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Public (dis)trust in science in digital media environments

ARTICLE

Who, if not science, can you trust to guide you through a crisis? The relationship between public trust in science and exposure to established and alternative online sources in times of crisis

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Abstract

In light of global crises such as COVID-19, we argue that people's trust in science drives their media choices in the digital sphere. The results from a German online survey show that individuals who perceive scientists as trustworthy in terms of ability, benevolence, and integrity, confidently expect science to provide accurate knowledge and guide reasonable decision-making in times of crisis. In turn, these positive trusting expectations towards science increase the use of established journalistic and scientific online sources for accessing scientific information. In contrast, people with low or no trust in science tend to resort to the messenger Telegram and 'alternative' online media outlets. Interestingly, the individual need for orientation does not amplify this association between trust in science and digital media use in a crisis situation.

Keywords

Digital science communication; Public perception of science and technology; Science and media

Additional Keywords

Public trust in science; Digital information behavior

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1 ▪ Introduction

Especially in times of global challenges such as the COVID-19 pandemic, the public requires reliable knowledge and guidance to navigate through uncertain situations. In the context of the corona crisis, scientific experts served as an important source of information and assessments for many people [Morani et al., 2022]. The access to these expert voices and science-based information is facilitated by digital media [e.g., Taddicken & Krämer, 2021]. However, the digital media environment is diverse and does not consistently offer reliable scientific information. During the pandemic, the role of social media as well as so-called 'alternative' media in spreading disinformation, rumors, and conspiracy narratives has been discussed [e.g., Hetzel et al., 2022; Zehring & Domahidi, 2023]. Against this background, it is crucial to understand which types of online sources people use when seeking information during crises and the factors influencing their choices.

Research literature suggests that it is especially trust in established social institutions such as journalistic news media or politics that drives (online) media usage. For instance, people who use established news media as well as digital news sites show higher levels of institutional trust, while using social media and video platforms is negatively correlated with trusting institutions such as national governments and science [Verboord et al., 2023]. Similarly, using social media as a primary news source is negatively related to trust in news media, whereas the use of both traditional and online news is positively associated with news media trust [Kalogeropoulos et al., 2019]. Additionally, exposure to (right-wing) alternative media is frequently attributed to a lack of trust in established news media and politics [Andersen et al., 2023; Hameleers et al., 2022; Schulze, 2020]. This study aims to extend the state of research in this field by exploring the relationship between *public trust in science* and digital information behavior in crisis situations. More specifically, we are interested in how people's trust in science shapes their use of established journalistic and scientific sources on the one hand and alternative media platforms and outlets on the other.

In high-risk situations such as a pandemic, we assume that people's (lack of) trust in science to provide accurate knowledge and guide reasonable decision-making affects their choice of information sources in the digital sphere. To test this assumption, we draw on empirical evidence from a German online survey.

2 ▪ Trust in science as a multi-layered concept

In the broadest sense, trust (in science) can be defined as a three-part relation: A (i.e., the trustor) trusts B (i.e., the trustee) to perform C (i.e., a task) [Baier, 1986]. In a trust relationship with science, A represents the public or specific laypeople, B denotes science as a social institution and professional scientists as generalized others, and C refers to a specific task or action that is delegated to science (see trusting expectations below). Further, we conceive of trust as a multi-layered concept with various interconnected components [Castelfranchi & Falcone, 2010; McKnight & Chervany, 2001; PytlikZillig & Kimbrough, 2016]. This allows us to integrate and connect various seemingly different definitions and meanings of trust(worthiness):

2.1 ▪ *Perceived trustworthiness of science / scientists*

Most conceptions differentiate between trustworthiness as a perception and trust as a (behavioral) decision. Perceived trustworthiness is a positive evaluation or belief that the trustee (i.e., science or scientists in general) possesses the qualities needed to achieve certain goals for the trustor (i.e., the public) [Castelfranchi & Falcone, 2010, p. 39]. Hence, it focuses on "those features of experts that decide whether recipients will depend on and defer to them due to their own limited resources" [Hendriks et al., 2015, p. 3]. Based on the work of Mayer et al. [1995], many authors consider trustworthiness as a triad of ability, integrity, and benevolence. Accordingly, scientists appear trustworthy if laypeople believe they possess the necessary scientific expertise and experience, adhere to scientific rules and standards, and have good intentions. Openness or transparency [Besley et al., 2021] and dialogue [Reif et al., 2024] have been proposed as additional criteria. These perceptions of trustworthiness form the necessary foundation of a multi-layered concept of trust in science, as they largely explain why certain scientific actors are trusted more than others.

2.2 ▪ *Trust in science as behavioral decision*

Trustworthiness perceptions should be distinguished from a trustor's behavioral decision to depend on a trustee's actions to achieve certain goals [Besley & Tiffany, 2023, p. 711; Castelfranchi & Falcone, 2010, p. 64]. This trusting decision or behavior always carries the risk of being disappointed or harmed by the trustee, as the trustor can neither predict nor control their actual conduct [Luhmann, 1988]. Thus, one of the best-known definitions characterizes trust as the "willingness of a party to be vulnerable to the actions of another party" [Mayer et al., 1995, p. 712]. In short, behavioral (or decisional) trust is a deliberate choice to take a risk by relying on another. Hence, a decision to trust science manifests as the willingness to rely on scientific information in decision-making without constant verification, despite the risk of inaccuracy or irrelevance [Besley et al., 2021, p. 4].

2.3 ▪ *Trust in science as confident positive expectation*

The behavioral decision to make oneself vulnerable can only be considered a distinct act of trust if it is "based on the expectation that the other will perform a particular action important to the trustor" [Mayer et al., 1995, p. 712].[1] This notion of trust as "confident positive expectations regarding another's conduct" [Lewicki et al., 1998, p. 439] is often overlooked in trust research, although it is a necessary condition to define trust in its full complexity. It denotes a trustor's subjective degree of certainty that a trustee will perform a particular action desired by the trustor [Gambetta, 1988, p. 217]. Trusting expectations thus imply both a prediction and a goal or task that the trustor expects the trustee to fulfill on their behalf [Castelfranchi & Falcone, 2010, p. 53].

To specify trust in science, we need to understand the specific expectations that the public addresses to this social institution. Sztompka [2007] points out two goals that people usually expect science to achieve: "the search for truth (as the primary goal), and for relevance, utility, practical applications…(as the secondary goal)" [2007, p. 213]. Indisputably, science pursues an epistemic goal, as it is concerned "with the discovery and contemplation of truth;

1. For example, there is also obliged, constrained, or desperate risk-taking, which is not an act of trust [Castelfranchi & Falcone, 2010, p. 18].

its function . . . is to build up a world picture that fits the facts of experience." [Bernal, 1939, p. 4]. Public trust in science is therefore mostly conceptualized as epistemic trust, which refers to the *positive expectation that science will deliver accurate knowledge about certain phenomena*: "We trust science to bring us the truth, or at least to bring us closer to the truth" [Sztompka, 2007, p. 213; see also Hendriks et al., 2015; Wilholt, 2013].

Beyond its epistemic function, science also fulfills a guidance function by taking the role as honest broker or public advisor [Bernal, 1939; Pielke, 2007]. By (scientific) guidance, we mean all (scientific) efforts that inform the decision-making of the public. This includes implicit guidance by providing application-oriented findings and assessments from which people can derive reasonable decisions (e.g., providing results on the benefits of wearing a face mask during the pandemic). Furthermore, the term implies explicit guidance through concrete recommendations for action (e.g., recommending wearing a face mask in crowded places). It seems reasonable that laypeople not only expect science to produce accurate knowledge, but also to provide relevant and applicable findings, assessments, and recommendations, on which they can base their decisions. This should especially hold true in times of crisis such as the COVID-19 pandemic, where uncertainty and thus the need for orientation are exceedingly high. Therefore, public trust in science also rests on the *positive expectation that science will guide reasonable decision-making*.[2] However, it seems obvious that the evaluation of scientific guidance depends on how one assesses the epistemic quality of the underlying knowledge. Consequently, epistemic and guidance expectations are closely intertwined and should therefore be considered together when analyzing public trust in science.

2.4 ▪ *The interplay between trustworthiness perceptions, trusting expectations, and behavioral trust in science*

We consider the three aforementioned trust-related concepts as distinct. Trustworthiness is the perception of a trustee's characteristics, while trusting expectations are predictions about their favorable future behavior. In contrast, behavioral trust is the deliberate decision to rely on a trustee. However, in a multi-layered model of trust, these components belong to the same conceptual family and are connected by a causal process link: "The process for arriving at the act of trusting entails the formation of such a positive expectation on and evaluation of Y [i.e., the trustee]" [Castelfranchi & Falcone, 2010, p. 18; see also PytlikZillig & Kimbrough, 2016, p. 37]. Regarding science, individuals first evaluate scientists (as generalized others) in terms of their trustworthiness. These (positive) perceptions probably lead to (positive) expectations regarding the epistemic and guiding performance of science. When people perceive scientists as able, benevolent, and high in integrity, they should become more confident that science will provide accurate evidence and useful guidance for their decision-making. Therefore, our first hypothesis reads as follows:

> ***H1:*** *The more positively people perceive the trustworthiness of scientists, the more positive their epistemic and guidance trusting expectations towards science are.*

2. This expectation for guidance is not addressed exclusively to science. For example, (science) journalism also aims to guide public decision-making in crisis situations. However, during the COVID-19 pandemic, it has become clear that the public was also looking for guidance specifically from scientific experts (see next chapter).

Based on these trusting expectations, people may eventually decide to make themselves vulnerable to science and base their actions on scientific information (i.e., behavioral trust). In the following section, we explain how digital information behavior can be understood as an initial form of this behavioral trust in science.

3 ▪ Relationship between trusting expectations and digital information behavior

3.1 ▪ *Trusting expectations and use of established online sources*

In today's digital media environment, scientists and scientific institutions regularly use online media channels, including websites and social media, to publicly disseminate their work [Van Noorden, 2014]. This becomes especially important in times of crisis. For instance, open access platforms, science blogs, and Twitter played a vital role in disseminating current research on COVID-19 [Fraser et al., 2021]. Additionally, established (online) news media are crucial for conveying scientific expertise to the public. During the pandemic, journalistic outlets frequently featured scientific experts, especially virologists and epidemiologists, who demonstrated high levels of expertise and predominantly represented the scientific consensus [Eisenegger et al., 2020; Leidecker-Sandmann et al., 2022].

Especially in times of crisis, public demand for this digital science communication is high. There is evidence that news use increased during the COVID-19 crisis [Van Aelst et al., 2021; Vermeer et al., 2022; Viehmann et al., 2020]. Particularly at the onset of the pandemic, most people obtained their information from established journalistic and scientific online sources such as news media, websites of research institutions, and science podcasts to gain insights into COVID-19 and access scientific assessments [Morani et al., 2022; Nielsen et al., 2020; Nohl, 2023; Viehmann et al., 2020].

There is evidence that this exposure to science communication is associated with the adoption of scientific knowledge about COVID-19 and disease protection behaviors [Szczuka et al., 2024; Utz et al., 2022]. Similarly, frequent exposure to established (online) news media during the pandemic aligns with increased risk perceptions concerning the virus and compliance with recommended preventive measures [Chu et al., 2022; Friemel & Geber, 2023; Vanherle et al., 2023]. This shows that most people who seek scientific information online are also willing to rely and act on this information in times of crisis. Therefore, we argue that using established scientific and journalistic (online) sources may be considered an initial form of behavioral trust in science. This being the case, this kind of digital information behavior should be based on positive trusting expectations towards science. Especially in uncertain times of crisis, people who confidently expect science to provide reliable knowledge and guidance are likely to prefer journalistic and scientific online sources, as these sources predominantly offer valid scientific information:

> ***H2:*** *The more people trust science to provide accurate knowledge and guide reasonable decision-making in crisis situations, the more they use established journalistic and scientific online sources for information about this crisis.*

3.2 ▪ *Trusting expectations and use of 'alternative' online media*

While most people obtained their news about the pandemic from established sources such as news media, authorities, and research institutions, a significant portion turned to so-called alternative online media on a daily basis to stay informed [Viehmann et al., 2020]. These self-proclaimed alternative news media position themselves as fundamental opposition to the established epistemic authorities [Holt et al., 2019], acting as a counter-hegemonic public sphere within the digital media environment [Downey & Fenton, 2003].

During the pandemic, alternative online media outlets have frequently undermined the perceived scientific 'mainstream', and spread (pseudo-)scientific disinformation and conspiracy theories that contradict scientific reasoning [Walther & McCoy, 2021; Rooke, 2021], while offering a platform for self-proclaimed 'experts' who challenged the scientific consensus [Schug et al., 2023]. In this context, particular attention should be given to Telegram, a messenger platform offering public channels and groups. It can be considered a vital part of the alternative ecosystem during the pandemic. Telegram is associated with the spread of COVID-19 related conspiracy theories, the quotation of pseudo-experts, and ad hominem attacks on 'mainstream' scientists. It also evolved into the central communication platform for 'Querdenken', a German social movement opposing measures such as vaccination and face mask mandates [Hetzel et al., 2022; Schwarzenegger & Wagner, 2023; Zehring & Domahidi, 2023].

Since alternative online media outlets as well as (potentially alternative) platforms such as Telegram often promote narratives opposing official scientific evidence, they likely appeal to individuals who lack trust in institutional science. When people do not believe science to provide reliable knowledge and guidance, they are not willing to depend on scientific reasoning in their decision-making. Therefore, they require an alternative source for knowledge and guidance, which may render them more susceptible to alternative online media. This should hold particularly true in uncertain times of crisis, when the need for knowledge and guidance is at its highest. Therefore, we suggest the following hypotheses:

> ***H3a:*** *The less people trust science to provide accurate knowledge and guide reasonable decision-making in crisis situations, the more they use Telegram for information about this crisis.*
> ***H3b:*** *The less people trust science to provide accurate knowledge and guide reasonable decision-making in crisis situations, the more they use alternative online media outlets for information about this crisis.*

3.3 ▪ *Need for orientation as moderator of the relationship between trusting expectations and use of online sources*

We assume that the aforementioned relationship between people's trusting expectations towards science and their digital information behavior depends on their need for orientation (NFO). NFO refers to an individual state shaped by the (perceived) uncertainty and relevance of a situation or an issue [Matthes, 2006]. A NFO towards an issue manifests as a tendency to continuously monitor this issue, seek detailed background information, and follow how it is being discussed [Matthes, 2006, pp. 433–432]. In the context of COVID-19, a moderate to high NFO was associated with an increased use of all types of (online) media to stay

informed about the pandemic [Lee et al., 2022; Van Aelst et al., 2021]. This suggests that whether individuals seek information during a crisis situation depends on their NFO. Those who perceive a crisis as irrelevant or not uncertain are unlikely to be motivated to invest resources in seeking information — regardless of their trust in science. Only when individuals experience a sufficient level of NFO will their trusting expectations towards science likely translate into corresponding information-seeking behaviors. Hence, confidently expecting science to provide proper knowledge and guidance should only lead to a willingness to rely on these services for people who are actually in need of this information and orientation. Similarly, individuals without positive expectations toward science would seek alternative knowledge and guidance only if they feel a significant NFO. We thus suppose the alleged associations between trusting expectations towards science and (established and alternative) online media use (see H2 and H3) to be stronger among audiences who experience a high NFO in challenging situations such as a pandemic.

> ***H4a:*** *Higher NFO in crisis situations amplifies the positive relationship between trusting expectations and using established online sources for information about this crisis.*
> ***H4b:*** *Higher NFO in crisis situations amplifies the negative relationship between trusting expectations and using Telegram for information about this crisis.*
> ***H4c:*** *Higher NFO in crisis situations amplifies the negative relationship between trusting expectations and using alternative online media outlets for information about this crisis.*

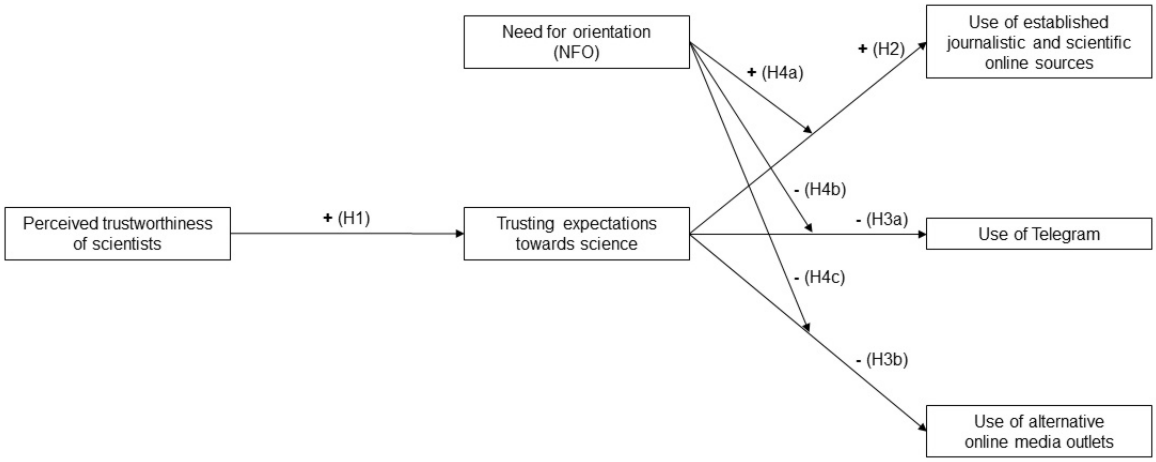

Figure 1. Path model with hypothesized effects. *Note.* The hypothesized direction of each relationship between two variables is indicated by a + (positive) or a - (negative) sign.

Figure 1 summarizes all hypotheses to be tested in a path model: the trusting expectations toward science act as a mediator between the perceived trustworthiness of scientists and the use of three types of digital information sources: established online sources, Telegram, and alternative online media outlets. NFO, in turn, moderates the effects of trusting expectations on these three outcomes.

4 ▪ Method

4.1 ▪ *Sampling and research design*

We tested our hypotheses using data from an online survey conducted between 23 February and 8 March 2024.[3] Using quota sampling, we drew a sample from an online access panel, which represented the German population in terms of gender, age, education level, and residency.

Initially, a total of $N_{initial}$ = 1,419 people completed the questionnaire. After excluding careless responders (e.g., based on response time), we obtained a net sample of N_{net} = 1,223 respondents. We found no significant differences between this final sample and the initial sample concerning age (95% $CI_{initial}$ [49.09, 50.74]; 95% CI_{net} [50.13, 51.90]), gender (χ^2[1] = 0.14, p = .71), education (χ^2[2] = 2.85, p = .24), and residency (χ^2[1] = 0.04, p = .84).

At the beginning of the survey, participants were asked to imagine a novel virus emerging in the near future, causing another global pandemic similar to the COVID-19 pandemic. The questions regarding trustworthiness, trusting expectations, need for orientation (NFO), and online media use were then related to this fictional scenario. Firstly, this gave participants the opportunity to answer trust-related questions based on a concrete, accessible, and realistic example. Secondly, the scenario simulated a specific risk or crisis situation to which our reasoning and hypotheses pertain.

4.2 ▪ *Measures*

The following measures were used in the German online questionnaire:[4]

Perceived trustworthiness of scientists. Respondents evaluated the trustworthiness of scientists by answering three items reflecting scientists' perceived ability, benevolence, and integrity on a five-point Likert scale (1 = "strongly disagree", 5 = "strongly agree"). The items demonstrated good internal consistency and were summed to create a mean index ($M_{trustworthiness}$ = 3.87, SD = 0.77, ω = .83).

Trusting expectations towards science. Respondents assessed how confidently they expect knowledge generation and guidance from science in a potential future pandemic on a five-point scale. Six items represent the expectations that science will provide accurate knowledge (epistemic expectation) and inform reasonable decision-making (guidance expectation). All items were combined into a mean index to reflect (positive) trusting expectations toward science ($M_{trusting\ expectations}$ = 3.90, SD = 0.79, ω = .90).[5]

Need for orientation. The participants' NFO was assessed on a five-point scale following the measures of Matthes [2006]. We adapted six items to the aforementioned pandemic scenario so that they reflect the NFO in the face of a potential new pandemic and formed a mean index (M_{NFO} = 4.02, SD = 0.75, ω = .85).

3. This study is part of a larger research project, which examines the features and dimensions and the role of trust in science in a pandemic context.
4. See Table 1 in appendix A of the Supplementary material for the exact question and item wordings.
5. For additional information on the development of the trusting expectations scale, see appendix B of the supplementary material.

Use of established journalistic and scientific online sources. We asked how often (1 "never" to 5 "very often") people would seek information in case of a future pandemic on (a) websites of scientific institutions or organizations and on (b) online presence of regular news media. We calculated a mean index from these two items ($M_{established\ sources}$ = 3.32, SD = 1.08, ρ = .63).

Telegram and alternative online media outlets use. We also measured how often (1 "never" to 5 "very often") people would likely seek information about a potential future pandemic (a) on the messenger Telegram and (b) on 8 major German alternative online media outlets (e.g., Compact, Epoch Times). The items were highly skewed, as the vast majority of respondents indicated "never" using Telegram or alternative online media outlets. Therefore, we dichotomized all items for the analysis (1 = intended use of Telegram or an alternative media outlet [regardless of frequency]; 0 = no intention to use the respective medium). Participants unfamiliar with a respective alternative media outlet were counted as non-users. Subsequently, the alternative media outlets were aggregated into a binary index indicating whether a person would use any or none of the alternative media sources (users of at least one alternative media outlet: 26%, KR-20 = .95). Telegram use was kept as a single item measure (Telegram users: 26%).

Controls. We added several potential confounders to our questionnaire. First, the basic demographics *gender* (female: 51%, male: 49%), *age* (M_{age} = 51.01, SD = 15.70), *education* (low: 35%, medium: 40%, high: 25%), and *residency* (West Germany: 85%, East Germany: 15%) were assessed. Second, we addressed scientific dispositions: this includes *occupational involvement in science* (involvement in science: 11%) and *interest in science*, measured from 1 "very little interest" to 5 "very high interest" ($M_{interest}$ = 3.34, SD = 0.95). Third, we captured political dispositions including *political ideology* ranging from 1 "left-wing" to 10 "right-wing" ($M_{ideology}$ = 5.12, SD = 1.64) and *populist partisanship* (AfD partisanship: 13%, other or no partisanship: 87%). Besides, we measured *populist attitudes* adopting a five-point scale composed of three items ($M_{populism}$ = 3.54, SD = 1.02, ω = .82). Finally, *trust in social institutions* other than science (i.e., news media, government, courts) was measured using three items on a 5-point scale ranging from 1 "do not trust at all" to 5 "trust completely" ($M_{institutional\ trust}$ = 2.96, SD = 0.90, ω = .80).[6]

4.3 ▪ *Analysis plan*

We employed R (Studio) to conduct all of the following analyses.[7]

To test hypothesis H1, we regressed people's trusting expectations towards science on their trustworthiness perceptions of scientists alongside all relevant control variables.

To analyze the relationship between trusting expectations towards science and our focal outcome variables, established online source use (H2), Telegram use (H3a), and alternative online media outlet use (H3b), we employed hierarchical (linear or logistic) regression. For each dependent variable, we first established an initial model that included the covariates, as well as perceived trustworthiness of scientists, NFO, and the other online media use variables

6. See Tables 3, 4, 5, and 6 in appendix C of the supplementary material for descriptive statistics and frequencies of all items and indices.
7. The R script that we used for data preparation and analysis can be found in the supplemental materials.

as predictors. In the next step, we added trusting expectations towards science as a predictor to the initial model and examined model improvement in each case.

Based on these models, we employed causal mediation analysis [see Tingley et al., 2014] to test whether trusting expectations towards science significantly mediate the effects of perceived trustworthiness on the three online media usage variables.

To examine whether the aforementioned relationships are moderated by NFO (H4a, H4b, & H4c), we extended each of the hierarchical regression models presented above by incorporating an interaction term between NFO and trusting expectations.

In all regression models, continuous predictors were mean-centered before the analyses, and heteroscedasticity-robust standard errors (HC3) were calculated to estimate p-values and 95% confidence intervals for the regression weights. Cases with missing values on any of the predictors or dependent variables were removed from the analyses to ensure the comparability of the models, leaving us with a total sample size of 1,175 participants.[8]

5 ▪ Results

5.1 ▪ *Effects of trustworthiness perceptions on trusting expectations towards science*

The first regression model demonstrates a good fit to the data, with the independent variables explaining 60% of the dependent variable, trusting expectations toward science (R^2 = .60, F[13, 1161] = 133.17, p < .001). The results indicate that perceived trustworthiness of scientists is by far the strongest predictor of trusting expectations towards science (β = .45, t[1161] = 15.34, p < .001, 95% CI [.39, .51]). Perceptions of scientists as trustworthy are positively correlated with people's epistemic and guidance trusting expectations, even when accounting for significant covariates such as interest in science, NFO, populist attitudes, populist partisanship, and institutional trust. This finding corroborates hypothesis H1.

5.2 ▪ *Effects of trusting expectations towards science on established online source use*

The initial model 2a with established online source use as the dependent variable fits the data significantly better than the null model. The independent variables explained 39% of the dependent variable's variance (R^2 = .39, F[15, 1159] = 48.64, p < .001). Interest in science, populist partisanship, institutional trust, NFO, Telegram use, alternative media outlet use, and perceived trustworthiness of scientists significantly predict the level of established online source use.

Adding trusting expectations towards science as predictor to the model (model 2b) results in a significant improvement in model fit (ΔR^2 = .03, F[1, 1158] = 62.50, p < .001). Consistent with our hypothesis H2, positive epistemic and guidance trusting expectations towards science are associated with an increased use of established online sources (β = .28, t[1158] = 7.89, p < .001, 95% CI [.21, .35]).

8. See Tables 7, 8, 9, 10, and 11 in appendix C of the supplementary material for the full results of all estimated models.

5.3 ▪ *Effects of trusting expectations towards science on alternative online media use*

The initial model 3a with Telegram use as the dichotomous dependent variable fits the data significantly better than the null model (Nagelkerke's R^2 = .11, χ^2 [14] = 88.41, p < .001). Gender, populist attitudes, and established online source use significantly predict the likelihood of using Telegram. When adding trusting expectations towards science as predictor (model 3b), the model fit improves significantly (ΔNagelkerke's R^2 = .03, χ^2 [1] = 28.98, p < .001). In line with our hypothesis H3a, a lack of positive epistemic and guidance trusting expectations towards science is associated with an increased likelihood of using the (alternative) media platform Telegram (OR = 0.47, z = -5.40, p < .001, 95% CI [0.35, 0.62]). We then calculated the average marginal effect (AME) of trusting expectations towards science on Telegram use. On average, the probability of using Telegram for information about a potential future pandemic decreases by 13%, for a one-unit increase in trusting expectations (AME = -.13, z = -5.55, p < .001, 95% CI [-.18, -.08]). This effect on the probability of Telegram use is illustrated in Figure 2.

Analogously, model 3c with alternative media outlet use as the dependent variable fits the data significantly better than the null model (Nagelkerke's R^2 = .13, χ^2 [14] = 108.83, p < .001). Education, interest in science, populist attitudes, populist partisanship, and established online source use significantly predict the likelihood of using an alternative media outlet. The addition of trusting expectations towards science as predictor (model 3d) also results in a significant model fit improvement (ΔNagelkerke's R^2 = .02, χ^2 [1] = 14.99, p < .001). Trusting expectations are also negatively and significantly associated with the use of alternative media outlets (OR = 0.58, z = -3.83, p < .001, 95% CI [0.44, 0.77]). The probability of using at least one of these outlets for information about a potential future pandemic decreases by an average of 9%, for a one-unit increase in trusting expectations (AME = -.09, z = -3.89, p < .001, 95% CI [-.14, -.05]) (see Figure 2).[9]

5.4 ▪ *Mediating effect of trusting expectations towards science*

Mediation analyses show that the perceived trustworthiness of scientists exerts significant indirect effects on the use of established online sources (ACME = .18, p < .001, 95% CI [.13, .23]), Telegram (ACME = -.06, p < .001, 95% CI [-.08, -.04]), and alternative media outlets (ACME = -.04, p < .001, 95% CI [-.06, -.02]).[10] Each effect is mediated by trusting expectations toward science. More positive trustworthiness perceptions lead to more positive trusting expectations, which in turn positively affect the use of established online sources and negatively affect the use of alternative online media. When including the mediator in the models, no significant direct effects of trustworthiness on the outcomes were observed. All effects of trustworthiness on media usage variables are fully mediated by trusting expectations.

9. In a sensitivity analysis, we could replicate these findings after removing participants who indicated that they were not familiar with any of the alternative online media outlets (N = 715). We thus assume our binary logistic regression results to be robust. See Table 12 in appendix C of the supplementary material for detailed results.
10. Average causal mediation effects (ACME) including their 95% bias-corrected and accelerated bootstrap confidence intervals (based on 10,000 draws) were calculated.

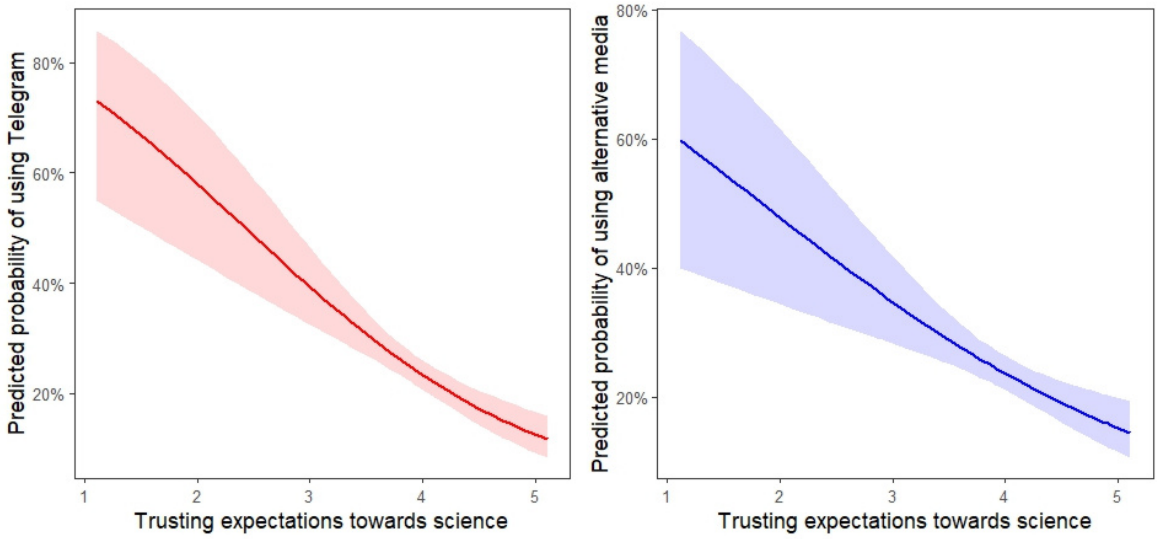

Figure 2. Probabilities of using Telegram and alternative media outlets as a function of trusting expectations towards science. *Note.* Predicted probabilities of using Telegram (left panel, red line) and alternative media outlets (right panel, blue line) at varying levels of trusting expectations towards science; Bands around the lines represent 95% confidence intervals; Predicted probabilities are calculated based on estimates from models 3b and 3d.

5.5 ▪ *Moderating effect of NFO*

The fit of model 2b, which predicts established online source use, is not significantly improved by adding the interaction term between trusting expectations and NFO ($\Delta R^2 < .001$, F[1, 1157] = 0.59, p = .44). Besides, the interaction effects are not significant (β = 0.01, t[1157] = 0.68, p = .50, 95% CI [-.02, .05]). The same holds true for the effect of the interaction on the usage of Telegram (OR = 1.00, z = -0.04, p = .97, 95% CI [0.84, 1.18]) and alternative media outlets (OR = 0.97, z = -0.36, p = .72, 95% CI [0.81, 1.16]). Accordingly, hypotheses H4a, H4b, and H4c are not supported. The association between trusting expectations towards science and established and alternative online source use is not moderated by people's NFO. Figure 3 illustrates the key findings of the study in a path model.

6 ▪ Discussion

6.1 ▪ *Summary of findings*

This study sheds light on the role of trust in science within the context of digitized information environments. The findings indicate that people's online information behavior in crisis situations is driven by two complementary trusting expectations towards science: epistemic and guidance expectations. Individuals who trust science to provide accurate knowledge and guide reasonable decision-making are more likely to obtain information about a crisis from established online sources (i.e., websites of scientific institutions and regular news media). For trusting individuals, the internet-based media serve as a source of profound scientific findings, assessments, and advice by established institutions that they are likely willing to rely on.

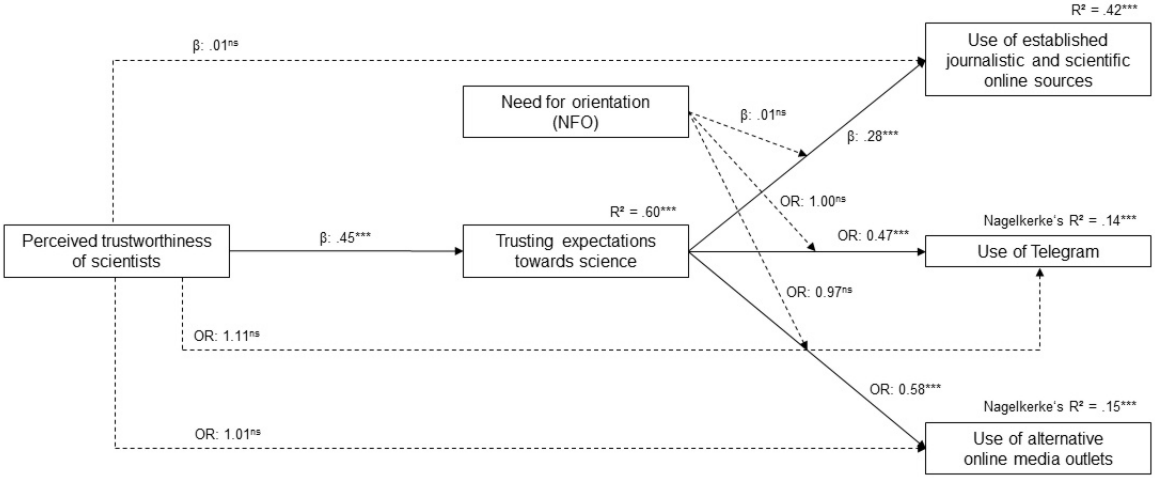

Figure 3. Path model with estimated effects. *Note.* The path model presents the direct and indirect effects on the key variables; Control variables are not included in the figure; Regression weights and coefficients of determination are based on the (linear and binary logistic) regression models 1, 2b, 3b, 3d, 4a, 4b, and 4c; For continuous DVs (i.e., "trusting expectations" and "use of established online sources"), standardized beta coefficients and R^2 are provided; For dichotomous DVs (i.e., "use of Telegram" and "use of alternative online media outlets"), odds ratios and Nagelkerke's R^2 are reported; Solid lines represent statistically significant paths, whereas dotted lines mean insignificant paths; $^{ns}p > .05$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

People with low or no trust in science, however, tend to resort to platforms such as the messenger Telegram and 'alternative' media outlets. For those who do not trust science in terms of knowledge generation and guidance, digital media environments offer a counter-public sphere, providing space for alternative information, interpretations, and recommendations [Downey & Fenton, 2003]. Thus, they are also more likely to be exposed to information that contradicts scientific consensus and/or includes misinformation and conspiracy narratives, which circulate in these 'alternative' spheres [Walther & McCoy, 2021; Rooke, 2021]. It is particularly noteworthy that a lack of trust in science correlates with *general* Telegram usage regardless of specific groups or channels. Accordingly, Telegram as a whole might be part of the alternative media ecosystem, largely permeated with 'alternative truths' and science-skeptical content. This conclusion aligns with findings identifying Telegram as the preferred social media platform of right-wing populist and extremist networks [e.g., Schwarzenegger & Wagner, 2023; Urman & Katz, 2020].

Another contribution to the field of trust in science is the distinction between trusting expectations and trustworthiness perceptions. While trusting expectations toward science are clearly based on the perceived trustworthiness of scientists, the two concepts are nonetheless distinct factors. The more positively people evaluate scientists in terms of ability, integrity, and benevolence, the more confident they become in trusting science to provide reliable knowledge and guidance. In turn, these (positive) trusting expectations predict digital information behaviors, as mentioned above. The influence of perceived trustworthiness on established and alternative online media use is fully mediated by trusting expectations. This indicates perceptions of scientists as trustworthy to be an important psychological root cause for the willingness to rely on scientific information online. However, the decisive factor for this initial behavioral trust is ultimately the respective trusting expectations derived from perceived trustworthiness.

Surprisingly, the need for orientation (NFO) does not moderate the relationship between trust in science and digital information behavior. More or less positive trusting expectations among our participants appear to be associated with established or alternative online media usage, *regardless* of their personal NFO. This finding contradicts our theoretical assumptions but may be explained as follows: NFO is a situational state shaped by the perceived uncertainty and relevance of a topic. Crises amplify feelings of general uncertainty. Therefore, "during a severe social disruption there is an unusually high need for information and sense-making by individuals" [Lowrey, 2004, p. 339]. Individual differences in NFO are leveled out in such extraordinary situations. The pandemic scenario we described might have elicited a high NFO across all respondents, as indicated by the high mean and low variance of the variable. Most respondents were motivated to obtain pandemic-related information. The degree of their trusting expectations towards science then determined which kind of sources they aimed to seek in order to satisfy their high NFO.

6.2 ▪ *Limitations and future research*

There are several limitations that restrict the generalizability of our findings. Firstly, our study is based on cross-sectional data. Thus, we cannot prove the causal chain, leading from trustworthiness through trusting expectations to digital information behavior, beyond doubt. However, this procedural sequence is derived from a widely accepted multi-layered model of trust and is therefore theoretically sound. Nevertheless, it is also conceivable that online media usage is not the result of trustworthiness and trusting expectations but rather their cause. Most likely, there is a dynamic, mutual influence, where trust in science and (established or alternative) online media usage reinforce each other. Future longitudinal studies could provide further insight into this matter.

Moreover, it is possible that the correlation between trusting expectations towards science and the use of established and alternative online media is partially driven by trust in other social institutions (e.g., news media). To prevent this confounding, we added respondents' general institutional trust as a covariate to our model. However, to avoid overloading the questionnaire, we relied on single-item measures of trust. Future studies could employ more sophisticated multidimensional scales of trust in news media and politics as control variables.

Besides, our questions regarding trust in science, NFO, and online media use were based on the scenario of a future pandemic. Hence, it could be assumed that our findings only apply to a specific example. However, we argue that trust cannot be measured independently of a specific situation. An abstract measure of trust in science (e.g., "How much do you trust science?") disregards the fact that trust is only necessary and relevant under the condition of a specific risk. Since COVID-19 has lost its threat in the general public's perception, we designed the scenario of a future, threatening pandemic. Since new pandemics are likely according to experts, this represents a realistic risk scenario and, therefore, a valid context for analyzing trust in science. However, future studies should assess the broader applicability of our findings by examining the relationship between trust in science, NFO, and online media use for other crises (e.g., climate change), but also beyond the crisis context. Although people particularly depend on accurate and applicable scientific information during crises, we suppose that epistemic and guidance expectations towards science can also shape their (information) behaviors in everyday contexts (e.g., regarding health, nutrition, or sports).

We measured the *intended* use of established and alternative online media use by referring to the fictional pandemic scenario and interpreted it as a form of initial behavioral trust in science. However, we have neither measured a person's current media usage behavior nor their actual reliance on scientific content directly. Nevertheless, intended media usage is certainly derived significantly from one's actual usage behavior. Moreover, various studies show that using certain media often accompanies the adoption of scientific information in reasoning and decision-making. Therefore, we believe that our measurement serves as an appropriate proxy for actual exposure to (pseudo-)scientific information, reflecting at least an initial willingness to rely on these sources. Nonetheless, it would be crucial for future studies to also employ direct measurements of online media usage and behavioral trust in science.

6.3 ▪ *Concluding remarks*

Despite these limitations, our study demonstrates that trust in science is essential for keeping citizens well informed about science-related topics in a digitized information environment. It helps prevent people from being misled by so-called alternative online media, which often undermine scientific advice and could lead to decisions that are detrimental to society and democracy [Strömbäck, 2023]. This conclusion aligns with other findings demonstrating that trust in established social institutions is crucial for high-quality news consumption [Verboord et al., 2023].

Once again, it has become evident that public trust should be a key target for science and science communication. In light of our study, this means fostering people's positive expectations that science will produce correct evidence and make valuable contributions to informed decision-making. This involves emphasizing the ability, benevolence, and integrity of scientists [see Besley et al., 2021; Hendriks et al., 2015], from which these positive expectations about their future actions are largely derived. In this way, one may strengthen people's willingness to rely on profound scientific facts and advice in times of crisis, even in an era of a fragmented digital public sphere.

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Supplementary material

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- Appendices:
  A. Online questionnaire;
  B. Additional information on scale development;
  C. Additional statistics.
- R script used for data preparation and analysis.

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