

**How personal experiences shaped risk judgements during COVID-19**

Michael Schulte-Mecklenbeck<sup>1,2</sup>, Gert G. Wagner<sup>2,3,4</sup>, and Ralph Hertwig<sup>2</sup>

<sup>1</sup>Department of Consumer Behavior

University of Bern

Switzerland

<sup>2</sup>Center for Adaptive Rationality

Max Planck Institute for Human Development

Berlin

Germany

<sup>3</sup>German Socio-Economic Panel Study (SOEP)

Berlin

Germany

<sup>4</sup>Harding Center for Risk Literacy

University of Potsdam

Germany

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The authors made the following contributions. Michael Schulte-Mecklenbeck  <https://orcid.org/0000-0002-0406-8809>: Conceptualization, Formal Analysis, Visualization, Writing - Original Draft Preparation, Writing - Review & Editing; Gert G. Wagner  <https://orcid.org/0000-0002-5985-4073>: Conceptualization, Writing - Review & Editing; Data curation Ralph Hertwig  <https://orcid.org/0000-0002-9908-9556>: Conceptualization; Writing - Original Draft Preparation, Writing - Review & Editing.

Correspondence concerning this article should be addressed to Michael Schulte-Mecklenbeck  <https://orcid.org/0000-0002-0406-8809>, Department of Consumer Behavior, University of Bern, Engehaldenstr. 4, 3012 Bern, Switzerland. E-mail: [research@schulte-mecklenbeck.com](mailto:research@schulte-mecklenbeck.com)

**Abstract**

During the COVID-19 pandemic, people had two important but imperfect teachers of risk. First, they learned about incidence, mortality rates, and reproduction numbers from reports and graphs. Second, they learned about the risk of infection through their own experience and the experience of others. Personal experience has been found to serve as an input for risk judgements in numerous contexts, including climate change. Here we examine how it shapes risk judgements within the dynamics of a pandemic, drawing on data collected from more than 15,000 German citizens between March 2020 and May 2022. People with personal experience of having contracted the virus consistently rated the risk of infection higher than those without such experience. The influence of others' experience increased with their social distance to the respondent. Media coverage also influenced risk judgements but to a lesser extent. We discuss the implications of these patterns for risk communication.

*Keywords:* risk judgement, COVID-19, experiential amplification, media

## How personal experiences shaped risk judgements during COVID-19

It is difficult to anticipate how the public will perceive the risk of hazardous events such as virus outbreaks, terrorist attacks, and the short- and long-term consequences of climate change. Several determinants of public risk judgements have been identified, including perceived properties of the risk itself (e.g., novelty, voluntariness of exposure, and dread potential; Slovic, 1987), attributes and values of the perceiving individual and collective (e.g., trust in government and science, individualism, and fairness; Douglas, 2013; Douglas and Wildavsky, 1983), and the dynamics of the information environment (e.g., social amplification of risk in the transmission of information; Kasperton et al., 1988; Moussaïd et al., 2015). A factor that has recently received increasing attention is the extent to which an individual has had *personal experience* of a risk, be it a macroeconomic shock such as the Great Depression (Malmendier & Nagel, 2011) or a period of inflation (Malmendier & Nagel, 2016); natural hazards such as floods, droughts, or earthquakes; (Wachinger et al., 2013); or living through a pandemic such as COVID-19 (Dryhurst et al., 2020). In the context of climate change, personal experience has been shown to have motivational and psychological relevance for a range of outcomes, including risk judgements and responses to risks (Akerlof et al., 2013; Demski et al., 2017; Myers et al., 2013; Reser et al., 2014; Van der Linden, 2014). For instance, Viscusi and Zeckhauser (2015) observed that relative to indirect experiences (i.e., the experience of peers / others), direct experiences have a stronger and more consistent effect on different measures of environmental risk beliefs. They also found that people with direct experiences are more likely to take precautionary measures. Relatedly, in an international survey of 24 countries, personal experience of global warming predicted endorsement of specific mitigation actions (Broomell et al., 2015).

Personal experience clearly matters. It is one of the main ways that individuals learn about risk and can be a powerful—though by no means perfect—teacher of risk (Hertwig & Wulff, 2022). Experience can be understood as the process and result of living

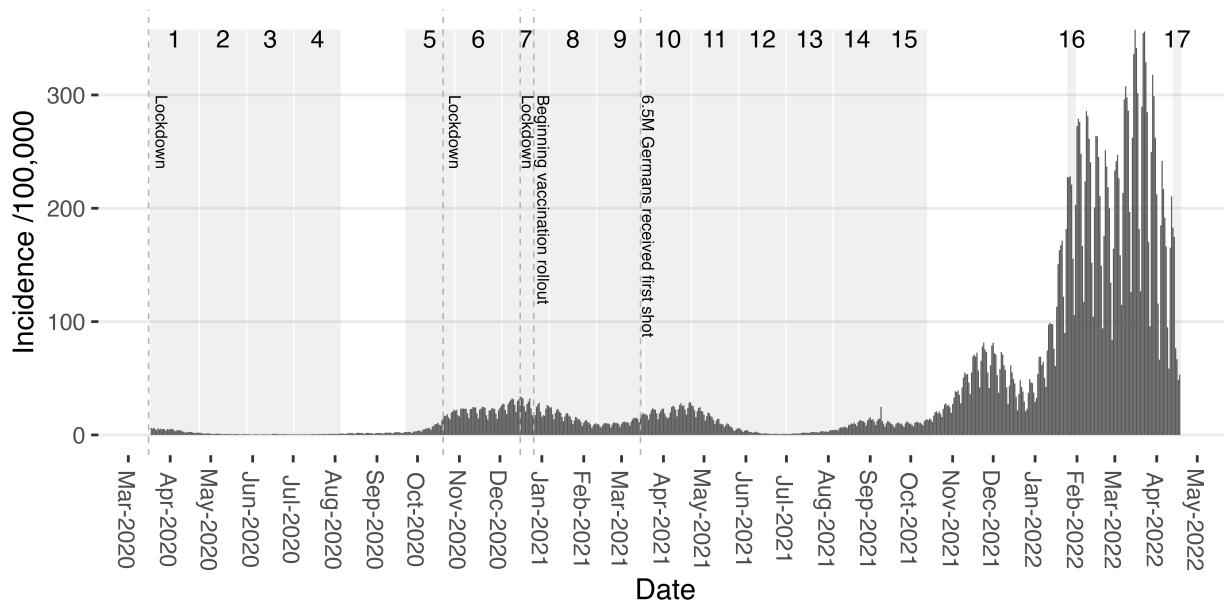
through events (Hertwig et al., 2018; March, 2010). It is multidimensional and includes cognitive (e.g., information), subjective (e.g., [un]pleasantness), and physiological (e.g., pain or pleasure) aspects; sometimes it has predominantly informational value and sometimes informational and material effects co-occur (Sutton & Barto, 1998). Experience can be used to evaluate past actions and guide future ones (March, 2010). Experiencing an option as positive increases the probability of that option being chosen in the future; the opposite holds for negative experiences (Denrell & March, 2001). Although undergoing an experience may require effort, learning from experience may also be relatively effortless and immediate for the individual concerned (e.g., avoiding a specific food after food poisoning). This also holds for risk experiences that are imposed by the environment (e.g., experiencing the health consequences of record temperatures during a heat wave) or acquired through voluntary exposure (e.g., fracturing your shinbone while skiing). Experience has, in any case, special authority, both to the person living through it and to others who are direct observers or to whom that experience is communicated (Kubin et al., 2021).

In this article, we focus on the role of personal experience for risk judgements during the COVID-19 pandemic. Examining how personal experience shapes risk judgements during a global health crisis such as a pandemic is especially informative because disease transmission often follows nonlinear spatio-temporal dynamics (Stone et al., 2007), causing, for instance, seasonal fluctuations in incidence, epidemic peaks, and intermittent drops to a minimum level. Figure 1 plots the incidence of COVID-19 infections in Germany between March 2020 (the onset of the pandemic in Germany) and April 2022, a period of about two years. Cases fluctuated seasonally, with peaks being highly variable (e.g., compare the peaks in April 2020, 2021, and 2022). The baseline likelihood of people having had personal experience of the COVID-19 virus therefore varied greatly across the period of observation.

How does experience affect people's judgement of the risk of getting infected with such a dynamic, recurrent disease? A study across 10 countries focused on the brief period between March and April 2020. Findings showed that the direct experience of COVID-19

**Figure 1**

*COVID-19 incidence in Germany across a 2-year time period, starting in March 2020 (the onset of the pandemic in Germany). Vertical dashed lines mark key events: lockdowns, beginning of vaccination rollout, and vaccination progress. The numbers from 1 to 17 indicate the survey waves.*



was indeed a significant predictor of risk judgements: “Specifically, people who have had direct personal experience with the virus perceive more risk compared to those who have not had direct experience” (Dryhurst et al., 2020; p. 998). In this article, we build on this finding of ‘experiential amplification’ of risk by addressing three main research questions. All three concern the judgement of the risk of contracting COVID-19 and consider the alignment (or misalignment) of the judged risk (likelihood) of an infection with the actual temporal dynamics of the pandemic, and the role of personal experience in this (dis-)association.<sup>1</sup> Our first research question takes *experiential amplification* of risk

<sup>1</sup> There are, of course, other key dimensions of COVID-19 risk judgements, such as fear of a life-threatening case of COVID-19. We also shed some light on this dimension of risk judgement (see Discussion and Figure A1 in the Appendix), but because of decisions on the COMPASS questionnaire (see Procedure for details)

(Dryhurst et al., 2020) as the starting point. Does having been infected with COVID-19—in other words, having *direct experience* of COVID-19 infection—consistently amplify the judged risk of an infection relative to *no experience* across the highly dynamic course of the pandemic from March 2020 to May 2022 (see Figure 1)?

Our second research question concerns the propagation of risk within a person's close social circles. Even if someone has not been infected themselves, a family member, friend, or colleague may have had the virus. The experience of family members is relatively tangible, immediate, and observable. Does such proxy *family experience* have the same amplifying effect on risk judgement, in magnitude and direction, as direct experience? Or does it have a lesser effect—potentially due to greater psychological distance?<sup>2</sup> We also investigated how the experience of socially more distant circles (e.g., friends, colleagues, and neighbours) influenced individual risk judgement. We refer to the experience of this more distal group as *network experience*.

Our third research question concerns the role of communication about the COVID-19 infection risk. According to sociologist and scholar of systems theory Niklas Luhmann, hazardous events have no social impact unless they are the subject of communication (Luhmann 2004, p. 63). That is, physical, chemical, or biological facts—even human deaths—only generate social resonance through communication. Communication about COVID-19 was extensive, especially in the early stages of the pandemic; the World Health Organization even coined the term ‘infodemic’ to describe the onslaught of information and false information.<sup>3</sup> Do dynamic changes in the intensity of

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over which we had no control, the data are incomplete. Fortunately, we do have complete data for judgements of the risk of contracting COVID-19 across the full 2-year period (see Method for details).

<sup>2</sup> Psychological distance is a construct referring to the extent to which an object is removed from the self. It can be brought about via temporal, spatial, and social distances (Trope & Liberman, 2010).

<sup>3</sup> “An infodemic is too much information including false or misleading information in digital and physical environments during a disease outbreak. It causes confusion and risk-taking behaviors that can harm health. It also leads to mistrust in health authorities and undermines the public health response. An

such communication amplify (Renn et al., 1992) or attenuate people's risk judgements, potentially causing a disconnect between the public's risk judgement and objective disease incidence? We tracked COVID-19 media mentions (in offline and online newspapers) and online searches for information on COVID-19 in relation to respondents' perceived risk judgements.

## Methods

### Procedure

We drew on data collected in the COMPASS (Corona-Online-Meinungs-Panel-Survey-Spezial) survey to examine the impact of personal experience on judgements of risk by German citizens. The COMPASS series was launched and financed by the commercial polling institute infratest dimap (<https://www.infratest-dimap.de>) in March 2020, we had limited control over the timing and content of the survey waves. Consequently, questions of particular interest (e.g., fear of a life-threatening case of COVID-19) were not consistently included in all waves; we return to this issue below.

Participants were recruited to the COMPASS panel from the German loyalty program PAYBACK, which has about 25 million members. Participation was voluntary. Our data derive from the 17 survey waves run between March 17, 2020, and April 19, 2022. Survey waves 1 to 15 lasted between 34 and 36 days each; wave 16 lasted 9 days and wave 17 lasted 6 days. Participants also responded to several questions not related to our analysis that are omitted here.

### Data

**Incidence.** COVID-19 incidence in Germany was accessed through the COVID-19 Datenhub (<https://npgeo-corona-npgeo-de.hub.arcgis.com>). This website is associated with

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infodemic can intensify or lengthen outbreaks when people are unsure about what they need to do to protect their health and the health of people around them." (Definition retrieved from <https://www.who.int/health-topics/infodemic>).

the Robert Koch Institute (RKI, <http://www.rki.de>), the German government's central scientific institute in the field of biomedicine. It is one of the most important centers for safeguarding public health in Germany, and is responsible for identifying, surveying, and preventing disease, especially infectious diseases.

**Risk judgements.** In the COMPASS survey, risk judgements were measured by the following question: "What is your estimate of the risk that you or members of your family will become infected with the coronavirus in the future?" Responses were given on a 11-point Likert scale with the end points 'very small' (=0) and 'very large' (=10). (The original German wording can be found in the Appendix, p. 25). This question was included in each of the 17 waves; we were therefore able to analyze the data across the full observation period.

**Infection status.** In waves 1–4, direct and indirect experience of infection was probed by the following question: "In many countries, including Germany, people have been infected with the coronavirus. Have you or anyone close to you had a confirmed infection, a suspected infection, or no indication of infection?" From wave 5 onwards, the question was worded: "Have you or anyone close to you been diagnosed with a COVID-19 infection since the outbreak of the corona pandemic?". Infection status was determined separately for six levels of social proximity (e.g., 'I was diagnosed' to 'In my neighbourhood someone was diagnosed') that were then recoded into the four distance levels: direct experience, family experience, network experience' and 'no experience' (See Appendix, p. 25, for the original wording)

**Media mentions and Google Trends analyses.** We used LexisNexis ([www.lexisnexis.com](http://www.lexisnexis.com)), an information and data provider specialized in news and business sources worldwide, to gauge the communication landscape on COVID-19 in Germany over the observation period. A keyword search for 'COVID\*' & 'Corona\*' with a geographical restriction to Germany was performed in six daily and one weekly print news outlets (Der Spiegel, Kölner Stadt-Anzeiger, Kölnische Rundschau, Rheinische Post, Stuttgarter

Zeitung, Südwest Presse) and two online-only outlets (Bild.de, Spiegel Online) between January 1, 2020, and May 1, 2022. The print newspapers represent seven of the 10 most widely read newspapers in Germany. Bild.de and Spiegel Online are German online news sources numbers one and three, respectively, in terms of visits. Our search resulted in 27,869 articles featuring the search terms. We divided the number of occurrences of the search term per article by the length (word count) of the article, resulting in a length-normalized measure of occurrence.

Communicative acts are not limited to the traditional media. Users of search engines such as Google also communicate through their exploratory behaviors. We therefore additionally conducted a Google Trends (<https://trends.google.com/>) analysis for the keywords ‘Corona\*’ and ‘Covid’<sup>4</sup> in Germany during the observation period. This analysis resulted in a normalized measure of search frequency for the search terms.

**Vaccination rates in Germany.** Vaccination rates were imported from the webpage of the Robert Koch Institute (<https://www.rki.de>; ‘Digitales Impfquoten Monitoring’). We calculated the cumulative number of vaccinations in Germany (aggregated across first, second, and third shot) for the observation period.

**Fear.** To provide insights into how fear about COVID-19 compared with fear of other risks, the COMPASS survey asked respondents to rate fear of 12 risks in various life domains: cancer, heart attack, stroke; climate change; COVID-19; damage to home through natural disasters; economic hardship; extreme weather events; financial hardship through natural disasters; flying; lack of digitalization; political extremism; tax hikes due to COVID-19; traffic accidents (see Appendix, p. 28, for the original wording, English translation, and response options). These data were obtained only once, in survey wave 15 (between September 9, 2021, and October 13, 2021)

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<sup>4</sup> Note that the relative searches for ‘Covid’ were comparably small. We therefore use this variable for the modeling but do not plot the respective data in Figure 5

## Participants

Table A1 in the Appendix shows the demographic characteristics of the panel. Overall, 15,015 unique participants (51.2% female) completed the questionnaires. Average age was  $M = 48.6$  years ( $SD = 17.1$ ) in women and  $M = 49.5$  years ( $SD = 16.9$ ) in men. This difference was statistically significant  $t(14995) = 3.21$ ,  $p = .001$ ,  $d = .05$ ; however, in terms of Cohen's  $d$ , the effect size was negligible. Although the gender age difference in the general German age distribution is in the opposite direction, with the female population being older (average age of 46.0 years for women and 43.4 years for men in 2021 (Bundesinstitut für Bevölkerungsforschung, 2023), it is not likely, given the sample size and the wide distribution in terms of age groups and education (see Table A1), that the present results were substantially affected).

Of the more than 15,000 participants in all waves the range of participants in each wave was relatively stable between waves 1 to 16 (*Range* = 9,234 to 11,200) with the maximum in the first wave. Table A2 in the Appendix lists these participation rates in detail. Only wave 16 and 17 had a substantial decline in participation, due to financial restrictions in inviting participants to the panel. Many participants were in more than one wave, column 'Percent participants in wave x and wave 1' indicates the percentage of participants who were in a given wave and also participated in the first wave, the range of these percentages is between 86 % and 89 %. There was also a stable core of 1107 participants who answered all 17 waves.

## Results

### Dynamics of incidence and risk judgements

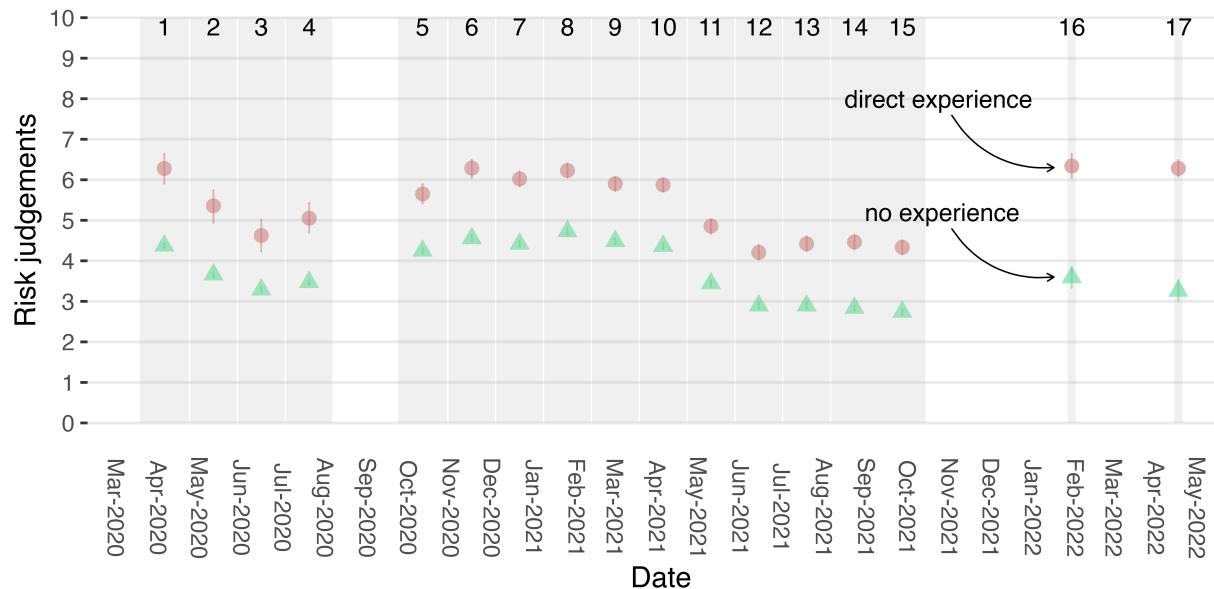
Figure 1 plots the incidence (i.e., the number of new infections over the past 7 days per 100,000 inhabitants) of COVID-19 infections across the 17 survey waves (indicated by grey blocks). To the extent that incidence is a proxy for the risk of contracting COVID-19, the temporal dynamics of the objective risk varied greatly over the observation period: Whereas the average incidence was as low as 4 cases in 100,000 in the first three survey

waves (March, April, and May, 2020), it rose to 253 in 100,000 in March 2022, thus increasing by a factor of 63.

Across the 17 survey waves, respondents were repeatedly asked to judge their risk of contracting COVID-19. Figure 2 plots the average risk judgements. Although the judgements track some features of the incidence distribution in Figure 1 (e.g., the decline in summer 2020), it is clear that the average subjective risk judgement does not closely follow the enormous fluctuations in incidence. This suggests that people's risk judgements do not simply reflect the objective incidence, but that they are also shaped by other factors.

## Figure 2

*Average risk judgements in each of the 17 survey waves, plotted separately for 'direct experience' and 'no experience' of COVID-19 infection. Error bars represent bootstrapped 95% CIs.*



## Does direct experience of COVID-19 infection influence risk judgements?

One potential factor is *direct experience* of COVID-19 infection, that is, having contracted the virus oneself. Figure 2 plots risk judgements as a function of whether

respondents had *direct experience* or *no experience* of COVID-19. Notwithstanding the dynamic course of the pandemic, the average risk judgement was—consistently across all waves—notably higher for respondents with direct experience ( $M = 5.3$ ,  $SD = 2.6$ ) than for those with no experience ( $M = 3.8$ ,  $SD = 2.5$ ). The effect size of this difference was  $d = 0.61$ .

To further examine this difference, we calculated a mixed-effects model, predicting *risk judgement* on the basis of *direct experience* or *no experience* of an infection. We added random effects for survey wave (nested in year and month of the pandemic) and participant (nested in age group). We calculated a basic model and a full model controlling for gender, age group, media mentions, Google searches, COVID-19 incidence, and aggregated vaccination numbers in Germany. The relevant variables were standardized and centered before being entered in the models. The results of the basic and full model are reported in Table A3 in the Appendix. Both models resulted in a significant effect of experience (direct vs. no experience) on risk judgement (full model:  $b = -0.25$ ,  $CI[-0.28 \text{ } - -0.22]$ ), indicating lower risk judgements in the *no experience* group than in the *direct experience* group.

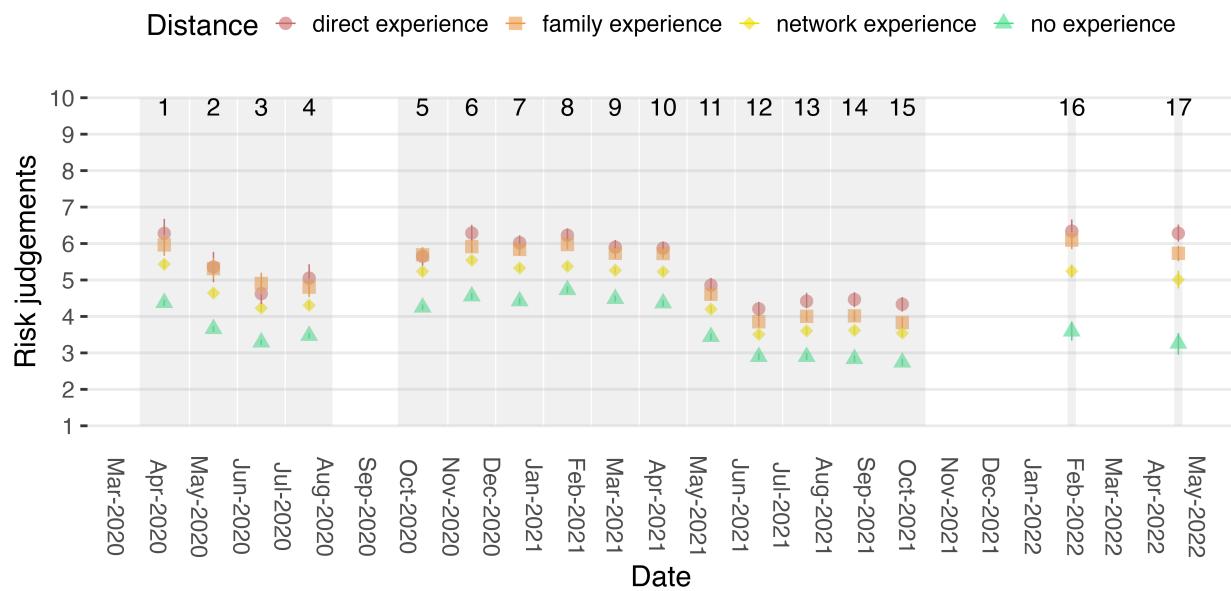
### **Does indirect experience of COVID-19 infection influence risk judgements?**

Relative to the power of personal experience, how does the proxy experience of others impact people's risk judgements? To find out, we distinguished between four categories of experience with increasing social distance to the target person: *direct experience*: the individual personally experienced infection; *family experience*: at least one family member experienced infection; *network experience*: someone in the target person's social network of friends, colleagues, and neighbours experienced infection, and *no experience*: none of the above.

Figure 3 plots risk judgements as a function of these four categories. A systematic pattern emerged. The further distant from the individual a COVID-19 infection was, the smaller the judged risk of contracting the infection. In the aggregate, this regularity can be

**Figure 3**

*Average risk judgements in each of the 17 survey waves, plotted separately for (in)direct experience and no experience of COVID-19 infection. Error bars represent bootstrapped 95% CIs.*



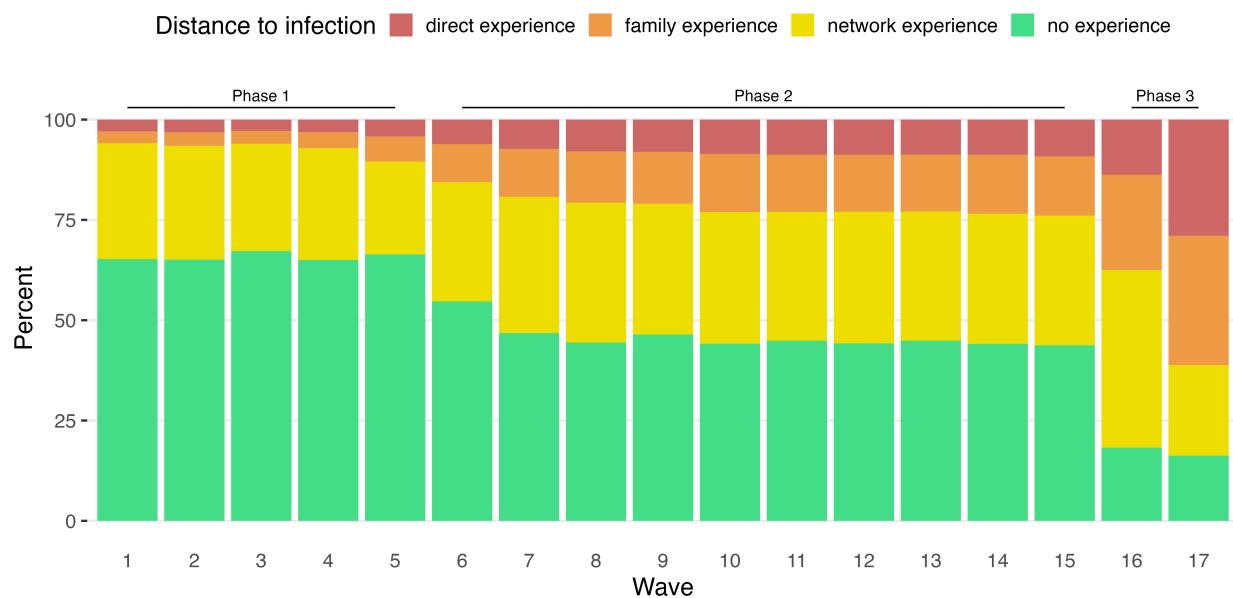
observed in decreasing average risk ratings across the four categories. The direct experience and no experience groups gave the highest and lowest risk judgements, as reported above, with family experience ( $M = 5.1, SD = 2.5$ ) and network experience ( $M = 4.6, SD = 2.48$ ) sandwiched in between. We used a mixed-effects model to further examine the effect of distance on experience, predicting *risk judgement* on the basis of the four experience categories. We again built a basic model and a full model with the same control variables. The full model revealed significant decreases in risk judgements between direct and family experience ( $b = -0.12, CI[-0.15 --0.09]$ ), between direct and network experience ( $b = -0.25, CI[-0.28 --0.22]$ ), and between direct and no experience ( $b = -0.36, CI[-0.39 --0.33]$ , (see Table A4 in the Appendix)).

The proportion of respondents with experience of an infection of course changed

over the pandemic. Figure 4 plots the proportion of participants with each category of experience of COVID-19 across the survey waves. Three phases can be identified: Phase 1, survey wave 1 to 5, with a relatively stable distribution of more than two-thirds of the sample having no experience of COVID-19. Phase 2, survey waves 6 to 15, with a steady increase in direct experiences of infection. Finally, phase 3, survey waves 16 and 17, with a sharp increase in the proportion of direct experience of infection (to 21% on average). The proportion of respondents with no experience of COVID-19 decreased accordingly, from, on average, 66% to 46% to 17% across the three phases.

**Figure 4**

*Proportions of participants with each category of experience across the 17 survey waves.*



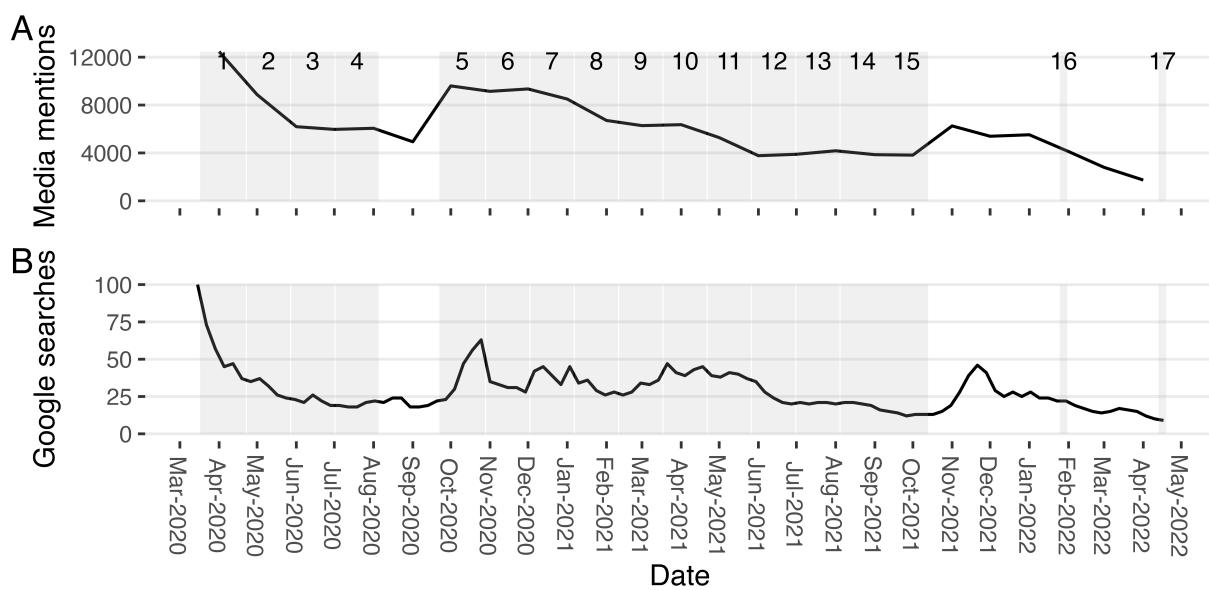
To summarize the findings on the effects of experience, direct experience of infection notably increased risk judgements across all survey waves. These results corroborate the findings of Dryhurst et al. (2020) and show that the *amplification effect* of direct experience persisted throughout the 2-year time window. Furthermore, we found that others' experience also increased risk judgements, with this effect being most pronounced

for family members. We now turn to our third research question, investigating the impact of media mentions and Google searches on risk judgements.

### Is the volume of communication about COVID-19 related to risk judgements?

**Figure 5**

*Panel A: Media mentions of ‘COVID\*’ and ‘Corona\*’ in major German print and online media outlets. Panel B: Google searches for ‘Corona\*’ in Germany.*



According to Luhmann, 2004, hazardous events have no social resonance unless they are communicated. Against this background, we investigated the extent to which media coverage of COVID-19 correlated with risk judgements. Figure 5A plots how often COVID-19 was mentioned in major German print and online media outlets across the 17 survey waves (length-normalized measure). Users of search engines such as Google also communicate through their exploratory behaviors. We therefore additionally tracked the frequency of Google searches for information on COVID-19. Panel 5B plots the results of the Google Trends analysis.

Both trends are almost mirror images of the incidence trend shown in Figure 1. Not

surprisingly, communication about the pandemic (in terms of media reporting and Google searches) was most pronounced during the early stages of the pandemic and then dropped, with substantial fluctuations, to a much lower level in May 2022. A mixed-effects model predicting risk judgements by changes in communicative trends, and with participant (nested in age group) as a random effect, yielded significant effects for both media mentions  $b = 0.10, CI[0.10 - 0.11]$  and Google searches  $b = 0.10, CI[0.10 - 0.11]$ . This indicates that higher risk judgements were positively associated with the frequency of media mentions and Google searches (see Table A5 in the Appendix for details). Nevertheless, during waves 16 and 17, when COVID-19 incidences were highest, media mentions and Google searches dropped to their lowest levels and apparently uncoupled from people's risk judgements.

Our analysis up to this point uses an important structural factor only as a co-variate: *age*. In what follows we first want to focus on the question whether age plays a moderating role for risk judgements and then turn to the analysis of fear in different life domains.

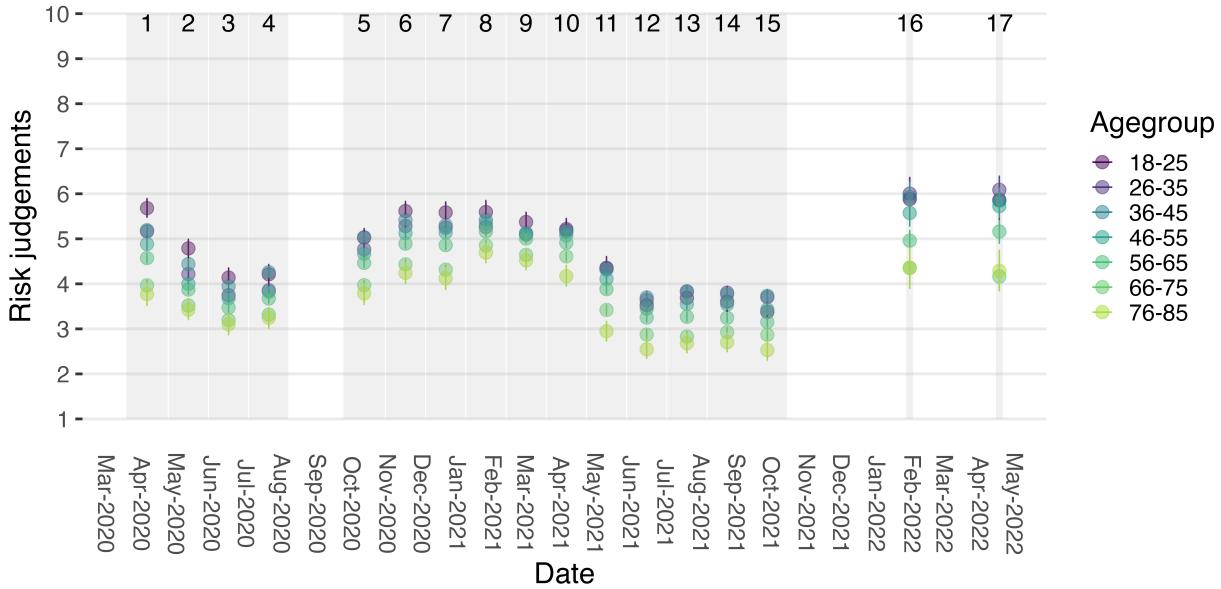
### **Does age moderate risk judgements?**

In the early days of COVID-19, the mortality risk was especially high for vulnerable groups. There is scientific consensus that the most vulnerable population group was the elderly (Daoust, 2020). Accordingly, many governments targeted older adults in their virus containment strategies, and introduced drastic public health measures including social isolation and lockdowns. Furthermore, older adults were prioritized once vaccines were available (Shahid et al., 2020). How did this heightened concern for their wellbeing affect the risk judgements of older adults? Across the 17 survey waves, we found that the two oldest age groups (66–75 years and 76–85 years) had the lowest perceived risk judgements, whereas the youngest age group (18–25 years) had the highest (see Figure 6).

This finding was substantiated by a multilevel analysis predicting risk judgements by age groups (using the youngest participants, aged 18–25 years, as the reference category). We found no significant difference between the youngest and the adjacent age

**Figure 6**

*Risk judgements across seven age groups. Error bars represent bootstrapped 95% CIs.*



groups up to 55 years. In contrast, the three older age groups had significantly lower risk judgements:  $b = -0.09, CI[-0.14 -- 0.03]$  for 56–65 years,  $b = -0.23, CI[-0.28 -- -0.17]$  for 66–75 years, and  $b = -0.30, CI[-0.38 -- -0.22]$  for 76–85 years (see Appendix A4 for details, note that we will focus on the 4-way split here. Results for the age groups, no effect up to 55, a significant effect for 56 and older, were similar using the 2-way split analysis reported above). We return to this somewhat puzzling finding in the Discussion.

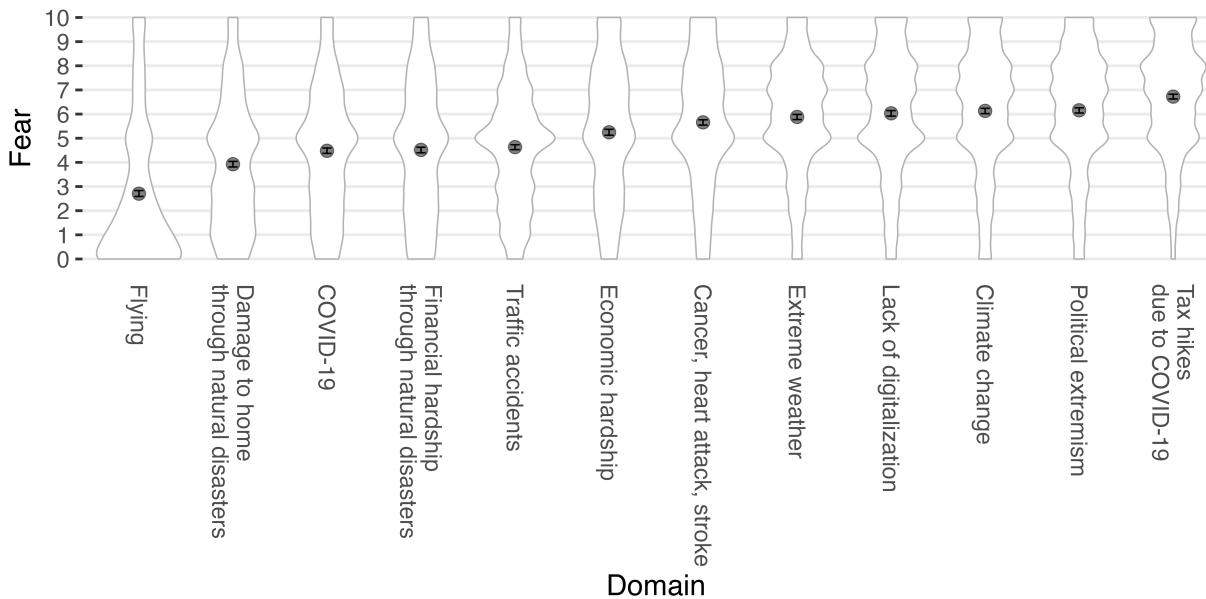
### How does fear of COVID-19 compare to other fears?

Our final analysis concerns how the fear of COVID-19 compares with other fears (e.g., fear of flying, extreme weather events, and political extremism). Figure 7 plots these average fear ratings (on a 11-point scale), ordered from lowest to highest.

Flying had the lowest average fear rating ( $M = 2.7, SD = 2.9$ ) and COVID-19 the third lowest ( $M = 4.5, SD = 2.6$ ) of the 12 evaluated fears. The average rating for other health fears (cancer, heart attack, stroke) was more than one scale point larger, at  $M = 5.7$

**Figure 7**

*Average fear ratings. Error bars represent bootstrapped 95% CIs.*



( $SD = 2.7$ ). At the time this question was asked (in wave 15; i.e., September–October 2021), participants seemed to be most worried about (in increasing order) Germany lagging behind on digitalization, climate change, political extremism, and tax hikes due to COVID-19 (all with  $M_s > 6.0$ ).

## Discussion

The world is currently in a state of *polycrisis*, defined as the simultaneous occurrence of several catastrophic events (Heading & Zahidi, 2023). These include the COVID-19 pandemic, the war in Ukraine, the energy crisis, the cost-of-living crisis, and the climate crisis. Faced with a world in polycrisis, how citizens perceive various risks is becoming increasingly important, particularly as it informs their willingness to take action. One factor driving risk judgements has received increasing attention in recent years: personal experience. The COVID-19 pandemic can serve as a ‘model risk’ to investigate how personal experience changes people’s risk judgements. Like climate change, a

pandemic is a process that unfolds in time—but at a much faster pace. Drawing on data from a panel survey with 17 waves from March 2020 to May 2022, we examined for a western society how direct and indirect experience of infection with COVID-19 affected the judgement of risk (of infection) relative to the impact of objective incidence and collective measures of communication about the hazard.

Our results can be summarized in four key findings about the link between personal experience of COVID-19 and risk judgements. First, there was a marked difference in risk judgements between people with *no experience* and those with *direct experience*. The latter deemed the risk of infection consistently and notably higher. This result is in line with the findings of Dryhurst et al. (2020), who found that direct experience of the virus was an important predictor of risk perception in the early months of the pandemic (and, for instance, the most important predictor of risk perception in the United States). We refer to the effect of direct experience as *experiential amplification* of risk. Second, we found a ‘gradient’ in the power of experience: The closer the respondent was to the person who was the source of experience, the stronger the impact on their risk judgement. For instance, a family member being infected had a stronger psychological impact than a friend or a colleague being infected. Third, we found a positive association between communication on the virus and risk judgements: When COVID-19 media mentions (in online and traditional newspapers) and Google searches for COVID-19-related information were high, the risk of infection was generally judged higher. This correlation vanished as media coverage and Google searches decreased over time. Finally, risk judgements (of contracting COVID-19) were consistently lower in older than in younger age groups.

Let us briefly discuss the effect of age. As Figure 6 shows, the two most vulnerable age groups, those aged 66 to 85 years, consistently gauged the risk of infection lowest—much lower than, for instance, those aged 18 to 25 years. There are at least two possible interpretations of this somewhat puzzling result. One is that the older age cohorts were not systematically more responsive to the threat of infection than younger cohorts,

and that, if anything, they were less responsive. Such an interpretation would echo the observation of Daoust (2020) that elderly people (age > 70 years, across 27 countries) were not more disciplined in terms of compliance with preventive measures (compared to people in their 50's and 60's). However, a worldwide assessment of adherence behavior from March through December 2020 in 124 countries found that the elderly (age > 60 years) adhered more initially and maintained greater relative adherence over time (Petherick et al., 2021). This is consistent with a second interpretation of the findings presented in Figure 6: Because older and more vulnerable risk groups adhered more strictly to precautionary measures (e.g., staying at home, wearing a face mask), their perceived risk of infection was lower. Indeed, as an additional analysis (see Figure A1 in the Appendix) of fear of a life-threatening disease showed, older age cohorts were not unduly optimistic (Weinstein, 1982) about their susceptibility to a severe (life-threatening) case of corona. Throughout 2020 and in early 2021, the older age groups' assessments of their risk of life-threatening disease were consistently much higher than those of the younger age groups. This only changed when vaccines became widely available in summer 2021.<sup>5</sup>

What are the policy implications of our results? Our findings converge with others that show (in)direct experience to be important for risk judgements. In further interpreting the role of direct experience in the pandemic, however, some important issues should be kept in mind. First, we do not know whether the risk judgements of people with (in)direct experience are better calibrated than those of people without. Second, policy makers should not focus solely on people with direct experience of infection; not having been infected over hundreds of days in all likelihood has strong informational value for the person. By the same token, as Hertwig and Wulff (2022) pointed out, most people living in the red zone of Mount Vesuvius, Europe's ticking time bomb, have never experienced it erupting—the last eruption was in March 1944. Many *all-clear experiences* are also a source of risk beliefs and may affect individuals' risk judgements. Third, if the risk judgements of

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<sup>5</sup> Data on fear of a life-threatening case of COVID-19 were collected in 13 of the 17 waves.

people with direct experience of an infection do prove to be better calibrated, then it raises the question of how the risk judgements of those who lack this experience can be improved. One approach could be to enrich standard risk information, that is, numerical and graphical descriptions, with what Kaufmann et al. (2013), in the context of investment decisions, have called *experience sampling*. Kaufmann et al. (2013) designed a simple *risk tool* that enabled participants to experience the distribution of a risky financial product. Rather than providing clients with standard risk information (e.g., fact sheets on historical returns), they had clients interactively sample possible outcomes, that is, possible returns on an investment. Each sampled outcome contributes to the return distribution, which is displayed at the end of the sampling process. Kaufmann et al. (2013) observed differences between experience and description on various dimensions. For instance, ‘experience’ investors allocated a larger percentage of their endowment to the risky fund than did ‘description’ investors; they were more accurate in their understanding of the options’ expected return and, importantly, in the estimated probability of a loss. Enlisting the methodology of experience sampling, Wegwarth et al. (2023) found that vaccine-hesitant adults who engaged with an interactive experience simulator were more likely to show positive change in COVID-19 vaccination intention and benefit-to-harm assessment than those presented with the same information in a conventional text-based format.

To conclude, the COVID-19 pandemic offers a unique opportunity to examine how changing personal experience shapes changing risk judgements across the highly volatile spatio-temporal dynamics of a recurrent disease. We found that direct experience of COVID-19 infection increased risk judgements. In addition, the impact of others’ experience gradually declined as a function of social distance. Personal experience has also been shown to matter for risk assessments and willingness to take action in the context of other risks, such as climate change. One resulting task for future risk communication is to go beyond one-size-fits all approaches and to tailor communication to people’s changing levels of experience.

## Appendix

**Table A1**

*Demographic characteristics of participants (N = 15,015)*

Characteristic	n	%
<b>Gender</b>		
Female	7690	51.2
Male	7325	48.8
<b>Age groups (in years)</b>		
18–25	1671	11.1
26–35	2288	15.2
36–45	2308	15.4
46–55	2676	17.8
56–65	3041	20.3
66–75	2448	16.3
76–85	580	3.9
<b>School-leaving qualification</b>		
Primary school or lower-track secondary school	2671	17.8
Intermediate-track secondary school	7112	47.4
College-track secondary school	5024	33.5
Left school without qualifications	100	0.7
Still in school	108	0.7

*Note.* The school-leaving qualification was translated from the following German school levels in brackets: Primary school or lower-track secondary school [Haupt- oder Volksschul-Abschluss]; Intermediate-track secondary school [Mittlere Reife oder Abschluss der polytechnischen Oberschule]; College-track secondary school [Abitur, Fachhochschulreife (Gymnasien oder erweiterte Oberschule)]; Left school without qualifications [Von der Schule abgegangen ohne Schulabschluss]; Still in school [Noch in Schulausbildung]

**Table A2**

*Number of participants per wave. The last column indicated the percentage of participants in a given wave who are also participating in wave 1, e.g., 89 % of participants from wave 2 also participated in wave 1*

Wave	Sample size	Percent participants in wave x and wave 1
1	11200	NA
2	10823	89
3	10560	89
4	10415	89
5	10942	89
6	10150	88
7	10115	89
8	10034	89
9	10028	87
10	9813	88
11	9586	88
12	9590	86
13	9260	87
14	9122	87
15	9234	87
16	2211	86
17	2072	86

**Questionnaire items: Original German wording and English translation**

Our questionnaires were distributed in German; here we provide translations for all items analyzed in the main text. Note that the wording of some questions (e.g., infection status) changed across waves; this is indicated below.

**Risk judgement**

**Original German:** Wie groß schätzen Sie das Risiko ein, dass Sie selbst oder Mitglieder Ihrer Familie sich künftig mit dem CoronaVirus anstecken? (0: ‘sehr klein’ – 10: ‘sehr groß’)

**English translation:** What is your estimate of the risk that you or members of your family will become infected with the coronavirus in the future? (0: ‘very small’ – 10: ‘very large’).

---

**Infection status**

**Original German, waves 1–4:** In vielen Ländern, darunter auch in Deutschland, sind Personen am sogenannten Corona-Virus erkrankt. Wurde bei Ihnen oder in Ihrem Umfeld eine Infektion festgestellt, gab es einen Verdacht auf Infektion oder keinen Hinweis auf eine Infektion?

**English translation, waves 1–4:** In many countries, including Germany, people have been infected with the coronavirus. Have you or anyone close to you had a confirmed infection, a suspected infection, or no indication of infection?

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**Original German, wave 5 onwards:**  
Wurde bei Ihnen selbst oder in Ihrem Umfeld seit Ausbruch der Corona-Pandemie eine COVID-19 Infektion festgestellt?

**English translation, wave 5 onwards:**  
Have you or anyone close to you been diagnosed with a COVID-19 infection since the outbreak of the corona pandemic?

---

Response categories for both questions:

**Original German:**

1. Infektion festgestellt.
2. Verdacht auf Infektion.
3. Keine Hinweise auf Infektion.
4. Trifft nicht zu/weiss nicht.

**English translation:**

1. Confirmed infection.
2. Suspected infection.
3. No evidence of infection.
4. Does not apply/don't know.

---

This variable was recoded from the following original categories: (1) The responses 'Confirmed infection' and 'Suspected infection' were combined into 'yes'; (2) 'No evidence of infection' was coded 'no'; (3) The remaining category 'Does not apply/don't know' was left as 'not applicable'.

These questions were asked separately for six levels of social proximity. The relevant part (e.g., Have you been diagnosed ... ? Has some in your family been diagnosed ... ?) was replaced in each of the six questions. In a second step the six questions were recoded into 4 groups used in the analysis: ‘direct experience’ (1), ‘family experience’ (2), ‘network experience’ (3-6). In the case the question was answered with ‘No evidence of infection’ the fourth category ‘no experience’ was used.

**Original German:**

1. Bei mir selbst.
2. In meiner Familie (Partner, Kind, Eltern, Geschwister).
3. In meinem Freundes- und Bekanntenkreis.
4. In dem Betrieb, in dem ich arbeite.
5. In der Schule oder KITA meines Kindes.
6. In meiner Nachbarschaft.

**English translation:**

1. I was diagnosed. [direct]
  2. Someone in my family (partner, child, parents, siblings) was diagnosed. [family]
  3. In my circle of friends and acquaintances. [network]
  4. In my workplace, someone was diagnosed. [network]
  5. In my child’s school or Kindergarten someone was diagnosed. [network]
  6. In my neighbourhood someone was diagnosed. [network]
-

**Fear****Original German:**

Angst davor, ...

---

... dass ich selbst oder Mitglieder meiner Familie sich mit dem neuen Corona-Virus anstecken werden.

---

... dass Deutschland immer häufiger von Wetterextremen wie Dürre, Hitzewellen oder Starkregen betroffen wird.

---

... dass sich der politische Extremismus ausbreitet.

---

... dass der Staat wegen der Schuldenlast der Corona-Krise dauerhaft Steuern erhöht oder Leistungen kürzt.

---

... dass der Klimawandel dramatische Folgen für die Menschheit hat.

---

... dass ich einen Unfall im Straßenverkehr erleide.

---

... dass ein schweres Naturereignis (wie zum Beispiel Starkregen, Überschwemmung oder Erdrutsch) das Gebäude, in dem ich wohne, stark beschädigt oder vollständig zerstört.

---

**English translation:**

Fear, ...

---

... that I or members of my family will get infected with the new Coronavirus.

---

... that Germany will increasingly be affected by extreme weather events such as droughts, heat waves, or heavy rainfall.

---

... that political extremism is spreading.

---

... that the state will permanently increase taxes or cut benefits due to the debt burden of the Corona crisis.

---

... that climate change will have dramatic consequences for humanity.

---

... that I will be involved in a traffic accident.

---

... that a natural disaster (such as heavy rainfall, floods, or landslides) will damage or destroy the building where I live.

---

... dass Deutschland bei der Digitalisierung hinterherhinkt.

---

... dass ich schwer an Krebs, einem Herzinfarkt oder einem Schlaganfall erkranke.

---

... in ein Flugzeug zu steigen.

---

... dass ich persönlich einmal wirtschaftlich in Not gerate, zum Beispiel durch Verlust des Arbeitsplatzes oder von Ersparnissen oder aufgrund sonstiger Ereignisse.

---

... dass die Folgeschäden eines schweren Naturereignisses (wie zum Beispiel Starkregen, Überschwemmung oder Erdrutsch) mich finanziell überfordern.

---

... that Germany is lagging behind in digitalization.

---

... that I will fall seriously ill with cancer, a heart attack, or a stroke.

---

... of flying.

---

... that I will experience economic hardship due to losing my job, my savings, or other events.

---

... that the consequences of a natural disaster (such as heavy rainfall, floods, or landslides) will cause me financial hardship.

### Results of multilevel modeling

**Table A3**

*Multilevel model predicting risk judgement by experience of infection (2-way split: direct or no experience)*

<b>Predictors</b>	<b>riskperception</b>			<b>riskperception</b>		
	<b>Estimates</b>	<b>CI</b>	<b>p</b>	<b>Estimates</b>	<b>CI</b>	<b>p</b>
(Intercept)	0.25	0.16 – 0.35	<0.001	1.01	0.60 – 1.43	<0.001
infection [no experience]	-0.26	-0.28 – -0.23	<0.001	-0.25	-0.28 – -0.22	<0.001
wave				-0.07	-0.11 – -0.03	0.001
gender [female]				0.05	0.02 – 0.07	<0.001
agegroup26-35				-0.01	-0.07 – -0.05	0.830
agegroup36-45				0.03	-0.03 – -0.09	0.294
agegroup46-55				-0.02	-0.08 – -0.03	0.425
agegroup56-65				-0.13	-0.18 – -0.07	<0.001
agegroup66-75				-0.28	-0.34 – -0.22	<0.001
agegroup76-85				-0.37	-0.45 – -0.29	<0.001
media				-0.10	-0.25 – -0.06	0.212
google hits				0.14	0.02 – 0.25	0.024
vaccination status				-0.10	-0.17 – -0.02	0.014
covid cases				0.15	0.12 – 0.18	<0.001
<b>Random Effects</b>						
$\sigma^2$	0.41			0.36		
$\tau_{00}$	0.52 PNR_fix:agegroup			0.51 PNR_fix:agegroup		
	0.08 wave:year_month			0.01 wave:year_month		
$\tau_{11}$	0.17 PNR_fix:agegroup.infectionno experience			0.16 PNR_fix:agegroup.infectionno experience		
$\rho_{01}$	-0.32 PNR_fix:agegroup			-0.24 PNR_fix:agegroup		
ICC	0.58			0.60		
N	14196 PNR_fix			12412 PNR_fix		
	7 agegroup			7 agegroup		
	17 wave			12 wave		
	22 year_month			13 year_month		
Observations	138777			83326		
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.004 / 0.584			0.113 / 0.647		

**Table A4**

*Multilevel model predicting risk judgement by experience of infection (4-way split: direct, family, network, or no experience)*

Predictors	riskperception			riskperception		
	Estimates	CI	p	Estimates	CI	p
(Intercept)	0.29	0.20 – 0.38	<0.001	1.02	0.62 – 1.43	<0.001
infection contact [family experience]	-0.10	-0.12 – -0.07	<0.001	-0.12	-0.15 – -0.09	<0.001
infection contact [network experience]	-0.22	-0.25 – -0.20	<0.001	-0.25	-0.28 – -0.22	<0.001
infection contact [no experience]	-0.37	-0.40 – -0.35	<0.001	-0.36	-0.39 – -0.33	<0.001
wave				-0.07	-0.11 – -0.03	<0.001
gender [female]				0.05	0.02 – 0.07	<0.001
agegroup26-35				0.00	-0.06 – 0.06	0.986
agegroup36-45				0.05	-0.01 – 0.11	0.110
agegroup46-55				0.01	-0.05 – 0.06	0.793
agegroup56-65				-0.09	-0.14 – -0.03	0.002
agegroup66-75				-0.23	-0.28 – -0.17	<0.001
agegroup76-85				-0.30	-0.38 – -0.22	<0.001
media				-0.09	-0.24 – 0.06	0.237
google hits				0.14	0.02 – 0.25	0.021
vaccination status				-0.10	-0.17 – -0.02	0.012
covid cases				0.14	0.11 – 0.18	<0.001
<b>Random Effects</b>						
$\sigma^2$	0.40			0.36		
$\tau_{00}$	0.52 PNR_fix:agegroup			0.51 PNR_fix:agegroup		
	0.07 wave:year_month			0.01 wave:year_month		
$\tau_{11}$	0.15 PNR_fix:agegroup.infection_contactfamily experience			0.17 PNR_fix:agegroup.infectionno experience		
	0.16 PNR_fix:agegroup.infection_contactnetwork experience					
	0.23 PNR_fix:agegroup.infection_contactno experience					
$\rho_{01}$	-0.34 PNR_fix:agegroup.infection_contactfamily experience			-0.29 PNR_fix:agegroup		
	-0.35 PNR_fix:agegroup.infection_contactnetwork experience					
	-0.37 PNR_fix:agegroup.infection_contactno experience					
ICC	0.59			0.59		
N	14252 PNR_fix			12412 PNR_fix		
	7 agegroup			7 agegroup		
	17 wave			12 wave		
	22 year_month			13 year_month		
Observations	142344			83326		
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.014 / 0.592			0.122 / 0.644		

**Table A5**

*Multilevel model predicting risk judgements by media mentions and Google searches*

<i>Predictors</i>	<b>riskperception</b>		
	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.01	-0.00 – 0.02	0.160
media	0.10	0.10 – 0.11	<0.001
google hits	0.10	0.10 – 0.11	<0.001
<b>Random Effects</b>			
$\sigma^2$	0.47		
T <sub>00</sub> PNR_fix:agegroup	0.51		
ICC	0.52		
N PNR_fix	14371		
N agegroup	7		
Observations	150124		
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.035 / 0.539		

## Additional Analysis

#### **Fear of a life-threatening disease**

**Original German:** Für wie groß halten Sie die Wahrscheinlichkeit, dass das neue Corona-Virus bei Ihnen bis Ende dieses Jahres eine lebensbedrohliche Erkrankung auslöst? (0: ‘überhaupt nicht wahrscheinlich’ – 100: ‘absolut wahrscheinlich’)

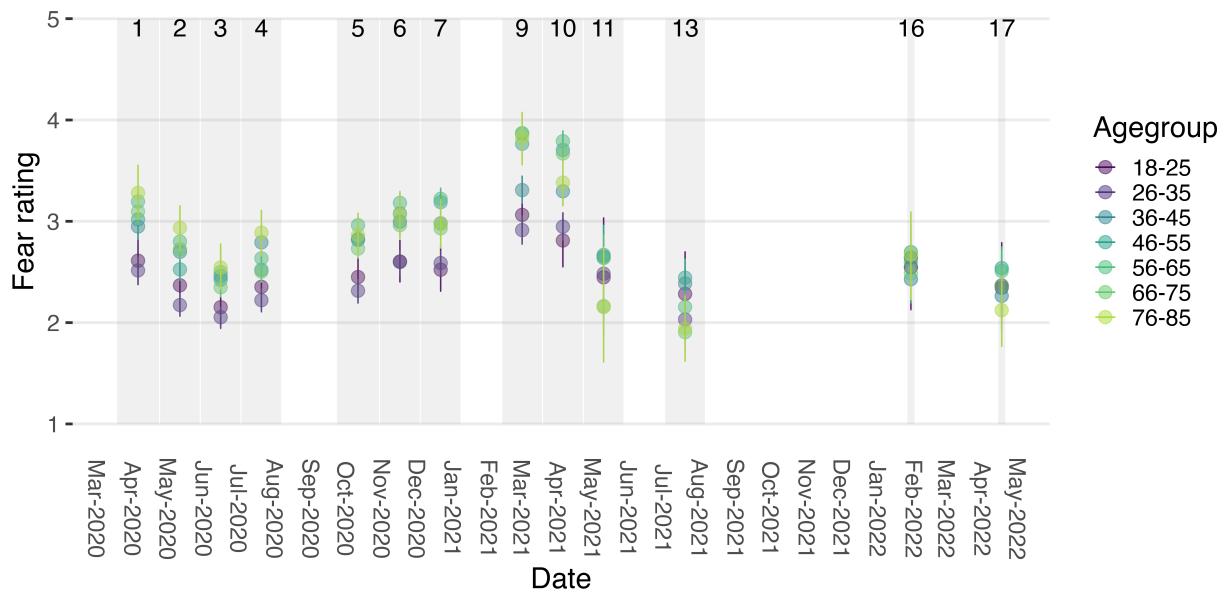
**English translation:** How likely do you think it is that the new corona virus will cause you a life-threatening illness by the end of this year? (0: ‘not at all likely’ – 100: ‘absolutely likely’)

---

The responses ranging from 0 to 100 were divided by 10 to make comparison with the other measures easier.

**Figure A1**

*Fear of a life-threatening disease by age group. Error bars represent bootstrapped 95% CIs.*



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