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Misinformation in Germany During the Covid-19 Pandemic

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A Cross-Sectional Survey on Citizens' Perceptions and Individual Differences in the Belief in False Information

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Abstract

During the Covid-19 pandemic, people have been exposed to vast amounts of misinformation. This "infodemic" has undermined key behavioural and pharmacological measures to contain the pandemic. In a cross-sectional survey of residents of Germany, we investigated the perceived prevalence of misinformation, the strategies people reported using to discern between true and false information, and individual differences in beliefs in misinformation at

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three time points from June 2020 to February 2021 (*N* = 3324). We observed four main results. First, there was an increase in the perceived prevalence of misinformation over time. Second, the most believed false claims included that the virus is no worse than the flu and that the EU has approved dangerous vaccines. Third, belief in misinformation was associated with support for the far-right AfD party; reliance on tabloids, neighbours and social media for information; lower levels of education; and migration background. Fourth, only about half of the respondents reported using strategies such as checking for consistency between different sources to identify misinformation. These results can inform the development of interventions, such as boosting the ability to discern accurate from misleading information, or enriching specific environments (e.g., neighbourhoods with high rates of migration) with accessible and high-quality information.

Keywords
Perceptions of misinformation, beliefs in misinformation, Covid-19, Germany.

Since early 2020, Covid-19 has dominated the global and national information landscapes. People have been exposed to an overwhelming amount and variety of information about the virus, including statistical information on infections, mortality and vaccination rates; medical information on symptoms, treatments and testing; and policy information on restrictions and behavioural measures to curb the spread of the virus. Unfortunately, they have also been exposed to a flood of misinformation (e.g., Li et al., 2020; Ofcom, 2020), some of it shared by world leaders. Brazil's president, Jair Bolsonaro, has made up to 199 false statements per month about Covid-19 since the onset of the pandemic (Freitas, 2021; Statista, 2021). Former U.S. president Donald Trump regularly minimised the threat of the virus, declaring, for example, that 99% of Covid-19 cases are "totally harmless" and claiming that "if we stopped testing right now, we'd have very few cases, if any" (Greenberg, 2020; Paz, 2020). In Germany, the populist AfD party ('Alternative for Germany') has repeatedly downplayed the risks of infection with Covid-19 (Gensing & Rohwedder, 2021) and spread misinformation about vaccines (Redaktionsnetzwerk Deutschland, 2022).

Misinformation[1] about Covid-19 can pose a severe threat to public and private health (Chung & Jones-Jang, 2021; Roozenbeek et al., 2020). Belief in misinformation has been shown to be related to lower compliance with public health guidance, such as wearing face masks and social distancing (Hornik et al., 2021, in a US sample) or washing hands and working from home (Roozenbeek et al., 2020, in samples from the UK, US, Ireland, Spain and Mexico). Exposure to online misinformation has been shown to reduce vaccination intentions (Loomba et al., 2021, in UK and US samples).

Moreover, belief in misinformation has been associated with lower trust in science (Plohl & Musil, 2021), the government (Kim & Cao, 2016) and the mainstream media (van der Linden et al., 2021).[2] A recent study has found that exposure to the narrative that the "powerful in one's society are exploiting the pandemic to their advantage" decreases institutional trust (Pummerer et al., 2022, p. 49). At the same time, low trust in institutions can increase the propensity to believe in misinformation and create a "downward spiral of distrust" (Frischlich & Humprecht, 2021, p. 20). Importantly, research has found that trust in the government, scientists and health authorities are strong predictors of adherence to protective measures (Dohle et al., 2020; Han et al., 2021).

Lack of institutional trust can also be related to a more general conspiracy mentality or conspiracy ideation (e.g., Swami et al., 2011)—a monological belief system in which people believe in multiple conspiracies at once. Indeed, belief in one Covid-19 conspiracy has been found to predict belief in other Covid-19 conspiracies (Miller, 2020; Roozenbeek et al., 2020). Individuals with a conspiracy mentality tend to deny official accounts of events (Uscinski et al., 2020), engage in a variety of strategies to maintain their worldview (e.g., Miller et al., 2016) and have a strong need for control (van Prooijen & Acker, 2015). In contexts such as pandemics, where many people experience a profound loss of control (e.g., over financial security, health; van Prooijen & Douglas, 2017), conspiracy theories offer a semblance of structure (Nocun & Lamberty, 2020). According to one conspiracy narrative, the German government is using the pandemic as a pretext to distract attention from other issues, such as the collapse of financial markets or an influx of immigrants (Schröder, 2020). Another narrative is that deadly vaccines are being used to reduce the global population (BR, 2021).

The Scope of Misinformation: Frequency, Sources and Content

Misinformation is, of course, anything but a novel problem (e.g., Nocun & Lamberty, 2020). Yet, the Covid-19 pandemic is the first global public health crisis to play out fully in the digital age. Therefore, digital technologies and social media may have enabled and amplified the spread of misinformation and thus intensified misinformation's negative impact (WHO, 2021). Focusing on social media, Boberg et al. (2020) analysed the content posted by German alternative news media on Facebook during the early pandemic (January–March 2020). Alternative news media view and present themselves as a corrective to traditional news outlets (Holt et al., 2019). Boberg et al. (2020) found a substantial increase in posts over this timeframe; however, with most of the posts mirroring mainstream media reports in terms of the topics covered (e.g., Covid-19 statistics; the government's crisis management). They also showed that interactions (likes, shares, comments) increased over time, perhaps reflecting a growing interest in the pandemic. In a quota survey conducted before the Covid-19 pandemic, between 8% and 15% of German adults reported being exposed to alternative news media with an affinity to populism at least occasionally (Müller & Schulz, 2021), but only between 1% and 3% reported consuming such content (Hölig & Hasebrink, 2019). Another pre-pandemic survey found that 80% of German respondents agreed fake news to be a threat (Reuter et al. 2019).

Complementing content analyses such as Boberg et al.'s, we focus on citizens' perception of misinformation during the Covid-19 pandemic. Specifically, we gauge people's perceptions in terms of self-reports about how frequently people believe to be misinformed by their neighbours, social media or tabloids, and also pinpoint popular topics of misinformation (even without engaging with it, through liking or sharing). The perceived spread of misinformation is a significant psychological dimension of misinformation as it signals people's awareness or lack thereof of how much they can trust the information ecosystem they experience.

Concerning specific claims that gained traction in Germany, a cross-sectional survey of the German population (Covid-19 Snapshot Monitoring, COSMO) showed that 18% of respondents believed Covid-19 pandemic to be a hoax, while 15% believed that the virus was created in a lab (COSMO Explorer, 2020). Consistent with findings from other countries, belief in these false claims was associated with the impression that government measures to curb the spread of the virus are exaggerated and was much higher among the unvaccinated. Some people

believed both contradictory claims simultaneously (7.6%–13.9%), which indicates a more general conspiracy mentality (COSMO Explorer, 2020). Since COSMO was designed to assess a broad range of knowledge, attitudes and perceptions with regard to the pandemic, the amount of claims COSMO respondents assessed was limited. The content analysis by Boberg et al. (2020) assessed all potential claims or narratives between January and March 2020. The most popular narratives were "Corona is a man-made laboratory virus" and "Corona is not worse than a normal flu epidemic" (p. 15). These claims and variants thereof have frequently been posted in various alternative news outlets. The content analysis does not speak to the extent to which people think these statements are true.

Misinformation and its Recipients: Belief in and Detection of Misinformation

Regarding individual differences in the belief in misinformation, recent research has shown that people are more likely to believe (mis-)information that is concordant with their political views (Faragó et al., 2020; Pennycook & Rand, 2019, 2021; Pereira et al., 2018), especially when it concerns politically divisive topics such as Covid-19 vaccination or climate change (see also Rutjens et al., 2021). Recent evidence from Germany has shown that the propensity to vote for extremist parties is linked to conspiratorial beliefs (Schemer et al., 2021) and that a right-wing political leaning is linked to perceiving distorted news as more credible (Arendt et al., 2019; Frischlich et al., 2021), to being less knowledgeable about Covid-19 (Nielsen et al., 2020) and (for AfD voters) to distrust of the media (Sängerlaub, 2017). Belief in misinformation has also been found to be associated with lower trust in science (Plohl & Musil, 2021) and the government (Kim & Cao, 2016), and with lower agreement with government measures (COSMO Explorer, 2020).

Another source of interindividual differences in the belief in misinformation could be the extent to which individuals perceive the virus to be a risk. People's risk assessment, in turn, may be impacted by different proxies of risk: local incidence statistics and personal experience of infection—either oneself or in one's social circle. The direction of a possible moderating influence of personal experience of infection is unclear: Depending on whether the illness is mild or severe, it may either increase individual risk perceptions and overrule misperceptions or amplify the belief that Covid-19 is no worse than the flu.

People also vary in their ability to detect misinformation. Simple rules and interventions that are known to help detect misinformation (Guess et al., 2020) include being sceptical of lurid or clickbait headlines, checking whether plausible evidence is included in the text, investigating the source of the information (e.g., on the About section of a website), comparing different sources and reports or consulting fact-checking websites.

It is unknown to what extent people were aware of and applied these strategies during the Covid-19 pandemic. At the same time, knowing whether people actually use such strategies to detect misinformation can inform efforts to systematically boost individual skills—for instance, by making people aware of effective strategies to identify misinformation they have not used before.

Overall, efforts to combat misinformation can succeed only if informed by a sound understanding of its properties: its prevalence, the nature of the false claims that gain traction, individual differences in the susceptibility to misinformation, and capabilities to detect it. The success of regulatory and cognitive countermeasures depends on the support and motivation of those affected. People will only be in a position to acquire and routinise behaviours to detect

misinformation and counteract its effects if they are aware of the problem and its dimensions. Therefore, we sought to contribute to the monitoring of misinformation during the Covid-19 pandemic with a focus on identifying key attributes of the German misinformation landscape from the perspective of the people navigating it.

We focused on four interrelated research questions: (1) What were people's perceptions of the frequency, sources and topics of misinformation during the Covid-19 pandemic in Germany? (2) Which false claims were especially convincing? (3) Who tended to believe in misinformation? and (4) Which self-reported competences do people draw on to deal with misinformation? The study was not preregistered. Questions 1, 2 and 4 are descriptive; for question 3 we correlated individual difference measures with belief in misinformation.

Methods

Participants

The present data were obtained from a total of 3324 respondents using the panel provider Respondi across three waves of data assessment: Wave 1 in early summer 2020 (29 May–7 June, 2020; $N_{W1:June2020} = 1110$), Wave 2 in late summer 2020 (23–29 September, 2020; $N_{W2:Sept2020} = 1109$), and Wave 3 in the winter of early 2021 (26 January–1 February, 2021; $N_{W3:Febr2021} = 1105$). For an overview of the three waves of data collection mapped onto the evolution of infection rates and deaths, see Supplementary Material S1. Wave 1 data were collected roughly five months after the first Covid-19 case was confirmed in Bavaria and Wave 3 data were collected roughly one year into the pandemic. Each sample is quota-representative of the German population with respect to the age range 18–69 years, gender and federal state. Although the sample was not quota-representative with respect to education, and was biased towards higher education relative to the general population, each educational level was well-represented across the three waves. For an overview of the demographic characteristics of the sample, see Supplementary Material S2.

The data presented here come from a larger survey on information search in the Covid-19 pandemic, for which respondents received a flat payment of €1.15 for an average of 23 minutes of their time (interquartile range = 16–34 minutes). The Institutional Review Board of the Max Planck Institute for Human Development approved the surveys. Some preliminary results from Wave 1 have been made available in German as part of a technical report on general information search (Leuker et al., 2020).

Measures

Here we report the variables employed in the current analyses (translated to English). All original items (in German) along with their English translations are available in Supplementary Material S3. Note that not all items were administered in all three waves. The full surveys for all three waves, including questions that do not pertain to misinformation and are not reported here, are posted on the Open Science Framework (https://osf.io/hz9yq/). Unless otherwise noted, we formulated the questions ourselves.

Perceptions of Misinformation. Respondents' perceptions of the prevalence, topics and sources of misinformation were assessed by three multiple choice questions, worded as follows: (1) "How often per week do you currently come across information on the coronavirus that you think is false or misleading?" [several times a day, every day or almost every day, several times a week, once a week, several times a month, rarely, never]; (2) "In your experience, which topics does false or misleading information on the coronavirus typically concern? Select all that apply" [list of topics such as "infection rates" or "progress in treatments"]; (3) "In your experience, which of the following institutions and individuals spread false and misleading information about the coronavirus? Select all that apply" [list of sources such as "public-sector television", "social media", "global health organisations"].

Belief in Misinformation. In Waves 2 and 3, we also assessed respondents' beliefs in misinformation by asking them to rate 12 (Wave 2) or 14 (Wave 3) statements: "There is much discussion of whether the public is fully informed about the truth on important topics. Please indicate for each of the following statements on the coronavirus whether you think it is true or false" [definitely false, probably false, don't know, probably true, definitely true] (question phrasing based on Brotherton et al., 2013). We included items known to be true, such as "SARS-CoV-2 is a novel coronavirus identified in early 2020 that is responsible for Covid-19 infections", and items known to be false, such as "All alleged 'corona deaths' were actually due to other causes". True statements were reverse-coded—here, *not* believing indicates higher belief in misinformation. A full list of statements, with both their complete wording and the brief labels used in our tables and figures, is provided in Supplementary Material S3. We created the list of statements based on publicly available information on false claims (Sessa, 2020) and their corrections, and we used fact-checking organisations' conclusions on their veracity as our ground truth (Correctiv, 2020).

Perceived Competence in Detecting Misinformation. Participants' self-reported ability to detect and deal with misinformation was assessed by three multiple choice questions, worded as follows: (1) "How confident are you in your ability to detect false and misleading information on the coronavirus?" [very confident, somewhat confident, not very confident, not confident at all]; (2) "How can you tell that a piece of information could be false or misleading? Select all that apply" [list of indicators such as "The headline is sensationalist ('clickbait')", see Figure 5b; not included in Wave 1]; (3) "What do you usually do if you are uncertain whether news or information on the coronavirus is true or false? Select all that apply" [list of strategies such as "I consult people in my social circle", see Figure 5c].

The following variables were used as covariates/predictors in regression analyses.

Agreement with Current Measures and Political Interventions. In all three waves, we asked two questions to assess respondents' agreement with Covid-19 containment measures and political interventions:

(1) *Current measures (agreement).* "What do you think of the official rules and measures to contain the spread of the virus in Germany (e.g., physical distancing, closing shops, schools and childcare facilities)?" [fully inadequate; mostly inadequate; mostly adequate; fully adequate] (adapted from Betsch, Wieler et al., 2020).

(2) *Political interventions (agreement).* "To what extent do you agree with the following statements about the role of the state?" [fully disagree, somewhat disagree, neither agree nor

disagree, somewhat agree, fully agree]. Here, participants were presented with three statements: (a) "The state can limit personal freedoms for the public good"; (b) "The state can enforce social, political and economic restrictions to protect public welfare under exceptional (humanitarian) circumstances"; (c) "The state can limit citizens' freedom of movement under exceptional (humanitarian) circumstances". For each respondent, we computed the average agreement with these three statements. The scale achieved high internal consistency (Cronbach's $\alpha = .93$). The measure was adapted from Betsch, Wieler et al., 2020, who directly asked about the acceptance of restrictions in the context of the pandemic, whereas we phrased the question in more general terms.

Trust. In Waves 2 and 3, we assessed respondents' trust in various groups and institutions by asking: "Do you trust the following groups of people or institutions in dealing with the coronavirus?" [full trust, fairly high trust, neutral, fairly low trust, no trust at all] with the items (a) scientists, (b) federal government, (c) the Robert Koch-Institute, (d) the Federal Ministry of Health, (e) doctors, (f) local government, (g) local health authorities (measure adapted from Betsch, Wieler et al., 2020, using a five-point Likert scale).

Sources. In all three waves, we assessed respondents' preferred sources of information on the coronavirus: "How long, per day, did you use the following sources (including their websites) to obtain information on the coronavirus in the last week?" [not at all, less than 10 minutes/day, 31–60 minutes/day, 1–2 hours/day, more than 2 hours/day] with the items (a) public-sector television, (b) private-sector television, (c) regional newspapers, (d) national newspapers, (e) tabloids, (f) government sources, (g) radio stations, (h) social media, (i) global health organizations, (j) national health authorities, (k) scientific institutions, (i) local news (e.g., website of the place of residence), (j) podcasts, (k) friends and family, (l) neighbours, (m) colleagues, (n) alternative sources (e.g., websites of independent organisations) [this final response option was not offered in Wave 1] (measure adapted from Ernala et al., 2020).

Perceived and Actual Risk. A set of variables assessed respondents' perceived and actual risk of infection:

(1) *Risk group (self).* "Do you belong to a risk group for developing severe Covid-19?" [yes, no].

(2) *Risk group (social circle).* "Do you know anybody belonging to a risk group for developing severe COVID-19?" [yes, no].

(3) *Infection (self).* "Have you been infected with COVID-19?" [yes—confirmed; yes—but not (yet) confirmed; yes—and I have recovered; no—I don't think so; no—confirmed; don't know].

(4) *Cases (social circle)*. "Which of the following statements applies to Covid-19 infections in your social circle? Select all that apply" [I know of ... untested suspected cases; confirmed cases; recovered cases; deaths; hospitalised cases; people who have been vaccinated; no cases].

(5) *Seven-day incidence.* To include a proxy for each respondent's objective risk of infection at the time of survey completion, we used the number of new Covid-19 infections recorded over the last 7 days per 100,000 inhabitants (7-day incidence) in the respondent's federal state. These data were retrieved from the Robert Koch-Institute's Covid-19 dashboard (RKI, 2021a), which is based on the reports of local health authorities (RKI, 2021b), and were matched to each respondent using the postcode they provided.

Demographic Information. We collected the following demographic information: (1) highest educational qualification [none; vocational track (*Hauptschulabschluss*); intermediate track (*Realschulabschluss*); academic track (*Abitur*); apprenticeship in dual system; university degree; doctorate]; (2) number of people in household; (3) monthly net income [less than €1000; €1000–1999; €2000–2999; €3000–3999; €4000–4999; €5000–5999; €6000 or more; prefer not to answer]; (4) Migration background [no migration background; born in Germany, but at least one parent born in another country; born outside Germany] (5) Location: "What are the first four digits of your postcode?" (optional). (6) In Wave 3, we asked respondents about their political affiliation (adapted from the German General Social Survey; see Wasmer & Baumann, 2019): "The terms 'left' and 'right' are often used when labelling political attitudes. When it comes to your own political attitudes, where would you locate yourself on that scale?" [7-point Likert scale with endpoints left, right]; (7) "If federal elections were held next Sunday, which party would you vote for?" [list of parties]. The variables age, gender and federal state were available from the panel provider.

Analyses

We applied Bayesian Generalized Linear Models using Stan in R for regression analyses with the brms package with default priors (flat priors for the predictors and a Student's *t* distribution for the error). Default priors were chosen to be non- or very weakly informative so that their influence on the results was negligible (Bürkner, 2017). In general, we report the mean of the posterior distribution of the parameter or statistic of interest and two-sided 95% equal tail credible intervals (CI) around each value. Our focus is on estimating the effects of particular predictors and our analyses reflect this goal; in comparing the models and predictors, however, the crucial issue is whether the CI includes 0 or not. If the interval around a given coefficient does not include 0, we refer to a credible (positive or negative) association between the variables in a given regression model. No respondents were excluded from the analyses. In our individual difference analysis, we relied on a dataframe with one row per statement. We used the belief that a statement is true (yes/no) as a dependent variable. Because each respondent judged multiple statements, we added 'respondent ID' as a random effect to control for individual differences beyond those modelled in the regression analyses (e.g., age, trust, political opinion). Moreover, 'statement' was added as a fixed effect to control for variability stemming from the contents of the statements themselves (e.g., because some statements were more difficult to judge than others). We modelled individual differences separately for Wave 2 and Wave 3 in order to see whether the same associations emerged in both models although the data came from different samples and were collected several months apart. Such consistency would indicate that the findings can be considered robust (we do not interpret effects that are present in one wave but not another). We specified multivariate models in which all individual difference measures were modelled simultaneously. All numeric predictors were standardised (*z*-scored); educational level was expressed in years of education.

Results

What were People's Perceptions of the Frequency, Sources and Topics of Misinformation on the Coronavirus During the Covid-19 Pandemic in Germany?

The perceived prevalence of misinformation on the coronavirus increased steadily over time. For example, the proportion of respondents who reported seeing misinformation several times a day almost doubled, from 9% in June 2020 to 17% in February 2021. Consistent with this pattern, 8% of respondents reported never encountering misinformation in June, relative to just 4% in February 2021 (see Figure 1).

The increase in the perceived prevalence of misinformation on the coronavirus from Wave 1 to Wave 2 was credible ($b_{W2:Sept2020} = 0.36$, CI = [0.19, 0.52]; regression model using perceived frequency as a dependent variable and wave as a predictor with June 2020 as the baseline), as was the increase in the perceived prevalence from Wave 2 to Wave 3 ($b_{W3:Febr2021} = 0.25$, CI = [0.08, 0.40]; regression model using perceived frequency as a dependent variable and wave as a predictor with September 2020 as the baseline).

Consistent with earlier research, respondents identified social media as the main source of Covid-19-related misinformation, with on average 72% of respondents who reported having encountered misinformation naming this source (ranging from 68% in Wave 3 to 79% in Wave 1). In addition, tabloids (range: 41%–43%), friends and family (range: 31%–36%) and neighbours (range: 29%–32%) were also raised as frequent sources of misinformation (see Supplementary Material S4).

As Table 1 shows, the major reported topics of misinformation in all waves were the origins of the pandemic and statistics (e.g., on the number of infections). In Waves 2 and 3, prominent topics included citizens' behaviours (in terms of compliance with measures) and information on vaccine development. Note, however, that the composition of topics changed across the three waves, with new topics emerging (e.g., vaccine development).

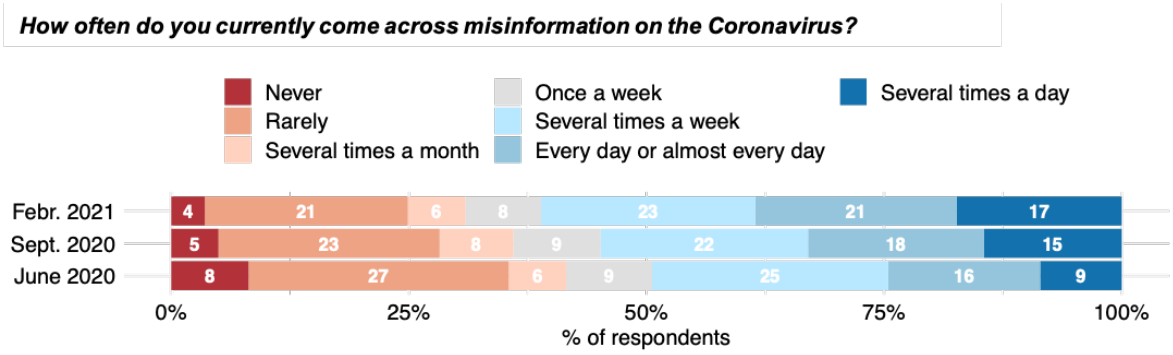

Figure 1. Perceived Prevalence of Misinformation on the Coronavirus Across the three Waves

Table 1. Perceived Topics of Misinformation by Wave of Data Collection, Ordered by Reported Prevalence in Wave 3 (Percentage Selected)

Topic (brief)	Wave 3: Feb. 21 (% selected)	Wave 2: Sept. 20 (% selected)	Wave 1: June 2020 (% selected)
Statistics	42.6	37.5	42.1
Origins of pandemic	42.3	50.2	61.1
Citizen behaviours	32.7	36.3	–
Vaccination benefits	30.1	–	–
Vaccine development	29.1	38.3	–
Forecasts end of pandemic	28.0	26.9	–
Treatments	24.9	28.9	35.7
Vaccination risks	24.9	–	–
Scientific findings	23.2	18.9	25.6
Health impact	22.4	17.8	20.1
Rules	21.5	16.0	14.7
International responses	18.8	21.3	–
Mental health impact	18.6	14.9	16.7
Vaccination strategy	18.5	–	–
Health advice	18.4	21.6	24.3
Climate impact	18.2	17.8	18.6
Tests	18.1	19.4	–
Regional differences	16.7	15.9	–
Long Covid	16.6	14.9	–
Personal stories	15.4	13.4	11.3
Easing of restrictions	14.8	–	–
Reinfection	14.5	16.1	–
Economic impact	14.0	10.3	9.9
Society	13.8	16.9	–
Travel warnings	13.2	16.7	–
Symptoms	12.7	12.7	15.3
Health system impact	12.1	10.7	7.2
Education system impact	11.4	11.4	11.2
Basic supplies	11.2	10.5	14.9
Risk factors	10.8	11.1	–
Financial advice	10.4	8.5	4.4
Legal advice	9.9	5.0	8.8
Risk groups	9.4	10.4	–
Basic services	7.5	8.1	6.7
Contact person	7.0	–	–
New waves	6.9	9.2	–
Behavioural advice	6.8	7.2	8.0

Note. Respondents could select as many topics as they liked; the first page of the survey was kept identical across waves (19 topics); further topics were added in Wave 2 (total 32 topics) and Wave 3 (total 37 topics). The topic list was generated by the author team. Topics not included in a wave are marked with a dash.

Which False Claims were Especially Convincing?

We presented respondents in Waves 2 and 3 with a set of statements to be judged as true or false. Overall, the belief in these claims was low (the median score across statements and waves was 2, corresponding to the judgment that a false statement was "probably false"). Figure 2 plots the distribution of responses per claim. As the top panel shows, most respondents across the two waves rated most false statements as "definitely false". For two statements—"High rates of infection cannot be explained by the false-positive rates of PCR tests" and "Vaccination against coronavirus SARS-CoV-2 can lead to infertility in women of childbearing age"—roughly half of the respondents (45% and 48%, respectively) endorsed the midpoint option "don't know" (see Supplementary Material S5; Figure S5.3). This distribution of data suggests that the two statements were difficult to interpret or ambiguous: Respondents may have had trouble interpreting the term "false-positive rates" and relating it to infection rates; the wording "*can* lead to infertility" was ambiguous at a time when scientific evidence on side effects was still evolving. Higher ratings on these two claims can therefore not be taken to reflect a stronger belief in misinformation. We therefore removed them from the regression analyses predicting beliefs in misinformation. In the following analysis, true claims were reverse-coded, such that higher values always signal higher belief in misinformation (e.g., "The Coronavirus exists" was coded as "The Coronavirus does *not* exist").

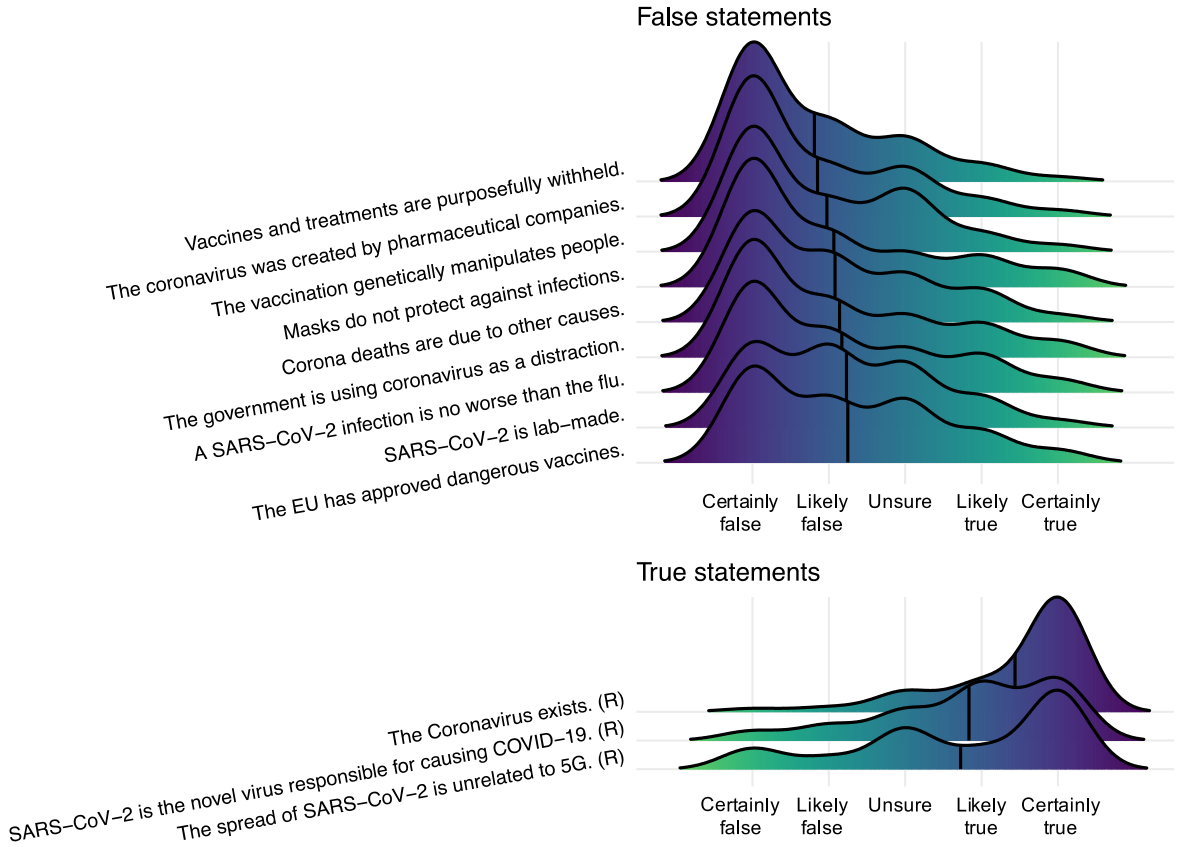

Figure 2. Beliefs in Coronavirus-Related Misinformation Across Waves 2 and 3

Note. Lighter colour indicates stronger belief in misinformation. Most claims were false (top panel); three were true (bottom panel)—such that a lower endorsement of these statements indicates stronger belief in misinformation. The true claims were reverse-coded (R) in the analyses, such that higher values indicate a stronger belief in misinformation. The figure shows smoothed densities of the raw data. Vertical lines indicate means. Statements are ordered from lowest to highest average belief.

The most believed false claims in terms of highest average belief (as shown by vertical lines in Figure 2) were that the EU has approved dangerous vaccines; that SARS-CoV-2 is lab-made; and that an infection with SARS-CoV-2 is no worse than the flu. When we dichotomised the data and coded "definitely true" and "likely true" as indicating belief in a statement (and "definitely false" and "likely false" as indicating lack of belief), between 17% and 21% of respondents believed that a COVID-19 infection is no worse than a flu (see Supplementary Material S5; Figure S5.4) and between 18% and 19% believed that the government is using Covid-19 as a pretext to distract from other issues.

The least believed claim was that the coronavirus does *not* exist (means and statistical analyses are reported in Supplementary Material S5; Table S5.1–2; Figure S5.4). Believing in one claim was moderately associated with believing in others (see Supplementary Material S5; Figure S5.5).

Who Tended to Believe in Misinformation?

Next, we investigated which, if any, individual differences—in demographic characteristics but also in behaviours—predicted belief in Covid-19-related misinformation. Figure 3 shows coefficients retrieved from a multivariate binomial regression that modelled respondents' belief in false statements or disbelief in true statements (controlling for individual respondents using a random intercept, 1|respondent and statement as a fixed effect; and with numeric predictors *z*-scored prior to the analysis). We ran separate regressions for Waves 2 and 3: The regressions are slightly different because political party preferences were only assessed in Wave 3 and thus not included in the Wave 3 regression. Recall that beliefs in misinformation were not assessed in Wave 1. A combined regression for Waves 2 and 3 (without political party preference as a predictor) is presented in Supplementary Material S6 (Figure S6). Supplementary Table S6 documents all coefficients for the individual and combined regressions. In the text, we report coefficients for the combined regression. We do this for the sake of brevity and because the combined regression is a good indicator of the 'net' strength of associations across waves (this also means that a negative effect in one wave and a positive effect in another wave can cancel each other out).

As Figure 3 shows, belief in misinformation was associated with lower trust in local government (b_{combined} = -0.25, CI = [-0.39, -0.13]), and lower trust in the Federal Ministry of Health (b_{combined} = -0.24, CI = [-0.38, -0.11]). Note that in the separate regression analyses—even though the effect is in the same direction—some of the credible intervals include or touch 0 (e.g., $b_{\text{Sept2020,Robert Koch-Institute}}$ = -0.17, CI = [-0.35, 0.00]; these noncredible associations are shown in grey).

Moreover, respondents who believed in misinformation were more likely to get their information on Covid-19-related topics from their neighbours (b_{combined} = 0.26, CI = [0.17, 0.36]), tabloids (b_{combined} = 0.13, CI = [0.05, 0.22]) or social media (b_{combined} = 0.21, CI = [0.13, 0.30]). Conversely, relying on public-sector television (b_{combined} = -0.15, CI = [-0.24, -0.05]) or national newspapers (b_{combined} = -0.11, CI = [-0.19, -0.02]) for Covid-19-related information was associated with lower belief in misinformation. This pattern of results is in line with previous findings identifying social media as the main driver in spreading misinformation, as well as with our findings on the sources of misinformation identified by respondents.

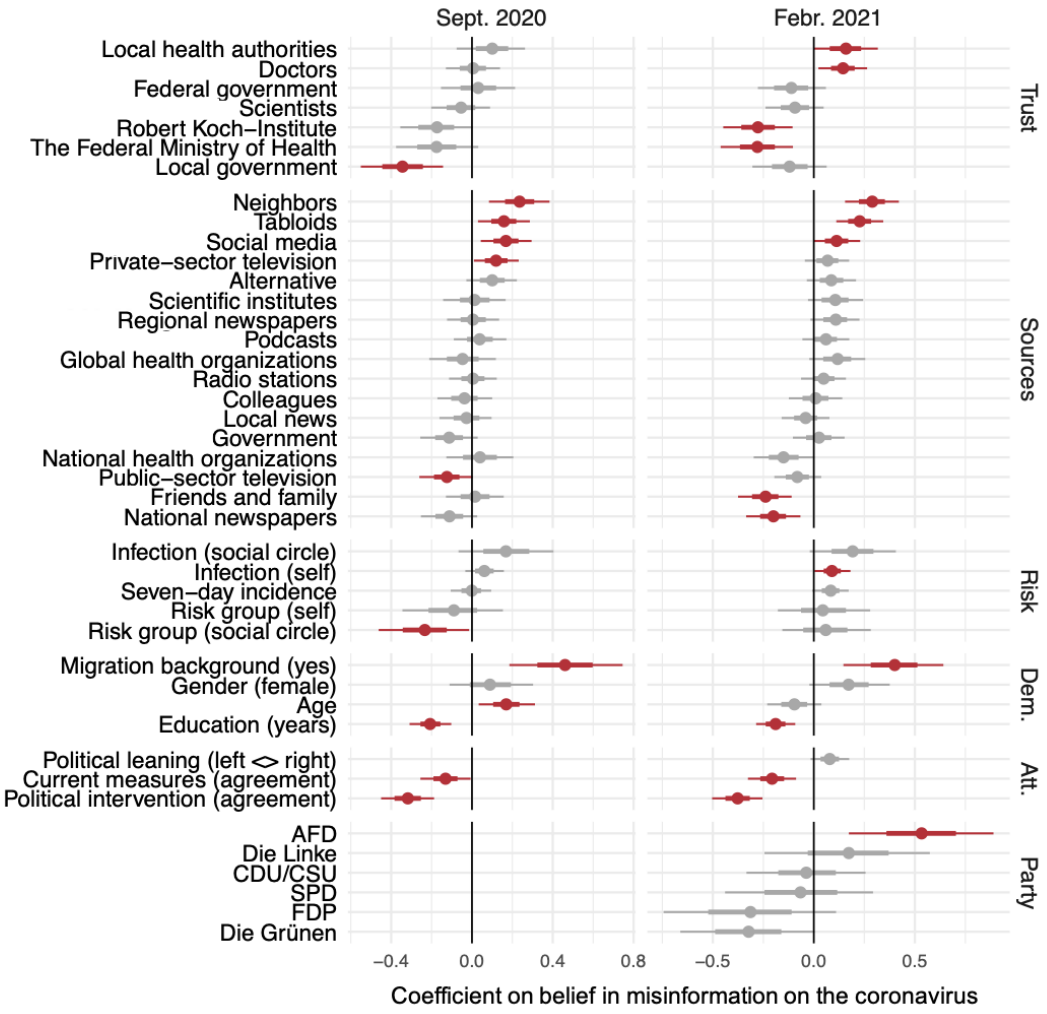

Figure 3. Regression Analyses Predicting Individual Differences in Belief in Misinformation on the Coronavirus in Waves 2 and 3

Note. Dots and error bars represent means and 95% (50%) highest density intervals of the posterior predictive distribution. Dem. = demographic characteristics; Att. = attitudinal measures; Party = Political party respondent would vote for in an upcoming election. Credible associations are shown in red. Results of a multivariate binomial regression predicting belief in a statement from the covariates shown, controlling for individual respondents using a random intercept (1|respondent) and statement as a fixed effect. Coefficients in the figure are based on one regression per wave. Political leaning and the political party a respondent would vote for in an upcoming election were only assessed in Wave 3.

Personal experience with the infection might also moderate belief in misinformation. Across waves, there was a weak positive association between having been infected ($b_{combined}$ = 0.16, CI = [0.01; 0.33]) or knowing someone who was infected ($b_{combined}$ = 0.17, CI = [0.01; 0.33]) and beliefs in misinformation.

Finally, we found that people who agreed with current governmental restrictions (b = -0.18, CI = [-0.26, -0.09]) and people who did not object to the government curtailing personal freedoms ($b_{combined}$ = -0.35, CI = [-0.44, -0.24]) were less likely to believe in misinformation.

What role do demographic variables play in the propensity to believe Covid-19-related misinformation? A higher level of education was associated with lower belief in misinformation ($b_{combined}$ = -0.21, CI = [-0.28, -0.14]). Having a migration background was associated with higher belief in misinformation ($b_{combined}$ = 0.43, CI = [0.25, 0.16]). We

explored to what extent recency of immigration mattered, and found a slightly stronger effect for first-generation ($b_{combined}$ = 0.78, CI = [0.41, 1.14]) than for second-generation immigrants ($b_{combined}$ = 0.67, CI = [0.37, 0.97]). However, membership of both groups was reliably associated with higher belief in misinformation than among respondents without a migration background. The effect of age was inconsistent across waves (positive in Wave 2 and negative in Wave 3); therefore, we do not interpret it further. Finally, voting intentions (assessed in Wave 3 only) were highly predictive of belief in false information: There was a credible link between the intention to vote for the AfD and belief in misinformation ($b_{Febr.2021}$ = 0.53, CI = [0.19, 0.90]). At the same time, left/right wing self-placement was not credibly linked with belief in misinformation.

Which Self-Reported Competences Can People Draw on to Deal with Misinformation?

Across all three waves, a majority of respondents felt confident in their ability to detect Covid-19-related misinformation: Between 78% and 87% reported being somewhat or very confident. However, perceived competence was slightly lower in Waves 2 and 3 than in Wave 1 ($b_{Sept2020}$ = -0.14, CI = [-0.20, -0.08]; $b_{Febr2021}$ = -0.14, CI = [-0.20, -0.08]). As Figure 4b shows, respondents reported that they were able to identify information as potentially false from cues such as the trustworthiness of the source (61%–65%), the consistency of information between sources (59%–60%) and the provision of plausible evidence (56%–59%). How do people respond when they think a piece of information could be false? As Figure 4c shows, many respondents said they would check the claim on independent websites (46%–54%) or ignore the information (37%–43%). Few indicated that they would share it (4%–8% across waves and items). A small subset of respondents in each wave (3%) described other more idiosyncratic but common-sense strategies, such as asking their doctor, talking to other well-informed individuals, awaiting official statements (e.g., on the Robert Koch-Institute's website), and reporting the false information.

Discussion

In autumn 2020, the WHO joined forces with other supranational organisations (WHO et al., 2020) to publish a statement warning that:

> "The Coronavirus disease (Covid-19) is the first pandemic in history in which technology and social media are being used on a massive scale to keep people safe, informed, productive and connected. At the same time, [...] technology [...] is enabling and amplifying an infodemic that [...] jeopardizes measures to control the pandemic."

Learning how to manage this infodemic will be crucial in coming to grips with this and future pandemics and global crises (e.g., the climate crisis). Governments must not only provide their citizens with accurate and reliable information; they must also actively combat the spread of misinformation. Our goal was to contribute to the monitoring of misinformation during the Covid-19 pandemic by documenting the perceived scope of misinformation in Germany, identifying correlates of belief in misinformation, and examining how well-equipped people thought they were to detect misinformation.

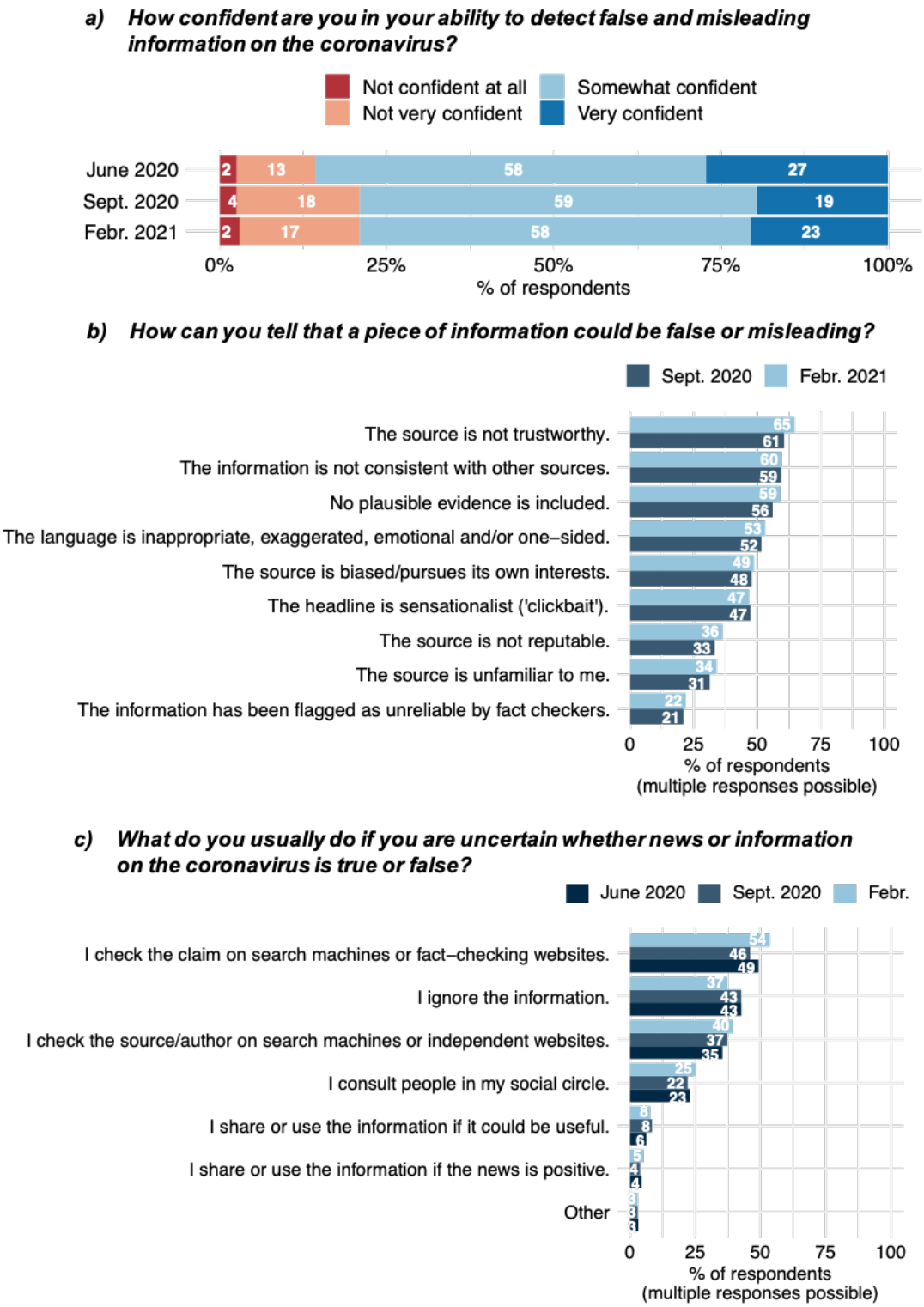

Figure 4. Perceived Competence in Detecting and Dealing with Misinformation on Covid-19

Note. (a) Confidence in ability to detect misinformation by wave. (b) Indicators of false or misleading information (multiple responses possible; Waves 2 and 3 only). (c) Primary strategies used when encountering potential misinformation (multiple responses possible).

What were People's Perceptions of the Frequency, Sources and Topics of Misinformation During the Covid-19 Pandemic in Germany?

Consistent with earlier research (e.g., Boberg et al., 2020), our findings showed that the perceived prevalence of misinformation on Covid-19 increased over time—potentially as a function of the more general increase in Covid-19-related information. The topics identified as most tainted by misinformation were the origins of the pandemic; official statistics (e.g., on the numbers of infections, hospitalisations, and deaths); and (in Wave 3, when the topic was most relevant) information on vaccines. Vaccine misinformation, particularly when it is "scientific-sounding", can reduce people's willingness to get vaccinated (Loomba et al., 2021, p. 337). Most respondents identified social media as the main source of misinformation, but tabloids and friends and family were also identified as frequent sources—an important extension on previous findings from content analyses (Boberg et al., 2020).

These findings also highlight opportunities for interventions. For instance, given the clustered spread of misinformation among friends, family and neighbours, measures that target not only the individual but also their social embedding seem promising. In this vein, public health authorities in Germany have rolled out vaccination campaigns in neighbourhoods with low vaccination rates, with mobile teams providing low-threshold and easy-to-understand vaccine information and educational videos being developed to target specific immigrant groups (e.g., Arabic speakers; WDR, 2021).

Which false Claims were Especially Convincing?

Unfortunately, two of the most believed false claims—that the EU has approved dangerous vaccines and that a coronavirus infection is no worse than the flu (see Figure 3)—are likely to increase vaccination hesitancy: One of the key reasons for not getting vaccinated is the perception that the benefits do not outweigh the costs. This reason—the 'calculation' factor in the five psychological antecedents of vaccination (i.e., the 5Cs, see Betsch et al., 2018)—has indeed been shown to have a large effect on vaccine hesitancy in Germany (COSMO Explorer, 2020; Betsch et al., 2021).

The finding that a considerable proportion of respondents believed that masks do not protect against infections (17% and 20% in Waves 2 and 3, respectively) further underscores that misinformation is not just a *perceived* problem (research question 1) but that it has a real impact on people's beliefs that can, in turn, affect their compliance with government guidelines and thus seriously endanger public and private health.

Who Tended to Believe in Misinformation?

In terms of individual differences, people with right-wing (AfD) voting intentions were more likely to believe in misinformation. Our data cannot establish causality: Does being an AfD voter make a person more prone to believe in misinformation or does believing in misinformation lead a person to vote for the AfD? A panel study on Germany's 2017 election suggests the latter: The propensity to believe in disinformation drove voters from the Christian Democratic Union (CDU; the main governing party at the time) to the AfD (Zimmermann & Kohring, 2020). At that time, the AfD's disinformation strategy was primarily focused on typically right-wing topics such as immigration. It has since extended to downplaying the risks of the virus by spreading misinformation on Covid-19 statistics (Gensing & Rohwedder, 2021) and Covid-19 vaccines (Redaktionsnetzwerk Deutschland, 2022). More generally, populist

movements often promote ideas that criticise 'the elite' (experts, scientists, journalists), which may fuel beliefs in misinformation among their voters (Mede & Schäfer, 2020). The link between belief in misinformation and far-right political leanings also echoes findings from other countries showing, for instance, that conservative ideology plays a notable role in the endorsement of conspiracy theories (Miller et al., 2016; van der Linden et al., 2021). Much prior research on misinformation has been conducted in the United States, a country with a two-party system. Here we found that the link between conservative ideology and the propensity to believe in misinformation appears to generalise to Germany's multiparty political system. The link between political party affiliation and belief in misinformation is, however, not necessarily an instance of politically motivated reasoning; it may be rooted in differences in prior beliefs (Pennycook & Rand, 2021).

There was a weak positive association between believing in misinformation and having been infected with Covid-19 and a weak positive association between believing in misinformation and knowing someone who was infected. On the one hand, one might expect personal experience to overrule misperceptions; on the other hand, people who believe false claims may be more likely not to take precautions and to get infected. It is also possible that the infection was mild, and that this personal experience amplified or reinforced beliefs in misinformation. Future studies should take a more fine-grained approach to measuring personal experiences.

Trust in institutions is another correlate of the belief in misinformation: People with lower trust in the federal government, the Robert Koch-Institute and the Federal Ministry of Health were more likely to believe in misinformation. This pattern converges with findings from the United Kingdom, Ireland, Mexico, Spain, and the United States (Roozenbeek et al., 2020).

In addition, respondents with lower levels of education and respondents with a migration background were more prone to believe in misinformation. This finding is also consistent with prior research (Goertzel, 1994; van Prooijen & van Lange, 2013). It may not be education or migration status per se that explain belief in misinformation (Nocun & Lamberty, 2020) but related characteristics: Conspiracy beliefs, in particular, appear to emerge when citizens feel powerless and not heard in the political discourse and when they distrust the political system and public figures—feelings that are even more likely among migrants and the less educated (van Prooijen & van Lange, 2013). Migration status may also be associated with lower trust in the government and institutions, which is itself a correlate of beliefs in misinformation. In addition, minorities are more vulnerable to disinformation campaigns because their "legal status, discrimination, and language barriers may limit access to otherwise publicly available preventative materials, health care and social services" (Regional Risk Communication and Community Engagement Working Group, 2020). The finding that those who got information on the pandemic from their neighbours were more likely to believe in misinformation is consistent with the notion that (mis-)information spreads differently in different social networks and milieus. In a similar vein, previous research has found geographic clusters in vaccine refusal (Lieu et al., 2015), which is possibly associated with spread of vaccination-related misinformation within the cluster (Roozenbeek et al., 2020).

Lastly, we found that relying on social media for news and information is linked to belief in misinformation. As Facebook provides both informative and entertaining content (e.g., Tandoc, 2019), users may rarely "stop and think" about a news item (Pennycook & Rand, 2021, p. 392). Yet more reflective readers are better at detecting misinformation. In addition, the spread of fake news can be greatly accelerated on social media. One reason for this is that there is a disconnect between what people share on social media and what they think is true: People's

sharing intentions also depend on how surprising, funny, politically aligned or interesting a news item is (Pennycook & Rand, 2021).

Which Self-Reported Competences Can People Draw on to Deal with Misinformation?

A large proportion of our respondents were confident that they are able to detect misinformation. Roughly half reported being able to identify specific cues that can help to detect misinformation (e.g., untrustworthy sources) and applying strategies to determine the truth of a statement (e.g., cross-checking sources). This means that a substantial portion of respondents were unaware of or did not report using effective fact-checking strategies. Potential policy interventions could thus involve low-threshold training in the use of simple strategies for digital information literacy (see also Kozyreva et al., 2020) based on the boosting approach (Hertwig & Grüne-Yanoff, 2017). For example they could teach people to verify the credibility of a website by using the lateral reading approach—leaving a site to see what other digital sources say about it (Wineburg et al., 2022; Wineburg & McGrew, 2017). Complementary strategies are inoculation interventions aimed at instilling cognitive resilience to manipulation and common disinformation tactics (e.g., van der Linden et al., 2020).

Limitations

One limitation of our study is our deliberate focus on self-reports. Self-reports can be tainted by the desire to give socially pleasing answers (e.g., few said they would knowingly share misinformation). Moreover, the understanding of what constitutes false information differs across individuals (Nielsen & Graves, 2020). People may overestimate their ability to detect false information, especially when they are in need of that very skill (Dunning, 2011). According to the third-person effect hypothesis, people tend to perceive that mass media messages have a greater effect on others than on themselves (Davison, 1983). Indeed, some studies have found that people consider themselves less vulnerable than others to Covid-19 disinformation (Liu & Huang, 2020). Alternative approaches to determining the prevalence of fake news include using web-browsing data, consulting the archives of fact-checking websites or focusing on particular fake news publishers (see Bader et al., 2020, for an overview of the German fake news landscape from 2015 to 2018). Some datasets have their own limitations in that they focus on what people click on and share, and not what they read in passing (Pennycook & Rand, 2021). Our data on perceptions of misinformation, its dimensions and topics, can complement such analyses of people's information ecologies.

A caveat for all approaches that attempt to quantify the prevalence of misinformation is that it can be notoriously difficult to draw a line between true and false information: Alternative news outlets may take a strong ideological stance, twist reality or stretch the truth, but they do not fabricate information entirely ("the best lie always has a true core", see Boberg et al., 2020, p. 17; see also Mourão & Robertson, 2020). Another limitation of our approach is that the topic list we presented to respondents was updated across the three waves. For example, the response option "risks and benefits of vaccinations" was not offered in Wave 1, which was conducted long before vaccines became available. However, all options in the initial topic list were presented across all three waves. Lastly, although our samples are representative of residents living in Germany with respect to age, gender and federal state, they are biased towards online-literate populations, and the sample was not representative with respect to education.

Conclusion

The spread of misinformation about the coronavirus and vaccinations will have a strong bearing on how well countries around the globe are able to respond to the Covid-19 health crisis. How citizens consume and evaluate information is a key factor in the spread of misinformation. Our findings showed that only about half of our respondents reported using simple strategies to identify misinformation, such as checking the trustworthiness of a source, lateral reading across sources or evaluating whether the language used is sensationalist or one-sided. Moreover, getting information on the coronavirus from one's neighbours or social media was associated with stronger beliefs in misinformation. These results can inform the development of promising interventions, such as boosting individual information literacy and providing understandable and high-quality information in people's proximate environments.

Notes

1. The term misinformation generally refers to information that is false but not necessarily intended to cause harm; it may even be shared by people trying to be helpful (Wardle, 2018). It is distinguished from disinformation (which is spread intentionally to cause harm) and fake news (pseudojournalistic disinformation; see Egelhofer & Lecheler, 2019; Tandoc, 2019; Tandoc et al., 2018). Here, we use the term misinformation as an umbrella term covering false claims in general (see also Lewandowsky et al., 2020), as it is impossible in this context to know the intention behind them.
2. Although lines can be blurred, the term mainstream media refers to established print and broadcasting outlets such as the *New York Times* or the *BBC* that most people know about and consider reliable (Collins, n.d.; Jackob et al., 2017), in contrast to hyperpartisan news outlets that take a strong ideological stance on current events (Pennycook & Rand, 2021).

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Supplementary Material

The supplementary material including additional figures, tables, and analyses can be found here: https://doi.org/10.47368/ejhc.2022.202. Data, analysis code, details of all statistical analyses and survey questions are provided online (https://osf.io/hz9yq/).

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Conflict of Interest

All authors declare no conflict of interests.

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