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COVID-19: Risk Perception, Risk Communication, and Behavioral Intentions

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Susan Joslyn[1], Sonia Savelli[2], Horacio A. Duarte[3], Jessica Burgeno[1], Chao Qin[1], Jee Hoon Han[1], and Gala Gulacsik[1]

[1] Department of Psychology, University of Washington
[2] Department of Human Centered Design and Engineering, University of Washington
[3] Department of Pediatrics, Division of Infectious Diseases, University of Washington

Critical to limiting the spread of Coronavirus disease 2019 (COVID-19) and future pandemics is compliance with behavioral recommendations such as mask wearing and social distancing. Compliance may depend upon understanding the seriousness of the health consequences and the likelihood they will occur. However, the statistics that speak to these issues in an ongoing pandemic are complex and may be misunderstood. An online experiment with a U.S. sample tested the impact on perceived likelihood, trust, concern, behavioral intentions, and agreement with government response of numeric (mortality/infection percentage by age group) and gist expressions (which age group was smaller [mortality] or roughly equivalent [infected]). While the differences in risk perception and willingness to engage in activities between younger and older participants were small, "gist infection and mortality" increased willingness to wear a mask among younger participants. Government restrictions (e.g., social distancing) impacted willingness to engage is risk-reduction and risk-seeking activities. The biggest differences were due to political ideology. Although conservatives perceived similar levels of risk as did liberals, they were much less willing to engage in protective behaviors and support government policies. However, conservatives were affected by some risk communication formats and restrictions suggesting that future work should be aimed at this issue.

Public Significance Statement

Peoples' risk perception may be influenced by messaging that focuses on single outcomes (more elderly among deaths) intended to protect the most vulnerable. Younger people may think they are also less likely to become infected. However, messages including both mortality and infection statistics can overcome this bias. Results also suggest that although there are large differences due to political ideology, government restrictions encourage appropriate protective behavior across the political spectrum.

Keywords: COVID-19, coronavirus, risk perception, risk communication, protective behavior

SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), which causes Coronavirus disease 2019 (COVID-19), had a devastating impact on global public health. Since being declared a pandemic in March of 2020, there have been over 170 million confirmed cases of COVID-19 and over 3.5 million deaths worldwide (Johns Hopkins University and Medicine Coronavirus Resource Center, 2021). Experts agreed from the outset that limiting the spread of the disease requires substantial changes to everyday behavior by individuals (World Health Organization, 2020), perhaps the most challenging of which involve limiting social contact. Governments in the United States and abroad issued recommendations and mandates to accomplish that goal ranging from "social distancing," "stay at home" to "shelter in place," and eventually the wearing of face masks in public. However, compliance with such recommendations varied (Barari et al., 2020; Cohen et al., 2020; Park et al., 2020; Roy-Chowdhury et al., 2020) and began to wane in many locations as the time people were asked to sustain those behavioral adjustments lengthened (Sblendorio, 2020). Although there are clearly many factors that contribute to the lack of compliance, at least part of the issue may have been people's understanding of the risk, both in terms of the seriousness of the potential health consequences as well as the likelihood that they would occur.

Indeed, many theories addressing willingness to engage in protective behaviors (Janz & Becker, 1984; Lindell & Perry, 2012), such as Protection Motivation Theory (Rogers & Prentice-Dunn, 1997), emphasize the importance of the decision makers understanding of both the severity and likelihood of the threat as well as other factors such as the efficacy of the

Susan Joslyn https://orcid.org/0000-0002-4452-0695
Jessica Burgeno https://orcid.org/0000-0001-8907-2294
Chao Qin https://orcid.org/0000-0001-7448-1597
Jee Hoon Han https://orcid.org/0000-0002-8105-526X

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Correspondence concerning this article should be addressed to Susan Joslyn, Department of Psychology, University of Washington, Guthrie 215, Box 351525, Seattle, WA 980105, United States. Email: susanj@uw.edu

recommended preventive behavior and trust in the information source. In fact, evidence suggests that such factors predict intentions to protect against COVID-19 (Al-Rasheed, 2020; de Bruin & Bennett, 2020) as well as swine flu, which requires similar measures (Rubin et al., 2009).

Therefore, risk communication may be successful to the degree that it addresses these factors. Here, we focus on the communication of the likelihood of the threat. Indeed, our own previous research in the domain of weather has shown that people are aware of the inherent uncertainty in predictions of adverse events (Savelli & Joslyn, 2013), understand fairly complex expressions of uncertainty such as numeric percent chance (e.g., 30% chance; Joslyn & LeClerc, 2012) and have greater trust in predictions that include such expressions (Joslyn & LeClerc, 2013). There is also evidence that people are more willing to comply with recommendations to protect themselves if the uncertainty of the outcome is acknowledged (LeClerc & Joslyn, 2015). Therefore, similar principles may be operating in the context of COVID-19. People may understand that if they attend a holiday gathering with family, it is not certain that they will contract or spread COVID-19. Thus, acknowledging the uncertainty may increase trust in COVID-19 messaging and by extension, willingness to comply with protective recommendations.

Communicating COVID-19 Risk

However, estimating and then communicating the risk of acquiring the COVID-19 virus is more complex than is estimating the risk of noncommunicable diseases with which members of the public may be more familiar. For example, one's risk of developing cardiovascular disease is primarily driven by individual-level factors, such as one's age, smoking history, weight/height, blood pressure, and cholesterol level (Kannel et al., 1976). In contrast, the risk of acquiring a communicable (infectious) disease depends on multiple dynamic factors that extend beyond the individual who is at risk of acquiring the infection. First, to become infected, one must be exposed to another individual who is infected with COVID-19. People who live in areas with a higher prevalence may be more likely to come in contact with an infected individual. Prevalence, which is an important measure of the frequency of a disease, is defined as the number of cases divided by the size of the population at a specified time. Random sampling and testing of large portions of the community are needed to accurately estimate prevalence (Menachemi et al., 2020); however, this type of data has been scarce. To date, percent positive rates (i.e., the percentage of SARS-CoV-2 tests performed that are positive) have been a common measure of the frequency of cases of COVID-19. However, this measure is prone to a selection bias, as individuals who have concerning symptoms or have had a known exposure may have been more likely to get tested than others. In addition, early in the pandemic when this study was conducted, nationwide positivity rates were unavailable in the United States. Second, even if accurate prevalence estimates were available, the probability of coming in contact with an infected individual also depends on behavior, that is, how likely the infected and noninfected individuals are to stay home and avoid public gatherings. This is further complicated by the fact that some infected individuals may be asymptomatic and not realize they should stay home. Finally, if an uninfected individual is indeed exposed to an infected individual, the risk of transmission occurring depends upon multiple factors. While there is general consensus that greater distance relative to the infected individual, being outdoors (compared to being indoors), and mask wearing by the infected individual and/or the person at risk all reduce the risk of transmission, it is at present not possible to quantify the absolute or relative risk associated with any of these factors. Thus, estimating the risk of contracting COVID-19 with available data in an ongoing pandemic is a complex and imperfect process at best. In contrast, estimating the likelihood of dying once you contract COVID-19 is simpler, as it can be informed by one metric known as a case-fatality rate (i.e., the number of fatal cases divided by the number of total cases identified). In addition, there is evidence that characteristics such as being older or having underlying medical conditions make some individuals more likely to suffer severe symptoms or die from COVID-19 (Onder et al., 2020). On the other hand, as far as we know, prior to the vaccine rollout, it was behavior alone that impacted the likelihood of contracting the disease (Bi et al., 2020; Koma et al., 2020; Verity et al., 2020; Wu & McGoogan, 2020) rather than characteristics such as age (e.g., Jones et al., 2020). Thus, the information that speaks to health risk in the context of infectious diseases such as COVID-19 is complex in both how it is expressed and how it relates to the likelihood of specific outcomes. For these reasons, it may be particularly difficult for people to understand.

Research Project

Risk Perception

In the research reported here, one of the major goals was to determine how risk messaging, based on the statistics available in the midst of the pandemic, impacted peoples' perception of the likelihood of contracting or dying from COVID-19. Indeed, perhaps one of the most well-known statistics pertaining to these issues was that more older than younger people become seriously ill and die from COVID-19 (Center for Disease Control and Prevention [CDC], COVID-19 Data Tracker). For instance, as of December 2020, according to the CDC website approximately 95% of the deaths due to COVID-19 were among those 50 years of age or older. Obviously, this does not mean that older people have a 95% chance of dying if they contract COVID-19. That likelihood, closer to 8% at the time, was estimated from the proportion of people who had died, among older people who had tested positive for COVID-19, the case-fatality rate. These two proportions (95%, 8%) are based on different reference classes, that is, the class of events or objects to which the percentage refers. People may not notice the difference in reference class, mistaking the proportion of older people who died among *all COVID-19 deaths* for the proportion of older people who died among *older people who tested positive for COVID-19*. This confusion could arise for a number of reasons because both numbers are percentages and due to this shared feature, one might be mistaken for the other, because users are expecting to hear about the latter, more relevant proportion, and/or because people are prone to reference class errors (Joslyn et al., 2009; Reyna & Brainerd, 2008). In other words, people may interpret messages describing proportions of deaths to mean that their likelihood of dying if they contract COVID-19 is much higher than it actually is. This interpretation could, in turn, decrease trust, if it is subsequently identified as an exaggeration (Rubin et al., 2009).

The prominence of risk messaging emphasizing the proportion of older people among deaths could give rise to misinterpretations

Q3

among younger people as well. Younger people may think that if they are less likely to suffer serious consequences of COVID-19, they are also less likely to contract and spread the disease. In fact, at the time that this study was conducted, approximately equal proportions of those testing positive were older and younger. Nonetheless, younger people may be tempted to think that if the severity of the event is low for them, so is the likelihood. Indeed, people have a tendency to conflate severity and likelihood, known as the severity bias (Bonnefon & Villejoubert, 2006; Harris et al., 2009). For instance, there is evidence that people systematically interpret lower probabilities for neutral than for more severe outcomes (Weber & Hilton, 1990). If this principle is operating in the context of COVID-19, then younger people may think that the likelihoods of getting and spreading the disease are low for them because the severity is low. This could, in turn, reduce willingness to comply with protective recommendations among younger people, as had been seen in some early studies (e.g., Barari et al., 2020; Cohen et al., 2020; Park et al., 2020; Roy-Chowdhury et al., 2020).

Thus, because the statistics that speak to the likelihood of contracting and dying of COVID-19 are complex, both in their expression as well as their relationship to the actual likelihood, people may take reasoning shortcuts when processing this information. Either of the assumptions described above, that proportions of an age group among deaths indicate the likelihood of death or that likelihood and severity are associated, may be due to common mental shortcuts (Kahneman, 2003). As such, they may not be open to conscious awareness. Many cognitive and behavioral scientists believe that there are at least two major kinds of human reasoning (Kahneman, 2011; Kahneman & Frederick, 2002), referred to as dual processes or dual systems accounts (Carruthers, 2009; see Keren, 2013; Keren & Schul, 2009; Kruglanski & Gigerenzer, 2011, for alternative interpretations). One is fast, automatic, largely unconscious, and based on associative processes such as pattern matching (*System 1*). The other, *System 2* is slow, deliberate, and open to conscious awareness. Although System 2 supports logical step-by-step reasoning, overall capacity is severely limited because it depends on working memory, roughly synonymous with consciousness (Baddeley, 2012). Therefore, when people encounter new information that is complex, simplifications are inevitable. Thus, System 1 simplifying assumptions may be applied to the available COVID-19 risk information, leading some people to think that the risk they face is greater than it is, and others to think that it is less. One of the main goals of the research presented here was to determine the impact of risk messages on users' understanding of the risk they face. Therefore, we manipulated several factors of risk messaging based on the available early-stage pandemic data. We provided participants with information about COVID-19 infections and mortality to determine whether *severity-likelihood biases* would be observed. If so, we would expect to see the following:

> *Hypothesis 1a*: Younger people would perceive a lower likelihood of infection with mortality than with infection statistics.

> *Hypothesis 1b*: Younger people will perceive a higher likelihood of dying with infection than mortality statistics.

> *Hypothesis 1c*: Older people will perceive a higher likelihood of infection with mortality than infection statistics.

> *Hypothesis 1 d*: Older people will perceive a lower likelihood of dying with infection than mortality statistics.

If such biases are observed, one way to overcome them may be to present both of these statistics together so that people can see the contrast.

> *Question 1e*: Will presenting mortality and infection statistics together lead to fewer biases (1a–d) than when they are presented singly?

In order to address the *reference class confusion* (e.g., mistaking the proportion of older people among COVID-19 deaths for deaths among older people infected with COVID-19), we included case-fatality rates which describe the percent of those infected who died.

> *Hypothesis 2*: People will perceive a more accurate (lower) likelihood of dying if they contract COVID-19 when receiving case-fatality rates compared to when given no information at all or statistics describing proportions of age groups among deaths.

Another way to overcome any potential biases may be to present age group comparisons excluding precise numeric percentages that might imply that they are likelihood estimates (see gist message in Table 1). Indeed, there is now strong evidence that reducing information to the meaningful essence (the gist) is preferred in complex reasoning and problem-solving tasks and is independent of working memory (Brainerd & Reyna, 2015). There is also evidence that reducing information to the most relevant components improves decisions (Peters et al., 2007). Moreover, this strategy has been applied successfully in the health domain (Blalock & Reyna, 2016; Reyna, 2012). Therefore, the gist format may be more compatible with peoples' natural tendency to condense complex statistics to representations indicating simply which is more or less (Reyna & Brainerd, 2008). This may in turn reduce processing load and allow reasoners to better appreciate the outcome targeted and reference class. For these reasons, we also manipulated whether participants received a gist or numeric format. Some participants received messages that included a numeric expression (e.g., 6.3%) and others a simplified format that described only which group was larger.

> *Question 3*: Will gist expressions lead to fewer biases?

However, the vagueness of gist expressions may lead to a reduction in trust because they may be seen as less useful. Indeed, there is some evidence that people prefer to receive numeric likelihood estimates rather than categorical terms (Olson & Budescu, 1997).

> *Hypothesis 4*: People will trust numeric estimates more than gist estimates.

Concern and Behavior

Misperceptions of risk, due to some forms of messaging could in turn, affect the degree of concern and subsequent behavior. Particularly worrisome is the possibility that younger people, thinking that they are less likely to become infected or spread COVID-19 may also be less inclined to engage in protective behavior, comply with government restrictions, and more inclined to take risks (Cammett & Lieberman, 2020). Thus, the second major goal of the research

Table 1
Risk Message Formats

Format condition	Numeric message	Gist message
No information (control)		
Infected	Among all those who tested positive for COVID-19, the percentage who were in each age group 0–49 years of age 46.5% 50–80+ years of age 53.5%	Among all those who tested positive for COVID-19, the percentage of people younger than 50 years of age is approximately equal to the percentage of people 50 years of age or older.
Mortality	Among all those who died of COVID-19, the percentage who were in each age group 0–49 years of age 6.3% 50–80+ years of age 93.7%	Among all those who died of COVID-19, the percentage of people younger than 50 years of age is much smaller than the percentage of people 50 years of age or older.
Infected + Mortality (both)	Among all those who tested positive for COVID-19, the percentage who were in each age group 0–49 years of age 46.5% 50–80+ years of age 53.5% Among all those who died of COVID-19, the percentage who were in each age group 0–49 years of age 6.3% 50–80+ years of age 93.7%	Among all those who tested positive for COVID-19, the percentage of people younger than 50 years of age is approximately equal to the percentage of people 50 years of age or older. Among all those who died of COVID-19, the percentage of people younger than 50 years of age is much smaller than the percentage of people 50 years of age or older.
Case fatality rate	Among those who tested positive for COVID-19 in each age group, the percentage who died in each age group. 0–49 years of age0.3% 50–80+ years of age 4.0%	—

Q4 *Note*. The seven risk messages and no-information condition here referred to as Format Conditions. COVID-19 = Coronavirus disease 2019.

reported below was to test the impact of risk messaging on concern, willingness to engage in various activities and support for government policies regarding such restrictions. Therefore, we asked participants to rate their willingness to engage in various behaviors and comply with government policies to determine the impact of messaging on these responses as well.

> *Question 5*: Will some forms of messaging increase concern, willingness to engage in protective behavior, support for government policies, and decrease willingness to engage in risky behavior?

Political Ideology

Finally, it was becoming increasingly clear at the time that this study was conducted that concern about COVID-19 (Brownstein, 2020; Chang, 2020; Rosenfeld, 2020) as well as attitudes toward protective behaviors (Allcott et al., 2020; Cakanlar et al., 2020; Rosenfeld, 2020) may differ due to political ideology. Indeed, there is growing evidence that decisions to protect oneself in situations like this (e.g., vaccination) are associated with sociopolitical characteristics. In many cases, conservatives have been less willing to
Q5 take such measures than have liberals (Baumgaertner et al., 2018; Hamilton et al., 2015). Moreover, recent research suggests that conservatives have been less willing than liberals and moderates to engage in recommended protective behaviors in response to COVID-19 such as social distancing and restricting travel (van Holm et al., 2020). This may be related to a greater distrust in science among conservatives which has changed over time. A study of trust in science among members of the public from 1974 to 2010 (Gauchat, 2012) revealed that conservatives began the period with the highest trust in science, relative to liberals and moderates, and ended it with the lowest. Therefore, we collected information on political ideology to determine the impact on risk perception and behavior and determine whether there were any differences in messaging related to this factor.

> *Question 6*: Will conservatives perceive less risk have less concern about COVID 19 and be less willing to take protective action and support government restrictions than will liberals?

Thus, in the experiment reported here, participants received Q6
messages in various formats (see Table 1), to determine the impact on risk perception, concern, willingness to engage in various activities, and support for government policies. In addition, we examined differences in these variables due to age as well as political ideology.

Experiment

To reiterate, at the time that the experiment was conducted (May 19–30, 2020), the data on COVID-19 in the United States were incomplete making it difficult for individuals to assess their risk of becoming infected with or dying from the disease. Nonetheless, it was clear by this time that in terms of mortality, the percentage of older individuals dying from COVID-19 was greater than that of younger individuals, a fact that had been widely publicized in an attempt to protect the elderly. However, this strategy may have had unintended consequences. The primary goal for this study was to determine whether this was the case as well as how available risk expressions impacted key variables. To answer these questions, we conducted an online survey experiment with a United States sample.

Method

Participants

Participants were 2,664 Amazon Mechanical Turk (MTurk) workers. MTurk is a data-collection domain administered by Amazon. Participants were accepted for this experiment if they met the following requirements: (a) overall approval rate of 95% or higher, (b) at least 100 approvals, (c) resided in the U.S., and (d) had not completed a pilot survey. They were paid $3.50 for their participation. Prior to conducting the analyses, 73 participants, who were identified as nonhuman "bots," by a Qualtrics ReCAPTCHA[1] scores less than 0.7, were excluded. Another 108 participants failed the attention check (described in the Method section below) leaving 2,483 participants. Of these, 45% were female, 51% identified as liberal, 17% identified as moderates, and 32% identified as conservatives. The mean age was 39 and 22% were over 50 years of age.

Stimuli

Risk messaging was based on one of the most complete data sets available at the time this experiment was conducted, from China where the pandemic was abating (Wu et al., 2020), describing the number of positive cases and deaths.[2] This data set does not include the number of tests administered. Table 1 shows the seven messages created. "Infected" messages described the percentage of those older and younger than 50 years of age, among all those who had tested positive for COVID-19. "Mortality" messages described the percentage of all those who died of COVID-19, who were older and younger than 50 years of age. Fifty years of age was chosen as the dividing point to maximize the number of participants in the MTurk sample who would fall into the older category, while still observing a stark difference in proportions of deaths in the data. Here, we tested numeric expressions that described the percentage in each age group and gist messages that simply indicated which group was smaller (mortality) or that they were roughly equivalent (infected). In both conditions, we tested either a single outcome (mortality or infected) or both (mortality + infected) to determine whether single estimates led to oversimplifying assumptions (e.g., smaller rates of infection for younger individuals with mortality). Finally, we tested the case-fatality rate, which speaks more directly to one's risk of dying from COVID-19. It describes the percent who died among those in each age group who tested positive. There was also a "no-information" control condition to assess participant's preexperimental understanding of these risks.

Procedure

Participants were recruited from MTurk between May 19 and May 31, 2020. After providing informed consent, participants received one of the seven risk messages in Table 1 or no information in the control condition. Messages were preceded by the following phrase, which explained where the data were obtained: "The information below is based on one of the most complete COVID-19 data sets currently available (Wu et al., 2020). Considering this information, please answer the questions below." Immediately following the message (or no information in the control condition) were three questions asking participants to rate their perception of the likelihood of becoming infected with COVID-19, infecting others, and of dying from the disease (Table 2), by moving a marker on a Visual Analog Scale (VAS) anchored on the left with "impossible" and on the right with "certain." Then participants rated how concerned they were about COVID-19 and, in the experimental conditions, how much they trusted the information provided in the messages, both with VAS scales anchored on the left by "not at all" and on the right by "completely."

Table 2
Risk Perception Rating Questions

Questions
1. How likely do you think it is that you would become infected with COVID-19?
2. If you become infected with COVID-19, how likely do you think it is that you would infect someone else with COVID-19?
3. If you become infected with COVID-19, how likely do you think it is that you would die from COVID-19?
4. If you become infected with COVID-19, how likely do you think it is that you would have no symptoms?
5. If you become infected with COVID-19, how likely do you think it is that you would return to your previous state of health?
6. If you become infected with COVID-19, how likely do you think it is that you would be hospitalized?

Note. COVID-19 = Coronavirus disease 2019.

Next participants were asked what activities they would be willing to engage in and their opinions about the government response. In an attempt to neutralize the impact of existing and variable restrictions in different regions across the United States where participants resided, we asked them to imagine that they were under one of three recommendations, "stay at home," "social distance," or "restriction lifted."[3] One of these three phrases appeared on the top of the next screen. Then, in order to determine whether restrictions or the messaging, reshown on the top of the screen, affected behavioral intentions, participants rated their willingness to engage in each of 52 activities[4] (see Appendices A and B) by moving a marker on a VAS anchored on the left by "Not at all willing" and on the right by "Very willing." Nine of these activities were risk reducing (Appendix A: Q6.1–Q6.9) such as wearing a mask indoors. The rest were risk seeking, such as attending a party. The order in which the activities were presented was randomized for each participant.[5] On the next screen, the risk message was reshown (or none in the no-information condition) and another set of risk perception questions was asked (Table 2, items 4–6), using the identical VAS response mode as those above. These involved risks (e.g., being hospitalized) that were not directly related to our hypotheses but may, nonetheless, have been affected by our messaging. Then, in order to determine whether any of the messaging impacted participant's opinions of government response to COVID-19, they were asked to rate their degree of agreement with a series of statements (see Table 3) on a VAS anchored on the left with "Disagree Completely" and on the right by "Agree Completely."

[1] An algorithm-generated score based on Google's ReCAPTCHA technology provided by Qualtrics to identify automated scripts.

[2] According to a CDC data set published after the completion of this experiment, at this time in the U.S. approximately 52% of cases and 5% of death were among those under 50 years old, aligning roughly with our messaging. However, these data were not available until later.

[3] We did not attempt to categorize by existing real-world restrictions in order to ensure approximately equal group sizes in each message condition, and representation of subject variables (e.g., age, political ideology) at each level. We did not show these earlier because we thought their primary impact would be on activities and policies.

[4] The majority of these were pretested in a pilot study (see Appendix B) to determine their perceived riskiness.

[5] At the bottom of this screen, participants could provide comments for the researcher to determine whether there were issues that we might have overlooked, however, none were detected.

Participants were also asked several demographic questions including age, gender, and political ideology (see Appendix A). The study ended with the following attention check question: “We just want to make sure you are paying attention. This study is about COVID-19, but we want you to choose Ebola for this question. Options: COVID-19, Cancer, Ebola, Diabetes.” The survey included several other questions that address issues that will be reported in a separate paper. After answering all questions, on the final page of the study a unique randomly generated survey code was issued that allowed participants to receive payment.

Design

The experiment employed an eight (message format: numeric-infected, numeric-mortality, numeric-both, gist-infected, gist-mortality, gist-both, case fatality, no-information) by three (restriction wording: stay at home, social distancing, restrictions lifted) between-groups Q7 design. Restriction wording, in that it was not presented until the page showing the activities questions, could not have affected the three risk perception (Table 2, items 1–3), trust, and concern variables that preceded it.

Research Questions

In the analyses reported below, we tested each of the hypotheses and questions delineated in the introduction above. To summarize: We hypothesized (Hypotheses 1a–d) that messages including a single statistic (mortality, infected) might give rise to biases in rating the statistic not mentioned (e.g., lower infection rating among younger participants for messages mentioning mortality alone). In addition, we predicted that the case-fatality rate message (Hypothesis 2) would lead to lower perceived likelihood of death due to COVID-19. We predicted that any biases observed might be reduced by combining statistics (Question 1e) or with gist messaging (Question 3). However, we predicted that trust would be lower for gist messages than for numeric messages (Hypothesis 4) because they might seem vague. In addition, we asked how messaging impacted participants’ willingness to engage in activities as well as their opinions about government response to the pandemic (Question 5). Finally, we asked whether there were differences in the main dependent variables due to political ideology (Questions 6).

Results

The results are presented here in two sections. In the first we focus on differences due to age, as our messaging emphasized these differences. In the second, we focus on the differences due to political ideology. This experiment was preregistered on the Open Science Framework at https://osf.io/3yxzm/

Table 3
Government Response Questions

Questions
1. The government is *overreacting* to the danger from COVID-19.
2. The danger from COVID-19 is being exaggerated.
3. We should get back to normal as soon as possible.

Note. COVID-19 = Coronavirus disease 2019.

Section 1: Age Differences

Likelihood ratings were analyzed first, comparing younger to older participants, as our main hypotheses address this variable. Then we analyzed trust, concern, willingness to engage in activities, and support for government policies, comparing younger to older participants with ANOVAs and independent samples t tests (or Q8 Welch’s version if unequal variances were observed) using an α level of .05. All post hoc comparisons were Bonferroni corrected.[6] Because the older age group had fewer participants (n = 557) than did the younger age group (n = 1,926), Hedges’ g was used for effect sizes for independent sample t tests comparing the two, while partial eta-squared (η_p^2) was used to report effect sizes for ANOVAs.

Likelihood Ratings

Data Analysis Plan. Our primary questions concerned the impact of messaging on likelihood ratings. Likelihood ratings were summarized as the percent of the line from the left anchor (impossible) to the point at which the participant placed the marker. For each rating, we first conducted an ANOVA that included age and message format (gist-infected, gist-mortality, gist-both, numeric-infected, numeric-mortality, numeric-both, case fatality, no-information) as the independent variables. Then, in order to determine the impact of the simplified gist format and whether infection or mortality statistics were provided, we conducted a second ANOVA with formats categorized by two factors: as gist (gist-infected, gist-mortality, gist-both), or numeric (numeric-infected, numeric-mortality, numeric-both) to which we refer as “presentation” and whether the statistic described infection or mortality rate, referred to as statistic. The three-factor ANOVAs (age, statistic, presentation) were conducted on dependent variables predicted to be impacted by statistic and gist (likelihood of infection, dying, and trust and concern). The no-information and case-fatality rate conditions were omitted from these analyses.

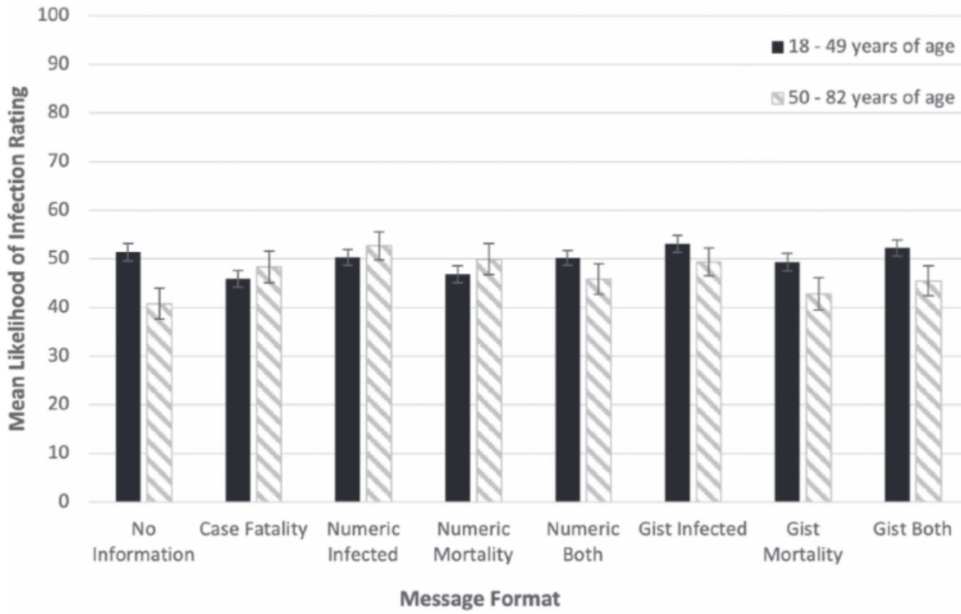
Self-Infected. The ANOVA on likelihood ratings for becoming infected with COVID-19, with message format and age group revealed a main effect of age, $F(1, 2467) = 5.64$, $p = .02$, $\eta_p^2 = 0.002$, such that younger individuals rated the likelihood of infection higher ($M = 49.89$, $SD = 26.45$) than did older individuals ($M = 46.96$, $SD = 25.93$). Moreover, messaging tended to bring the two age groups closer together. There was a significant interaction between age group and message format, $F(7, 2467) = 2.08$, $p = .04$, $\eta_p^2 = 0.006$, such that the age difference was largest in the no-information condition. Indeed, post hoc comparisons revealed that younger participants rated infection likelihood significantly higher in the no-information condition ($M = 51.4$, $SD = 27.02$), than did older participants, $M = 40.77$, $SD = 27.55$; $t(311) = 2.94$, $p = .004$, $g = 0.39$. No other between age group comparisons reached significance. See Figure 1.

We predicted that younger individuals would rate the likelihood of becoming infected with COVID-19 lower with mortality than

[6] Here, we have chosen a conservative approach although we acknowledge that this may increase the chance of Type II errors (Midway et al., 2020).

Figure 1
Likelihood Estimates of Being Infected With COVID-19

Q9



Note. COVID-19 = Coronavirus disease 2019. Mean likelihood rating of being infected with COVID-19 for younger (18–49 years of age) and older (50–82 years of age) age groups are shown by message format (error bars show ±1 standard error).

with infection statistics and that older individuals would do the opposite (Hypotheses 1a and 1c). However, we thought this bias might be attenuated by messages including both statistics (Question 1e) or a gist expression (Question 3). To address these issues, the second ANOVA on likelihood rating for becoming infected was conducted with statistic (infection, mortality, both), presentation (gist, numeric), and age group as the independent variables. Although the interaction between age and statistic did not reach significance, planned contrasts (one-tailed *t* tests) revealed that, as predicted, younger participants rated the likelihood of infection significantly lower in the mortality ($M = 48.09$, $SD = 28.03$) than in the infection condition, $M = 51.71$, $SD = 25.82$, $t(953) = 2.08$, $p = .02$, $g = 0.14$. As predicted, the bias was attenuated by including both mortality and infection statistics ($M = 51.17$, $SD = 24.49$) which increased likelihood ratings, compared to mortality alone, $t(955) = 1.81$, $p = .04$, $g = 0.13$. Although the gist-mortality message increased the rating ($M = 49.36$, $SD = 28.73$) compared to the numeric-mortality message ($M = 46.38$, $SD = 27.22$) the difference failed to reach significance. Nor did the difference between infection and mortality in the older group, reach significance.

There was also an unpredicted significant interaction between age group and presentation, $F(2, 1838) = 4.34$, $p = .04$, $\eta_p^2 = 0.002$, such that gist expressions tended to *increase* likelihood ratings for becoming infected among younger participants ($M = 51.57$, $SD = 27.07$) compared to numeric expressions ($M = 49.12$, $SD = 25.23$), while they *decreased* ratings among older participants ($M = 46.01$, $SD = 25.52$) compared to numeric expressions ($M = 49.70$, $SD = 25.26$), increasing the difference in likelihood ratings between the two age groups.

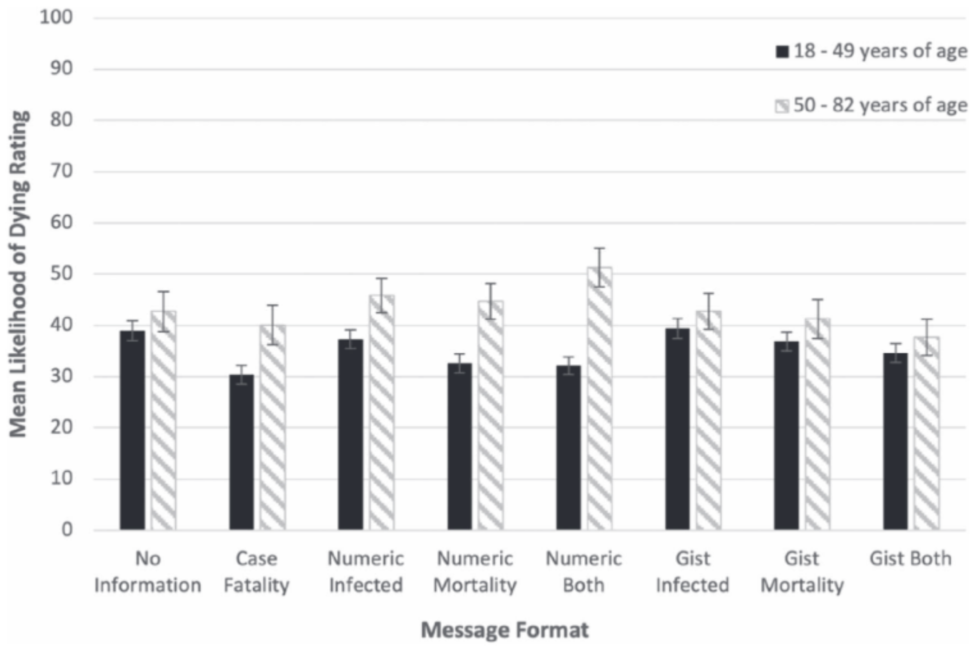
Die if Infected. The ANOVA on the likelihood of dying ratings with format and age group revealed a significant main effect of age group, $F(1, 2467) = 32.49$, $p < .0001$, $\eta_p^2 = 0.01$, such that older participants rated the likelihood of dying ($M = 43.17$, $SD = 30.54$) significantly higher than did younger participants ($M = 35.23$, $SD = 28.9$). See Figure 2. The interaction between age group and format, $F(7, 2467) = 1.94$, $p = .06$, $\eta_p^2 = 0.005$, approached but failed to reach significance.

As predicted (Hypothesis 2), the likelihood of dying was rated lowest overall with the case-fatality message ($M = 32.44$, $SD = 29.88$). Planned contrasts revealed that mean likelihood rating in the case-fatality condition was significantly lower than in the no-information condition, $M = 39.86$, $SD = 30.89$, $t(631) = 3.07$, $p = .002$, $g = 0.24$, and the text-infected condition, $M = 40.17$, $SD = 29.72$, $t(633) = -3.27$, $p = .001$, $g = 0.26$. No other differences reached significance.

We predicted that younger individuals would rate the likelihood of dying higher with infection than with mortality statistics and that older individuals would do the opposite (Hypotheses 1b and 1d). We thought this effect might be attenuated by having both statistics (Question 1e) or by gist expressions (Question 3). To address these issues, a second ANOVA was conducted on likelihood rating for dying, with a presentation, statistic, and age group as the independent variables. Although the interaction between age and statistic did not reach significance, planned contrasts (one-tailed *t* tests) revealed that, as predicted, younger individuals rated the likelihood of dying higher with the infection ($M = 38.37$, $SD = 29.04$) than with mortality statistics, $M = 34.72$, $SD = 29.27$, $t(953) = 1.94$, $p = .03$, $g = 0.13$. As predicted, the bias was attenuated by including both statistics, $M = 33.32$, $SD = 27.23$, $t(958) = 2.78$, $p = .003$,

Figure 2

Likelihood Ratings of Dying of COVID-19



Note. COVID-19 = Coronavirus disease 2019. Mean likelihood ratings of dying from COVID-19 for younger (18–49 years of age) and older (50–82 years of age) are shown by format condition (error bars show ±1 standard error).

$g = 0.18$. Contrary to our prediction, however, the gist expression enhanced (gist infection $M = 39.4$, $SD = 29.74$; numeric infection $M = 37.31$, $SD = 28.33$) rather than attenuated the effect. No other planned contrasts reached significance.

Again, there was a significant main effect of age, $F(1, 1838) = 27.52$, $p < .0001$, $\eta_p^2 = 0.01$ such that older ($M = 43.77$, $SD = 29.81$) rated the likelihood of dying higher than did younger participants ($M = 35.47$, $SD = 28.58$). There was also a significant unpredicted interaction between age and presentation, $F(1, 1838) = 9.93$, $p = .003$, $\eta_p^2 = 0.005$. Among younger participants, the likelihood of dying was rated highest in the gist condition ($M = 37.01$, $SD = 28.67$) and least in the numeric condition ($M = 33.96$, $SD = 28.44$). Among older participants the pattern was reversed. Likelihood of dying was rated least in the gist ($M = 40.51$, $SD = 30.07$) and highest in the numeric ($M = 47.12$, $SD = 29.25$).

Thus, the severity-likelihood prediction (Hypotheses 1a–d, Question 1e) was partially supported in that younger individuals rated the likelihood of infection lower when mortality statistics were provided and the likelihood of dying higher when infection statistics were provided. In addition, these biases were attenuated by including both statistics in the message. However, the impact of the gist expressions among younger individuals was to enhance likelihood ratings overall rather than to attenuate these biasing effects. Moreover, none of the comparisons among older individuals reached significance.

Asymptomatic, Previous State of Health, and Hospitalized. Participants also rated the likelihood of four possible COVID-19 outcomes (infecting others, asymptomatic, returning to previous state of health, hospitalization), not directly related to the message formats tested. A series of ANOVAs were conducted on these ratings with age group and message format (gist-infected, gist-mortality, gist-both, numeric-infected, numeric-mortality, numeric-both, case fatality, no-information) as the independent variables. Younger participants rated the likelihood of infecting others significantly higher ($M = 65.27$, $SD = 24.65$) than did older participants, $M = 60.68$, $SD = 25.94$, $F(1, 2467) = 14.68$, $p < .0001$, $\eta_p^2 = 0.006$. In addition, there was significant interaction between age group and format, $F(7, 2467) = 2.50$, $p = .01$, $\eta_p^2 = 0.007$, such that the difference between younger and older individuals was smallest in the numeric-mortality condition and largest in the gist-mortality condition. Younger participants rated the likelihood of being asymptomatic if infected ($M = 55.34$, $SD = 23.54$) significantly higher than did older participants, $M = 46.84$, $SD = 24.58$, $F(1, 2467) = 55.57$, $p < .0001$, $\eta_p^2 = 0.02$. Younger participants rated the likelihood returning to their previous state of health if infected ($M = 70.05$, $SD = 22.00$) significantly higher than did older participants, $M = 63.34$, $SD = 24.9$, $F(1, 2467) = 38.09$, $p < .0001$, $\eta_p^2 = 0.02$. However, older participants rated the likelihood of being hospitalized if infected significantly higher ($M = 54.41$, $SD = 27.93$) than did younger participants, $M = 46.25$, $SD = 28.08$, $F(1, 2467) = 37.47$, $p < .0001$, $\eta_p^2 = 0.01$. There were no other effects of message format either predicted or observed.

Trust and Concern

We also asked participants the degree to which they trusted each of the messages and how concerned they were about COVID-19. Both ratings were summarized as the percent of the line from the left anchor (not at all) to the point at which the participant placed the marker.

With regard to trust, we predicted that participants would provide higher ratings for numeric (numeric-mortality, numeric-infected, numeric-both) than for the gist formats (gist-mortality, gist-infected, gist-both) because of the vagueness of the latter (Hypothesis 4). To test this hypothesis, an ANOVA on trust was conducted with presentation (gist, numeric), statistic (infection, mortality), and age group (younger, older) as the independent variables. Indeed, there was a significant main effect of presentation, $F(1, 1838) = 6.43$, $p = .01$, $\eta_p^2 = 0.003$. However, the effect was in the opposite direction to that predicted. The mean trust rating of gist formats ($M = 66.47$, $SD = 23.11$) was significantly higher than the mean of numeric formats ($M = 63.42$, $SD = 23.62$). In addition, there was an interesting effect of statistic, $F(2, 1838) = 13.48$, $p < .0001$, $\eta_p^2 = 0.01$, such that mortality statistics ($M = 69.21$, $SD = 23.10$) were trusted more than were infection statistics ($M = 60.59$, $SD = 23.47$). There was also a significant interaction between statistic and presentation, $F(2, 1838) = 3.41$, $p = .03$, $\eta_p^2 = 0.004$, such that the increase in trust for mortality statistics was greater in the gist than in the numeric formats. See Figure 3. Finally, there was a significant main effect of age group, $F(1, 1838) = 4.51$, $p = .03$, $\eta_p^2 = 0.002$, such that mean trust rating was higher among younger ($M = 65.57$, $SD = 22.76$) than among older participants ($M = 62.73$, $SD = 25.45$).

The ANOVA on concern with the independent variables presentation, statistic, and age group revealed a significant interaction between age group and presentation, $F(1, 1838) = 11.98$, $p = .0006$, $\eta_p^2 = .006$. Following the pattern of the likelihood ratings, younger individuals rated more concern with gist ($M = 71.68$, $SD = 25.91$) than with numeric expressions ($M = 67.8$, $SD = 27.73$). Older individuals rated more concern with numeric ($M = 72.68$, $SD = 28.46$) than with gist expressions ($M = 65.72$, $SD = 30.03$).

Activities and Government Policies

Next, we turn to the participants' willingness to engage in various activities and agreement with statements about the government response to COVID-19, to determine whether messaging impacted these variables (Question 5).

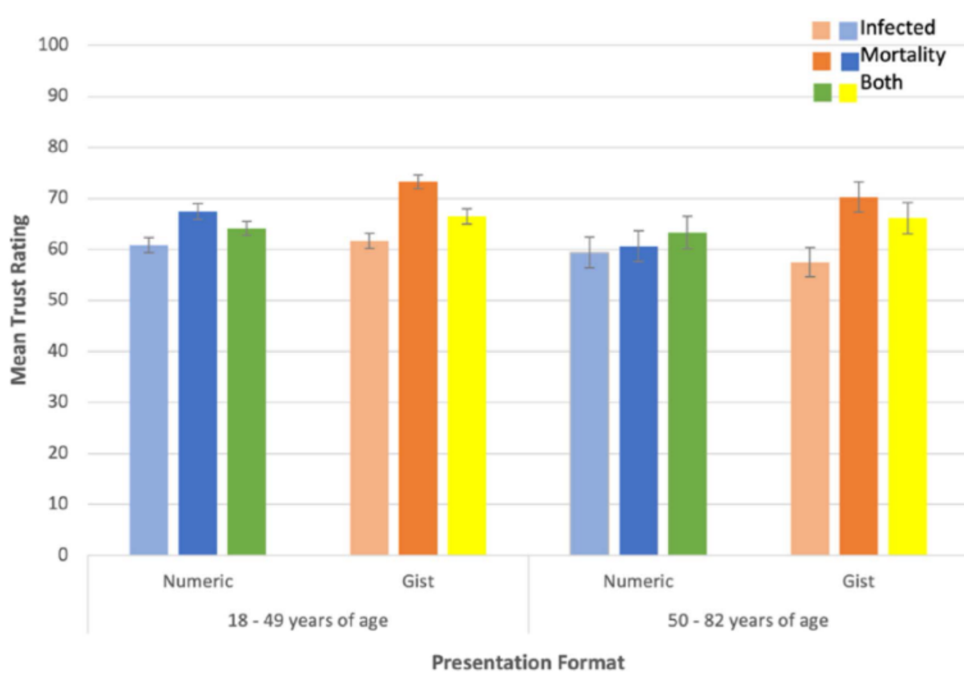
Data Analysis Plan. Willingness ratings were summarized as the percent of the line between the left anchor "not at all" and the point to which the participant moved the marker. In an attempt to neutralize the impact of existing and variable restrictions in different regions across the United States, we asked participants to imagine that they were under one of three recommendations, "stay at home," "social distance," or "restriction lifted." Therefore, the ANOVAs reported below include three independent variables, age group, message format, and restrictions wording.

Risk Reduction: Willingness to Wear a Mask. First, because of the increasing importance of masks in curtailing the spread of COVID-19 (Fischer et al., 2020), we examined willingness to wear a mask indoors (Appendix A: Q6.5). There was a main effect of age, $F(1, 2435) = 6.37$, $p = .01$, $\eta_p^2 = 0.003$. Older participants were more willing to wear a mask indoors ($M = 81.01$, $SD = 29.73$) than were younger people ($M = 77.58$, $SD = 27.75$). No other main effects or interactions reached significance. Nor were there significant differences in mean willingness to engage in risk-reduction activities (Q6.1–Q6.4, Q6.6–6.9 Appendix A) overall.

Because younger people were significantly less willing to engage in this crucial safety precaution, wearing a mask indoors, we narrowed our focus to that group to determine whether there was

Figure 3

Trust Rating by Presentation Format and Age



Note. Mean trust ratings for Coronavirus disease 2019 (COVID-19) information for younger (18–49 years of age) and older (50–82 years of age) participants shown by presentation format (error bars show ±1 standard error). See the online article for the color version of this figure.

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any communication format that was more encouraging. In the ANOVA on willingness to wear a mask among younger participants, with message format and restrictions as the independent variables, there was a significant main effect of message format, $F(7, 1902) = 2.45, p = .02, \eta_p^2 = 0.009$, with the greatest willingness among those receiving the gist-both (infection + mortality) message ($M = 81.70$, $SD = 24.42$). Post hoc comparisons indicated that the gist-both message led to significantly greater willingness to wear a mask than the no-information condition, $M = 74.38$, $SD = 30.05$, $t(454.46) = 2.86, p = .004, g = 0.26$. There was also a main effect of restriction, $F(2, 1902) = 4.16, p = .0174, \eta_p^2 = 0.004$, with the greatest willingness among those in the social distancing ($M = 79.25$, $SD = 25.79$) condition and the least in the restrictions lifted condition ($M = 75.09, SD = 29.75$). Post hoc comparisons revealed that this difference was significant as well, $t(1269.2) = 2.69$, $p = .007, g = 0.15$.

Risk-Seeking Activities. A mean was calculated for the risk-seeking activities (Q6.10–Q6.52, Appendix A) and submitted to an ANOVA with age group, format and restrictions wording as the independent variables. There was significant main effect of age group, $F(1, 2435) = 4.62, p = .03, \eta_p^2 = 0.002$, with younger participants being more willing on average ($M = 39.36, SD = 24.36$) than older participants $M = 36.78, SD = 23.14$) to participate in risk-seeking activities. There was also a main effect of restriction wording, $F(2, 2435) = 19.88, p < .001, \eta_p^2 = 0.02$, such that participants were most willing to engage in risk-seeking activities when restrictions were lifted ($M = 43.17, SD = 23.8$) and least willing when "stay at home" was in effect ($M = 34.84$, $SD = 23.62$).

Thus, for activities, the major factor influencing willingness was restriction wording. This was seen among younger participants for whom recommendations to maintain social distancing increased willingness to wear a mask indoors. Both younger and older participants were least willing to engage in risk-seeking activities if "stay at home" was in effect. However, message format had little impact here with the important exception of willingness to wear a mask indoors among younger participants. The gist message describing both the infection and the mortality proportions increased willingness to wear a mask indoors.

Support for Government Policies

Next, we examined agreement with government policies regarding COVID-19. Here, there were some differences between younger and older participants. In an ANOVA on agreement rating with age group, format and restrictions wording as the independent variables, younger participants rated significantly greater agreement with "the government is overreacting" (younger: $M = 35.12, SD = 33.76$; older: $M = 29.52$ $SD = 35.14$); $F(1, 2435) = 10.87$, $p < .001$, $\eta^2 = .004$, and "the danger was exaggerated" (younger $M = 35.16$, $SD = 34.00$; older $M = 28.89$ $SD = 35.26$); $F(1, 2435) = 13.20, p < .001, \eta_p^2 = .005$). However, for both groups, an agreement was only about a third of the scale between not at all and completely. In addition, there were no significant differences in agreement with "get back to normal as soon as possible," both groups were at about the 50% mark (younger $M = 48.77$, $SD = 33.03$; older $M = 50.30$, $SD = 34.63$). No significant effects of message format or restrictions wording were observed.

Summary: Section I

Thus, participants had fairly accurate perceptions of the age-relative likelihood of COVID-19 outcomes. Younger participants thought it was more likely that they would be asymptomatic and return to their previous state of health than did older participants. In addition, older participants thought it was more likely that they would die and be hospitalized if infected with COVID-19 than did younger participants. Interestingly, younger participants thought they were *more* likely to become infected and to infect others than did older people, which was not in line with the data upon which our messaging was based or the proportions available in the U.S. in May 2020[7] when this study was conducted. However, younger people were more willing to engage in risk-seeking activities as well. Thus, their perception of increased risk of infection may have been based on this knowledge as has been seen in previous work (Mills et al., 2008).

As predicted, single outcome messaging had a biasing effect among younger participants, decreasing perceived likelihood of becoming infected with mortality compared to infection statistics and increasing the likelihood of dying with infection compared to mortality statistics (Hypotheses 1a and 1b). In addition, there was some evidence that these biases could be attenuated by providing both statistics together in the same message (Question 1e). However, no such biases were observed among older individuals (Hypotheses 1c and 1d).

In addition, there was the unpredicted effect of the gist compared to the numeric presentation. Gist messages tended to have the opposite effects on the two age groups, increasing likelihood ratings among younger participants for self-infected, and dying while decreasing likelihood ratings among the older group for both (this will be addressed further in the conclusion). In line with this result, younger participants were more concerned about COVID-19 with gist messaging and more willing to wear a mask indoors when the message was presented as a gist expression and included both infection and mortality statistics. In addition, participants in general trusted the gist more than they did the numeric presentation. Taken together these results suggest that there are some important practical advantages for gist messaging.

Despite some differences in perceived likelihood, the two age groups rated concern similarly overall and rated similar willingness to engage in risk-reduction activities (excluding mask indoors). In addition, both groups were impacted by governmental restrictions, rating less willingness to engage in risk-seeking activities when "stay at home" was in effect. Also similar between groups, was their willingness to agree with statements critical of government policies. Although younger rated slightly higher agreement, both groups' ratings were on the lower third of the agreement scale.

Secton 2: Political Ideology

Those from different political perspectives might differ in terms of perceived COVID-19 risks as well as how they should be managed (Question 6). To determine whether that was the case, we compared differences due to political ideology in likelihood rating, trust, concern, willingness to engage in activities, and agreement with policies.

[7] These did not include all data from the month of May 2020.

Data Analysis Plan

We conducted ANOVAs on each dependent variable with political ideology (liberal, conservative), age group (younger, older), and message format (numeric-infected, numeric-mortality, numeric-both, gist-infected, gist-mortality, gist-both, case fatality, no-information) as the independent variables. The independent variable, restrictions wording (stay at home, social distancing, restrictions lifted) was included in analyses on willingness to engage in activities and agreement with policies, which were rated after restrictions wording was shown. For all of these analyses, we included participants who identified as liberals (extremely liberal, liberal, slightly liberal, $n = 1{,}273$) and those who identified as conservatives (extremely conservative, conservative, slightly conservative, $n = 781$).[8] We omitted the 429 participants who identified as moderates to more clearly observe the contrast in viewpoints. All of the age group differences reported in Section 1 above reached significance in these analyses as well. In the interest of brevity, they will not be reported here.

Likelihood Ratings

Self-Infected. In the ANOVA on infection likelihood ratings, there was a significant main effect of political ideology, $F(1, 2022) = 7.48$, $p = .005$, $\eta_p^2 = 0.004$, such that liberals rated the likelihood higher ($M = 50.98$, $SD = 25.01$) than did conservatives ($M = 48.06$, $SD = 28.92$). There was also a significant age group by political ideology interaction, $F(1, 2022) = 4.36$, $p = .037$, $\eta_p^2 = 0.002$, such that among conservatives, older participants rated the likelihood lower ($M = 43.19$, $SD = 28.01$) than did younger participants ($M = 49.97$, $SD = 29.08$). However, among liberals the ratings were similar (older $M = 50.12$, $SD = 24.74$; younger $M = 51.19$, $SD = 25.32$).

Die if Infected. In the ANOVA on ratings for the likelihood of dying, there was a significant main effect of message format that mirrored the analysis reported in Section 1 above. Mean rating was the lowest with case fatality and the highest in the no-information condition. There was also a significant interaction between political ideology and age. Among conservatives, the likelihood rating was similar between older ($M = 40.10$, $SD = 31.59$) and younger participants ($M = 38.82$, $SD = 32.16$). However, among liberals, older participants rated the likelihood much higher ($M = 47.28$, $SD = 28.03$) than did younger ($M = 34.57$, $SD = 28.03$). There was also a significant three-way interaction among format, political ideology, and age, $F(7, 2022) = 2.10$, $p = .04$, $\eta_p^2 = 0.007$. As Figure 4 shows, for conservatives, messaging tended to increase ratings among younger individuals, while it decreased ratings among older. For liberals, the pattern reversed: Messaging tended to decrease ratings for younger and increase ratings for older.

Infecting Others, Asymptomatic, Previous State of Health, and Hospitalized. A series of ANOVAs with age, format, and political ideology as the independent variables were also conducted on the likelihood of the four possible COVID-19 outcomes, not directly related to the message formats tested. In every case, there was a significant effect of political ideology. In the ANOVA the likelihood of infecting others, liberals rated the likelihood higher ($M = 65.54$, $SD = 24.63$) than did conservatives, $M = 62.88$, $SD = 25.88$, $F(1, 1958) = 4.33$, $p = .04$, $\eta_p^2 = 0.002$. In the ANOVA on the likelihood of being asymptomatic, conservatives ($M = 55.35$, $SD = 25.44$) rated the likelihood higher than did liberals, $M = 53.43$, $SD = 23.35$, $F(1, 1958) = 4.56$, $p = .03$, $\eta_p^2 = 0.002$. Similarly, in the ANOVA on likelihood of returning to ones' previous state of health, conservatives ($M = 72.40$, $SD = 22.77$) rated the likelihood higher than did liberals, $M = 66.56$, $SD = 22.76$, $F(1, 1958) = 30.41$, $p < .001$, $\eta_p^2 = 0.02$. Here, there was also a significant interaction between format and age, $F(7, 1958) = 2.06$, $p = .04$, $\eta_p^2 = 0.007$, such that with the exception of a few formats (Case Fatality, gist infection, and gist both) ratings tended to be lower among older than younger participants. In the ANOVA on rating for the likelihood of hospitalization, there was a significant interaction between age and political ideology, $F(1, 2022) = 4.12$, $p = .04$, $\eta_p^2 = 0.002$, such that among liberals, older participants rated the likelihood of hospitalization much higher ($M = 57.57$, $SD = 26.18$) than did younger ($M = 46.37$, $SD = 27.25$). However, among conservatives, older participants rated the likelihood only slightly higher ($M = 53.03$, $SD = 29.41$) than did younger ($M = 47.89$, $SD = 30.16$).

Thus, the impact of political ideology on likelihood ratings was as one might expect: Liberals rated the likelihood of being infected and infecting others, higher than did conservatives. Conservatives rated the likelihood of being asymptomatic and returning to one's previous state of health higher than did liberals. However, the effects were small and failed to reach significance in the analyses on the likelihood of dying and being hospitalized. For these ratings, as well as for likelihood of infection, the interaction with age revealed that the main differences due to political ideology were among older individuals. Older liberals rated the likelihood of dying and being hospitalized higher than the other groups, which aligns with the risk information available at the time. Whereas older conservatives rated these items similarly to younger participants. Moreover, they rated the likelihood of becoming infected, *lower* than other groups.

Trust and Concern

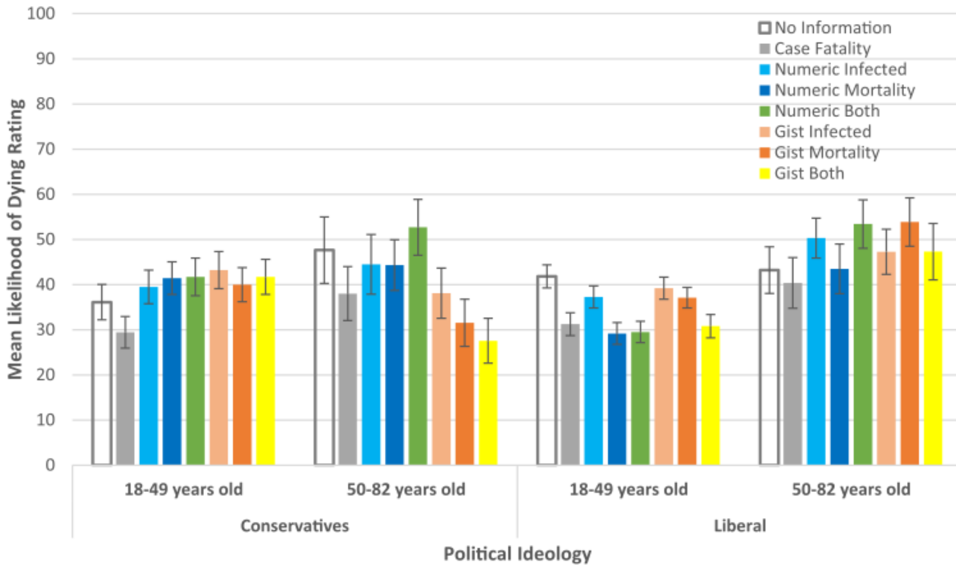
The effect of political ideology extended to trust and concern. See Figure 5. In the ANOVA on trust rating, with political ideology, age group and message format as the independent variables, liberals rated significantly higher trust ($M = 65.60$, $SD = 22.01$) than conservatives, $M = 58.17$, $SD = 27.33$, $F(1, 1958) = 66.69$, $p < .001$, $\eta_p^2 = 0.03$. There was also an age group by political ideology crossover interaction, such that among conservatives, older participants rated lower trust ($M = 51.73$, $SD = 29.19$) than did younger ($M = 60.71$, $SD = 26.15$), while, among liberals older rated higher trust ($M = 68.81$, $SD = 19.79$) than younger ($M = 64.81$, $SD = 22.46$).

Similarly, in the ANOVA on concern, there was a main effect of political ideology, $F(1, 1958) = 100.76$, $p < .001$, $\eta_p^2 = 0.05$, such that liberals rated trust higher ($M = 75.08$, $SD = 23.71$) than did conservatives ($M = 62.59$, $SD = 31.39$). There was also a significant crossover interaction between political ideology and age, $F(1, 1958) = 9.03$, $p = .003$, $\eta_p^2 = 0.005$). Among conservatives older participants rated concern lower ($M = 58.87$, $SD = 33.95$) than did younger participants ($M = 64.06$, $SD = 30.22$), whereas among liberals, older rated concern higher ($M = 77.76$, $SD = 23.21$) than younger ($M = 74.42$, $SD = 23.80$).

[8] There were slightly fewer younger participants (72%) among conservatives than liberals (80%).

Figure 4

Likelihood of Dying Rating by Age, Political Ideology, and Format



Note. Mean likelihood of dying rating for younger (18–49 years of age) and older (50–82 years of age) participants by message format and political ideology (error bars show ±1 standard error). See the online article for the color version of this figure.

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Thus, the impact of political ideology was greater on trust and concern than on likelihood ratings. Conservatives had less trust in the message and were less concerned about COVID-19. Moreover, the interaction between age and political ideology seen in some previous analyses was more distinct. Older conservatives rated both trust and concern lower than did younger conservatives or liberals. The pattern reversed among liberals with older liberals rating both trust and concern higher than other groups.

Activities

Next, we turn to the participants' willingness to engage in the 52 activities to determine whether these differed by political ideology. These ANOVAs included as independent variables, age group, message format, political ideology, as well as restrictions wording. Indeed, conservatives were significantly less willing to wear a mask indoors ($M = 70.26, SD = 32.21$) than were liberals, $M = 84.47, SD = 23.13$, $F(1, 1958) = 118.94, p < .001, \eta_p^2 = 0.06$. There was also a significant interaction between political ideology and age, $F(1, 1958) = 4.72$, $p = .03$, $\eta_p^2 = 0.002$. Among conservatives, older ($M = 70.72$, $SD = 35.06$) and younger participants ($M = 70.08, SD = 31.05$) rated similar willingness to wear a mask. However, among liberals older ($M = 89.59$, $SD = 21.37$) rated much higher willingness to wear a mask than did younger ($M = 83.20, SD = 23.39$). Here, there was also a significant interaction between political ideology and message format, $F(7, 1958) = 2.68, p = .03, \eta_p^2 = 0.008$. For both groups the messages tended to increase willingness ratings compared to the no-information condition, although this was less true among liberals whose willingness was already high. However, the most striking difference appears to be with the case-fatality rate which *decreased* willingness ratings among conservatives and *increased* willingness ratings among liberals. See Figure 6.

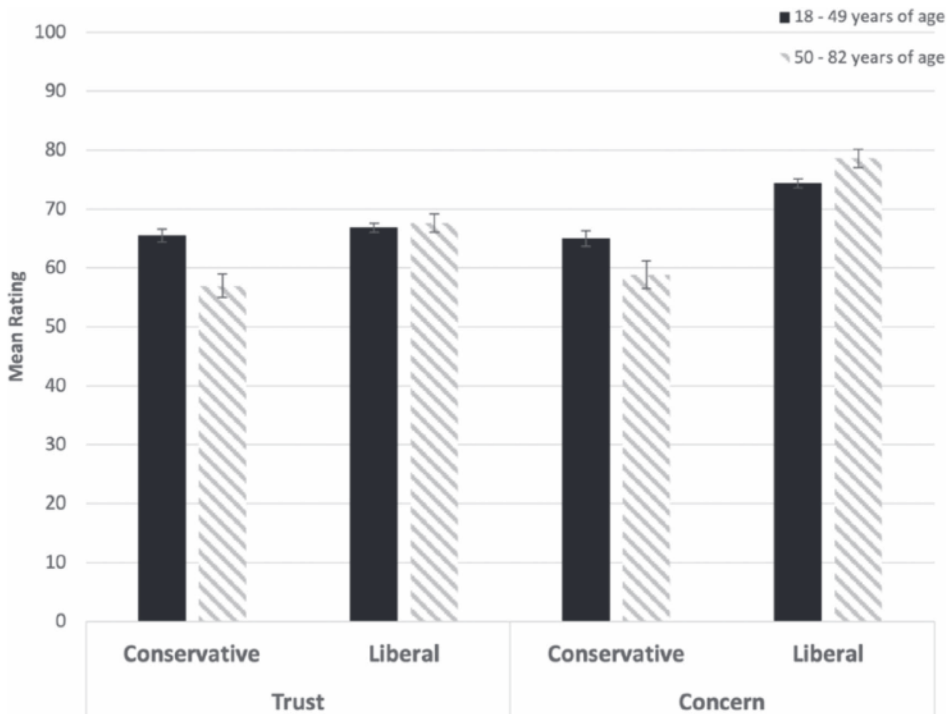
Liberals were also more willing to engage in risk-reduction activities in general ($M = 75.59, SD = 16.72$) than were conservatives, $M = 67.52$, $SD = 20.00$, $F(1, 1958) = 89.53$, $p < .001$, $\eta_p^2 = 0.04$. Nonetheless, the main effect of restrictions wording approached significance, $F(2, 1958) = 2.57, p = .08, \eta_p^2 = .003$, with willingness highest when social distancing was in place ($M = 73.49, SD = 17.89$) and lowest when restrictions were lifted ($M = 71.22, SD = 19.04$).

Again, there was a significant interaction between age group and political ideology, $F(1, 1958) = 5.30, p = .02, \eta_p^2 = 0.003$. Among conservatives, older rated similar willingness ($M = 66.89$, $SD = 21.47$) to younger participants ($M = 67.76, SD = 19.40$). However, among liberals older ($M = 78.05, SD = 15.14$) rated higher willingness to engage in risk-reduction activities than did younger participants ($M = 74.98, SD = 17.04$). There was also a significant interaction between political ideology and message format, $F(7, 1958) = 2.92, p = .005, \eta_p^2 = 0.01$. For both groups the messages tended to increase willingness ratings compared to the no-information condition, although this was less true among liberals whose willingness was already high. Again, the most striking difference appears to be with case-fatality rate, which, unlike all other message formats, reduced willingness among conservatives compared to the no-information condition, while it increased willingness among liberals compared to the no-information condition. See Figure 7.

Conservatives were more willing to engage in risk-seeking activities ($M = 48.30, SD = 26.18$) than were liberals, $M = 34.08, SD = 22.01$, $F(1, 1958) = 135.63, p < .001, \eta_p^2 = 0.06$. There was also a main effect of restriction wording, $F(2, 1958) = 21.58$, $p < .001$, $\eta_p^2 = 0.02$, mirroring that reported in Section 1 above, with participants in general rating much higher willingness when restrictions were lifted ($M = 44.02, SD = 24.25$) than when social distancing ($M = 39.01$, $SD = 24.55$) or stay at home ($M = 39.43, SD = 24.46$) were in effect.

Figure 5

Trust and Concern Ratings by Age and Political Ideology



Note. Mean trust and concern rating for younger (18–49 years of age) and older (50–82 years of age) participants by political ideology (error bars show ±1 standard error).

Thus, with respect to activities, the effects of political ideology were larger than with risk perception, although they followed the same general pattern. Conservatives were less willing to engage in risk-reduction activities, including wearing a mask, and more willing to engage in risk-seeking activities than were liberals. As with the analyses reported in Section 1 above, restrictions wording appeared to matter most. Here, this effect was seen across political boundaries. Participants in general were less willing to engage in risk-seeking activities and more willing to engage in risk-seeking activities when restrictions were lifted compared to when social distancing and stay-at-home orders were in effect.

Government Policies

Although it is clear that there are distinct differences between conservatives and liberals in terms of their willingness to engage in risk-reduction and risk-seeking activities, perhaps the biggest differences were in ratings on agreement with the government response (see Figure 8). For all these statements, "government is overreacting," "danger is exaggerated," and "get back to normal as soon as possible," conservatives rated agreement much higher than did liberals.

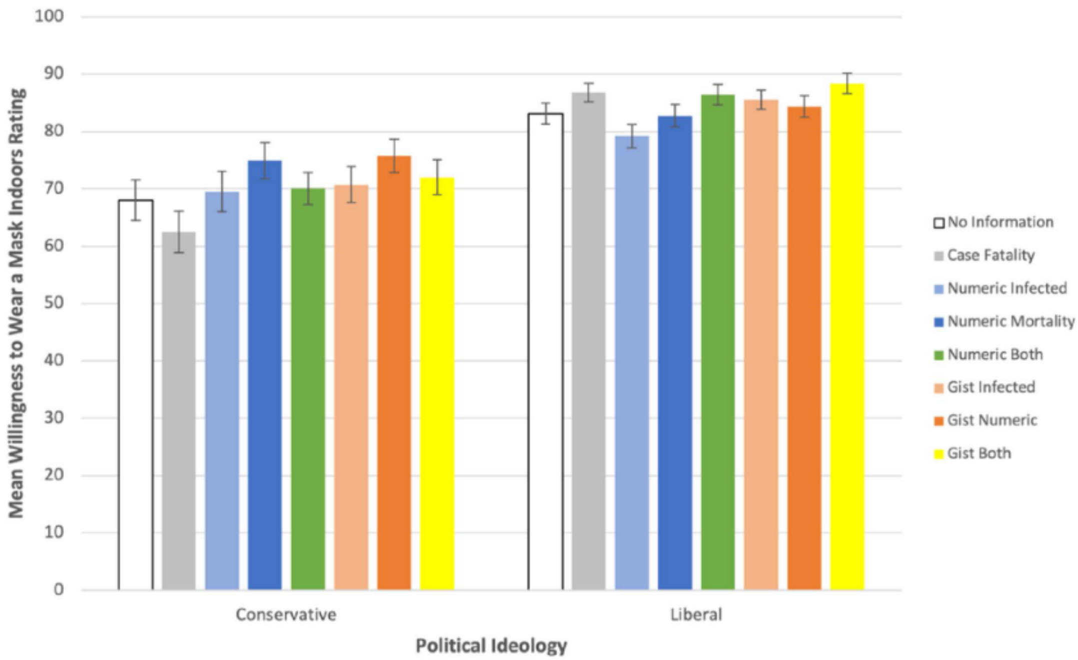
In the ANOVA on agreement with the statement "The government is overreacting," conservatives rated much higher agreement ($M = 52.38$, $SD = 33.25$) than did liberals ($M = 23.04$, $SD = 30.83$, $F(1, 1958) = 358.87$, $p < .001$, $\eta_p^2 = 0.15$. There was also a significant interaction between political ideology and age, $F(1, 1958) = 7.49$, $p = .006$, $\eta_p^2 = 0.004$, such that among conservatives the ratings of older ($M = 50.03$, $SD = 36.02$) and younger ($M = 53.31$, $SD = 32.08$) were similar. However, among liberals older rated much less agreement ($M = 13.10$, $SD = 25.89$) than did younger ($M = 25.50$, $SD = 31.47$). In addition, there was a three-way interaction between political ideology, message format and restriction wording, $F(14, 1958) = 2.09$, $p = .01$, $\eta_p^2 = 0.01$. This appears to be due to a tendency for most messaging to decrease agreement ratings, compared to the no-information condition, among conservatives when restrictions were lifted or social distancing was in place. However, messaging slightly increased agreement among liberals in the same conditions. See Figure 8.

Conservatives were in much greater agreement with "the danger is exaggerated" ($M = 52.38$, $SD = 33.25$) than were liberals, $M = 23.04$, $SD = 30.83$, $F(1, 1958) = 335.61$, $p < .001$, $\eta_p^2 = 0.14$. There was a significant interaction between political ideology and age, $F(1,1958) = 4.63$, $p = .03$, $\eta_p^2 = 0.002$, such that among conservatives the ratings of older were slightly lower ($M = 48.62$, $SD = 37.04$) than younger ($M = 53.36$, $SD = 32.25$). However, among liberals older rated much less agreement ($M = 13.31$, $SD = 25.76$) than did younger ($M = 25.52$, $SD = 31.75$). There was also a three-way interaction between political ideology, message format and restriction wording, $F(14, 1958) = 1.88$, $p = .02$, $\eta_p^2 = 0.01$. As with agreement with "overreacting" this appears to be due to the tendency for most messaging to decrease agreement ratings, compared to the no-information condition, among conservative when restrictions were lifted or social distancing is in place. However, messaging tended to increase agreement among liberals in the same conditions. See Figure 9.

Conservatives were in much greater agreement with "get back to normal as soon as possible" ($M = 67.63$, $SD = 28.65$) than were

Figure 6

Willingness to Wear a Mask Indoor by Political Ideology and Format



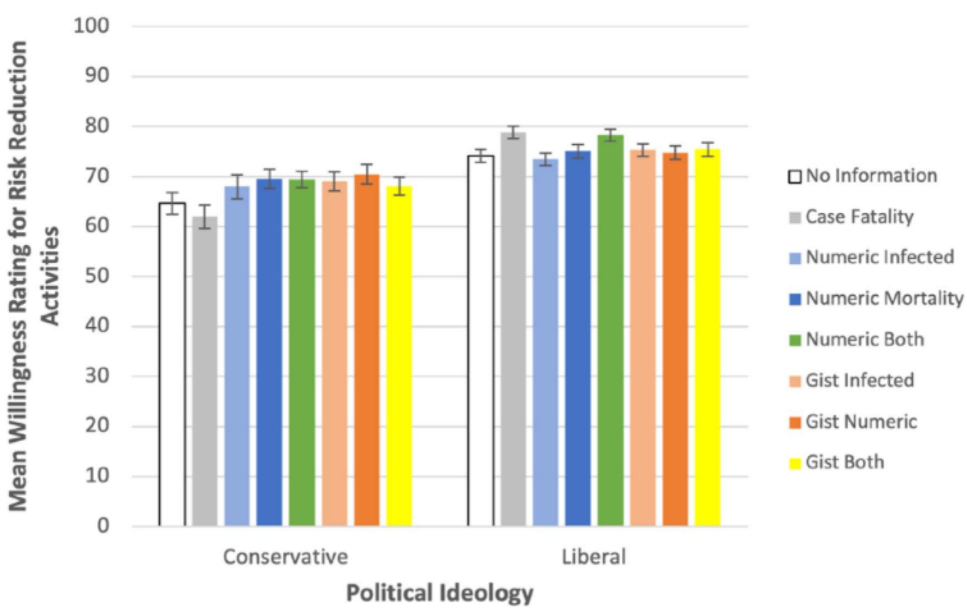
ONLINE COLOR

Note. Mean rating for willingness to wear a mask indoors by message format and political ideology (error bars show ±1 standard error). See the online article for the color version of this figure.

liberals, $M = 37.56$, $SD = 31.61$, $F(1, 1958) = 406.89$, $p < .001$, $\eta_p^2 = 0.17$. There was also an age group by political ideology interaction, $F(1, 1958) = 13.44$, $p < .001$, $\eta_p^2 = 0.007$, such that among conservatives, older participants ($M = 71.26$, $SD = 29.46$) rated higher agreement than did younger ($M = 66.20$, $SD = 28.22$). However, among liberals, the pattern reversed with older rating lower agreement ($M = 32.60$, $SD = 29.62$) than younger ($M = 38.79$, $SD = 31.98$).

Figure 7

Willingness to Engage in Risk-Reduction Activity by Political Ideology and Format

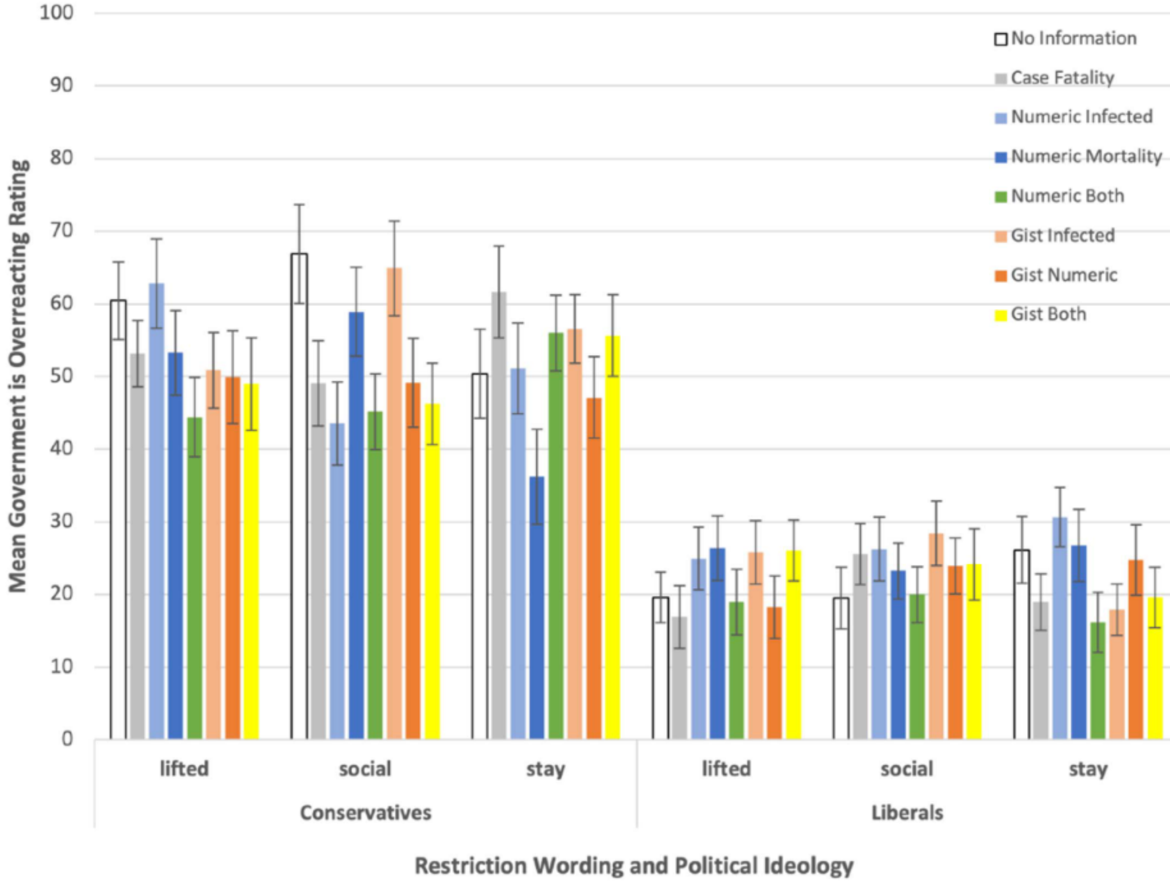


ONLINE COLOR

Note. Mean rating for willingness to engage in risk-averse activities by message format and political ideology (error bars show ±1 standard error). See the online article for the color version of this figure.

Figure 8

Government Overreacting Rating by Political Ideology, Message Format, and Restriction Wording



ONLINE COLOR

Note. Mean rating of government is overreacting for conservatives and liberals by message format and restriction wording (error bars show ±1 standard error). See the online article for the color version of this figure.

Thus, conservatives were significantly more critical of government policies than were liberals. In addition, it is clear that the most prominent differences were among older participants. Although older liberals appear to be less critical than younger liberals, this was less true of older conservatives compared to younger conservatives. There were also two interesting three-way interactions with political ideology, restrictions wording, and message formatting. Among conservatives, agreement with both "the government is overreacting" and "the danger was exaggerated" was reduced among conservatives by most messaging formats when restrictions were lifted or social distancing was in place. However, messaging did not seem to impact agreement when the more stringent "stay-at-home" restrictions were in place.

Summary: Section II

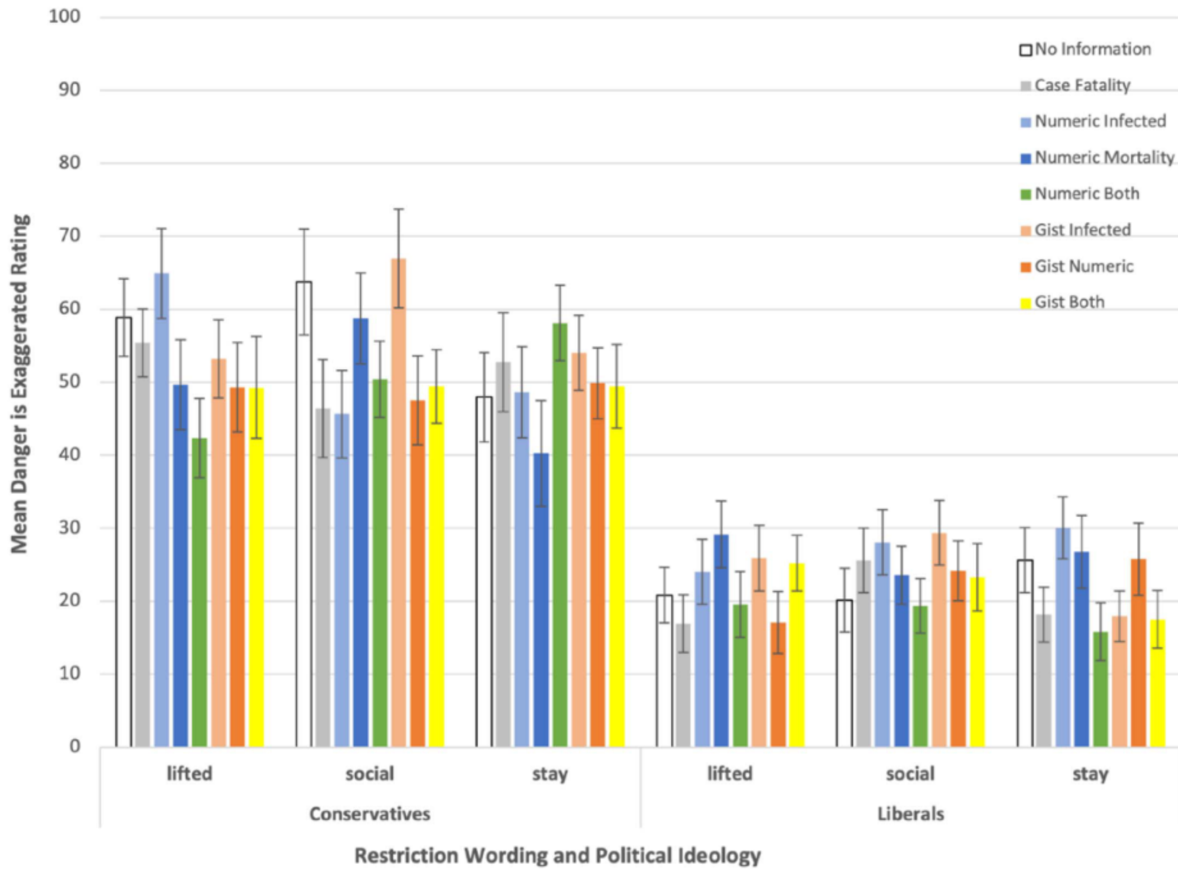
In sum, although conservatives rated a similar likelihood of COVID-19 outcomes as did liberals, their other responses to COVID-19 were quite different. Conservatives were less concerned and less willing to engage in risk-reduction activities than were liberals. They were more willing to engage in risk-seeking activities and in greater agreement with statements that the danger was exaggerated, the government was overreacting and we should get back to normal as soon as possible. Despite this, conservatives appeared to be at least somewhat responsive to messaging. The case-fatality expression reduced perceived likelihood of dying among conservatives as it did the larger group. However, this may also have reduced conservatives' willingness to engage in risk-reduction activities as evidenced by the interactions between political ideology and message format. On the positive side, conservatives were influenced, like the larger group, by restrictions wording, being more willing to engage in risk-reduction activities, and less willing to engage in risk-seeking activities when social distancing was in place. In addition, there was an interesting set of interactions between message form, restriction wording, and political ideology suggesting that some messaging may reduce conservative's agreement with government critical statements when the less restrictive policies (lifted, social distancing) were in place.

Discussion

The statistics related to the risk of contracting and dying of COVID-19 that were available during the course of the COVID-19 pandemic were not only complex but bore a complex relationship to one's actual risk. This makes it challenging for members of the

Figure 9

Danger Exaggerated Rating by Political Ideology, Message Format, and Restriction Wording



Note. See the online article for the color version of this figure.

ONLINE COLOR

public to judge the likelihood that they will become infected and/or suffer serious consequences in situations like this. Because perceived likelihood is an important factor in willingness to engage in protective behaviors (Janz & Becker, 1984; Lindell & Perry, 2012), we sought to assess it during the early stages of the pandemic as well as the impact of risk messaging on risk perception.

Risk Perception

Participants had fairly accurate (CDC; Feng et al., 2020) intuitions about some aspects of COVID-19-related risks. They appeared to understand the age-relative likelihood of being asymptomatic, returning to their previous state of health (younger greater than older) and the likelihood of being hospitalized as a result of COVID-19 (younger less than older). In addition, participants trusted the mortality statistics to a greater degree than the infection statistics, suggesting that they understood that mortality statistics were more closely related to the risk of dying from COVID-19 than were the infection statistics to the risk of infection. In other words, participants may have had intuitions about the multiple dynamic factors extending beyond the individual, each with its own level of risk, that determine the risk of acquiring the infection.

However, it is interesting to note that participants in general greatly overestimated the likelihood of dying if infected with COVID-19, suggesting a reference class confusion (Reyna & Brainerd, 2008). For instance, older individuals may have thought that 94% of deaths meant a 94% chance of death. However, if this were the case overall, we would expect to see more participants indicating higher likelihoods, when in fact the distribution of likelihood estimates among older individuals was slightly right skewed indicating more lower than higher estimates. Moreover, the overestimation was also observed in the no-information condition, which hovered around 40% for both groups. Thus, although these misunderstandings may explain a few overestimates, they do not explain the majority of cases, nor do they explain overestimation among younger participants. In fact, the case-fatality rates in May when this study was conducted were less than 1% for younger and about 8%[9] for older people. Thus, participants' estimates were about 39 times greater for younger and about 5 times greater for the older group.

Perhaps a more plausible explanation for the overestimation observed here is that participants were overweighting the likelihood of death due to a combination of well-known biases. Overestimating the small likelihoods could be due in part to the classic probability weighting function, in which people tend to perceive greater

[9] As of this writing the case-fatality rate for younger (18–49) is 0.2% and for older (50+) is 5%.

differences in changes of likelihoods near 0% and 100% than in the midranges (e.g., Gonzalez & Wu, 1999; Tversky & Kahneman, Q10 1992). Alternatively, as predicted by fuzzy trace theory (Brainerd & Reyna, 1992) the difference between 0% and 1% (or 8%) might seem larger because it is the difference between no risk and some risk. However, the degree of overestimation observed here across conditions suggests an additional impact of affect (e.g., fear), which can also enhance risk perception (Keller et al., 2006; Rottenstreich & Kivetz, 2006; Slovic et al., 2005). In the case of COVID-19, the numbers available at the time did not speak directly to ones' risk, making some additional estimation on the part of the user reasonable. In addition, in situations like this, the error of underestimating the likelihood carries greater costs than does overestimating the likelihood (Weber, 1994). Thus, fear may have consciously or unconsciously led people to estimate a greater likelihood than is warranted, despite messaging to the contrary. In other words, overestimating the likelihood of death due to COVID-19 may be a System 1 tendency to err on the side of cautiousness. Indeed, although perceived likelihood of dying was reduced to some degree in the case-fatality condition (to about 30% chance), it was still many times greater than indicated by the case-fatality messages. Overestimation of this risk might seem advantageous in terms of motivating protective behavior. However, it could reduce trust if it comes to be seen as the result of an exaggeration on the part of the information source (Rubin et al., 2009).

Risk Messaging

We worried that the prominence of warnings describing the serious consequences for older people would have unintended consequences. In particular, it might have led younger people to think that they would be less likely to become infected with and spread COVID-19. This might, in turn, encourage more risky behavior among younger people, enhancing the spread of this virus. As predicted, for younger participants, mortality statistics describing the larger proportion of older people among deaths, decreased perceived likelihood of infection compared to infection statistics. Similarly, infection statistics describing similar proportions of older and younger among infections increased perceived likelihood of dying compared to mortality statistics. However, these biases were attenuated when both infection and mortality statistics were provided in the same message. Thus, emphasizing increased risks of severe outcomes for some groups, as was done here and abroad in course of the COVID-19 pandemic, may indeed have had an unforeseen cost in terms of people's understanding of the risk of infection. For that reason, future messaging should include both critical outcomes to provide a balanced picture of the risks facing members of the public in general.

In addition, we found that gist expressions *increased* perceived likelihood of becoming infected and dying among younger participants, while they *decreased* perceived likelihood among older participants, compared to numeric expressions. This appears to have been because younger participants tended to overestimate the likelihoods when less explicit gist expressions were presented, while precise numeric estimates provided a corrective effect. The opposite may have been true of older adults with precise numeric expressions increasing likelihood estimates. Indeed, this appears to be supported by the age differences in no-information group. Younger participants rated the likelihood of infection significantly higher than did older participants in the no-information condition, when in fact the proportions were similar for age groups. For likelihood of dying, ratings in the no-information condition were similar between older and younger when in fact, the likelihood of dying was much higher for older adults. In sum, for statistics that describe the comparison between age groups the numeric format brought relative perceived likelihood into alignment with the best estimates available at the time, making the two groups more similar to one another for likelihood of becoming infected but increasing the difference in the two age groups for perceived likelihood of dying of COVID-19. Gist expressions may have allowed more room for previous perceptions to be maintained. Interestingly, numeric expressions despite nudging participants toward more accurate risk perception were trusted less; perhaps because participants doubted the level of precision they implied (Olson & Budescu, 1997).

It is also important to note that a gist format may have encouraged more appropriate protective intentions among younger participants by increasing risk perception in general for that group. The gist-both (infection + mortality) message increased willingness to wear a mask among younger participants, bringing their willingness in line with that of older participants. This is similar to effects noted in previous work showing that gist representations are beneficial in reducing risk-seeking behaviors among young adults (Brainerd & Reyna, 2015). However, the gist both (infection and mortality) may have been particularly effective in this case because it addressed the discrepancy between age groups in likelihood to die but clarified that it did not extend to becoming infected. This contrast may have been more accessible in the simplified gist format. Thus, although numeric formats may communicate likelihood slightly better, gist formats may better motivate appropriate protective behavior, perhaps by reducing processing load. Granted, this effect of message format was only observed on willingness to wear a mask indoors among the activities tested here. Nonetheless, this form of gist messaging may be a promising avenue to pursue in future research.

Government Restrictions

The strongest impact on behavioral intentions was due to government restrictions introduced prior to the activities section in the survey. "Social distancing" recommendations increased willingness to wear a mask among younger participants and "stay-at-home" recommendations decreased willingness to engage risk-seeking activities for the group as a whole. In addition, there was, surprisingly, no difference detected in effectiveness of restrictions due to political ideology. This suggests that these kinds of measures may be widely, if not universally effective.

Thus, older and younger individuals were not as different as one might expect in terms of their risk perception or their willingness to engage in risk-reduction and risk-seeking activities. Although there were some differences with respect to agreement for government policies, younger were in greater agreement with "the government is overreacting" and "the danger is exaggerated," these effects were also small. The bottom line is that contrary to our initial intuitions, the differences along the age divide in risk perception and response to COVID-19 were small.

Political Ideology

The biggest differences were due to political ideology; these effect sizes were much larger than any of the differences between younger and older. Conservatives were less willing to wear a mask, engage in risk-reduction activities, more willing to engage in risk-seeking activities, and more critical of government policies than were liberals.[10] This was despite the fact that the differences in risk perception among the two groups were negligible, suggesting that in some cases risk perception is not as important to protective decisions as are other factors. Indeed, it was clear that even in May 2020, that political ideology was an important driver of attitudes toward protective behavior in the context of COVID-19.

There were some interesting interactions between political ideology and age in this MTurk sample that suggested that the largest differences due to political ideology were among older participants. Older liberals tended to be more trusting of messaging, more concerned about COVID, more cautious in terms of activities and less critical of government policies than were younger liberals. Among conservatives however older and younger tended to be more similar (both groups less cautious and more critical of government policies than liberals).

Nonetheless, there were some encouraging results suggesting that some forms of communication are effective across the boundaries of political ideology. Indeed, liberals and conservatives appeared to be equally sensitive to governmental restrictions (stay at home, social distancing, restrictions lifted) when considering risk-seeking activities. In addition, there were some interesting interactions between political ideology and messaging. Messaging describing infection and mortality statistics tended to decrease agreement among conservatives with "government is overreacting" and "the danger is exaggerated" when less restrictive policies (lifted, social distancing) were in place. This suggests that some forms of communication may well be helpful in guiding behavioral choices despite political ideology. This will be a particularly important line of research to pursue as similar issues will be important in making sure that vaccines are more widely accepted.

However, the case-fatality rate may have had a boomerang effect (Hart & Nisbet, 2012) among conservatives. Recall that due to the fact that participants generally vastly overestimated the likelihood of dying from COVID-19, the case-fatality rate, describing the number of deaths among those who tested positive, may have been much lower than participants anticipated. Although this message did not impact behavioral intentions among liberals, it may have further reduced willingness among conservatives to wear a mask and engage in risk-reduction activities as the analyses for those dependent variables suggested. However, we interpret these effects due to message format, when broken down by age and political ideology, with caution due to the smaller n in some conditions. Thus, additional research is necessary to better understand this potentially negative impact and the form of messaging that might attenuate it.

In sum, this work suggests that risk messaging plays an important but complex role in risk perception, behavioral intentions, and support for government policies in the course of an ongoing pandemic such as COVID-19. In this study, in which age-relative statistics were provided, peoples' risk perception was biased by single outcome messaging, such as the greater proportion of the elderly among deaths. Similar expressions in widespread use at the time were intended to protect the most vulnerable. These results suggest that they may have inadvertently decreased risk perception among younger people. However, as we demonstrated here, messaging including a combination of outcomes can overcome these biases and should be employed in the future. We also discovered that gist messaging may be effective in some cases, especially among younger individuals. Moreover, these results suggest that, although conservatives are generally more reluctant to take protective measures, government restrictions are effective in encouraging appropriate protective behavior across the political spectrum. Q11

[10] Although there were slightly more younger participants among liberals, the age difference observed for this variable was in the opposite direction (older more willing to wear a mask than younger).

References

Allcott, H., Boxell, L., Conway, J., Gentzkow, M., Thaler, M., & Yang, D. (2020). Polarization and public health: Partisan differences in social distancing during the coronavirus pandemic. *Journal of Public Economics*, *191*, Article 104254. https://doi.org/10.1016/j.jpubeco.2020.104254

Al-Rasheed, M. (2020). Protective behavior against COVID-19 among the public in Kuwait: An examination of the protection motivation theory, trust in government, and sociodemographic factors. *Social Work in Public Health*, *35*(7), 546–556. https://doi.org/10.1080/19371918.2020.1806171

Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology*, *63*(1), 1–29. https://doi.org/10.1146/annurev-psych-120710-100422 Q12

Barari, S., Caria, S., Davola, A., Falco, P., Fetzer, T., Fiorin, S., Hensel, L., Ivchenko, A., Jachimowicz, J., King, G., Kraft-Todd, G., Ledda, A., MacLennan, M., Mutoi, L., Pagani, C., Reutskaja, E., Roth, C., & Slepoi, F. R. (2020). Evaluating COVID-19 public health messaging in Italy: Self-reported compliance and growing mental health concerns. MedRxiv. https://doi.org/10.1101/2020.03.27.20042820v2

Baumgaertner, B., Carlisle, J. E., Justwan, F., & Rabinowitz, M. (2018). The influence of political ideology and trust on willingness to vaccinate. *PLOS ONE*, *13*(1), Article e0191728. https://doi.org/10.1371/journal.pone.0191728

Bi, Q., Wu, Y., Mei, S., Ye, C., Zou, X., Zhang, Z., Liu, X., Wei, L., Truelove, S. A., Zhang, T., Gao, W., Cheng, C., Tang, X., Wu, X., Wu, Y., Sun, B., Huang, S., Sun, Y., Zhang, J., . . . Feng, T. (2020). Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: A retrospective cohort study. *The Lancet. Infectious Diseases*, *20*(8), 911–919. https://doi.org/10.1016/S1473-3099(20)30287-5

Blalock, S. J., & Reyna, V. F. (2016). Using fuzzy-trace theory to understand and improve health judgments, decisions, and behaviors: A literature review. *Health Psychology*, *35*(8), 781–792. https://doi.org/10.1037/hea0000384

Bonnefon, J.-F., & Villejoubert, G. (2006). Tactful or doubtful? Expectations of politeness explain the severity bias in the interpretation of probability phrases. *Psychological Science*, *17*(9), 747–751. https://doi.org/10.1111/j.1467-9280.2006.01776.x

Brainerd, C. J., & Reyna, V. F. (1992). Explaining "memory free" reasoning. *Psychological Science*, *3*(6), 332–339. https://doi.org/10.1111/j.1467-9280.1992.tb00042.x

Brainerd, C. J., & Reyna, V. F. (2015). Fuzzy-trace theory and lifespan cognitive development. *Developmental Review*, *38*, 89–121. https://doi.org/10.1016/j.dr.2015.07.006

Brownstein, R. (2020, March 20). Red and blue America aren't experiencing the same pandemic. *The Atlantic*. https://www.theatlantic.com/politics/archive/2020/03/how-republicans-anddemocrats-think-about-coronavirus/608395/

Cakanlar, A., Trudel, R., & White, K. (2020). Political ideology and the perceived impact of coronavirus prevention behaviors for the self and others. *The Association for Consumer Research*. Advance online publication. https://doi.org/10.1086/711834

Cammett, M., & Lieberman, E. (2020). Building solidarity: Challenges, options, and implications for COVID-19 responses. COVID-19 rapid response impact initiative, White Paper 4. Edmond J. Safra Center for Ethics, 30.

Q13 Carruthers, P. (2009). An architecture for dual reasoning. In J. S. B. T. Evans & K. Frankish (Eds.), *In two minds: Dual processes and beyond* (pp. 109–127). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199230167.003.0005

Center for Disease Control and Prevention. *COVID data tracker*. https://covid.cdc.gov/covid-data-tracker/#demographics

Q14 Center for Disease Control and Prevention. *Coronavirus disease 2019 (COVID-19)*. https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/older-adults.html

Q16 Q15 Chang, A. (2020, March 17). Poll shows partisan differences over how seriously people are taking coronavirus. *NPR*. https://www.npr.org/2020/03/17/817354092/poll-shows-partisandifferences-over-how-seriously-people-are-taking-coronavirus

Cohen, A. K., Hoyt, L. T., & Dull, B. (2020). A descriptive study of COVID-19-related experiences and perspectives of a national sample of college students in spring 2020. *The Journal of Adolescent Health*, *67*(3), 369–375. https://doi.org/10.1016/j.jadohealth.2020.06.009

Q17 de Bruin, W. B., & Bennett, D. (2020). Relationships between initial COVID-19 risk perceptions and protective health behaviors: A national survey. *American Journal of Preventative Medicine*, *61*(3), 157–167. https://doi.org/10.1016/j.amepre.2020.05.001

Q19 Q18 Feng, Y., Ling, Y., Bai, T., Xie, Y., Huang, J., Li, J., & Qu, J. (2020). COVID-19 with different severities: A multicenter study of clinical features. *American Journal of Respiratory and Critical Care Medicine*, *201*(11), 1380–1388. https://doi.org/10.1164/rccm.202002-0445OC

Fischer, E. P., Fischer, M. C., Grass, D., Henrion, I., Warren, W. S., & Westman, E. (2020). Low-cost measurement of face mask efficacy for filtering expelled droplets during speech. *Science Advances*, *6*(36), Article eabd3083. https://doi.org/10.1126/sciadv.abd3083

Q21 Q20 Gauchat, G. (2012). Politicization of science in the public sphere: A study of public trust in the United States, 1974 to 2010. *American Sociological Review*, *77*(2), 167–187. https://doi.org/10.1177/0003122412438225

Gonzalez, R., & Wu, G. (1999). On the shape of the probability weighting function. *Cognitive Psychology*, *38*(1), 129–166. https://doi.org/10.1006/cogp.1998.0710

Q22 Hamilton, L. C., Hartter, J., & Saito, K. (2015). Trust in scientists on climate change and vaccines. *SAGE Open*, *5*(3). https://doi.org/10.1177/2158244015602752

Q23 Harris, A. J., Corner, A., & Hahn, U. (2009). Estimating the probability of negative events. *Cognition*, *110*(1), 51–64. https://doi.org/10.1016/j.cognition.2008.10.006

Hart, P. S., & Nisbet, E. C. (2012). Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. *Communication Research*, *39*(6), 701–723. https://doi.org/10.1177/0093650211416646

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education Quarterly*, *11*(1), 1–47. https://doi.org/10.1177/109019818401100101

Johns Hopkins University and Medicine Coronavirus Resource Center. (2021, June 1). https://coronavirus.jhu.edu/map.html

Q24 Jones, T. C., Mühlemann, B., Veith, T., Biele, G., Zuchowski, M., Hoffmann, J., Stein, A., Edelmann, A., Corman, V. M., & Drosten, C. (2020). An analysis of SARS-CoV-2 viral load by patient age. *MedArXiv*. https://doi.org/10.1101/2020.06.08.20125484v1

Joslyn, S., Nadav-Greenberg, L., & Nichols, R. M. (2009). Probability of precipitation: Assessment and enhancement of end-user understanding. *American Meteorological Society*, *90*(2), 185–194. https://doi.org/10.1175/2008BAMS2509.1 Q25

Joslyn, S. L., & LeClerc, J. E. (2012). Uncertainty forecasts improve weather-related decisions and attenuate the effects of forecast error. *Journal of Experimental Psychology: Applied*, *18*(1), 126–140. https://doi.org/10.1037/a0025185

Joslyn, S., & LeClerc, J. (2013). Decisions with uncertainty: The glass half full. *Current Directions in Psychological Science*, *22*(4), 308–315. https://doi.org/10.1177/0963721413481473

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist*, *58*(9), 697–720. https://doi.org/10.1037/0003-066X.58.9.697

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Kahneman, D., & Frederick, S. (2002). Heuristics of intuitive judgment: Extensions and applications. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics of intuitive judgment: Extensions and applications* (pp. 1–30). Cambridge University Press. https://doi.org/10.1038/2251090a0

Kannel, W. B., McGee, D., & Gordon, T. (1976). A general cardiovascular risk profile: The Framingham Study. *The American Journal of Cardiology*, *38*(1), 46–51. https://doi.org/10.1016/0002-9149(76)90061-8

Keller, C., Siegrist, M., & Gutscher, H. (2006). The role of the affect and availability heuristics in risk communication. *Risk Analysis*, *26*(3), 631–639. https://doi.org/10.1111/j.1539-6924.2006.00773.x

Keren, G. (2013). A tale of two systems: A scientific advance or a theoretical stone soup? Commentary on Evans & Stanovich (2013). *Perspectives on Psychological Science*, *8*(3), 257–262. https://doi.org/10.1177/1745691613483474

Keren, G., & Schul, Y. (2009). Two is not always better than one: A critical evaluation of two system theories. *Perspectives on Psychological Science*, *4*(6), 533–550. https://doi.org/10.1111/j.1745-6924.2009.01164.x

Koma, W., Neuman, T., Claxton, G., Rae, M., Kates, J., & Michaud, J. (2020). *How many adults are at risk of serious illness if infected with coronavirus? Updated data*. https://www.kff.org/global-health-policy/issue-brief/how-many-adults-are-at-risk-ofserious-illness-if-infected-with-coronavirus/ Q26

Kruglanski, A. W., & Gigerenzer, G. (2011). Intuitive and deliberate judgments are based on common principles. *Psychological Review*, *118*(1), 97–109. https://doi.org/10.1037/a0020762

LeClerc, J., & Joslyn, S. (2015). The cry wolf effect and weather-related decision making. *Risk Analysis*, *35*(3), 385–395. https://doi.org/10.1111/risa.12336

Lindell, M. K., & Perry, R. W. (2012). The protective action decision model: Theoretical modifications and additional evidence. *Risk Analysis*, *32*(4), 616–632. https://doi.org/10.1111/j.1539-6924.2011.01647.x

Menachemi, N., Yiannoutsos, C. T., Dixon, B. E., Duszynski, T. J., Fadel, W. F., Wools-Kaloustian, K. K., & Halverson, P. K. (2020). Population point prevalence of SARS-CoV-2 infection based on a statewide random sample—Indiana, April 25–29, 2020. *Morbidity and Mortality; Weekly Report*, *69*(29), 960–964. https://doi.org/10.15585/mmwr.mm6929e1

Midway, S., Robertson, M., Flinn, S., & Kaller, M. (2020). Comparing multiple comparisons: Practical guidance for choosing the best multiple comparisons test. *PeerJ*, *8*, Article e10387. https://doi.org/10.7717/peerj.10387

Mills, B., Reyna, V. F., & Estrada, S. (2008). Explaining contradictory relations between risk perception and risk taking. *Psychological Science*, *19*(5), 429–433. https://doi.org/10.1111/j.1467-9280.2008.02104.x

Olson, M. J., & Budescu, D. V. (1997). Patterns of preference for numerical and verbal probabilities. *Journal of Behavioral Decision Making*, *10*(2), 117–131. https://doi.org/10.1002/(SICI)1099-0771(199706)10:2<117::AID-BDM251>3.0.CO;2-7 Q27

Onder, G., Rezza, G., & Brusaferro, S. (2020). Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. *Journal of the American Medical Association*, *323*(18), 1775–1776. https://doi.org/10.1001/jama.2020.4683

Park, C. L., Russell, B. S., Fendrich, M., Finkelstein-Fox, L., Hutchison, M., & Becker, J. (2020). Americans' COVID-19 stress, coping, and adherence to CDC guidelines. *Journal of General Internal Medicine*, *35*(8), 2296–2303. https://doi.org/10.1007/s11606-020-05898-9

Peters, E., Dieckmann, N., Dixon, A., Hibbard, J. H., & Mertz, C. K. (2007). Less is more in presenting quality information to consumers. *Medical Care Research and Review: MCRR*, *64*(2), 169–190. https://doi.org/10.1177/1077558707064002030l

Reyna, V. F. (2012). Risk perception and communication in vaccination decisions: A fuzzy-trace theory approach. *Vaccine*, *30*(25), 3790–3797. https://doi.org/10.1016/j.vaccine.2011.11.070

Reyna, V. F., & Brainerd, C. J. (2008). Numeracy, ratio bias, and denominator neglect in judgments of risk and probability. *Learning and Individual Differences*, *18*(1), 89–107. https://doi.org/10.1016/j.lindif.2007.03.011

Q28 Rogers, R. W., & Prentice-Dunn, S. (1997). Protection motivation theory. In D. Gochman (Ed.), *Handbook of health behavior research: Vol. 1. Determinants of health behavior: Personal and social* (pp. 113–32). Plenum Press.

Roy-Chowdhury, V., Perera, D., Tagliaferri, G., Mottershaw, A., & Egan, M. (2020). *Young men are hardest to engage on coronavirus guidance: Analysis of 11 trials with 20,000 UK adults*. Behavioral Insights Team. https://www.bi.team/blogs/young-m

Rosenfeld, D. L. (2020). *Political ideology and the outbreak of COVID-19 in the United States*. https://psyarxiv.com/jrpfd/

Rottenstreich, Y., & Kivetz, R. (2006). On decision making without likelihood judgment. *Organizational Behavior and Human Decision Processes*, *101*(1), 74–88. https://doi.org/10.1016/j.obhdp.2006.06.004

Rubin, G. J., Amlôt, R., Page, L., & Wessely, S. (2009). Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: Cross sectional telephone survey. *BMJ*, *339*, Article b2651. https://doi.org/10.1136/bmj.b2651

Savelli, S., & Joslyn, S. (2013). The advantages of predictive interval forecasts for non-expert users and the impact of visualizations. *Applied Cognitive Psychology*, *27*(4), 527–541. https://doi.org/10.1002/acp.2932

Sblendorio, P. (2020, November 22). More than 1 million people traveled on planes in US on a single day ahead of Thanksgiving amid coronavirus pandemic. *Daily News*. https://www.msn.com/en-us/news/world/more-than-1-million-people-traveled-on-planes-in-us-on-a-single-day-ahead-of-thanksgiving-amid-coronavirus-pandemic/ar-BB1bgcME?tblci=GiCI5eASVjYFy3qihWN53Bko9MK_edcfyr2EcUnnftgQTSCC-00+

Slovic, P., Peters, E., Finucane, M. L., & Macgregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology*, *24*(Suppl. 4), S35–S40. https://doi.org/10.1037/0278-6133.24.4.S35

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323. https://doi.org/10.1007/BF00122574 Q29

van Holm, E., Monaghan, J., Shahar, D. C., Messina, J. P., & Surprenant, C. (2020). The impact of political ideology on concern and behavior during COVID-19. Available at SSRN 3573224.

Verity, R., Okell, L. C., Dorigatti, I., Winskill, P., Whittaker, C., Imai, N., & Ferguson, N. M. (2020). Estimates of the severity of coronavirus disease 2019: A model-based analysis. *The Lancet. Infectious Diseases*, *20*(6), 669–677. https://doi.org/10.1016/S1473-3099(20)30243-7 Q30

Weber, E. U. (1994). From subjective probabilities to decision weights: The effect of asymmetric loss functions on the evaluation of uncertain outcomes and events. *Psychological Bulletin*, *115*(2), 228–242. https://doi.org/10.1037/0033-2909.115.2.228

Weber, E. U., & Hilton, D. J. (1990). Contextual effects in the interpretations of probability words: Perceived base rate and severity of events. *Journal of Experimental Psychology: Human Perception and Performance*, *16*(4), 781–789. https://doi.org/10.1037/0096-1523.16.4.781

World Health Organization. (2020). *Protect yourself and others from the spread COVID-19*. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public

Wu, J. T., Leung, K., Bushman, M., Kishore, N., Niehus, R., de Salazar, P. M., & Leung, G. M. (2020). Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China. *Nature Medicine*, *26*(4), 506–510. https://doi.org/10.1038/s41591-020-0822-7

Wu, Z., & McGoogan, J. M. (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: Summary of a Report of 72,314 Cases from the Chinese Center for Disease Control and Prevention. *Journal of the American Medical Association*, *323*(13), 1239–1242. https://doi.org/10.1001/jama.2020.2648

Appendix A

Questions Asked in Experiment

Risk Perception Questions (1)

1. How likely do you think it is that you would become infected with COVID-19? VAS with endpoints Impossible (left) and Certain (right)
2. If you become infected with COVID-19, how likely do you think it is that you would infect someone else with COVID-19? VAS with endpoints Impossible (left) and Certain (right)
3. If you become infected with COVID-19, how likely do you think it is that you would die from COVID-19? VAS with endpoints Impossible (left) and Certain (right)

Trust and Concern Questions

4. How concerned are you about COVID-19? VAS with endpoints Not at all (left) and Completely (right)
5. How much do you trust the information about COVID-19 that is provided above? VAS with endpoints Not at all (left) and Completely (right)

Activity Questions

6. How willing would you be to participate in the activities below, [if you were advised to Stay at Home/if you were advised to practice Social Distancing/if all the COVID-19-related restrictions in your community were lifted? VAS with endpoints Not at all willing (left) and Very willing (right)

6.1. Maintain a 6-foot distance from people (with whom I am not living)
6.2. Use a delivery service to get my groceries
6.3. Use a delivery service to get my restaurant to-go order
6.4.Avoid people who have traveled or been to large gatherings recently
6.5. Wear a mask in all public indoor spaces
6.6. Wear a mask in all public outdoor spaces
6.7. Avoid personal contact with people with whom I am not living
6.8.Avoid personal contact with older relatives and friends

(*Appendices continue*)

6.9. Disinfect packages before bringing them into the house.
6.10. Walk a pet
6.11. Jog/Walk/Run in your neighborhood
6.12. Go hiking on a trail with few other people
6.13. Go for a bike ride on public roadways
6.14. Participate in outdoor activities, such as boating, fishing, swimming, kayaking, etc.
6.15. Play a low contact sport, such as golf
6.16. Play a high contact sport, such as basketball
6.17. Go swimming in a public pool
6.18. Visit a public park or beach
6.19. Work out at a gym
6.20. Go to a restaurant to pick up to-go order
6.21. Go to the grocery store or pharmacy
6.22. Use grocery carts or touch surfaces in public places without using sanitizing wipes
6.23. Dine at an outdoor cafe/restaurant
6.24. Dine indoors at a restaurant
6.25. Visit a hair salon, barbershop, or spa
6.26. Go to a shopping mall for nonessential items, such as clothing
6.27. Go to bar or club
6.28. Go to a movie at an indoor movie theater
6.29. Get together with a few friends in an outdoor setting
6.30. Get together with a few friends in an indoor setting
6.31. Host/Attend a large party in an outdoor setting
6.32. Host/Attend a large party in an indoor setting
6.33. Attend a wedding
6.34. Attend a funeral
6.35. Visit a church or other religious gathering
6.36. Attend large gatherings in an outdoor venue (e.g., concerts, sporting events, etc.)
6.37. Visit or volunteer at care facilities, such as hospitals, nursing homes, homeless shelters, etc.
6.38. Visit a doctor's or dentist's office for a routine checkup.
6.39. Attend medical appointments in person for non-COVID related issues (e.g., sprained ankle)
6.40. Go to the emergency room for non-COVID-related issues (e.g., heart attack or stroke symptoms)
6.41. Ride in friend's vehicle or drive a friend
6.42. Use a ride-hailing service (e.g., Uber, Lyft, etc.) or other small vehicle where you do not personally know the driver
6.43. Ride on public transportation (e.g., bus)
6.44. Go on a cruise
6.45.Visit an amusement park
6.46. Airline travel within the United States
6.47. Airline travel outside of the United States
6.48. Stay at a hotel or motel
6.49. Vote in person at your local polling place
6.50. Go to workplace/school in person
6.51. Send pre-Kindergarten children back to daycare, if open
6.52. Send Kindergarten to 12th-grade children back to school, if district opens schools

7. Do you have any comments for the researcher on the activities listed above?

Risk Perception Questions (2)

8. If you become infected with COVID-19, how likely is it that you would have no symptoms? VAS with endpoints impossible (left) and Certain (right)

9. If you become infected with COVID-19, how likely is it that you would return to your previous state of health? VAS with endpoints impossible (left) and Certain (right)

10. If you become infected with COVID-19, how likely is it that you would be hospitalized? VAS with endpoints impossible (left) and Certain (right)

Government Response Questions

11. How much do you agree with the following statements? VAS with endpoints Disagree Completely (left) and Agree completely (right)

    11.1. The government is *overreacting* to the danger from COVID-19.
    11.2. The danger from COVID-19 is being exaggerated.
    11.3. We should get back to normal life as soon as possible.

Demographic Questions:

1. Gender (Options: Male, Female, Other)t

2. Age (in years): Numeric

3. What is the highest degree or level of school that you have completed? Please select ONE option. Options: Did not complete high school, High school diploma or GED equivalent, Some college, technical school, or associate's degree, Bachelor's degree (e.g., BA, BS), Master's degree (e.g., MA, MS, MEng, MEd, MSW, MBA), Professional degree or doctorate (e.g., MD, DDS, DVM, LLB, JD, PhD, EdD) Q31

4. Please select ALL that apply to you. Options: White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, Hispanic/Latinx, Middle Eastern/North African, Other, Prefer not to answer

5. Marital status. Options: Single, Married with children, Married without children, Divorced, Separated, Widowed, Domestic partnership, Prefer not to answer

6. How many people are currently living or staying in your home (count everyone living and sleeping in your home most of the time, including yourself, young children, roommates, and friends and family members who are living with you, even temporarily)?

7. Which of the following categories best describes your current employment? Select one from Essential personnel, working 40 hr or more per week; On-call essential

(*Appendices continue*)

personnel, working only when called to work; Nonessential personnel, working 40 hr or more per week from home; nonessential personnel, working fewer than 40 hr from home; Full-time or part-time student working from home; Nonessential personnel, not currently allowed to work due to stay safe orders; Nonessential working out of the home

8. Please indicate the answer that includes your entire household income in (previous year) before taxes. Select one from: less than $10,000; $10,000–$19,999; $20,000–$29,999; $30,000–$39,999; $40,000–$49,999; $50,000–$59,999; $60,000–$69,999; $70,000–$79,999; $80,000–$89,999; $90,000–$99,999; $100,000–$149,999; $150,000 or more; Prefer not to answer

9. Have you been tested for COVID-19? Yes, No, Prefer not to answer

10. Have you tested positive for COVID-19? Yes, No, Prefer not to answer

11. Political ideology: In general, do you think of yourself as: Extremely Liberal; Liberal; Slightly Liberal; Moderate, middle of the road; Slightly conservative; Conservative; Extremely Conservative

12. In which State do you currently live. Options: All 50 states and 5 inhabited territories

13. City [test field, free format]

14. Community [urban/suburb/rural]

15. Is there a person in your family or group of friends, who is elderly or has chronic health problems? Yes, No

Appendix B

Pilot Study Assessing Risk Perception

Mean rating for the degree of risk associated with each of these activities, on a VAS anchored on the left by "not at all risky" and on the right by "extremely risky," converted to a 5-point scale.

Activities	*M*	*SD*
Risk reduction		
Maintain a 6-foot distance from people	2.29	1.13
Use a delivery service to get my groceries	2.60	1.08
Use a delivery service to get my restaurant to-go order	2.75	1.10
Risk seeking		
Walk a pet	2.33	1.14
Jog/Walk/Run in your neighborhood	2.45	1.17
Go hiking on a trail with few to no other people (10 or fewer)	2.90	1.22
Go to a restaurant to pick up to-go order	3.12	1.05
Visit a park	3.18	1.15
Get together in person only with those who have not traveled or not been to large gatherings in the past 2 weeks	3.50	1.08
Go to the grocery store or pharmacy	3.58	0.92
Ride in friend's vehicle or drive a friend	3.66	0.99
Host/attend a small dinner party with a few friends (four or fewer)	3.70	1.02
Attend medical appointments (non-COVID related) in person	3.77	0.96
Visit an outdoor cafe	3.86	0.94
Ride on Uber or other small vehicles where you do not personally know the driver	4.07	0.90
Have personal contact with people with whom I am not living	4.07	1.09
Use grocery carts or touch surfaces in public places without using sanitizing wipes	4.09	0.91
Have personal contact with older relatives and friends	4.10	0.93
Go to workplace/school in person	4.21	0.89
Visit a church or other religious gathering	4.36	0.83
Ride on public transportation (e.g., bus)	4.40	0.78
Visit a hospital	4.41	0.77
Visit or volunteer at care facilities, such as hospitals, nursing homes, homeless shelters, etc.	4.41	0.78
Attend large gatherings in an outdoor venue	4.47	0.80

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Queries

Q1. Kindly check and confirm the edit made in the title.

Q2. Please check and confirm the given names and surnames of the author(s) are identified correctly and amend, if necessary. Names currently identified as surnames are highlighted.

Q3. Please update the year of publication here (Center for Disease Control and Prevention [CDC]).

Q4. Kindly check and confirm the edit made in the Tables footnotes.

Q5. "Baumgaertner et al. 2020" is replaced with "Baumgaertner et al., 2018", please confirm

Q6. Please check that the edit made in the sentence beginning with "Thus, in the experiment reported here . . . " is OK and that the meaning has not been changed.

Q7. Does the sentence beginning with "Restriction wording, in that it was not presented..." mean the three risk variables such as risk perception, trust, and concern? Please confirm.

Q8. Please provide expansion for the abbreviation "ANOVA" used in the article.

Q9. Kindly check and confirm the edit made in the Figures 1 & 2 foot note.

Q10. "Brainard & Reyna, 1999" is replaced with "Brainerd & Reyna, 1992", please confirm

Q11. Please check the edit made in the sentence beginning with "Moreover, these results suggest that . . . " and correct, if necessary.

Q12. Kindly check and confirm whether the issue number is correctly identified (Ref. "Baddeley, 2012").

Q13. Please provide complete details for the reference (Ref. "Cammett & Lieberman, 2020").

Q14. Please provide year of publication for " Center for Disease Control and Prevention, *COVID data tracker*"

Q15. Please provide year of publication for " Center for Disease Control and Prevention, *Coronavirus disease 2019*"

Q16. 'Center for Disease Control and Prevention, *Coronavirus disease 2019*,' is not cited in text. Please add citation or delete from list.

Q17. Kindly check and confirm whether the issue number is correctly identified (Ref. "Cohen et al., 2020").

Q18. Kindly check and confirm whether the volume/issue number/page number is correctly identified (Ref. "de Bruin & Bennett, 2020").

Q19. Author name "de Bruin" has been edited. Kindly check and confirm. (Ref. "de Bruin & Bennett, 2020").

Q20. The title was updated but differs from the author's original: Low-cost measurement of mask efficacy for filtering expressed droplets during speech. (Ref. "Fischer, Fischer, Grass, Henrion, Warren, Westman, 2020")

Q21. Kindly check and confirm whether the article number "eabd3083" is correctly identified (Ref. "Fischer et al., 2020").

Q22. Kindly check and confirm whether the issue number is correctly identified (Ref. "Gonzalez & Wu, 1999").

Q23. Please provide page range for the reference (Ref. "Hamilton et al., 2015").

Q24. Please provide webtitle for the reference (Ref. "Johns Hopkins University, 2021").

Q25. Year has been changed from "2008" to "2009" in both reference list and citation (Ref. "Joslyn et al., 2009"). Kindly check and confirm.

Q26. The given URL is seems to be incorrect. Kindly check and update. (Ref. "Koma et al., 2020").

Q27. Kindly check and confirm whether the issue number is correctly identified (Ref. "Olson & Budescu, 1997").

Q28. A Kindly check and confirm whether the issue number is correctly identified (Ref. "Reyna & Brainerd, 2008").

Q29. Kindly check and confirm whether the issue number is correctly identified (Ref. "Tversky &Kahneman, 1992").

Q30. Kindly check and confirm whether the issue number is correctly identified (Ref. "Verity et al., 2020").