Trust in Science:

When the Public Considers Whom to Trust - the Example of COVID-19

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English Abstract

The chapter provides a conceptual clarification of the concept 'public trust in science'. Our starting point is the model of trust formulated by Mayer, Davis, and Schoormann (1995), which has been widely used in trust research since then. Here, it is now specified for the context of citizens' encounter with science, by using the example of the COVID-19 pandemic, and in particular the Hydroxychloroquine controversy (which started with a heavily criticized as methodologically flawed study by French microbiologist D. Raoult, who continued to sell the study's claims on the media). We differentiate *trust* from *trustworthiness*; and propose a distinction between *epistemic trust* (depending on science regarding the validity of knowledge) and *instrumental trust* (depending on science regarding its impact on one's aims). We then introduce the notion of *informed* trust to describe that public trust in science has a rational basis. Finally, challenges and ways for the promotion of public trust in science are outlined.

German Abstract

In dem Kapitel wird konzeptuelle Klarstellung des Konzepts 'Wissenschaftsvertrauen' vorgenommen. Ausgangspunkt ist das Vertrauensmodell, das Mayer, Davis & Schoormann bereits 1995 formuliert haben und das seitdem in der Vertrauensforschung vielfach verwendet wurde. Hier wird es nun für den Kontext der Begegnung von Bürger:innen mit Wissenschaft, am Beispiel der COVID-19 Pandemie, und im speziellen der Hydroxychloroquin-Kontroverse (die durch eine als methodisch fragwürdig heftig kritisierte Studie des französischen Mikrobiologen D. Raoult ausgelöst wurde, der seine Schlussfolgerungen trotzdem weiter in den (sozialen) Medien teilte). Wir differenzieren *Vertrauen* und *Vertrauenswürdigkeit*; und schlagen eine Unterscheidung zwischen von *epistemischem Vertrauen* (sich von Wissenschaft abhängig machen in Bezug auf die Gültigkeit von Wissen) und *instrumentellem Vertrauen* (sich von Wissenschaft abhängig machen in Bezug auf ihren Einfluss auf die Erreichung eigener Ziele) vor. Dann führen wir den Begriff des *informierten Vertrauens* ein, um zu beschreiben, dass Wissenschaftsvertrauen rational begründet sein kann. Abschließend werden Herausforderungen und Ansatzpunkte für die Förderung des Wissenschaftsvertrauens skizziert.

Keywords

Trust in Science; Epistemic Trust; Inferences

Introduction

When in the beginning of 2020 the first reports of the Coronavirus disease 2019 (COVID-19) frightened the world, it became rapidly clear that taking effective action against the evolving pandemic would depend upon the general public as well as decision makers on all levels being willing to rely on science (Bromme et al, 2022). The COVID-19 pandemic (as is climate change) is an illustrative example on an issue which reveals that public trust in science is integral for confronting global challenges, thus, we use it for elaborating why and for whom trust in science¹ matters, but also for reflecting on the conditions and pitfalls of citizens' *informed* trust judgments.

The MDS model of trust (Mayer, Davis, & Schoorman, 1995) provides a fruitful starting point (for a more elaborate discussion, see Mayer & Mayer, Intro Chap, and MDS, chap X); the main components of MDS (and of related trust models, see Blöbaum, 2021; PytlikZillig & Kimbrough, 2016) will be summarized below². In theory, *trust* is the voluntary dependence of a *trustor* on the actions of a *trustee*. The *choice* to trust (in principle, the trustor could choose not to rely on the trustee's critical action) rests on expectations, namely, ascriptions of *trustworthiness*. The trustee's action is beneficial for achieving the trustor's *goals*, who is not able to achieve these using his/her own capabilities. This implies *risk*: the trustor doesn't have *full control over the provision of the expected action* or over its *quality*. Insofar the trustor accepts a *vulnerability* when choosing to trust. Here, *trust* is characterized as a *social relationship*, when in other work, trust is considered a *process*, with a focus on the *development* and the *use* of the above-mentioned expectations (about the trustor) for making goal-directed decisions (Blöbaum, 2021).

Trust in Science

In the following, we will use the "Hydroxychloroquine controversy" (see also, Berlivet & Löwy, 2020) to specify these components for *trust in science*. In March 2020, the French microbiologist Professor Didier Raoult published a study claiming that Hydroxychloroquine (a Malaria drug) was highly effective for treating COVID-19. Rapidly, Raoult's results

¹ In this chapter, the notion *science* is used in the broad sense of the German concept of *Wissenschaft*, including the sciences of the natural world, the social world (social science), and the cultural world (humanities). The case of the COVID-19 pandemic exemplifies that all these disciplinary perspectives are required for a research-based understanding of the pandemic and its effects on the world.

² Our perspective on trust in science is based on psychological research, and informed by *epistemological* and *sociological* perspectives on trust in science.

became well known and were picked up by politicians in France and the US (especially President Trump and media leaning to him). Simultaneously, the study was scrutinized by other researchers, who pointed to methodological shortcomings. Just a few weeks later, the journal which had accepted the paper in a fast-track procedure, retracted it. Further studies then corroborated the lack of effectiveness of Hydroxychloroquine treatment against COVID-19 (Lee et al., 2021).

Risk. This case shows how 'trust in science' can be simultaneously crucial and fragile. When the pandemic emerged, the nature and epidemiology of the disease and its possible treatments were not well understood, but it became clear that the pathogen was a new version of the well-known coronavirus family. Therefore, researchers worldwide were able to come up with provisional (albeit, not univocal) answers regarding the virus' containment and its treatment. However, there was little evidence yet to back up these claims (epistemic uncertainty), and implementing measures of prevention based on these predictions were costly (and were deeply affecting personal freedom). Therefore, by trusting Raoult's claims, the *risk* for the trustor is the probability of being (by intention or not) misinformed about the *veracity of a claim about a critical issue*, which seemed to have been the case when citizens as well as political leaders trusted the claims of the (later retracted) Hydroxychloroquine study.

Epistemic Trust. When Raoult published his findings, all stakeholders were *epistemically* dependent from this expert (as from other experts' claims). There might be variance among researchers about the criteria for accepting a claim as "true", as it was in the just mentioned case (Berlivet & Löwy, 2020), especially when the critical issue is directly implemented into practical application. For example, scientists and general practitioners might use different thresholds for accepting a treatment as effective. Furthermore, uncertainty is a central feature of science, allowing only for tentative determination of "truth". However, especially in cases in which the epistemic risk (believing a false claim) is connected to a personal or societal risk (patients' health), trust in science relies on the tightening of conventions for deciding whether to accept a claim as true (Wilholt, 2013), something Raoult refused to by violating the methodological conventions of and even arguing against randomized controlled trials (Berlivet & Löwy, 2020).

When it comes to a medical practitioner (as trustor) and the researcher (for example Raoult) as trustee, the *epistemic* nature of the risk is obvious. Patients, however, have limited *choice* about the medical treatment on the first glance because their knowledge and understanding of alternatives might not allow a truly informed decision. What is their *epistemic* risk and which vulnerability do they accept? Patients legally must agree to being treated in a certain way. Furthermore, the cognitive and the emotional acceptance of a treatment matters for its clinical effectiveness. Such acceptance is not only based on *epistemic* trust, because patients must rely on the medical system in non-epistemic ways (e.g., the quality of instruments used for their treatment). Nevertheless, the final justification of any treatment is based on the assumed veracity of the claim that this treatment is more effective than an alternative or no treatment.

What about citizens who are not directly affected by COVID-19, but interested in news about the pandemic? They also have the *choice* to believe in Raoult's (vs. his critics) claims. Provided the assumption the issue at stake matters for the general understanding of the world, the *risk* entails accepting a claim as "true" which is (on empirical grounds) less appropriate, and hence, restrains understanding of and making decisions about the natural or social world. In the case of the Hydroxychloroquine controversy, claims of effectiveness came along with further, far-reaching claims about the future course of the pandemic and measures to take against it. In fact, when it comes to the public understanding of science, vulnerability does not only come along with the risk of believing false claims, but also with integrating these beliefs into a larger worldview. If claims are justified by evidence, believing them results in a rational and science-based view of the world. Otherwise, the epistemic risk of believing false claims intertwines with the societal and individual risk following a less rational, science-based understanding of the world (in the case of a pandemic, followed along by health risks for the individual and the community). Recent debates about post-truthism as a societal challenge (Lewandowsky, Ecker & Cook, 2017) allow for the conclusion that this is a serious risk.

Instrumental Trust. Beside its *epistemic* nature, trust in science can have an *instrumental* function. *Instrumental trust* refers to the expectation that the trustee's actions work toward the goals of the trustor. This conceptual distinction mirrors different roles scientists have in society, as researchers (production of valid knowledge) and as public advisers (brokers of valid knowledge) (Pielke, 2007). Scientific advice often is embedded in public discourses, for

example about the acceptability of negative side effects of Hydroxychloroquine. Thus, trust in science may be instrumental for the individual by informing personal decisions.

It is an empirical question if people's trust in science has an *epistemic* or an *instrumental* focus. This question could be answered only if the conceptual distinction suggested here is also reflected within research designs and survey items, which is not always the case. Most surveys on trust in science put an emphasis on instrumental trust, when for example asking about citizens' approval of spending tax money for science, or when asking whether they believe that science makes life easier (Castell et al., 2014; National Science Board, 2018), and in fact, having a science “positivistic” attitude is related to high trust in science (Wintterlin et al., 2022). In contrast, asking respondents whether they believe that science has sufficiently understood the causes of climate change, or whether there is scientific consensus about this issue (Pasek, 2018), are examples of a focus on *epistemic* trust.

The Trustee. In trust research, it is well established to differentiate conceptually between individuals, groups, institutions as trust object (Blöbaum, 2021), which could be, respectively, single scientists, research labs, or universities. In fact, the COVID-19 pandemic has brought a few scientists to the center of public attention (Kupferschmidt, 2020). Moreover, people also have trust in science as an *abstract* entity because science contributes to the everyday understanding of the social world, just as *politics* or *religion* (CITE OTHER CHAPTERS). It is again an empirical question which meaning people assign to the abstract notion if “science” or “research”. When asked, German respondents referred to medicine, general ideas about the role of science, technology, environmental issues, and physics and space research, listed here by rank order of frequencies (Ziegler et al., 2018).

Often, experiences with science are *mediated*, for example by journalists, public relations officers, teachers, or science museum designers (Schäfer, 2016). These could serve as trustees, as well. The Internet helps attract more diverse audiences but also offers opportunities for communication about science to a more diverse group of actors. For example, citizens could act as mediators of approved scientific knowledge (the most illustrative example is Wikipedia) but also as partisans of science denialism, for example regarding vaccination in the context of the COVID-19 pandemic (Nguyen & Catalan-Matamoros, 2020). It is again an empirical question if these sources of science related

information are seen as the ultimate trustees, or as stand-ins for someone else (usually a scientist) who guarantees for the veracity of a claim.

Trustworthiness. The MDS model (MDS, 1995) assumes that people ascribe trustworthiness to the trustee on the dimensions expertise, integrity, and benevolence, impacting their willingness to trust (Hamm, Smidt & Mayer, 2019). These may be based on preexisting beliefs and on inferences following indicative cues (Landrum et al., 2015). For trustworthiness ascriptions to experts, people make differentiated judgments depending on cues relating to these three dimensions, indicating that the dimensions are, albeit interrelated, clearly distinct from each other (Hendriks et al., 2015). *Expertise* refers to the trustees' amount of knowledge and skill. *Integrity* includes adherence to the rules of the profession and—in the context of science—to the intention to work in an unbiased way. *Benevolence* means considering the interests of the trustor or, more generally, the positive impact of scientists' work on society. Other researchers found similar dimensions, for example perceptions of knowledge and expertise, openness, and concern and care (Peters, Covello, & McCallum, 1997). Besley et al. (2020) built an inventory on the 'perceptions of scientists' integrating 40 studies (published in well-established science communication journals). A two-factor solution encompassed expertise and the cluster of all the further items, subsumed by Besley et al. as positive personal characteristics. An alternative four-factor solution encompassed expertise, integrity, benevolence, and openness. Openness is represented by items like *respectful—disrespectful, clear—unclear, willing... —unwilling to explain decisions*.

While the dimensions *expertise*, *benevolence*, and *integrity* replicate well in the context of science, their meaning is specific to this context. For example, the dimension of *integrity* typically is understood as the trustees' adherence to values and principles which are shared by the trustor (Hamm, Smidt & Mayer, 2019). When it comes to science, these values and principles are those shared by the scientific community. Laypersons must not necessarily have a deep understanding about these rules and principles, but a general sense that adherence to these rules is vital to produce true and unbiased knowledge.

Why trust is inevitable in people's encounters with science.

To sum up: In modern societies, scientific knowledge is inevitable for citizens' personal problem solving and for an understanding of the natural and the social world. Many different

disciplines and fields of science (in the broad sense) contribute to the scientific understanding of today's problems, such as climate change or global pandemic response. But in modern science, knowledge can be gathered only through an elaborated division of cognitive labor. It takes years to acquire the skills and the understanding necessary for judging about the 'truth' of scientific knowledge, resulting in a set of highly specialized fields and disciplines. Insofar, people must rely on the testimony of experts about what is true (*dependence*). Regarding many issues of interest (for example establishing which is the best treatment against COVID-19) this reliance cannot be based alone on one's own (as laypersons) capabilities for understanding of what is true and what is false. Most people do not have the expertise, the resources, and the time for valid first-hand judgements. Instead, one's reliance on experts must be based on second-hand judgment about whom to trust (*expectations*, Bromme & Goldman, 2014), even though believing experts for knowledge comes with the *risk* to acquire false beliefs. In that sense, the relationship between citizens and science is *inevitably* a relationship of trust (or distrust) in science (in the manifold sense described above), whenever people refer to scientific knowledge (in discourse, for personal decision making, or for their personal understanding of the social and the natural world).

Challenges for *informed* epistemic trust

Inspired by the concept of patients' informed decision making (Bekker et al., 1999), we have suggested the notion of *informed trust* as a concept for a *knowledge based and rational* process of trust (Bromme, 2020; see also Bromme & Gierth, 2021 on the relationship between *rationality* and *trust*). A main challenge for *informed* trust is that science can be conceived as an epistemic as well as a social endeavor (Hendriks et al., 2016b). When we refer to science as an epistemic endeavor, we refer to data, knowledge, methods, rules, and regulated ways of discourse aimed at both the production and the critique of 'truth'. In empirical disciplines, 'truth' starts with theoretical notions about the research object which are constrained by data. Simultaneously, science refers to the social endeavor in which individuals and organizations collaboratively produce and negotiate "truth". To do this effectively, scientists rely on each other³ based on conventions, which are closely upheld, and controlled by others (and penalized if not). In this sense, what is accepted as "true" is based on a kind of consensus among scientists, which is not arbitrary but regulated by methods and conventions and must

³This why trust is also essential among scientists (Hardwig, 1991; Wilholt, 2013). Due to space limitations, we do not cover the role of trust *among* scientists and *within* science.

align with the available data. It is not possible to establish a consensus 'against evidence'- at least not on the long run.

Even this humble description⁴ of science immediately reveals one of the main challenges of informed trust: For judgments of informed trust in science, it is necessary to consider and weigh up information on both the epistemic and the social nature of science. In the easiest case, this means judgments about scientists' expertise, integrity, and benevolence, to identify the most trustworthy expert. However, trust in science also relies on more general expectations about science and its processes. Accepting that climate change is real because there is a consensus among the vast majority of climate scientists is not in accordance with the everyday understanding of reality and truth: One would not accept that it is raining when the majority of their neighbors agree about the weather. Only if one understands the role of consensus in science, it would be rational to believe a claim based on consensus. Thus, understanding scientific consensus has been considered a 'gateway belief' for accepting the present state of scientific knowledge about climate change (van der Linden, 2021). However, the duality of the epistemic and the social side of science can also be a gateway for science denialism (Kienhues et al., 2020). Strategies to undermine trust in scientists and in science are claiming that there are alternative scientists having their own consensus, and the outright rejection of the duality by insisting on an idea of immediate truth, appealing to peoples' intuitions and personal experience (Boudry et al., 2015).

Fostering citizens' informed trust judgments

The dimensions of trustworthiness are informative for reflecting on challenges in making judgments of *informed* trust. Beyond this, they inform implications for science communication to foster such judgments. In the following, we outline a few examples.

Expertise. People use superficial indicators for determining scientists' expertise about a topic, as for example a professorship or doctorate in a relevant discipline (Hendriks et al., 2015; Winter & Krämer, 2012), an affiliation to a well-known university, and even the use of technical terms (Thon & Jucks, 2017). These cues can inform judgments about "whom to trust", especially for distinguishing between pseudo-science and science. However, from the notion of the cognitive division of labor follows that scientists are highly specialized experts.

⁴ This is a quite condensed picture of the process of scientific knowledge production. It is based on recent philosophy of science approaches, aiming for a conceptual reconstruction of the real processes of science, see for example Oreskes, 2020.

Thus, expertise is graded, relative to the breadth of a topic (Bromme & Thomm, 2016), leading to *pertinence* (as a specific feature of expertise) being vital for finding to expert best connected to the topic of interest. Science communication could include information on the disciplinary structure of scientific fields (highlighting boundaries of expertise) to inform citizens' reasoning about experts' pertinence. Furthermore, the *relevance* of an expert (indicated by prestige within the scientific community and the number of relevant publications and their citations) is a reasonable indicator for expertise considering that science itself is a social endeavor (Hendriks et al., 2016b).

Integrity. Science communication could inform judgments about the integrity of scientists by transparently describing the scientific processes with which knowledge was gathered. Especially through the Open Science movement, transparency in research processes have been considered (at least inner-scientific) a signifier of trustworthiness through fostering replicability and reproducibility (Peels & Bouter, 2021). Hence, transparency about research processes is an indicator for scientists' integrity (Jamieson et al., 2019). Empirical results show that when a university or company commits to transparent research practices in a public statement, they are trusted more than in absence of such a statement (Landrum et al., 2018). Similarly, a scientists' integrity might be positively affected, if a scientist performs self-criticism of research methodology (Altenmüller, Nuding & Gollwitzer, 2021a), or discloses previous overstatements (Hendriks et al., 2016a).

However, science communication addressing low replicability within a discipline (such as psychology) may lead to lower trust compared to a condition of comparably high replicability (Wingen et al., 2019), or a control condition (Anvari & Lakens, 2018). Importantly, these two studies were not successful in repairing such loss of trust by providing information about reforms (here, the open science movement in psychology). Ophir & Jamieson (2021) similarly found that news stories which portrayed science as broken (because of low replicability) and in which problems within science are explored and potentially addressed result in lower trust than a narrative describing a single scientist being on the honorary quest for truth. These results show why it is so important to explore and support *people's beliefs about science as a social system*, because fostering trust in science could build on prevailing beliefs about the self-correcting power of science (Ophir & Jamieson, 2021; Mede et al, 2021).

Benevolence. This dimension is related to Merton's norm of disinterestedness: Scientists should not be influenced by extrinsic (e.g., profit, prestige) motivations. In fact, citizens prefer intrinsic motivations (e.g., being curious, wanting to help) over extrinsic motivations for scientists (Johnson & Dieckmann, 2020). Cues pointing to the possibility of vested interests typically reduce trust in science and trigger a critical stance against the claims put forward by these scientists (Besley et al., 2017, Gierth & Bromme, 2020). However, when a researcher has a personal connection to a research topic (studying perceptions of veganism while himself being vegan), he/she is perceived as being more trustworthy (affecting benevolence/integrity – loading on one factor – as well as expertise), but only when participants had a favorable view of the topic; the effect was reversed when participants had a negative attitude towards the topic (Altenmüller, Lange & Gollwitzer, 2021).

These results raise the question whether there can be a disinterested researcher – the public does not seem to perceive this. In fact, many historical examples show that science has been influenced by moral and political values (Allchin, 1999), sometimes with deeply troubling results, such as with the Tuskegee syphilis study. In consequence of such cases, there might be deeply rooted mistrust in science (Pierre, 2020). However, in the choice of research questions or the assignment of monetary resources, moral and/or political values are sometimes unavoidable and can be justified (Douglas, 2000). Again, informed trust could resolve this tension by understanding science as both an epistemic and a social endeavor. Regarding the instrumental function of science, value judgments affecting research processes can be reasonable, for example when investigating health risks (Wilholt, 2013). In contrast, when establishing the veracity of knowledge claims—the epistemic function of science—a disinterestedness in aims and values (beyond epistemic values, as for example objectivity) should be expected to justify the ascription of trust.

Conclusion

The MDS trust model and related models conceptualize trust as a social process between trustor and as trustee, benefitting the trustors' understanding of and agency in the world, based on his/her belief systems (knowledge). Insofar, trust in science can be conceptualized similar to trust in other contexts. However, the division of cognitive labor leads to a specific form of vulnerability: The trustor can only achieve a partial understanding of the world, based on only fragments of scientific knowledge (Keil, 2019). While there is no need to understand the world

in depth, the trustor could rely on experts to gain knowledge (the epistemic function of science), and gain agency (the instrumental function of science), if and only if these experts are trustworthy. In this chapter, we have focused on these functions of trust by elaborating the concept of *epistemic* trust. It would be worthwhile to look for the triangle of trustor, trustee, and belief systems (which are not fully represented within individual's cognitive systems) also in other contexts, for example, cognitive development (Harris, 2012), religion (CHAP this book) and politics (CHAP this book).

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