005; Raddick et al. 2009), some may want to prevent environmental hazards (Overdevest/Mayer 2007) or to reach their own learning goals (McCallie et al. 2009; Weston et al. 2003).

1.3 How Does Citizen Science Connect Science, Society, and Politics?

Citizen science is understood as an approach to bridge science and society through the engagement of citizens in scientific research activities (Bonney et al. 2009; Haklay 2015; Sanz et al. 2015). Online platforms like *Bürgerschaffenwissen* or *Österreich forscht* list manifold projects covering a variety of scientific fields from biodiversity to astrophysics, from public health to community based resource management, from history to arts (Pettibone et al. 2017). Generally, there are two ways how links between the different knowledge domains can be achieved. Either, the research questions are developed and formulated by scientists or members of society raise questions and identify the required field of expertise needed to answer these questions. The latter is also referred to as bottom-up approach (Bonn et al. 2016; Wilderman et al. 2004). By combining a variety of knowledge domains and introducing new perspectives citizen science has an extensive potential that goes far beyond the traditional voluntary engagement in science.

But to what extent do citizens seek involvement in science? In Germany, nearly one third of the population shares an interest in being actively involved in a scientific research project (Wissenschaftsbarometer 2014; Wissenschaftsbarometer 2016). Within the policy sector awareness for the potential of citizen science is rising, too. Already in 2013, the German government formulated a call for more participation in the formal coalition agreement by stating: "We intend to develop new forms of citizen participation and scientific communication and to combine them to an overall concept" (Koalitionsvertrag 2013, Trans. JS/AR). Further, the scientific community addressed the potentials of citizen science and together with over 1000 participants from over 300 organizations and institutions the Citizen Science Strategy 2020 for Germany was launched in 2016 to highlight the potentials and identify the capacities needed to achieve a joint vision for citizen science in Germany (Bonn et al. 2016). This vision encompasses the creation and strengthening of existing structures and framework

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conditions for the participation of citizens in scientific processes (Bonn et al. 2016). At the same time capacities in society, science, technology, media, education, and politics are also needed to unleash the full potential of citizen science. Most important is the provision of both long-term financial and human resources for the establishing and growing citizen science community (Pettibone et al. 2015), as well as effective internal and external communication. Comprehensive quality management of the data and the development of data protection as well as data quality are identified as central challenges (Richter et al. 2015). Technical advancements in data management and the implementation of open science in research institutions could enable a flexible and successful implementation of active co-design and co-production in citizen science.

As citizen science becomes more formalized, e.g., as seen in the formation of national and international associations (e.g., *European Citizen Science Association*; *Australian Citizen Science Association*) and platforms for citizen science activities (e.g., *Österreich forscht*; *Schweiz forscht*; *Bürgerschaffenwissen*), capacity building paired with political commitment is required to garner support for and recognition of citizen science as a discipline (Richter et al. 2018). The untapped potentials require ongoing discursive and transparent dialogues among and within the communities (e.g., science; policy; society) (Newman et al. 2012).

All over Europe great efforts were made to foster citizen science alongside of professional science. Such developments are driven by the awareness that it is not enough to do great research, produce new and relevant scientific results and to communicate them (Sanz et al. 2015) – to achieve societal transitions and successfully face global challenges, it is crucial to include the perspectives of citizens as well (Turnhout et al. 2012). Citizen science has also been reinforced by the European Commission through the promotion in several calls in their research and innovation program Horizon 2020. In addition, several practical guides and reviews were released (Pocock et al. 2014; Roy et al. 2012) and initiatives such as the *European Citizen Science Association* (ECSA) were launched to foster citizen science in Europe. ECSA represents an association, which is driven by the understanding that research, innovation, and empowerment are closely linked to sustainable development (Storksdieck et al. 2016).

1.4 How Can Transformation be Achieved Through Citizen Science?

As citizen science is increasingly recognized as an innovation tool by science and society, we will highlight some of the hopes and expectations associated with the rise of citizen science in the different domains.

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For society, citizen science represents a new form of public involvement that can generate significant added value: through empowerment people can enhance their scientific literacy and scientific reasoning skills, they can learn how scientific knowledge is gained, and also understand the limitations of scientific methods and findings (Bela et al. 2016; Devictor et al. 2010; Fernandez-Gimenez et al. 2008; Jordan et al. 2011). This also implies to understand that scientific results are often controversial, inconsistent, and tentative, and that it is not a shortcoming of science that there often is no definite answer (Böschen/Wehling 2004; Janich 2012; Zehr 2000). If we assume that citizen science can enhance public empowerment and engagement in decision-making through scientific literacy (Bela et al. 2016), this also means that citizen science can present one avenue to equip people with necessary skills to fulfill their civic role in a democratic society. Indeed, shifts in awareness and behavioral changes could be observed after participating in citizen science projects, like, e.g., engaging in political processes or being inspired to tackle societal challenges through a feeling of empowerment (Bela et al. 2016; Bonney et al. 2009; O'Sullivan et al. 2002).

From a policy perspective, this public involvement can foster science-policy-society interfaces supporting democratic structures in research and thus improving sound decision making with legitimized outcomes (McKinley et al. 2017; Sanz et al. 2015).

For science, citizens' participation has the potential to increase the transparency and societal relevance of research, to enhance options for collecting and analyzing large-scale data sets, and to make new perspectives accessible. Thus, citizen science may serve as a motor for innovation in science and society (Jordan et al. 2011; Reed 2008; Sanz et al. 2015), informing and engaging citizens likewise (McKinley et al. 2017). Apart from the fact that citizen scientists can contribute great manpower (Cohn 2008), also their own experience-based knowledge is of high value (Turnhout et al. 2012). Besides that, scientists are not only interested in direct scientific outcome – some may be intrigued by conservation efforts or by the opportunity to actively support education (Dickinson et al. 2010; Firehock/West 1995; Swaisgood/Sheppard 2010). In addition, they may start to see citizens as holders of specific knowledge instead of perceiving them as an anonymous crowd (Bela et al. 2016; Buytaert et al. 2014). Furthermore, it becomes prevalent for scientists that they need to obtain the acceptance and good will of the broader public to implement outcomes in urgently needed decision making and to turn them to action (Danielsen et al. 2010; Soma/Haggett 2015). In a democratic society that is nothing the scientific or political community can do single-handedly. From the scientists' perspective, improving

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visibility and accessibility of research and involving citizens at an early stage can lead to higher acceptance of the scientific results and improve the public's understanding of decisions derived on the basis of those results. Hereby, it is possible to move towards a more transparent, socially relevant and democratic way of conducting science – encouraging a scientific culture that carries out research with and for society (Conrad/Hilchey 2011; Cosquer et al. 2012).

The implementation and strengthening of citizen science finally lead to a new communicative situation in which knowledge is not just presented and open for exploration. Instead, active participation enables scientific topics to become an integral element in the reality of people's lives. Citizens now have got the chance to shape some parts of science and integrate their own perspectives. This conveys a sense of ownership to the participants; in the field of biodiversity research, for example, by establishing a connection to the collected data as well as to the habitats, species, and landscapes they assessed (Dickinson et al. 2012; Newman et al. 2012; Reed 2008). Furthermore, this opens up possibilities to complement the established field of science communication by providing new and promising avenues to convey in-depth understanding of scientific methods and approaches.

2 The Current Situation in Public Discourse About Science

We demonstrated in the previous chapter that citizen science holds an untapped transformative potential for science and society, which is valuable on its own. Beyond that, citizen science could play an essential role in improving the current situation in the public discourse about science. But before elaborating on the role of citizen science in more detail, it may be useful to take a step back to try to capture some of the complexity in the relationship of science and society and understand the need for new approaches and concepts.

2.1 Current Situation in Public Discourse

Historically, the relationship between science and society was characterized by an exponentially growing interaction, leading to today's knowledge society (Schiele 2008). However, we are currently experiencing a time in western democratic societies, in which distrust in science is growing and fueling anti-science movements (Gauchat 2012; Nature Editorial 2017a; Pittinsky 2015). Science

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seems to be diverging from society, causing a lack of public acceptance and understanding. Similar concerns have been expressed by many scientific institutions (Nature Editorial 2017b) and are also reflected by some awards to counterpose populistic attempts and communicate the value of research (cf. Prize for Higher Education Communication 2017, Knowledge for society: communicating current higher education research, or the Communicator Award by the German Research Foundation). In line with that, the president of the German Research Foundation (DFG) was very outspoken at their annual meeting in 2017 about the current distrust in science and anti-intellectual movements. He strongly complained about unjustifiable simplifications, insinuation, and general distrust against academic experts (Strohschneider 2017). In contrast to this "politicization of science" (Gauchat 2012), educators and politicians are increasingly concerned about the generally low motivation of the public to actively engage in politics and participate in rational societal discourse (Biesta/Lawy 2006; Lawy/Biesta 2006; Rutten/Soetaert 2013).

2.2 What Are Possible Reasons for Public Distrust?

Confronted with the situation of widespread public distrust in science, many disciplines tried to find reasons and solutions to understand and improve the relationship. In the following we will shortly present some of these perspectives to raise awareness for the complexity of the situation.

The prevention of a joint discourse. Modern science is highly specialized and difficult to understand for the general public. Therefore, the usual approach is to call upon science communicators to mediate between scientists and the public, trying to make scientific knowledge accessible (Bucchi 1996). Without denying manifold advantages of science communication, it often contributes to a situation in which a clear separation between the scientists who pass through the protracted process of gaining knowledge and the public who receives the readily produced knowledge in a simplified version afterwards is strongly enforced. Thus, "the public discourse of science begins where scientific discourse ends," keeping both parts clearly separated (Bucchi 1996). So the public is "institutionally excluded" from the research process and only involved when active participation is in fact no longer possible (Bucchi 1996). The observation that the public and policy makers often just receive output that is shortened and simplified in order to be effective as publicity implies that the process of research, which is crucial for deeper understanding, remains untold. That is to say, many aspects that are key for understanding research processes are hidden exclusively within the scientific community, e.g., the fact that science is always

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confronted with uncertainty, the nature of hypotheses-driven work and falsification, and the peer-review processes that most scientific publications have to pass. Very likely, this can lead to misunderstandings, hampering the willingness to support research (Bela et al. 2016; Bucchi 1996; Firestein 2015). This lack of profound and comprehensive information makes it very difficult for citizens to take part in science or even follow recent developments and discussions. At the same time, if we think about global challenges like the biodiversity crisis or anthropogenic climate change, we often expect citizens to understand, support, and implement scientific knowledge on a great scale – however, without giving them a real chance to do so (Crall et al. 2013; Lindemann-Matthies/Bose 2008; Lorenzoni et al. 2007; Novacek 2008).

Intuitive cognitive constraints. From the perspective of cognitive sciences, scientific inquiry is a complex endeavor that requires cognitive skills and comprehensive training to understand scientific approaches and outcomes, particularly because scientific theories are often counterintuitive (Carey 1986; McCloskey 1983; Shtulman 2017; Zimmerman 2007). Parts of this intuition are based on people's tendency to divide the world in clear, discrete, and unfalsifiable categories, a phenomenon that is well described by psychological essentialism (Brock/Haslam 2006; Gelman 2003; Keller 2005; Medin/Ortony 1989). For example, it could be shown that people who are closer to essentialist thinking have greater problems understanding genetic concepts or the theory of evolution (Dar-Nimrod/Heine 2011; Evans 2001; Shtulman/Schulz 2008). In addition, people are intuitively prone to teleological thinking in nature and, thus, also in respect to scientific work (Kelemen et al. 2013; Ojalehto et al. 2013; Tamir/Zohar 1991). This effect is particularly strong in children (Inagaki/Hatano 2004; Kelemen 1999b; Kelemen 1999a), but could also been shown for educated adults (González Galli/Meinardi 2011; Kelemen et al. 2013). The dimension of this challenge becomes obvious when we envision that even within the natural sciences debates about the incompatibility of teleological thinking and biology, especially evolutionary biology (Bardapurkar 2008), were fought out for decades until the scientific community finally reached some consensus (Gould/Lewontin 1979; Mayr 2004). These cognitive intuitions have the power to impair science understanding and call for new approaches to make scientific thinking easily accessible.

Moral and emotional constraints. Another reason for people to be reluctant towards scientific findings is the fact that their implications are often opposed to existing moral values. This could be the case for some of the most prominent topics in public discourse, like for example GMO's, climate change, or skepticism against vaccination (Blancke et al. 2015; Bliuc et al. 2015; Browne et

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al. 2015; Hoffman 2011; Lewandowsky/Oberauer 2016; Lewandowsky et al. 2012; McCright/Dunlap 2011; Scott et al. 2016; Silver 2007). Studies were able to provide evidence that political conservatism combined with an advocacy of free-market economics are sufficient to predict people's skepticism against anthropogenic climate change (Hornsey et al. 2016; Lewandowsky et al. 2013a; Lewandowsky/Oberauer 2016; Lewandowsky et al. 2013b).

So, it is important to understand that the distrust in science is not necessarily caused by a lack of knowledge. "When doubt is wrapped up in one's cultural identity or powerful emotions, facts often not only fail to persuade, but may further entrench skepticism" (Rosenbaum 2017b). In fact, it could be shown that people who have a better understanding of science are more capable of ignoring certain evidence that would force them to adapt their beliefs (Kahan et al. 2012).

Dubiousness of scientific results and studies. Studies in social psychology revealed that there is severe public distrust towards the general motivation of scientists and scientific agendas (Gleick et al. 2010; Rutjens/Heine 2016), providing evidence that the integrity of scientists is strongly questioned. Sometimes this distrust is even resulting in conspiracy theories of hidden agendas and disguise, in turn leading to additional obstacles to support scientists' research findings (Jolley/Douglas 2014b; Jolley/Douglas 2014a; Lewandowsky et al. 2013a; Lewandowsky et al. 2013b; van der Linden 2015). Obviously, this kind of conspiracy thinking is difficult to address by the scientific community, since all arguments presented might well be part of the ongoing conspiracy to mislead the public on a big scale (Lewandowsky et al. 2015). This results in a considerable discrepancy: although scientists are amongst one of the occupational groups people seem to respect the most (National Science Board 2016; The Harris Poll 2014), there is considerable distrust when it comes to the acceptance of particular findings. This certainly represents a major challenge in the relationship between science and society that could be linked to some of the emotional constraints mentioned above (Gleick et al. 2010; Nature Editorial 2017a; Pittinsky 2015).

Some of this defensive attitude may be explained or even amplified by prominent cases revealing highly questionable practices within the scientific community. There is mounting evidence that research funded by the food industry often delivers results favoring their sponsors' products, thus strongly impairing the credibility of science (Lesser et al. 2007; Levine et al. 2003; Rowe et al. 2009). Similar relationships have been shown for research funded by the pharmaceutical industry, since conflicting interests concerning the outcome are likely to occur (Bekelman et al. 2003; Blumenthal 2003; Moses et al. 2005). In social sciences, the so called replicability crisis led to another source of funda-

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mental distrust (Baker 2016; Open Science Collaboration 2015). Furthermore, the intentional misconduct of some members of the scientific community, accompanied by deficient peer-review processes could exacerbate public distrust in science (Bohannon 2013; Brumfiel 2002; Esquivel 2000; Van Noorden 2014). In order to understand what nurtures such behavior within the scientific community, Ioannidis (2005) could show that misleading or even wrong research outcomes are especially produced when economic interests are in place or when working groups have competing interests and try to outrun their rivals. Up to now, the scientific system often provides strong incentives for quantity, fast derived conclusions, and exaggeration of impact (Rosenbaum 2017a), leaving little space for highlighting negative findings or the limitations of scientific work, despite their great importance (Firestein 2015).

> If anyone tried to publish a story more like real life, in which hypotheses were dropped for lack of support, apparatus couldn't be made to work within the parameters of the original experiment, and so on, it would be turned down. Journals do not publish inconclusive work. [...] Science must present a smiling face both to itself and to the world. (Harré 1990)

While these circumstances well reflect the fact that science is always a social endeavor (Fleck 1979; Kuhn 1996; Latour/Woolgar 1979; Lakatos/Musgrave 1970), they also provide explanations why the morality of some scientists can be questioned with good reason. Furthermore, the highly increased demand for popularizing and communicating science, which resulted in various formats for scientists' self-display and promotion of their findings (Caliendo 2012; Sugimoto et al. 2013; Turney 2008), reinforces questionable research methods or at least offers an incentive to present them in a highly dramatized and effectively shortened way. Needless to say, news media often add to the notion of "hedonistic celebration of triviality" while also bolstering the decontexualization of scientific dissent (Hollander 2014; McDevitt et al. 2013; McDevitt et al. 2017).

2.3 Ways for Improvement

Not surprisingly, there are ongoing discussions on how to improve the situation and address reasonable public concerns, hereby simultaneously preventing populistic tendencies to dominate the public discourse about science. Apart from raising general awareness of the constraints described above, attempts to advance transparency and communication structures are amongst the most obvious options.

Open Science. Especially the cases revealing questionable methods or practices within the scientific community could be addressed by improving commu-

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nication structures and support open science attempts (Edwards/Roy 2017; Lewandowsky/Bishop 2016; Morey et al. 2016; Nosek et al. 2015). Following open science policies, all stages of the research process should be open for scrutiny, from pre-registration of hypotheses to full accessibility of research results and methods (Nosek et al. 2015). By improving transparency, scientist may be able to rectify their public perception from a moral point of view, while at the same time increasing the public understanding of scientific knowledge gain, thereby reducing sources of distrust. This would imply that people perceive science as a continuous process, in which results are always tentative, even if no questionable methods are ever applied (van Dijk 2011; Firestein 2015; Popper 1957; Wong/Hodson 2009; Zehr 2000). There were some promising initiatives and platforms like the Open Science Strategy by the European Commission or the global OA2020 initiative that marked a step in the right direction.

Knowing the limits of scientific approaches and knowledge. Building on that, it is key that scientists and science communicators are very clear about the scope of scientific methods in general – by clarifying precisely what kind of knowledge they are able to provide – and the implications of scientific findings in particular (Rosenbaum 2017a). This includes the need to embrace that science never delivers unquestionable certainties (Firestein 2015; Strohschneider 2017). Furthermore, scientific findings, especially from basic research, are usually not able to give instructions what to do and how to behave. Taking the risk of natural fallacies seriously, we should always remind ourselves that science can inform, but cannot make decisions that require careful weighing of moral aspects and societal as well as personal goals (Ott 2010; Potthast/Eser 1999).

This calls for a general improvement in communicating science (Rosenbaum 2017b), which can certainly not be solved by oversimplification.

> In the public debate, a question of staggering complexity has been reduced to a binary choice between two extremes: Either climate change is a ‘hoax’ or is an unquestionable certainty. […] In other words, the ‘consensus’ dangerously conflates what is known with what is crucial but not known, giving the public the message that the issue is closed. (Kabat 2017)

These reflections are arguably all steps in the right direction. However, it may be necessary to fundamentally rethink the way knowledge and information are gained and communicated. If our goal is to foster societal coherence and tackle global challenges, we will need to find new and innovative forms of reciprocal knowledge transfer that enable scientific discourse to enter social and political domains in a better way. Here, we present some avenues how the transforma-

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tive power of participatory approaches could be used to shape science, society, and educational systems.

2.4 Citizen Science – A New Approach to Tackle the Problem?

As already described in chapter 1, participatory approaches hold an untapped potential to advance scientific knowledge and to improve societal coherence and scientific literacy. In this way, citizen science could capture many of the aforementioned aspects for improvement, while simultaneously adding additional value to the misrouted perception of science in society. There is a huge potential in citizen science approaches to enable participants not only to gain scientific knowledge, but also to understand and reflect on scientific inquiry, and maybe develop more positive attitudes towards science in general (Bell et al. 2009; Bonney et al. 2009). As stated by the national Research Council of the US, as soon as learners are participating in real scientific research this opens up possibilities for "asking questions, planning and conducting an investigation, using appropriate tools and techniques, thinking critically and logically about the relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments" (National Research Council 1996).

While involved in citizen science projects, participants become increasingly aware of their role as citizens to critically reflect science as an institution (Bela et al. 2016), but not in the sense of general distrust, but rather by sharpening one's mind for discrepancies within the system, thus encouraging critical thinking. In addition, Overdevest et al. (2004) were able to show that through participation citizens were able to improve their personal networks and increased their level of political participation. Despite the long tradition social sciences as well as rhetoric have in studying the causes of change in people's attitudes, there is still a strong need to further assess the potential of citizen science in this context (Crall et al. 2013). Referring to the Elaboration Likelihood Model (Petty/Cacioppo 1986; Petty/Cacioppo 1996) it can be assumed that active engagement in scientific projects – including critical examination of the research question and approach – will very likely lead to a stable, more positive attitude towards the research topic and science in general. Based on the initial "need for cognition" the participant will be highly motivated to learn and engage, whereas well-founded persuasion is possible through spending thoughtful attention to the target. This may result in behavioral changes, engagement in environmental projects or political campaigns, or simply a feeling of empowerment and being capable of making changes (Bonney et al. 2009; Brossard et al. 2005).

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In the following, we would like to elaborate further on how this transformative process could be initiated within society to make best use of the potential of citizen science. In our view, high schools represent a pivotal point of knowledge exchange and social transformation. By integrating citizen science in high school education, we identified one promising avenue to promote societal change and scientific literacy from bottom-up (Bela et al. 2016).

3 The Significant Role of Formal Education in Making Best Use of the Potential of Citizen Science

Within the Citizen Science Strategy 2020 for Germany, ten potential fields of action were identified – including the establishment of new structures, the strengthening of existing structures, and the integration of citizen science into other concepts. The latter includes the integration of citizen science into concepts in formal education (Bonn et al. 2016). Here, citizen science provides the possibility to move towards educational concepts for society as a whole that can strengthen key competences for a successful life and a functioning society (Bela et al. 2016). In Germany, integrating citizen science into the practice of existing educational institutions is, however, still in its infancy. This applies to formal educational institutions such as schools and universities, but also to extracurricular education offered for example by associations, non-governmental organizations, or museums. So far, citizen science activities mainly take place outside of school lessons and involve mostly adult participants. However, citizen science stakeholders are currently revisiting whether the integration of the concept into formal education might be desirable (Bonn et al. 2016; Hodson 2003; Jenkins 1999). Lifelong learning through engagement is a promising approach that can be integrated in school lessons and in curricular activities. Through its various forms of participation it can be practiced in many different learning environments (Shah/Martinez 2016). Indeed, first exemplary projects show that citizen science can be successfully applied in schools and in higher education (Alexander/Russo 2010; Heigl/Zaller 2014). By doing so, teachers and their students are able to work with real data and real scientific questions instead of following long-approved protocols (Berkowitz 1997; Moss et al. 1998). Scientists, on the other hand, are able to cover large geographic areas and establish long-term monitoring projects in collaboration with schools (Tinker 1997).

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Despite the general appreciation for scientific and societal literacy, these abilities are rarely taught sufficiently in current educational systems (Rutten/Soetaert 2013). Thus, awareness is increasingly raised that participatory approaches could help to foster scientific and societal literacy that are both urgently needed in science-based societies. Hereby, we can make our future citizens capable of understanding debates about technological achievements or environmental topics, enabling them to embrace their rights and duties in a democratic society (Miller 2004). Similar to that, Colucci-Gray (2014) is highlighting the need to foster rational skepticism within the framework of a "transformative citizenship" and also Biesta/Lawy (2006) are promoting the view of students as "citizens in the making." Following Rutten/Soetaert (2013) one may also refer to Martha Nussbaum (2016) to broaden the perspective by stating that education should support students in becoming democratic citizens who are able to critically question authorities, counteract simplifications and polarizations, acknowledge different perspectives, and establish a culture of dialogue. It is this kind of critical thinking that is needed to cope with the complexity of today's world and to fulfill the role of a literate citizen in a democratic society (Nussbaum 2016). This again puts emphasis on the fact that applying citizen science to education does not only cover scientific learning objectives but can be equally helpful to meet learning objectives of the humanities and to convey a general understanding of society.

However, the goal to apply citizen science projects in classrooms goes along with specific constraints that need to be considered to allow successful collaborations. For example, there are time restrictions, based on the need to fit in curriculum and school hours (Zoellick et al. 2012). In addition, the specific learning outcomes that need to be achieved may not completely overlap with the scientific goal of the study. Especially when long-term collaborations are intended, it is crucial to make sure that all needs are equally addressed (Zoellick et al. 2012). Based on that, Zoellick et al. (2012) suggest that a third-party perspective – coming for example from universities – could be helpful to supervise the whole project and to make sure that the different goals and outcomes are balanced (Houseal et al. 2014). This also refers to a genuine characteristic of citizen science projects: as "collaborative endeavors between science researchers and public participants" (Shirk et al. 2012) there should be an intrinsic goal to be mindful of the interests and needs of all involved actors. From the perspective of teachers this new way of knowledge transfer comprises the need to also train teachers in scientific thinking to enable them to find the right balance between teaching facts (i.e., state of the art) and establishing trust in science, while not hiding the tentative nature of science or controversies amongst experts

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(Bryce 2010; Bryce/Day 2014a). It is a demanding balancing act to teach students "when and where to trust science" (Fensham 2014) that requires careful preparation. Nevertheless, advantages by far outweigh these additional challenges as mutual benefits can be derived from citizen science projects for education, science, and society.

In response to earlier studies that reported hardly any changes in scientific literacy or behavioral changes of their participants (Brossard et al. 2005; Crall et al. 2013; Jordan et al. 2011) we argue that integrating citizen science in formal educational curricula may open up new possibilities to establish long-term partnerships and apply repeated interventions by educating a new generation of literate citizen scientists. In this setting changes in attitudes and literacy are more likely to be obtained and subsequently transferred to behavioral changes, given that we allow enough time to internalize and reflect new knowledge and insights (Jordan et al. 2011; Merriam et al. 2012). By increasing the investment of participants, already detected changes in planned behavior may eventually result in actual behavioral changes as suggested by Crall et al. (2013).

It is well known that many participants in citizen science programs already have a connection to science and generally show higher scientific literacy than average (Crall et al. 2013; Evans et al. 2005). We can avoid this preselection and make a step towards educational justice if we establish interest in science and critical thinking already in schools (Gura 2013).

Similar to work by Day/Bryce (Day/Bryce 2011; Day/Bryce 2013), integrating participatory approaches in formal education could offer ways to combine the "learning of science, the learning to do science, and the learning about science" (Bryce/Day 2014b). By following this approach, students are not only trained as future scientists, but also as "scientifically literate citizen[s]" (Bryce/Day 2014b).

4 Conclusion

We envision a situation in Germany in which the concept and the approach of citizen science is further developed and successfully anchored in society and politics. This recognition is reflected by a firm implementation of citizen science in educational concepts (i.e., in the curriculum of schools and universities) and scientific concepts (e.g., ecosystem services; see Schröter et al. 2017) as an important step towards the effective utilization of the manifold potentials of citizen science. Citizen science enriches educational concepts by facilitating a higher level of learning through the active engagement of students in real scientific investigations, whereas simultaneously enhancing a general scientific and

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societal literacy that goes far beyond the specific scientific discovery. While experiencing participation – understood as taking part in science from the very early agenda setting to the evaluation of scientific findings – students at school as well as at university may also appreciate the value of participation in democratic processes on a political level. Therefore, students might be less susceptible to political apathy or simplified populist attempts. In this way, a main goal of civic education is successfully targeted: to prepare a new generation of future scientists and future citizens for participation in society and for shaping public discourse.

Ideally, this may induce self-enhancing processes spreading in society: after participating in citizen science projects, students and teachers can use their gained knowledge to join current discussions and can themselves act as key communicators in their own social environments and communities, motivating others to engage in science and policy related discussions. By sharing their insights, citizen scientists can pass on empowerment, spreading the notion to become actively engaged in society. Thus, citizen science as a tool for innovation embraces a huge potential to pave the way for societal transformation and to strengthen the understanding of everyone's opportunities to form our future society. As a result, a new culture of enhancing and communicating knowledge is established, with changing roles and perspectives that allow mutual learning on equal footing.

References

Alexander, A. & Russo, S. (2010). Let's Start in Our Own Backyard: Children's Engagement with Science Through the Natural Environment. *Teaching Science: The Journal of the Australian Science Teachers Association*, 56, 47–54.

Baker, M. (2016). 1,500 Scientists Lift the Lid on Reproducibility. *Nature News*, 533, 452–454. DOI: 10.1038/533452a.

Bardapurkar, A. (2008). Do Students See the "Selection" in Organic Evolution? A Critical Review of the Causal Structure of Student Explanations. *Evolution: Education and Outreach*, 1, 299–305. DOI: 10.1007/s12052-008-0048-5.

Bekelman, J. E., Li, Y., & Gross, C. P. (2003). Scope and Impact of Financial Conflicts of Interest in Biomedical Research: A Systematic Review. *Jama*, 289, 454–465. DOI: 10.1001/jama.289.4.454.

Bela, G., Peltola, T., Young, J. C., Balázs, B., Arpin, I., Pataki, G., Hauck, J., Kelemen, E., Kopperoinen, L., & Herzele, A. (2016). Learning and the Transformative Potential of Citizen Science. *Conservation Biology*, 30, 990–999. DOI: 10.1111/cobi.12762.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Bell, P., Lewenstein, B., Shouse, A., & Feder, M. E. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. Washington, DC: The National Academies Press. DOI: 10.17226/12190.

Berkowitz, A. (1997). *A Simple Framework for Considering the Benefits of SSPs. National Conference on Student and Scientist Partnerships: Conference Report*. Cambridge, MA: TERC, 38–41.

Biesta, G. & Lawy, R. (2006). From Teaching Citizenship to Learning Democracy: Overcoming Individualism in Research, Policy and Practice. *Cambridge Journal of Education*, 36, 63–79. DOI: 10.1080/03057640500490981.

Blancke, S., Van Breusegem, F., De Jaeger, G., Braeckman, J., & Van Montagu, M. (2015). Fatal Attraction: The Intuitive Appeal of GMO Opposition. *Trends in Plant Science*, 20, 414–418. DOI: 10.1016/j.tplants.2015.03.011.

Bliuc, A.-M., McGarty, C., Thomas, E. F., Lala, G., Berndsen, M., & Misajon, R. (2015) Public Division About Climate Change Rooted in Conflicting Socio-Political Identities. *Nature Climate Change*, 5, 226. DOI: 10.1038/nclimate2507.

Blumenthal, D. (2003). Academic–Industrial Relationships in The Life Sciences. *The New England Journal of Medicine*, 349,2452–2459. DOI: 10.1056/NEJMhpr035460.

Bohannon, J. (2013) Who's Afraid of Peer Review? *Science*, 342, 60–65. DOI: 10.1126/science.342.6154.60.

Bonn, A., Richter, A., Vohland, K., Pettibone, L., Brandt, M., Feldmann, R., Goebel, C., Grefe, C., Hecker, S., & Hennen, L. (2016). *Green Paper: Citizen Science Strategy 2020 for Germany*. Leipzig/Berlin.

Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., & Wilderman, C. C. (2009). *Public Participation in Scientific Research: Defining the Field and Assessing Its Potential for Informal Science Education. A CAISE Inquiry Group Report*. Washington, DC: CAISE.

Bonney, R., Shirk, J. L., Phillips, T. B., Wiggins, A., Ballard, H. L., Miller-Rushing, A. J., & Parrish, J. K. (2014). Next Steps for Citizen Science. *Science*, 343, 1436–1437. DOI: 10.1126/science.1251554.

Bonney, R., Shirk, J., & Phillips, T. B. (2015). Citizen Science. *Encyclopedia of Science Education*, 152–154.

Böschen, S. & Wehling, P. (2004). *Wissenschaft zwischen Folgenverantwortung und Nichtwissen. Aktuelle Perspektiven der Wissenschaftsforschung*. Wiesbaden: Springer.

Brock, B. & Haslam, N. (2006). Psychological Essentialism and Stereotype Endorsement. *Journal of Experimental Social Psychology*, 42, 228–235. DOI: 10.1016/j.jesp.2005.03.003.

Brossard, D., Lewenstein, B., & Bonney, R. (2005). Scientific Knowledge and Attitude Change: The Impact of a Citizen Science Project. *International Journal of Science Education*, 27(9), 1099–1121. DOI: 10.1080/09500690500069483.

Browne, M., Thomson, P., Rockloff, M. J., & Pennycook, G. (2015). Going Against the Herd: Psychological and Cultural Factors Underlying the 'Vaccination Confidence Gap'. *PloS ONE*, 10(9), e0132562. DOI: 10.1371/journal.pone.0132562.

Brumfiel, G. (2002). Misconduct Finding at Bell Labs Shakes Physics Community. *Nature*, 419(6906), 419–421. DOI: 10.1038/419419a.

Bryce, T. (2010). Sardonic Science? The Resistance to More Humanistic Forms of Science Education. *Cultural Studies of Science Education*, 5(3), 591–612. DOI: 10.1007/s11422-010-9266-6.

Bryce, T. G. & Day, S. P. (2014a). Scepticism and Doubt in Science and Science Education: The Complexity of Global Warming as a Socio-Scientific Issue. *Cultural Studies of Science Education*, 9(3), 599–632. DOI: 10.1007/s11422-013-9500-0.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Bryce, T. G. & Day, S. P. (2014b). Scepticism and the Science of Global Warming: A Rejoinder. *Cultural Studies of Science Education*, 9, 1025–1037. DOI: 10.1177/2158244015579723.
Bucchi, M. (1996). When Scientists Turn to the Public: Alternative Routes in Science Communication. *Public Understanding of Science*, 5(4), 375–394. DOI: 10.1088/0963-6625/5/4/005.
Buytaert, W., Zulkafli, Z., Grainger, S., Acosta, L., Alemie, T. C., Bastiaensen, J., De Bièvre, B., Bhusal, J., Clark, J., & Dewulf, A. (2014). Citizen Science in Hydrology and Water Resources: Opportunities for Knowledge Generation, Ecosystem Service Management, and Sustainable Development. *Frontiers in Earth Science*, 2, 26. DOI: 10.3389/feart.2014.00026.
Caliendo, G. (2014). The Popularisation of Science in Web-Based Genres. *The Language of Popularization: Theoretical and Descriptive Models* (Eds. G. Caliendo & G. Bongo). Bern: Peter Lang, 101–132. DOI: 10.3726/978-3-0351-0670-1.
Carey, S. (1986). Cognitive Science and Science Education. *American Psychologist*, 41(10), 1123–1130. DOI: 10.1037/0003-066X.41.10.1123.
Chandler, M., See, L., Copas, K., Bonde, A. M. Z., López, B. C., Danielsen, F., Legind, J. K., Masinde, S., Miller-Rushing, A. J., Newman, G., Rosemartin, A., & Turak, E. (2016). Contribution of Citizen Science Towards International Biodiversity Monitoring. Biological Conservation. *Biological Conservation*, 213, 280–294. DOI: 10.1016/j.biocon.2016.09.004.
Cheng, A. S., Bond, K., Lockwood, C., & Hansen, S. (2008). Calibrating Collaboration: Monitoring and Adaptive Management of the Landscape Working Group Process on the Grand Mesa, Uncompahgre and Gunnison National Forests in Western Colorado. *Partnerships for Empowerment* (Eds. C. Wilmsen, W. Elmendorf, L. Fisher, J. Ross, B. Sarathy, & G. Wells). London/Sterling, VA: Earthscan, 147–166.
Cohn, J. P. (2008). Citizen Science: Can Volunteers do Real Research? *BioScience*, 58(3), 192–197. DOI: 10.1641/b580303.
Colucci-Gray, L. (2014). Beyond Evidence: A Critical Appraisal of Global Warming as a Socio-Scientific Issue and a Reflection on the Changing Nature of Scientific Literacy in School. *Cultural Studies of Science Education*, 9(3), 633–647. DOI: 10.1007/s11422-013-9556-x.
Conrad, C. C. & Hilchey, K. G. (2011). A Review of Citizen Science and Community-Based Environmental Monitoring: Issues and Opportunities. *Environmental Monitoring and Assessment*, 176, 273–291. DOI: 10.1007/s10661-010-1582-5.
Cooper, C. B., Shirk, J., & Zuckerberg, B. (2014). The Invisible Prevalence of Citizen Science in Global Research: Migratory Birds and Climate Change. *PloS ONE*, 9(9), e106508. DOI: 10.1371/journal.pone.0106508.
Cosquer, A., Raymond, R., & Prevot-Julliard, A.-C. (2012). Observations of Everyday Biodiversity: A New Perspective for Conservation? *Ecology and Society*, 17(4), 2. DOI: 10.5751/ES-04955-170402.
Crall, A. W., Jordan, R., Holfelder, K., Newman, G. J., Graham, J., & Waller, D. M. (2013). The Impacts of an Invasive Species Citizen Science Training Program on Participant Attitudes, Behavior, and Science Literacy. *Public Understanding of Science*, 22(6), 745–764. DOI: 10.1177/0963662511434894.
Cumming, G., Guffey, S. J., & Norwood, C. (2008). Opportunities and Challenges in Community Capacity-Building: Lessons From Participatory Research in Macon County, North Carolina. *Partnerships for Empowerment: Participatory Research for Community-Based Natural Resource Management* (Eds. C. Wilmsen, W. Elmendorf, L. Fisher, J. Ross, B. Sararthy, & G. Wells). London: Earthscan, 127–146.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Danielsen, F., Burgess, N. D., Jensen, P. M., & Pirhofer-Walzl, K. (2010). Environmental Monitoring: The Scale and Speed of Implementation Varies According to the Degree of Peoples Involvement. *Journal of Applied Ecology*, 47(6), 1166–1168. DOI: 10.1111/j.1365-2664.2010.01874.x.
Dar-Nimrod, I. & Heine, S. J. (2011). Genetic Essentialism: On the Deceptive Determinism of DNA. *Psychological Bulletin*, 137(5), 800–818. DOI: 10.1037/a0021860.
Day, S. P. & Bryce, T. G. (2011). Does the Discussion of Socio-Scientific Issues Require a Paradigm Shift in Science Teachers' Thinking? *International Journal of Science Education*, 33(12), 1675–1702. DOI: 10.1080/09500693.2010.519804.
Day, S. P. & Bryce, T. G. (2013). The Benefits of Cooperative Learning to Socio-Scientific Discussion in Secondary School Science. *International Journal of Science Education*, 35(9), 1533–1560. DOI: 10.1080/09500693.2011.642324.
Devictor, V., Van Swaay, C., Brereton, T., Brotons, L., Chamberlain, D., Heliölä, J., Herrando, S., Julliard, R., Kuussaari, M., & Lindström, Å. (2012). Differences in the Climatic Debts of Birds and Butterflies at a Continental Scale. *Nature Climate Change*, 2, 121–124. DOI: 10.1038/NCLIMATE1347.
Devictor, V., Whittaker, R. J., & Beltrame, C. (2010). Beyond Scarcity: Citizen Science Programmes as Useful Tools for Conservation Biogeography. *Diversity and Distributions*, 16(3), 354–362. DOI: 10.1111/j.1472-4642.2009.00615.x.
Dickinson, J. L., Shirk, J., Bonter, D., Bonney, R., Crain, R. L., Martin, J., Phillips, T., & Purcell, K. (2012). The Current State of Citizen Science as a Tool for Ecological Research and Public Engagement. *Frontiers in Ecology and the Environment*, 10, 291–297. DOI: 10.1890/110236.
Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. (2010). Citizen Science as an Ecological Research Tool: Challenges and Benefits. *Annual Review of Ecology, Evolution, and Systematics*, 41, 149–172. DOI: 10.1146/annurev-ecolsys-102209-144636.
Edwards, M. A. & Roy, S. (2017). Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hypercompetition. *Environmental Engineering Science*, 34(1), 51–61. DOI: 10.1089/ees.2016.0223.
Esquivel, E. (2000). Ein Gefühl der Desillusionierung. Innenansichten der Forschungsgruppe Herrmann/Brach. *Forschung und Lehre*, 8, 423–425.
Evans, C., Abrams, E., Reitsma, R., Roux, K., Salmonsen, L., & Marra, P. P. (2005). The Neighborhood Nestwatch Program: Participant Outcomes of a Citizen-Science Ecological Research Project. *Conservation Biology*, 19(3), 589–594. DOI: 10.1111/j.1523-1739.2005.00s01.x.
Evans, E. M. (2001). Cognitive and Contextual Factors in the Emergence of Diverse Belief Systems: Creation Versus Evolution. *Cognitive Psychology*, 42(3), 217–266. DOI: 10.1006/cogp.2001.0749.
Fensham, P. J. (2014). Scepticism and Trust: Two Counterpoint Essentials in Science Education for Complex Socio-Scientific Issues. *Cultural Studies of Science Education*, 9(3), 649–661. DOI: 10.1007/s11422-013-9560-1.
Fernandez-Gimenez, M., Ballard, H., & Sturtevant, V. (2008). Adaptive Management and Social Learning in Collaborative and Community-Based Monitoring: A Study of Five Community-Based Forestry Organizations in the Western USA. *Ecology and Society*, 13(2), 4.
Firehock, K. & West, J. (1995). A Brief History of Volunteer Biological Water Monitoring Using Macroinvertebrates. *Journal of the North American Benthological Society*, 14(1), 197–202. DOI: 10.2307/1467734.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Firestein, S. (2015). *Failure: Why Science is so Successful*. New York, NY: Oxford University Press.
Fleck, L. (1979). *Genesis and Development of a Scientific Fact*. Chicago, IL: University of Chicago Press.
Freitag, A. & Pfeffer, M. J. (2013). Process, not Product: Investigating Recommendations for Improving Citizen Science "Success". *PloS ONE*, 8(5), e64079. DOI: 10.1371/journal.pone.0064079.
Gauchat, G. (2012). Politicization of Science in the Public Sphere: A Study of Public Trust in the United States, 1974 to 2010. *American Sociological Review*, 77(2), 167–187. DOI: 10.1177/0003122412438225.
Gelman, S. A. (2003). *The Essential Child: Origins of Essentialism in Everyday Thought*. New York, NY: Oxford University Press. DOI: 10.1093/acprof:oso/9780195154061.001.0001.
Gleick, P. H., Adams, R., Amasino, R., Anders, E., Anderson, D., Anderson, W., Anselin, L., Arroyo, M., Asfaw, B., & Ayala, F. (2010). Climate Change and the Integrity of Science. *Science*, 328, 689–690. DOI: 10.1126/science.328.5979.689.
González Galli, L. M. & Meinardi, E. N. (2011). The Role of Teleological Thinking in Learning the Darwinian Model of Evolution. *Evolution: Education and Outreach*, 4, 145–152. DOI: 10.1007/s12052-010-0272-7.
Gould, S. J. & Lewontin, R. C. (1979). The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme. Proceedings of the Royal Society of London. *Biological Sciences*, 581–598. DOI: 10.1098/rspb.1979.0086.
Gura, T. (2013). Citizen Science: Amateur Experts. *Nature*, 496, 259–261. DOI: 10.1038/nj7444-259a.
Haklay, M. (2013). Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. *Crowdsourcing Geographic Knowledge* (Eds. D. Sui, S. Elwood, & M. Goodchild). Dordrecht: Springer, 105–122. DOI: 10.1007/978-94-007-4587-2_7.
Haklay, M. (2015). *Citizen Science and Policy: A European Perspective*. Washington, DC: The Wodrow Wilson Center Commons Lab.
Harré, R. (1990). Some Narrative Conventions of Scientific Discourse. *Narrative in Culture: The Uses of Storytelling in the Sciences, Philosophy, and Literature* (Ed. C. Nash). New York, NY: Routledge, 81–101.
Heigl, F. & Zaller, J. G. (2014). Using a Citizen Science Approach in Higher Education: A Case Study Reporting Roadkills in Austria. *Human Computation*, 1(2).
Hodson, D. (2003). Time for Action: Science Education for an Alternative Future. *International Journal of Science Education*, 25(6), 645–670. DOI: 10.1080/09500690305021.
Hoffman, A. J. (2011.) The Growing Climate Divide. *Nature Climate Change*, 1, 195–196.
Hollander, P. (2014). Popular Culture, The New York Times and the New Republic. *Society*, 51, 288–296. DOI: 10.1007/s12115-014-9779-9.
Hornsey, M. J., Harris, E. A., Bain, P. G., & Fielding, K. S. (2016). Meta-Analyses of the Determinants and Outcomes of Belief in Climate Change. *Nature Climate Change*, 6, 622–626. DOI: 10.1038/nclimate2943.
Houseal, A. K., Abd-El-Khalick, F., & Destefano, L. (2014). Impact of a Student–Teacher–Scientist Partnership on Students' and Teachers' Content Knowledge, Attitudes Toward Science, and Pedagogical Practices. *Journal of Research in Science Teaching*, 51(1), 84–115. DOI: 10.1002/tea.21126.
Inagaki, K. & Hatano, G. (2004). Vitalistic Causality in Young Children's Naive Biology. *Trends in Cognitive Sciences*, 8(8), 356–362. DOI: 10.1016/j.tics.2004.06.004.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Ioannidis, J. P. (2005). Why Most Published Research Findings Are False. *PLoS Medicine*, 2(8), e124. DOI: 10.1371/journal.pmed.0020124.

Janich, P. (2012). Vom Nichtwissen über Wissen zum Wissen über Nichtwissen. *Nichtwissenskommunikation in den Wissenschaften. Interdisziplinäre Zugänge* (Ed. N. Janich, A. Nordmann, & L. Schebek). Frankfurt a. M.: Peter Lang, 23–51. DOI: 10.3726/b14164.

Jenkins, E. W. (1999). School Science, Citizenship and the Public Understanding of Science. *International Journal of Science Education*, 21(7), 703–710. DOI: 10.1080/095006999290363.

Jolley, D. & Douglas, K. M. (2014a). The Social Consequences of Conspiracism: Exposure to Conspiracy Theories Decreases Intentions to Engage in Politics and to Reduce One's Carbon Footprint. *British Journal of Psychology*, 105(1), 35–56. DOI: 10.1111/bjop.12018.

Jolley, D. & Douglas, K. M. (2014b). The Effects of Anti-Vaccine Conspiracy Theories on Vaccination Intentions. *PloS ONE*, 9(2), e89177. DOI: 10.1371/journal.pone.0089177.

Jordan, R. C., Gray, S. A., Howe, D. V., Brooks, W. R., & Ehrenfeld, J. G. (2011). Knowledge Gain and Behavioral Change in Citizen-Science Programs. *Conservation Biology*, 25(6), 1148–1154. DOI: 10.1111/j.1523-1739.2011.01745.x.

Kabat, G. C. (2017). Taking Distrust of Science Seriously. *EMBO Reports*, 18, e201744294. DOI: 10.15252/embr.201744294.

Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks. *Nature Climate Change*, 2, 732. DOI: 10.1038/nclimate1547.

Kelemen, D. (1999a). Why Are Rocks Pointy? Children's Preference for Teleological Explanations of the Natural World. *Developmental Psychology*, 35(6), 1440. DOI: 10.1037/0012-1649.35.6.1440.

Kelemen, D. (1999b). Function, Goals and Intention: Children's Teleological Reasoning About Objects. *Trends in Cognitive Sciences*, 3(12), 461–468. DOI: 10.1016/S1364-6613(99)01402-3.

Kelemen, D., Rottman, J., & Seston, R. (2013). Professional Physical Scientists Display Tenacious Teleological Tendencies: Purpose-Based Reasoning as a Cognitive Default. *Journal of Experimental Psychology: General*, 142(4), 1074–1083. DOI: 10.1037/a0030399.

Keller, J. (2005). In Genes We Trust: The Biological Component of Psychological Essentialism and its Relationship to Mechanisms of Motivated Social Cognition. *Journal of Personality and Social Psychology*, 88(4), 686–702. DOI: 10.1037/0022-3514.88.4.686.

Koalitionsvertrag (2013). *Deutschlands Zukunft gestalten. Koalitionsvertrag zwischen CDU, CSU und SPD. 18. Legislaturperiode.* Berlin. https://www.cdu.de/sites/default/files/media/dokumente/koalitionsvertrag.pdf.

Kuhn, T. S. (1996). *The Structure of Scientific Revolutions* (3rd ed.). Chicago, IL: University of Chicago Press.

Kullenberg, C. & Kasperowski, D. (2016). What is Citizen Science? – A Scientometric Meta-Analysis. *PloS ONE*, 11(1), e0147152. DOI: 10.1371/journal.pone.0147152.

Lakatos, I. & Musgrave, A. (Eds.) (1970). *Criticism and the Growth of Knowledge: Proceedings of the International Colloquium in the Philosophy of Science, London, 1965*. Cambridge, UK: Cambridge University Press. DOI: 10.1017/CBO9781139171434.

Latour, B. & Woolgar, S. (1979). *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Lawy, R. & Biesta, G. (2006). Citizenship-as-Practice: The Educational Implications of an Inclusive and Relational Understanding of Citizenship. *British Journal of Educational Studies*, 54(1), 34–50. DOI: 10.1111/j.1467-8527.2006.00335.x.
Lesser, L. I., Ebbeling, C. B., Goozner, M., Wypij, D., & Ludwig, D. S. (2007). Relationship Between Funding Source and Conclusion Among Nutrition-Related Scientific Articles. *PLoS Medicine*, 4(1), e5. DOI: 10.1371/journal.pmed.0040005.
Levine, J., Gussow, J. D., Hastings, D., & Eccher, A. (2003). Authors' Financial Relationships With the Food and Beverage Industry and Their Published Positions on the Fat Substitute Olestra. *American Journal of Public Health*, 93(4), 664–669. DOI: 10.2105/ajph.93.4.664.
Lewandowsky, S. & Bishop, D. (2016). Don't Let Transparency Damage Science. *Nature*, 529(7587), 459–461. DOI: 10.1038/529459a.
Lewandowsky, S. & Oberauer, K. (2016). Motivated Rejection of Science. *Current Directions in Psychological Science*, 25(4), 217–222. DOI: 10.1177/0963721416654436.
Lewandowsky, S., Cook, J., Oberauer, K., Brophy, S., Lloyd, E. A., & Marriott, M. (2015). Recurrent Fury: Conspiratorial Discourse in the Blogosphere Triggered by Research on the Role of Conspiracist Ideation in Climate Denial. *Journal of Social and Political Psychology*, 3(1), 142–178. DOI:10.5964/jspp.v3i1.443.
Lewandowsky, S., Gignac, G. E., & Oberauer, K. (2013a). The Role of Conspiracist Ideation and Worldviews in Predicting Rejection of Science. *PloS ONE*, 10(8), e75637. DOI: 10.1371/journal.pone.0134773.
Lewandowsky, S., Oberauer, K., & Gignac, G. E. (2013b) NASA Faked the Moon Landing — Therefore, (Climate) Science is a Hoax: An Anatomy of the Motivated Rejection of Science. *Psychological Science*, 24(5), 622–633. DOI: 10.1177/0956797612457686.
Lewandowsky, S., Ullrich, K. H. E., Colleen, M. S., Norbert, S., & John, C. (2012). Misinformation and Its Correction: Continued Influence and Successful Debiasing. *Psychological Science in the Public Interest*, 13(3), 106–131. DOI: 10.1177/1529100612451018.
Lindemann-Matthies, P. & Bose, E. (2008). How Many Species Are There? Public Understanding and Awareness of Biodiversity in Switzerland. *Human Ecology*, 36, 731–742. DOI: 10.1007/s10745-008-9194-1.
Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers Perceived to Engaging With Climate Change Among the UK Public and Their Policy Implications. *Global Environmental Change*, 17, 445–459. DOI: 10.1016/j.gloenvcha.2007.01.004.
Mayr, E. (2004). *What Makes Biology Unique? Considerations on the Autonomy of a Scientific Discipline*. New York, NY: Cambridge University Press.
McCallie, E., Bell, L., Lohwater, T., Falk, J. H., Lehr, J. L., Lewenstein, B. V., Needham, C., & Wiehe, B. (2009). *Many Experts, Many Audiences: Public Engagement With Science and Informal Science Education. A CAISE Inquiry Group Report*. Washington, DC: CAISE.
McCloskey, M. (1983). Intuitive Physics. *Scientific American*, 248, 122–131.
McCright, A. M. & Dunlap, R. E. (2011). The Politicization of Climate Change and Polarization in the American Public's Views of Global Warming, 2001–2010. *The Sociological Quarterly*, 52(2), 155–194. DOI: 10.1111/j.1533-8525.2011.01198.x.
McDevitt, M., Briziarelli, M., & Klocke, B. (2013). Social Drama in the Academic-Media Nexus: Journalism's Strategic Response to Deviant Ideas. *Journalism*, 14(1), 111–128. DOI: 10.1177/1464884912443191.
McDevitt, M., Parks, P., Stalker, J., Lerner, K., Benn, J., & Hwang, T. (2017). Anti-Intellectualism Among US Students in Journalism and Mass Communication: A Cultural Perspective. *Journalism*, 19(6). DOI: 10.1177/1464884917710395.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

McKinley, D. C., Miller-Rushing, A. J., Ballard, H. L., Bonney, R., Brown, H., Cook-Patton, S. C., Evans, D. M., French, R. A., Parrish, J. K., & Phillips, T. B. (2017). Citizen Science Can Improve Conservation Science, Natural Resource Management, and Environmental Protection. *Biological Conservation*, 208, 15–28. DOI: 10.1016/j.biocon.2016.05.015.

Medin, D. L. & Ortony, A. (1989). Psychological Essentialism. *Similarity and Analogical Reasoning* (Eds. S. Vosniadou & A. Ortony). Cambridge University Press, 179– 195.

Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2012). *Learning in Adulthood: A Comprehensive Guide*. San Francisco, CA: John Wiley & Sons.

Miller, J. D. (2004). Public Understanding of, and Attitudes Toward, Scientific Research: What We Know and What we Need to Know. *Public Understanding of Science*, 13(3), 273–294. DOI: 10.1177/0963662504044908.

Morey, R. D., Chambers, C. D., Etchells, P. J., Harris, C. R., Hoekstra, R., Lakens, D., Lewandowsky, S., Morey, C. C., Newman, D. P., & Schönbrodt, F. D. (2016). The Peer Reviewers' Openness Initiative: Incentivizing Open Research Practices Through Peer Review. *Royal Society Open Science*, 3(1), 150547. DOI: 10.1098/rsos.150547.

Moses, H., Dorsey, E. R., Matheson, D. H., & Thier, S. O. (2005). Financial Anatomy of Biomedical Research. *Jama*, 294(1), 1333–1342. DOI: 10.1001/jama.294.11.1333.

Moss, D. M., Abrams, E. D., & Kull, J. A. (1998). Can We Be Scientists Too? Secondary Students' Perceptions of Scientific Research From a Project-Based Classroom. *Journal of Science Education and Technology*, 7, 149–161. DOI: 10.1023/A:1022564507639.

National Research Council (1996). *National Science Education Standards*. Washington, DC: National Academy Press. DOI: 10.17226/4962.

National Science Board (2016). *Public Attitudes About S&T in General.* https://www.nsf.gov/statistics/2016/nsb20161/#/report/chapter-7/public-attitudes-about-s-t-in-general/promises-and-reservations-about-s-t.

Nature Editorial (2017a). Beware the Anti-Science Label. *Nature*, 545(7653), 133–134. DOI: 10.1038/545133b.

Nature Editorial (2017b). Researchers Should Reach Beyond the Science Bubble. *Nature*, 542(7642), 391. DOI: 10.1038/542391a.

Nerbonne, J. F. & Nelson, K. C. (2004). Volunteer Macroinvertebrate Monitoring in the United States: Resource Mobilization and Comparative State Structures. *Society and Natural Resources*, 17(9), 817–839. DOI: 10.1080/08941920490493837.

Newman, G., Wiggins, A., Crall, A., Graham, E., Newman, S., & Crowston, K. (2012). The Future of Citizen Science: Emerging Technologies and Shifting Paradigms. *Frontiers in Ecology and the Environment*, 10(6), 298–304. DOI: 10.1890/110294.

Nosek, B. A., Alter, G., Banks, G. C., Borsboom, D., Bowman, S. D., Breckler, S. J., Buck, S., Chambers, C. D., Chin, G., & Christensen, G. (2015). Promoting an Open Research Culture. *Science*, 348(6242), 1422–1425. DOI: 10.1126/science.aab2374.

Novacek, M. J. (2008). Engaging the public in biodiversity issues. *Proceedings of the National Academy of Sciences*, 105, 11571–11578. DOI: 10.1073/pnas.0802599105.

Nussbaum, M.C. (2016). *Not for Profit: Why Democracy Needs the Humanities*. Princeton, NJ/Oxford: Princeton University Press.

Ojalehto, B., Waxman, S.R., & Medin, D.L. (2013). Teleological Reasoning About Nature: Intentional Design or Relational Perspectives? *Trends in Cognitive Sciences*, 17(4), 166–171. DOI: 10.1016/j.tics.2013.02.006.

Open Science Collaboration (2015). Estimating the Reproducibility of Psychological Science. *Science*, 349(6251). DOI: 10.1126/science.aac4716.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

O'Sullivan, E., Morrell, A., & O'Connor, M. A. (2002). *Expanding the Boundaries of Transformative Learning: Essays on Theory and Praxis*. New York, NY: Palgrave Macmillan. DOI: 10.1007/978-1-349-63550-4.

Ott, K. (2010). *Umweltethik zur Einführung. Naturschutz, ökologische Krise, Zukunftsverantwortung, Werte der Natur, Nachhaltigkeit*. Hamburg: Junius.

Overdevest, C. & Mayer, B. (2007). Harnessing the Power of Information Through Community Monitoring: Insights From Social Science. *Texas Law Review,* 86(7), 1493–1526.

Overdevest, C., Orr, C.H., & Stepenuck, K. (2004). Volunteer Stream Monitoring and Local Participation In Natural Resource Issues. *Human Ecology Review*, 11(2), 177–185.

Pahl-Wostl, C., Mostert, E., & Tàbara, D. (2008). The Growing Importance of Social Learning in Water Resources Management and Sustainability Science. *Ecology and Society*, 13(1), 24.

Pattengill-Semmens, C. V. & Semmens, B. X. (2003). Conservation and Management Applications of the Reef Volunteer Fish Monitoring Program. *Coastal Monitoring Through Partnerships* (Eds. B. D. Melzian, V. Engle, M. McAlister, S. Sandhu, & L. K. Eads). Dordrecht: Springer, 43–50. DOI: 10.1007/978-94-017-0299-7_5.

Pettibone, L., Vohland, K., & Ziegler, D. (2017). Understanding the (Inter)Disciplinary and institutional Diversity of Citizen Science: A Survey of Current Practice in Germany and Austria. *PLoS ONE*, 12(6), e0178778. DOI: 10.1371/journal.pone.0178778.

Pettibone, L., Ziegler, D., Richter, A., Hecker, S., Bonn, A., & Vohland, K. (Eds.) (2015). *GEWISS Dialogforum: Forschungsförderung für Citizen Science. GEWISS Bericht Nr. 7*. https://www.buergerschaffenwissen.de/sites/default/files/grid/2017/11/20/7_gewiss_forschungsfoerderung_bericht.pdf.

Petty, R. E. & Cacioppo, J. T. (1986). The Elaboration Likelihood Model of Persuasion. *Advances in Experimental Social Psychology*, 19, 123–205.

Petty, R. E. & Cacioppo, J. T. (1996). *Attitudes and Persuasion: Classic and Contemporary Approaches*. New York, NY: Routledge. DOI: 10.4324/9780429502156.

Pimm, S.L., Alibhai, S., Bergl, R., Dehgan, A., Giri, C., Jewell, Z., Joppa, L., Kays, R., & Loarie, S. (2015). Emerging Technologies to Conserve Biodiversity. *Trends in Ecology & Evolution*, 30(11), 685–696. DOI: 10.1016/j.tree.2015.08.008.

Pittinsky, T. L. (2015). America's Crisis of Faith in Science. *Science*, 348(6234), 511–512. DOI: 10.1126/science.348.6234.511-a.

Pocock, M. J., Chapman, D. S., Sheppard, L. J., & Roy, H. E. (2014). *Choosing and Using Citizen Science: A Guide to When and How to Use Citizen Science to Monitor Biodiversity and the Environment*. Wallingford: NERC/Centre for Ecology & Hydrology.

The Harris Poll (2014). *Prestige of 23 Professions and Occupations*. https://theharrispoll.com/when-shown-a-list-of-occupations-and-asked-how-much-prestige-each-job-possesses-doctors-top-the-harris-polls-list-with-88-of-u-s-adults-considering-it-to-have-either-a-great-deal-of-prestige-45-2/.

Popper, K. (1957). Philosophy of Science. *British Philosophy in the Mid-Century* (Ed. C. A. Mace). London: George Allen and Unwin.

Potthast, T. & Eser, U. (1999). *Naturschutzethik. Eine Einführung für die Praxis*. Baden-Baden: Nomos.

Raddick, M. J., Bracey, G., Gay, P. L., Lintott, C. J., Murray, P., Schawinski, K., Szalay, A. S., & van den Berg, J. (2010). Galaxy Zoo: Exploring the Motivations of Citizen Science Volunteers. *Astronomy Education Review*, 9, 010103. DOI: 10.3847/AER2009036.

Reed, M. S. (2008). Stakeholder Participation for Environmental Management: A Literature Review. *Biological Conservation*, 141(10), 2417–2431. DOI: 10.1016/j.biocon.2008.07.014.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Richter, A., Dörler, D., Hecker, S., Heigl, F., Pettibone, L., Serrano Sanz, F., Vohland, K., & Bonn, A. (2018). Capacity Building in Citizen Science. *Citizen Science: Innovation in Open Science, Society and Policy* (Eds. S. Hecker, M. Haklay, A. Bowser, Z. Makuch, J. Vogel, & A. Bonn). London: UCL Press, 269–283.
Richter, A., Hauck, J., Feldmann, R., Kühn, E., Harpke, A., Hirneisen, N., Mahla, A., Settele, J., & Bonn, A. (2018). The social fabric of citizen science—drivers for long-term engagement in the German butterfly monitoring scheme. *Journal of Insect Conservation*, 22, 731–743. DOI: 10.1007/s10841-018-0097-1.
Richter, A., Mahla, A., Tochtermann, K., Scholz, W., Zedlitz, J., Wurbs, A., Vohland, K., & Bonn, A. (2015). *GEWISS Dialogforum: Datenqualität, Datenmanagement und rechtliche Aspekte in Citizen Science. GEWISS Bericht Nr. 6.* https://www.buergerschaffenwissen.de/sites/default/files/grid/2017/11/24/gewiss_6_datenbericht.pdf.
Rosenbaum, L. (2017a). The March of Science—The True Story. *New England Journal of Medicine*, 377(2), 188–191. DOI: 10.1056/NEJMms1706087.
Rosenbaum, L. (2017b). Resisting the Suppression of Science. *New England Journal of Medicine*, 376, 1607–1609.
Rowe, G. & Frewer, L. J. (2005). A Typology of Public Engagement Mechanisms. *Science, Technology, & Human Values*, 30(2), 251–290. DOI: 10.1177/0162243904271724.
Rowe, S., Alexander, N., Clydesdale, F., Applebaum, R., Atkinson, S., Black, R., Dwyer, J., Hentges, E., Higley, N., Lefevre, M., Lupton, J., Miller, S., Tancredi, D., Weaver, C., Woteki, C., & Wedral, E. (2009). Funding Food Science and Nutrition Research: Financial Conflicts and Scientific Integrity. *Nutrition Reviews*, 67(5), 264–272. DOI: 10.1111/j.1753-4887.2009.00188.x.
Roy, H. E., Pocock, M. J., Preston, C. D., Roy, D. B., Savage, J., Tweddle, J., & Robinson, L. (2012). Understanding Citizen Science and Environmental Monitoring: Final Report on Behalf of UK Environmental Observation Framework. *NERC/Centre for Ecology & Hydrology*, 173. http://www.ukeof.org.uk/documents/understanding-citizen-science.pdf.
Rutjens, B. T. & Heine, S. J. (2016). The Immoral Landscape? Scientists Are Associated With Violations of Morality. *PloS ONE*, 11(4), e0152798. DOI: 10.1371/journal.pone.0152798.
Rutten, K. & Soetaert, R. (2013). Rhetoric, Citizenship, and Cultural Literacy. *CLCWeb: Comparative Literature and Culture*, 15(3). DOI: 10.7771/1481-4374.2242.
Sanz, F. S., Holocher-Ertl, T., Kieslinger, B., García, F. S., & Silva, C. G. (2014). White Paper on Citizen Science in Europe. *Socientize Consortium*. http://www.zsi.at/object/project/2340/attach/White_Paper-Final-Print.pdf.
Schiele, B. (2008). On and About the Deficit Model in an Age of Free Flow. *Communicating Science in Social Contexts* (Eds. D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, & S. Shi). Springer: Dordrecht, 93–117. DOI: 10.1007/978-1-4020-8598-7_6.
Schmeller, D. S., Henry, P.-Y., Julliard, R., Gruber, B., Clobert, J., Dziock, F., Lengyel, S., Nowicki, P., Déri, E., Budrys, E., Kull, T., Tali, K., Bauch, B., Settele, J., Van Swaay, C., Kobler, A., Babij, V., Papastergiadou, E. V. A., & Henle, K. (2009). Advantages of Volunteer-Based Biodiversity Monitoring in Europe. *Conservational Biology*, 23(2), 307–316. DOI: 10.1111/j.1523-1739.2008.01125.x.
Schröter, M., Kraemer, R., Mantel, M., Kabisch, N., Hecker, S., Richter, A., Neumeier, V., & Bonn, A. (2017). Citizen Science for Assessing Ecosystem Services: Status, Challenges and Opportunities. *Ecosystem Services*, 28, 80–94. DOI: 10.1016/j.ecoser.2017.09.017.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Scott, S. E., Inbar, Y., & Rozin, P. (2016). Evidence for Absolute Moral Opposition to Genetically Modified Food in the United States. *Perspectives on Psychological Science*, 11(3), 315–324. DOI: 10.1177/1745691615621275.

Shah, H. R. & Martinez, L. R. (2016). Current Approaches in Implementing Citizen Science in the Classroom. *Journal of Microbiology & Biology Education*, 17(1), 17–22. DOI: 10.1128/jmbe.v17i1.1032.

Shirk, J., Ballard, H., Wilderman, C., Phillips, T., Wiggins, A., Jordan, R., McCallie, E., Minarchek, M., Lewenstein, B., & Krasny, M. (2012). Public Participation in Scientific Research: A Framework for Deliberate Design. *Ecology and Society*, 17(2), 29. DOI: 10.5751/ES-04705-170229.

Shtulman, A. (2017). *Scienceblind: Why Our Intuitive Theories About the World Are so Often Wrong*. Philadelphia, PA/New York, NY: Hachette.

Shtulman, A. & Schulz, L. (2008). The Relation Between Essentialist Beliefs and Evolutionary Reasoning. *Cognitive Science*, 32(6), 1049–1062. DOI: 10.1080/03640210801897864.

Silver, L. M. (2007). *Challenging Nature: The Clash Between Biotechnology and Spirituality*. New York, NY: Harper Collins.

Silvertown, J. (2009). A New Dawn for Citizen Science. *Trends in Ecology & Evolution*, 24, 467–471. DOI: 10.1016/j.tree.2009.03.017.

Soma, K. & Haggett, C. (2015). Enhancing Social Acceptance in Marine Governance in Europe. *Ocean & Coastal Management*, 117, 61–69. DOI: 10.1016/j.ocecoaman.2015.11.001.

Storksdieck, M., Shirk, J., Cappadonna, J., Domroese, M., Göbel, C., Haklay, M., Miller-Rushing, A., Roetman, P., Sbrocchi, C., & Vohland, K. (2016). Associations for Citizen Science: Regional Knowledge, Global Collaboration. *Citizen Science: Theory and Practice*, 1(2), 10. DOI: 10.5334/cstp.55.

Strohschneider, P. (2017). Über Wissenschaft in Zeiten des Populismus. Speech at Annual Assembly of the DFG. *Deutsche Forschungsgemeinschaft (DFG)*. http://www.dfg.de/download/pdf/dfg_im_profil/reden_stellungnahmen/2017/170704_rede_strohschneider_festveranstaltung.pdf.

Sugimoto, C. R., Thelwall, M., Larivière, V., Tsou, A., Mongeon, P., & Macaluso, B. (2013). Scientists Popularizing Science: Characteristics and Impact of TED Talk Presenters. *PloS ONE*, 8(4), e62403. DOI: 10.1371/journal.pone.0062403.

Swaisgood, R. R. & Sheppard, J. K. (2010). The Culture of Conservation Biologists: Show Me the Hope! *BioScience*, 60(8), 626–630. DOI: 10.1525/bio.2010.60.8.8.

Tàbara, J. D. & Pahl-Wostl, C. (2007). Sustainability Learning in Natural Resource Use and Management. *Ecology and Society*, 12(2).

Tamir, P. & Zohar, A. (1991). Anthropomorphism and Teleology in Reasoning About Biological Phenomena. *Science Education*, 75(1), 57–67. DOI: 10.1002/sce.3730750106.

Theobald, E. J., Ettinger, A. K., Burgess, H. K., DeBey, L. B., Schmidt, N. R., Froehlich, H. E., Wagner, C., HilleRisLambers, J., Tewksbury, J., & Harsch, M. (2015). Global Change and Local Solutions: Tapping the Unrealized Potential of Citizen Science for Biodiversity Research. *Biological Conservation*, 181, 236–244. DOI: 10.1016/j.biocon.2014.10.021.

Tinker, R. F. (1997). Student—Scientist Partnerships. *Internet Links for Science Education* (Ed. K. C. Cohen). Boston, MA: Springer, 5–16. DOI: 10.1007/978-1-4615-5909-2.

Troudet, J., Grandcolas, P., Blin, A., Vignes-Lebbe, R., & Legendre, F. (2017). Taxonomic Bias in Biodiversity Data and Societal Preferences. *Scientific Reports*, 7, 9132. DOI: 10.1038/s41598-017-09084-6.

EBSCOhost - printed on 2/10/2023 10:59 AM via . All use subject to https://www.ebsco.com/terms-of-use

Turney, J. (2008). Popular Science Books. *Handbook of Public Communication of Science and Technology* (Eds. M. Bucchi & B. Trench). London: Routledge, 5–14.
Turnhout, E., Bloomfield, B., Hulme, M., Vogel, J., & Wynne, B. (2012). Conservation Policy: Listen to the Voices of Experience. *Nature*, 488, 454–455. DOI: 10.1038/488454a.
van der Linden, S. (2015). The Conspiracy-Effect: Exposure to Conspiracy Theories (About Global Warming) Decreases Pro-Social Behavior and Science Acceptance. *Personality and Individual Differences*, 87, 171–173. DOI: 10.1016/j.paid.2015.07.045.
van Dijk, E. M. (2011). Portraying Real Science in Science Communication. *Science Education*, 95, 1086–1100. DOI: 10.1002/sce.20458.
Van Noorden, R. (2014). Publishers Withdraw More Than 120 Gibberish Papers. *Nature*, 24. DOI: 10.1038/nature.2014.14763.
Weston, M., Fendley, M., Jewell, R., Satchell, M., & Tzaros, C. (2003). Volunteers in Bird Conservation: Insights From The Australian Threatened Bird Network. *Ecological Management & Restoration*, 4(3), 205–211. DOI: 10.1046/j.1442-8903.2003.00169.x.
Wilderman, C. C., Barron, A., & Imgrund, L. (2004). Top Down or Bottom Up? ALLARMs Experience With Two Operational Models for Community Science. Proceedings of the 4th National Monitoring Conference, Chatanooga, Tennessee, USA. *National Water Quality Monitoring Council*. http://water.usgs.gov/wicp/acwi/monitoring/conference/2004/proceedings_contents/13_titlepages/posters/poster_235.pdf.
Wissenschaftsbarometer (2014). *Wissenschaft im Dialog*. http://www.wissenschaft-im-dialog.de/fileadmin/user_upload/Projekte/Wissenschaftsbarometer/Dokumente/Ergebnistabellen_Wissbarometer 2014_neu.pdf.
Wissenschaftsbarometer (2016). *Wissenschaft im Dialog*. https://www.wissenschaft-im-dialog.de/fileadmin/user_upload/Projekte/Wissenschaftsbarometer/Dokumente_16/Wissenschaftsbarometer2016_web.pdf.
Wong, S. L. & Hodson, D. (2009). From the Horse's Mouth: What Scientists Say About Scientific Investigation and Scientific Knowledge. *Science Education*, 93(1), 109–130. DOI: 10.1002/sce.20290.
Wulfhorst, J., Eisenhauer, B. W., Gripne, S. L., & Ward, J. M. (2008). Core Criteria and Assessment of Participatory Research. *Partnerships for Empowerment: Participatory Research for Community-Based Natural Resource Management* (Eds. C. Wilmsen, W. F. Elmendorf, L. Fisher, J. Ross, B. Sarathy, & G. Wells). Routledge, 23–46.
Wynne, B. (1992). Misunderstood Misunderstanding: Social Identities and Public Uptake of Science. *Public Understanding of Science*, 1, 281–304.
Zehr, S. C. (2000). Public Representations of Scientific Uncertainty About Global Climate Change. *Public Understanding of Science*, 9, 85–103. DOI: 10.1088/0963-6625/9/2/301.
Zimmerman, C. (2007). The Development of Scientific Thinking Skills in Elementary and Middle School. *Developmental Review*, 27(2), 172–223. DOI: 10.1016/j.dr.2006.12.001.
Zoellick, B., Nelson, S. J., & Schauffler, M. (2012). Participatory Science and Education: Bringing Both Views Into Focus. *Frontiers in Ecology and the Environment*, 10(6), 310–313. DOI: 10.1890/110277.

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on the generality of citizen science. Currently, she is involved in the establishment of citizen science in agricultural landscapes to complement national biodiversity monitoring schemes (MonViA Project: https://www.agrarmonitoring-monvia.de/en/). Teaching and supervising next-generation scientists as well as international and diverse collaborations are important to Anett.

Julia Siebert is an interdisciplinary researcher at the German Centre for integrative Biodiversity Research (iDiv). With a study background in biology, philosophy, and rhetoric, she is particularly interested in working at the interface of natural sciences, humanities, and society. After completing a PhD on global change effects on soil organisms and ecosystem functioning, she coordinated an integrative project assessing the transformative potential of citizen science in high school education in close collaboration with environmental psychologists, teachers, and local politicians. Moreover, Julia Siebert is experienced in science communication and the facilitation of stakeholder dialogues and civic engagement.

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