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The effects of efficacy framing in news information and health anxiety on COVID-19-related cognitive outcomes and interpretation bias

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Abstract

Within the 2019 Coronavirus (COVID-19) pandemic, disease-related information is omnipresent in the media, whereas information about how to manage the pandemic is less often covered. Under the context where threat is present, this study investigated whether and how the strength of efficacy framing (i.e., the perspective adopted by a communicating text that emphasizes one’s possibilities to cope with an external threat) of COVID-19-related news, as well as its interaction with trait health anxiety under the COVID-19 context, related to people’s COVID-19-related cognitive outcomes. One hundred and ninety-three participants reported demographics, trait health anxiety, and COVID-19-related behaviors (e.g., precautionary measures, information-seeking behaviors). They then either read high-efficacy ($n = 112$; e.g., cure rate) or low-efficacy ($n = 81$; e.g., mortality rate) information about COVID-19. Afterwards, their tendency to interpret illness- and COVID-19-related information more negatively, and other COVID-19-related cognitions (e.g., risk perception, behavioral change intentions) were assessed. High-efficacy framing resulted in lower risk perception and marginally weaker COVID-19-related interpretation bias, compared to low-efficacy framing. There was some evidence of an interaction with health anxiety such that high-efficacy framing, as compared to low-efficacy framing, was associated with greater intention to adopt protective behaviors, particularly for individuals with higher levels of health anxiety. Media framing of COVID-19 information affects how people respond to the pandemic; a high-efficacy communication style might more effectively encourage healthy behaviors than a low-efficacy narrative, particularly for people who are already anxious about their health.

Keywords: Coronavirus; News Media; Framing Effects; Health Anxiety
Introduction

Since the first positive COVID-19 case on 23 January 2020, Hong Kong experienced a wax and wane of the pandemic over February (first wave) and March (second wave). Entering April, the pandemic went under control and remained stable. In late June, Hong Kong achieved a three-week streak of zero local infections. On 5 July, another local case marked the beginning of a third wave of the pandemic. On 9 July 2020, 42 new cases were confirmed, including 34 local infections with 10 reporting unknown sources. The third wave saw an exponential increase in positive cases which reached its peak of 149 per day on 30 July 2020. The entire third wave lasted for over two months until early September. As no vaccinations were available at that time, social distancing was the main countermeasure available. From 10 July 2020 onwards, a series of regulations were announced, including school suspensions, restricted social gatherings of no more than 4 people, a ban of dining-in between 18:00 pm and 05:00 am, and mandatory mask-wearing with violations leading to HK$5,000 (~US$642) fines. Under the third-wave pandemic, data collection for this current study took place from 16 to 30 July 2020.

On a global level, since its outbreak, the 2019 Coronavirus Disease (COVID-19) has quickly spread across the globe, infecting over 219 million people and causing over 4.55 million deaths. Given the possible spread of the coronavirus from asymptomatic and even untraceable cases, coupled with the situation that vaccines are yet to be administered on a global scale, adherence to protective behaviors remains one of the most important measures to protect against infections. As such, how COVID-19-related health messages are communicated between the media and community members is of critical importance.

Framing in the context of media communication refers to the process to “select some aspects of a perceived reality and make them more salient in a communicating text” (Entman, 1993, p. 52). How an event is represented in the media depends on the specific perspective
taken, and through directing the audience’s attention towards some aspects of a situation and away from the others, framings determine what the audience recognize and remember about an event, as well as shape their evaluations of and responses to a specific issue (Entman, 1993). Based on research during previous pandemic experiences (e.g., H1N1; Sandell et al., 2013), media reports are usually narrated under different thematic frames, with two common examples being the risk magnitude frame and the self-efficacy frame. When the risk magnitude frame is adopted, the media focuses on threatening information such as how likely citizens would contract and/or die from a health issue; when the self-efficacy frame is adopted, the media focuses on educating the readers to recognize symptoms of the health issue and take protective actions.

Among mainstream media coverage of COVID-19, researchers have suggested that media could highlight the danger of the pandemic so as to elevate the public’s risk perception (Garfin et al., 2020; Olagoke et al., 2020) and related negative emotional states (e.g., fear, worry, anger; Harper et al., 2020; Liu, 2020; Oh et al., 2020), and in turn, steer protective behaviors, such as hand washing, surface sanitizing, and social distancing. One observational study in Nigeria (Nwakpu et al., 2020), for example, pointed out that local newspapers mainly adopted threatening framings (e.g., contamination, fatality) when reporting COVID-19, and this was assumed to explain public adoption of precautionary measures. However, this relationship is yet to be confirmed experimentally. Moreover, some research has called for attention to the undesirable side-effects of such framing, such as media fatigue (Klemm et al., 2016) and even mental health burden (Bendau et al., 2020; Gao et al., 2020; Olagoke et al., 2020; Trnka & Lorencova, 2020), following an unbalanced emphasis towards threat.

To date, various health behavior theories have been proposed to explain the complicated nature of, and relationships among, the underlying motivators of health behaviors. One of the influential theories is the Extended Parallel Process Model (EPPM;
Witte, 1992). This model is built upon two core constructs, perceived threat (i.e., susceptibility and severity) and perceived efficacy (i.e., response efficacy and self-efficacy). Depending on whether perceived efficacy outweighs perceived threat or vice versa, either the danger control or the fear control process is activated, which could respectively activate protective motivation (and adaptive changes) or defensive motivation (and maladaptive changes).

EPPM has now been applied within the context of COVID-19 (e.g., Jahangiry et al., 2020; Lin & Chen, 2021; Rui et al., 2021). However, while Jahangiry et al. (2020) observed that higher perceived efficacy predicted adaptive danger control processes, Lin and Chen (2021) alternatively found that it was perceived threat instead (but not perceived efficacy) that was associated with prevention behaviors. Finally, Rui et al. (2021), with their six-wave repeated-measures survey, emphasized that both perceived threat and perceived efficacy were relevant, differentially responsible for certain behaviors at particular stages of the pandemic. While a shared theme of the abovementioned theoretical and empirical work is that threat goes hand-in-hand with efficacy in facilitating health awareness and self-protection behaviors, results have so far been inconclusive regarding the actual roles these different factors play. Another issue worth noting is that these three studies were all correlational, lacking conditions where framing methods are controlled experimentally and presented to participants so that conclusions about causality can be drawn. There is, however, one such experimental study related to a past pandemic, Ebola (Ort & Fahr, 2018). In their study, participants were randomized to different conditions where they browsed a mock website on vaccination against Ebola, with information varying in threat and efficacy degrees. Results showed that compared to threat messages, efficacy promotion more positively affected vaccination-related attitudes and intentions. Whether similar patterns could be observed under COVID-19 remains unknown.
Further, it is worth noting that past studies took the view that perceived efficacy may be superior to perceived threat (or the other way around), whereas the original model put forward by Witte (1992) suggested that efficacy and threat are not necessarily independent of one another. More specifically, only when perceived threat is high will people move on to the subsequent step of comparing the levels of perceived threat and efficacy, after which protective or defensive motivation will be activated; contrarily, if perceived threat starts low, the potential threat will be ignored without any further processing. It was summarized as “threat determines the degree or intensity of the response, while efficacy determines the nature of the response” (Witte, 1992, p. 345). COVID-19 has created a high-threat environment to study the suggestions of EPPM, where news information may provide varying levels of perceived efficacy. The present investigation therefore manipulated efficacy levels so as to introduce differences in the relative levels of threat and efficacy (i.e., threat outweighing efficacy in one condition whereas efficacy outweighing threat in the other), and see how this difference might influence COVID-19-related concerns (e.g., risk perception, behavioral change intentions).

Aside from COVID-19-related concerns and intentions, the present investigation also measured the effects of framing methods on participants’ tendencies to draw negative interpretations of otherwise ambiguous interoceptive (e.g., physiological events) and exteroceptive (e.g., environmental situations) stimuli (Kőteles & Witthöft, 2017; Leonidou & Panayiotou, 2018). Interpretation biases have been extensively studied within the context of emotional (Mathews & MacLeod, 2005) and somatic disorders (e.g., chronic pain; Chan et al., 2020a) in which anxiety about potential threats is prominent and where this interpretative tendency is thought to act as a causal and maintaining factor. In the present investigation, we examined whether exposure to particular framing methods can influence this tendency such that exposure to framing methods where threat outweighs efficacy would lead to greater
tendency to interpret ambiguous information in a negative way than if efficacy outweighs threat.

Relatedly, we examined the moderating role of health anxiety in the effects of framing on our dependent variables, as well as the unique contributions of health anxiety. Health anxiety, defined as concerns over threats to one’s health, is a dimensional construct spanning from total absence of health awareness (low health anxiety) to pathological worries (high health anxiety; Ferguson, 2009). The cognitive theory of health anxiety proposes that individuals with higher health anxiety may estimate the likelihood and/or the consequences of contracting a health issue to be higher (Rachman, 2012). Therefore, health anxiety may be associated with greater interpretation bias and a higher risk perception of the COVID-19.

Interestingly however, though health anxiety is derived from the much better-known psychopathological condition of hypochondriasis, it has been normalized by the current COVID-19 context. For most people, when experiencing respiratory symptoms, they would reasonably consider the possibility of infection, due to its high prevalence. In fact, moderate levels of health anxiety are desirable as they could encourage proper health behaviors. Generally speaking, most studies under a pandemic context showed that in the general population, individuals with higher levels of anxiety were more likely to adopt precautionary measures (Alrubaiee et al., 2020; Bish & Michie, 2010; Kwok et al., 2020; Leung et al., 2005). Critically speaking, these findings should be interpreted against either too little or too much health anxiety. Specifically, an optimism bias may lead to an underestimated need to adhere to recommended practices (Pascual-Leone et al., 2021; Tyrer, 2020), whereas severe health anxiety could trivialize the usefulness of health behaviors (e.g., hygiene practices) following a biased belief that physical illnesses are unavoidable (Schwind et al., 2015; Sirri et al., 2015). Further supporting this dimensional lens, Solymosi et al. (2021) categorized people as unworried, functionally worried or dysfunctionaly worried, within the context of
COVID-19. While the dysfunctional worry group suffered many negative outcomes on emotional wellbeing (e.g., a lack of satisfaction or meaning with life), the functional worry group adopted more health behaviors (e.g., social distancing) than both the dysfunctional worry and unworried groups. Put otherwise, while excessively high levels of anxiety could predispose individuals to exacerbating concerns and debilitating fears (Rivera & Carballea, 2020), moderate levels of anxiety and the accompanying vigilance for health-related threats could be functional as they motivate preventative behaviors that save lives (Asmundson & Taylor, 2020).

Furthermore, Jungmann and Witthöft (2020) found that COVID-19 anxiety was the strongest in those who had high levels of pre-pandemic health anxiety and who suffered stress due to excessive health information search (i.e., cyberchondria). This interesting finding suggests that existing health anxiety not only influences a person’s COVID-19-related thoughts and behaviors on its own, but it could also interact with external information to induce compound effects. This inspired us to ask whether similar patterns could also be observed in the case of news framing. Specifically, we intended to study whether people with differing levels of health anxiety, following exposure to high- vs. low-efficacy information, might display different responses in terms of their concerns about the pandemic and/or their willingness to change their behaviors in order to prevent infection. Explorations have been done in the contexts of AIDS/HIV (Witte & Morrison, 2000) and hypothetical mosquito infection (De Meulenaer et al., 2015), but empirical evidence is scarce and inconclusive, and this issue remains largely unexplored in a pandemic context. Therefore, we left our hypotheses involving the moderation effects non-directional.

In summary, we investigated whether and how varied levels of efficacy framing of COVID-19 information, health anxiety under the COVID-19 context, and the interaction between framing and health anxiety, impacted (1) COVID-19-related concerns (e.g., risk
perception, behavioral change intentions) and (2) people’s interpretation of COVID-19- or illness-related information. Participants were randomly assigned to conditions where they read an article about COVID-19 with different framings (high-efficacy vs. low-efficacy framing). We hypothesized that high-efficacy framing, compared to low-efficacy framing, would be associated with (1) lower COVID-19-related risk perception but higher behavioral change intentions (primary hypothesis), and (2) less negative interpretations for COVID-/illness-related situations (secondary hypothesis). We also expected that higher trait health anxiety under the COVID-19 context would be associated with more negative interpretation biases and higher risk perception, whereas for behavioral change intentions, it would be higher (lower) under moderately (severely) higher levels of health anxiety. Finally, we anticipated that anxiety would moderate the effects of framing such that framing effects would differ across the spectrum of health anxiety.

**Method**

**Participants**

Ethics approval was obtained from the corresponding author’s institution (Ref.: EA2005009). Participants were recruited if they were (1) aged 18 years or above, (2) based in Hong Kong at the time of study participation, (3) able to read Traditional Chinese, (4) not diagnosed with COVID-19 either at the time of study participation or in the past, and (5) not diagnosed with any neurological or psychological disorders either at the time of study participation or in the past.

A total of 330 individuals completed all study questions. Fourteen individuals were excluded due to technical errors, and 123 individuals were excluded on the basis of manipulation check results detailed in the section “Manipulations” below. Some additional analyses were conducted to compare systematic differences between the included and excluded individuals (see Supplemental Tables S1-S2 for details). Our final sample consisted
of 193 participants (54 males, 27.98%), whose age ranged from 18 to 69 years ($M = 27.50$, $SD = 10.46$). Of all participants, 172 (89.10%) had an education level of university or above. Of all participants, 112 were assigned to the high-efficacy framing group and 81 were assigned to the low-efficacy framing group. The groups of high- and low efficacy (for later data analyses) were created based on the experimental manipulation conditions.

A priori power analyses indicated that to identify a significant medium effect ($d = 0.5$) of group differences from planned independent-samples Mann-Whitney U tests at 80% power and $p < .050$, a minimum of 67 participants per group (134 in total) would be needed (G*Power 3.1; Faul et al., 2007). Similarly, to identify a significant medium effect ($f^2 = 0.15$) from planned three-step hierarchical linear regression models with eight independent variables (five covariates, two main factors, one interaction factor) at 80% power and $p < .050$, a minimum of 92, 68, and 55 participants would be needed for the three steps respectively (Faul et al., 2007). Hence, our sample size ($n = 193$) would be sufficient for statistically sound conclusions.

**Pre-Manipulation Measures**

*Demographics questionnaire*

Information on participants’ age, gender, and education level was collected.

*COVID-19-related behaviors*

Participants were asked a series of questions regarding their engagement in COVID-19-related behaviors *over the past one week* (Ng et al., 2020). Specifically, these included six questions about avoidance behaviors (e.g., “Avoid going to crowded places?”) with binary yes/no responses (1 = yes, 0 = no), six questions on precautionary measures (e.g., “Use facemasks when going outside?”) with a four-point Likert scale (1 = never, 4 = always), and four questions on information seeking behaviors (e.g., “How often do you seek out health information relating to COVID-19 on the Internet?”) with a six-point Likert scale (1 = never,
Avoidance behavior was quantified through summing the frequency of all six items, whereas precautionary measures and information seeking behaviors were quantified through calculating the mean scores. For all three indices, a higher score indicated more frequent behavior adoption. Avoidance behaviors, precautionary measures and information seeking behaviors had Cronbach’s α of .601, .753, and .938, respectively. Given the exploratory nature of this investigation, we collected data for all three measures, but since Cronbach’s α = 0.7 is defined as the benchmark for acceptable internal reliability (Nunnally, 1978), we only included the precautionary measures and information-seeking behaviors in the final analyses.

Health anxiety

The Short Health Anxiety Inventory (SHAI; Salkovskis et al., 2002) was used to measure participants’ perceptions regarding the likelihood and perceived negative consequences of contracting illness over the past six months. In our current study, we administered traditional Chinese version of this inventory (Zhang et al., 2015). The full SHAI contained four sections, and the first two were used in this study. The first subscale includes 14 items where for each, participants can choose one of four statements that best describes the extent of their anxiety (e.g., [a] = I do not worry about my health, [b] = I occasionally worry about my health, [c] = I spend much of my time worrying about my health, [d] = I spend most of my time worrying about my health). In the case where two or more responses were chosen, the highest score was adopted. The second subscale includes four items on the perceived awfulness of contracting an illness, organized in a similar format. We rephrased the wordings in the second subscale from “serious illness” to “COVID-19”, but no modifications were done to the first subscale. While we operationally kept the terminology “health anxiety” for this construct, readers are suggested to bear in mind this adaptation in wording when interpreting the results. A total score was generated through summing all items on the SHAI, with a
higher score indicating a higher level of health anxiety. The SHAI had a Cronbach’s $\alpha$ of .885.

**Manipulations**

*COVID-19-related high- vs. low-efficacy framing manipulations*

Two fictional newspaper articles that were an amalgamation of real news articles and blog posts were used (available here: https://doi.org/10.17605/OSF.IO/VZUFC). These included some background information about the COVID-19 threat (which was the same for both manipulation groups) and then information specific to either high- or low-efficacy. Participants in the high-efficacy framing read through information talking about recovery from COVID-19, effective measures that have been used to prevent transmission, international and local actions spreading knowledge and information, as well as worldwide efforts in the global race for a cure/vaccine; participants in the low-efficacy framing group read through information about mortality and the long-term danger of the COVID-19, why transmission remained high despite measures taken, and why we could not count too much on vaccines. These framing conditions aimed to manipulate the *relative* levels of efficacy as compared to threat, such that threat was present for all, but the high-efficacy (low-efficacy) framing group perceived *more* (*less*) efficacy than threat.

**Manipulation check**

Manipulation check was performed using the following three steps:

*Step 1: Reading comprehension questions*. After reading the information on COVID-19, all participants were asked five questions. For participants who answered incorrectly on certain questions, the correct answers were shown to them. This procedure was meant to reinforce the manipulation effects and to help us screen out participants who may not have read the articles. Participants with an accuracy rate of below 80% were considered to be inattentive and thus excluded from the final analyses.
Step 2: Perceived orientation of the article. At the end of the study, the participants were asked to indicate on a dichotomized question whether the article was better described as death- or cure-oriented. This step ensured that participants in each group perceived the article information similarly to other group members in the intended way. Participants who read the high-efficacy (or low-efficacy) article but chose the death- (or cure-) orientation were thus excluded from the final analyses.

Step 3: Perceived positivity/optimism of the article. Additionally, participants were asked to rate on a -10 to +10 scale how positive/negative (-10 = very negative, +10 = very positive) and how optimistic/pessimistic (-10 = very pessimistic, +10 = very optimistic) they perceived the article to be. This step was included to further confirm whether the two groups perceived the articles significantly differently from each other. Evidence of successful manipulation was inferred from a between-group difference on perceived positivity and optimism such that these two constructs are higher in the high-efficacy framing manipulation condition. No participants were excluded on the basis of their responses to these questions though.

Post-Manipulation Measures

COVID-19-related cognitions

Participants were asked six questions (two for each of the following) on their threat belief, risk perception, and behavioral change intentions related to COVID-19, adapted from Rosoff et al. (2012). Regarding threat belief, participants were asked to indicate on a scale of 0 (impossible) to 100 (certain) their (1) perceived likelihood of infection, and (2) perceived likelihood of becoming seriously ill if infected. For risk perception, participants were asked to rate on a six-point Likert scale (1 = strongly disagree, 6 = strongly agree) their perceived risk of COVID-19 (1) to themselves, and (2) to others. For behavioral change intentions, participants were asked to rate on a six-point Likert scale (1 = strongly disagree, 6 = strongly
agree) their (1) willingness to change their daily routine, and (2) desire to avoid public spaces. Threat belief, risk perception and behavioral change intentions were all computed through averaging the scores on their two subitems, with higher scores indicating higher levels of the relevant cognitions. Threat belief, risk perception, and behavioral change intentions had Cronbach’s αs of .671, .798, and .819, respectively. Again, only the latter two (Cronbach’s αs > 0.7; Nunnally, 1978) were included in the final analyses.

Interpretation biases

The Interpretation Bias Task (IBT; Chan et al., 2020b), i.e., the Chinese adaptation of the Adolescent Interpretations of Bodily Threat Task (AIBT; Heathcote et al., 2016), was used to capture interpretation biases. Its full version consists of 23 personally relevant vignettes, referring to four domains (i.e., immediate bodily injury, long-term illness, social rejection, performance failure). In each vignette, participants are first shown an ambiguous situation depicted by an incomplete sentence with two options for completing the sentence, one benign and one negative. Participants are asked to imagine themselves in each of these scenes, and rate the likelihood of both endings, respectively, on a scale of 1 (not at all likely) to 100 (extremely likely), and the two scores do not need to add up to 100. Interpretation bias in each domain could be quantified by two scores: 1) the mean perceived likelihood of the benign interpretations (with a higher score indicating greater beliefs in the possibility of the benign interpretations), and 2) the mean perceived likelihood of the negative interpretations (with a higher score indicating greater negative interpretation biases under ambiguity). For this current study, we only used the six vignettes from the long-term illness domain. One example is “You take a pill every morning at breakfast. The pill is a …”, for which the two options are “vitamin” (benign interpretation) and “medicine” (negative interpretation).

Additionally, following the same logic of the original IBT, we created a new set of five vignettes that aimed to capture COVID-19-related interpretation biases (available on
OSF: https://doi.org/10.17605/OSF.IO/VZUFC). One example is “You are in a restaurant and the person sitting at the table next to yours has a running nose. You believe he is …”, for which the two options are “allergic” (benign interpretation) and “infected” (negative interpretation). Similarly, two scores were generated, i.e., the mean perceived likelihood of the benign interpretations and that of the negative interpretations (with a higher score on the latter indicating greater COVID-19-related interpretation biases under ambiguity).

For perceived likelihood scores in both the long-term illness and the COVID-19 domains, the benign interpretation scores had Cronbach’s αs of .489 and .455, whereas the negative interpretation scores had Cronbach’s αs of .840 and .742. Given the need to create new IBT measures without pilot testing, and the poor reliability of the benign interpretation scores, only negative interpretation scores (Cronbach’s α > 0.7; Nunnally, 1978) were included in the final analyses.

**Procedure**

Participants were recruited through institutional mass email. They provided informed consent and completed the study on Qualtrics (https://www.qualtrics.com) with their own computers. They first filled out the background demographics information and the pre-manipulation measures, before being randomly assigned to the high- or low-efficacy framing manipulation. Afterwards, they completed the post-manipulation measures and the manipulation check. All procedures of this study were administered in traditional Chinese, and all the manipulation materials as well as the pre- and post-manipulation measures, with the exceptions of the SHAI and the long-term illness IBT (with translation details stated above), were originally written in traditional Chinese. Finally, participants were fully debriefed, were provided with the other article shown to the other manipulation group, and were entered into a lucky draw for monetary compensation.

**Data Analyses**
Analyses were conducted with IBM SPSS Statistics 25. Relevant assumptions were checked before parametric tests were conducted; otherwise, the non-parametric equivalents were used. Where appropriate, independent-samples Mann-Whitney U tests and $\chi^2$ tests identified differences between high- and low-efficacy manipulation groups in pre-manipulation measures: age, gender, education level, health anxiety, or COVID-19-related precautionary measures and information seeking behaviors. Multiple regressions tested whether the groups differed in the manipulation check variables (i.e., perceived positivity and perceived optimism of the article), while controlling for any pre-manipulation measures identified as differing between the groups.

As for our main analyses, hierarchical linear regressions were conducted. All categorical variables were coded as dummy variables before being entered into the models. These models examined whether framing condition, health anxiety and the framing $\times$ health anxiety interaction term explained post-manipulation outcome variables (COVID-19-related cognitions, interpretation biases). Other pre-manipulation measures were included as covariates (i.e., age, gender, education level, COVID-19-related precautionary measures, COVID-19 information seeking behaviors). Independent variables were entered into the models in three blocks in the following sequence: covariates were entered in Step 1, framing condition and health anxiety were entered in Step 2 alongside covariates, and the interaction term was entered in Step 3 alongside all other variables. We followed the sequence illustrated in To and Mandracchia’s (2019) example. Model improvement in Step 2 would signal main effects of framing condition and/or health anxiety on top of the background covariates in the base model, whereas model improvement in Step 3 would signal a further interaction effect between framing and health anxiety in addition to the main effects.

Significance level was set at .05 by default. For main analyses specifically, multiplicity corrections were also carried out.
Results

Group differences in pre-manipulation variables

Table 1 summarizes between-group differences in all pre-manipulation variables. Independent-samples Mann-Whitney U tests and $\chi^2$ tests showed that there were no systematic differences between the high- and low-efficacy framing groups in age, gender ratio, COVID-19-related precautionary measures or COVID-19-related information seeking behaviors ($p$'s > .050). However, the high-efficacy framing group had a significantly higher proportion of participants with university education or above, $\chi^2(1) = 5.902, p = .015, \phi = 0.175$, and a lower level of pre-manipulation health anxiety, $U = 3622.500, p = .017, r = 0.172$. However, further correlational analyses showed that the association between framing manipulation and pre-manipulation health anxiety was only weakly significant, $r = -.147, p = .042$ (Supplemental Table S3).

Manipulation check

The multiple regressions for the manipulation check variables showed that, after holding constant health anxiety and education level, the high-efficacy framing group ($M = 5.43, SD = 3.87$) had a significantly more positive perception of their manipulation article than the low-efficacy framing group ($M = -3.62, SD = 3.48$), $\beta = .777, SE = .047, p < .001, 95\% CI [.683, .871]$. Furthermore, the high-efficacy framing group ($M = 5.04, SD = 3.53$) also showed a significantly more optimistic perception of the manipulation article than the low-efficacy framing group ($M = -3.62, SD = 3.28$), $\beta = .785, SE = .046, p < .001, 95\% CI [.693, .876]$. This indicated that on a group level, framing effects were successfully induced as intended.

Descriptive statistics for post-manipulation measures

Participants reported a mean score of 4.31 ($SD = 1.12$) for COVID-19-related risk perception and a mean score of 5.27 ($SD = 0.77$) for COVID-19-related behavioral change intentions,
wherein both scores had a possible range of 1-6. Participants obtained an average score of 26.18 (SD = 17.80) for long-term illness interpretation bias and an average score of 41.38 (SD = 16.29) for COVID-19-related interpretation bias, wherein a score of 1-100 was possible. The skewness statistics of the four outcome measures ranged from -1.383 to 0.738, falling within the acceptable boundaries of -2 to 2 (Hair et al., 2010; Kline, 2011).

**COVID-19-related risk perception**

Regarding the regression model for COVID-19-related risk perception, in the first step when only covariates were present, the outcome was explained by younger age (β = -.231, SE = .073, p = .002, 95% CI [-.375, -.087]) and pre-manipulation information seeking behaviors (β = .187, SE = .072, p = .010, 95% CI [.045, .329]), but not by gender, education level, or pre-manipulation precautionary measures (p’s ranged from .090 to .971), ΔR² = .108, F(5,186) = 4.517, p < .001.

The addition of framing and health anxiety in the second step of the model accounted for additional significant variance above and beyond the covariates, ΔR² = .190, F(2, 184) = 24.889, p < .001, with both low-efficacy framing (β = -.164, SE = .064, p = .011, 95% CI [-.290, -.038]) and health anxiety (β = .406, SE = .065, p < .001, 95% CI [.278, .534]) demonstrating significant relationships with risk perception. However, the addition of the framing × health anxiety interaction term (β = .013, SE = .160, p = .936, 95% CI [-.303, .329]) in the third step did not significantly improve the model, ΔR² < .001, F(1, 183) = 0.007, p = .936. The overall model for COVID-19-related risk perception was significant, accounting for R² = .298 (adjusted R² = .267) of the variance, F(8, 183) = 9.719, p < .001 (Table 2).

To conclude, high-efficacy framing was related to lower risk perception, and higher health anxiety was associated with higher risk perception, but the framing × health anxiety interaction term was not a significant factor for risk perception.
COVID-19-related behavioral change intentions

As for the regression model for COVID-19-related behavioral change intentions, in the first step when only covariates were present, the outcome was explained by pre-manipulation precautionary measures ($\beta = .352$, $SE = .070$, $p < .001$, 95% CI [.214, .491]), but not by age, gender, education level, or pre-manipulation information seeking behaviors ($p$’s ranged from .147 to .414), $\Delta R^2 = .165$, $F(5,186) = 7.325$, $p < .001$.

Whereas the addition of framing ($\beta = .082$, $SE = .069$, $p = .237$, 95% CI [-.054, .219]) and health anxiety ($\beta = .078$, $SE = .070$, $p = .267$, 95% CI [-.060, .217]) in the second step did not significantly improve the model as compared to what was explained by the covariates, $\Delta R^2 = .011$, $F(2, 184) = 1.202$, $p = .303$, interestingly though, the addition of the framing × health anxiety interaction term ($\beta = .335$, $SE = .172$, $p = .053$, 95% CI [-.005, .674]) in the third step improved the model on a marginally significant level, $\Delta R^2 = .017$, $F(1, 183) = 3.786$, $p = .053$ (and in subsequent models with multiplicity correction with significance level set at .0125, this effect was no longer considered to be marginal (Supplemental Table S4)). The overall model for COVID-19-related behavioral change intentions was significant, accounting for $R^2 = .192$ (adjusted $R^2 = .157$) of the variance, $F(8, 183) = 5.436$, $p < .001$ (Table 2).

We decomposed this interaction effect with PROCESS (Hayes, 2017). Results showed that when all the covariates were adjusted for, the framing effect was conditional on the level of health anxiety. The effect was not significant when health anxiety was one standard deviation below mean (SHAI = 8.36) or at mean (SHAI = 15.474), $p$’s = .572 and .269 respectively, but it was significant when health anxiety was one standard deviation above mean (SHAI = 22.586), $\beta = .326$, $SE = .148$, $p = .029$, 95% CI [.034, .618], with individuals from the high-efficacy induction condition ($M = 5.49$) reporting higher behavioral change intentions than individuals from the low-efficacy induction condition ($M = 5.16$).
Furthermore, as an exploratory attempt supplementing the abovementioned analyses, we also conducted separate multiple linear regressions for the two framing conditions respectively, with health anxiety alongside other covariates entered as independent variables, health anxiety was a significant correlate of behavioral change intentions for the high-efficacy framing group, $\beta = .202, SE = .091, p = .029, 95\% CI [.021, .383]$, but not for the low-efficacy framing group, $\beta = -.112, SE = .109, p = .308, 95\% CI [-.330, .106]$. 

In sum, behavioral change intentions were generally greater in the high-efficacy framing than the low-efficacy framing group, and this difference was conditional to higher levels of health anxiety. See Figure 1 for a visual illustration.

*Long-term illness interpretation bias*

No covariates significantly related to long-term illness interpretation bias in the first step ($p$’s range from .148 to .987), $\Delta R^2 = .012, F(5,186) = 0.450, p = .813$. The regression model for long-term illness interpretation bias accounted for significant variance only after the second step, i.e., the addition of framing and health anxiety on top of the covariates, $\Delta R^2 = .210, F(2, 184) = 24.812, p < .001$. However, only health anxiety demonstrated a significant association, $\beta = .473, SE = .068, p < .001, 95\% CI [.338, .608]$, whereas framing did not, $\beta = -.035, SE = .067, p = .607, 95\% CI [-.167, .098]$. The addition of the framing $\times$ health anxiety interaction term ($\beta = -.052, SE = .169, p = .756, 95\% CI [-.385, .280]$) in the third step did not significantly improve the model, $\Delta R^2 < .001, F(1, 183) = 0.097, p = .756$. The overall model for long-term illness interpretation bias was significant, accounting for $R^2 = .222$ (adjusted $R^2 = .188$) of the variance, $F(8, 183) = 6.536, p < .001$ (Table 3). In short, higher health anxiety related to greater illness interpretation bias but there was no main or interacting effect of framing.

*COVID-19-related interpretation bias*

Finally, no covariates significantly related to COVID-19-related interpretation bias in the first
step (p’s range from .090 to .712), $\Delta R^2 = .029$, $F(5,186) = 1.125$, $p = .348$. The regression model for COVID-19-related interpretation bias accounted for significant variance only after the second step, i.e., the addition of framing and health anxiety on top of the covariates, $\Delta R^2 = .252$, $F(2, 184) = 32.232$, $p < .001$, with health anxiety demonstrating a significant association, $\beta = .497$, $SE = .066$, $p < .001$, 95% CI [.367, .626], and high-efficacy (low-efficacy) was marginally associated with lower (higher) COVID-19-related interpretation bias, $\beta = -.121$, $SE = .065$, $p = .063$, 95% CI [-.248, .007] (and in subsequent models with multiplicity correction with significance level set at .0125, this effect was no longer considered to be marginal (Supplemental Table S5)). However, the addition of the framing × health anxiety interaction term ($\beta = .011$, $SE = .162$, $p = .945$, 95% CI [-.309, .331]) in the third step did not significantly improve the model, $\Delta R^2 < .001$, $F(1, 183) = 0.005$, $p = .945$.

The overall model for COVID-19-related interpretation bias was significant, accounting for $R^2 = .281$ (adjusted $R^2 = .250$) of the variance, $F(8, 183) = 8.949$, $p < .001$ (Table 3). To summarize, stronger COVID-19-related interpretation bias was associated with more health anxiety, and it was also marginally weaker under the high-efficacy framing.

**Analyses without manipulation check exclusions**

Additional analyses were conducted that included participants who were otherwise excluded (participants who were inattentive or who had an incorrect perception of the articles they were shown) in order to examine the contribution of these variables to our findings.

First, compared to attentive participants ($n = 217$), inattentive participants ($n = 99$) were more likely to have adopted more precautionary measures, and participants were more likely to be inattentive under the low-efficacy framing manipulation (Supplemental Table S1).

Second, participants who incorrectly perceived the high-efficacy article to be death-oriented ($n = 14$) reported significantly higher health anxiety levels than both participants
who incorrectly perceived the low-efficacy article to be cure-oriented \( (n = 10) \), or those who correctly perceived the intended orientation of the article, i.e., our final sample of included participants \( (n = 193; \text{Supplemental Table S2}) \). As this discrepancy between intended and perceived orientations may provide important insights into cognitive biases (which were implicated in the outcomes of this current study), we additionally conducted a parallel set of analyses with a sample of \( N = 217 \), with no participants excluded based on this Step 2 of manipulation check. These findings are presented in their entirety in Supplemental Tables S6-S8. Most of the observed effects reported above were the same after including these additional participants, including group differences in ratings of perceived positivity and optimism for the framing articles, alongside many other main outcomes of interest. However, several noteworthy findings concerning framing effects emerged. Namely, there was no longer a difference in participants’ health anxiety between the two framing conditions (Supplemental Table S6). Also, although the interaction between framing condition and health anxiety on COVID-19-related behavioral change intentions was now significant (Supplemental Table S7), the marginal framing effect on COVID-19-related interpretation bias continued to be non-significant (Supplemental Table S8).

**Discussion**

We provide an experimental test of media framing in health communication on COVID-19-related cognitive processes and behavioral intentions. High-efficacy framing was associated with lower perceptions of COVID-19-related risk and marginally lower tendency to attribute ambiguous internal sensations and external scenarios to signals of COVID-19. Elevated health anxiety under the COVID-19 context was also associated with heightened risk perceptions, as well as greater tendencies to interpret potentially benign situations as signs of COVID-19, or long-term illnesses in general. Health anxiety and framing also showed a trend towards interacting to explain behavioral intentions, such that the intention to engage in
greater societal avoidance in order to protect against COVID-19 was greatest for participants who received high-efficacy framing and who had elevated health anxiety.

Partially supporting our hypothesis on the experimental effects of framing, we observed between-group differences in risk perception and COVID-19-related interpretation bias. While it is widely held that capitalization on the danger of the disease could raise public awareness (Olagoke et al., 2020), our results further suggested that in the presence of threat, risk perception inversely depends on the efficacy that the information we receive confers on us. Additionally, findings for between-group differences in behavioral change intentions were mixed, suggesting that risk perception does not necessarily guarantee desirable health behaviors.

Participants exposed to high-efficacy COVID-19 information, as compared to low-efficacy information, exhibited marginally weaker tendency to interpret benign physiological symptoms or social scenarios as signs of COVID-19. To our knowledge, our study is among the first to investigate this specific cognitive process in the context of COVID-19 and as an outcome variable of media framing. This suggests that even in the absence of personal experience or vicarious acquisition, absorption of disturbing information (e.g., through media exposure) suffices the formulation of interpretation bias and further worries (Rachman, 2012; Tyrer, 2020). From the experiences during previous health crises, media’s tendency to disproportionally dramatize threat coupled with its neglect of efficacy information (Klemm et al., 2016) may provide some insights for why COVID-19-related media exposure has been suggested to disrupt mental health (Bendau et al., 2020; Gao et al., 2020; Garfin et al., 2020; Trnka & Lorencova, 2020). Given the theoretical implications of interpretation bias in various types of psychopathology (Chan et al., 2020a; Mathews & MacLeod, 2005), our findings have not only shed light on the possibility that interpretation bias could serve as an underlying cognitive mechanism explaining how media can disrupt mental health, but may
also speak for suggestions about how to tackle this through framing news media in a way that builds people’s efficacy. Interestingly, these framing effects were confined to COVID-19-related interpretations as there was no evidence of framing effects on interpretations related to more general long-term illnesses. Further, this marginal framing effect was observed only when readers did receive the information of the article as intended. This suggests that any effect of COVID-19-related news media on interpretation biases is context-specific, and is probably subject to the readers’ internalization of the particular framing that they are shown.

Regarding health anxiety under the COVID-19 context, our study found that it related to both risk perception and interpretation biases. These are in line with existing cognitive theories of health anxiety (Rachman, 2012), that individuals with high levels of health anxiety may overestimate the likelihood of suffering from an illness, and an overestimation of the negative consequences if they actually contract this illness, which then in turn further keep the affected individuals in a vicious cycle of health anxiety (Antognelli et al. 2020). This is not to say that health anxiety (alongside its accompanying risk perception or interpretation biases) is bad in and of itself. Under the current pandemic, potential COVID-19 symptoms reasonably call for people’s attention, but again, it is more about a matter of degree (Asmundson & Taylor, 2020; Solymosi et al., 2021; Tyrer, 2020). Individuals with overly high levels of interpretation bias may be more likely to make suboptimal decisions and engage in maladaptive behaviors, such as excessively monitoring of health, repetitive information and reassurance seeking, panic resource stockpiling, or even abuse of healthcare services, whilst paradoxically disbelieving medical test results that are supposed to disconfirm their fears (Asmundson & Taylor, 2020; Rachman, 2012; Tyrer, 2020). In a broader sense, interpretation bias could perpetuate transdiagnostic repetitive negative thinking (e.g., rumination, worry) that could contribute to a series of mental health issues (Hirsch et al., 2020). It is also worth noting that while increased sensitivity may be more
common under earlier stages of the pandemic when the virus appeared uncertain to most people, persisting interpretation bias in spite of growing scientific knowledge would deserve some attention.

Our study has revealed an interesting finding of the moderating role of health anxiety. Our finding is relatively unique in a sense that it attempted to answer how health anxiety as an individual difference factor may play a role in the processing of and responses to health messages with differing efficacy levels. Among our current sample, for individuals with relatively higher levels of health anxiety, they reported greater behavioral change intentions under the high-efficacy condition. This was not observed for individuals with relatively lower levels of health anxiety.

Under the COVID-19 context, for individuals with lower levels of health anxiety, they were probably more likely to hold an optimism bias regarding their own immunity from the coronavirus, which may then result in a greater likelihood to overlook the necessity to adopt recommended health behaviors (Pascual-Leone et al. 2021). Even though these individuals were able to comprehend threat and efficacy appeals, the absence of a framing effect may reflect a lack of personal incentive to respond regardless. For individuals with higher levels of health anxiety, on the contrary, they may be worrying as much as they should worry under this global health crisis, which prepared them for action once they also possessed the right tools (i.e., high-efficacy information). It should be acknowledged, however, that our results may not speak for individuals with clinical levels of anxiety, because our sample was fundamentally non-clinical in nature, with a mean health anxiety score of around 15. This was below the suggested cut-offs (up to 27) on the SHAI for possible hypochondriasis or other anxiety disorders (Alberts et al., 2013).

For our participants with higher levels of health anxiety, our results were in favor of high-efficacy, not only because these individuals reported higher behavioral change
intentions under the high-efficacy framing condition, but also because when compared against their counterparts with lower health anxiety, their intentions were higher only under the high-efficacy (but not low-efficacy) framing condition. Our high-efficacy article emphasized that efficacy outweighed threat (e.g., although the coronavirus could spread, there are effective countermeasures), whereas the low-efficacy article emphasized the opposite (e.g., although vaccination development is under process, there are reasons why we should not count too much on it). Our results suggest that pessimistic narratives that make people feel as though there is little that they can do to mitigate an impending threat might reduce people’s intentions to engage in protective behaviors (Abramson et al., 1978; Alloy & Ahrens, 1987). This echoes experimental studies supporting the role of efficacy cues in health behaviors in other pandemics (Ort & Fahr, 2018), and correlational evidence that perceived efficacy is found to play a role in adaptive danger control processes under COVID-19 (Jahangiry et al., 2020). However, as we did not include objective outcome measures of actual health behaviors, we could not confirm with certainty whether our participants’ behavioral change intentions would further translate into real behavioral changes, as there could be intention-behavior gaps (Sheeran & Webb, 2016).

Taken together, our results of this moderation effect have theoretical implications for a better understanding of both the EPPM model and health anxiety, under the specific context of the COVID-19 pandemic. Our results contribute to Witte and Morrison’s (2000) statement that individual differences determine how external threat or efficacy information is received and integrated into existing schemas that ultimately guide actions. In a previous study that similarly tested this postulation with a hypothetical mosquito infection (De Meulenaer et al., 2015), higher perceived efficacy encouraged more recommended behaviors, particularly for individuals with lower levels of general anxiety. It was thus inferred that high-anxiety individuals’ responses are predominantly driven by fearful emotions instead of cognitive
processing of threat and efficacy information. In contrast, we found that the framing effect was more salient for higher health anxiety, that is, those with higher levels of health anxiety not only cognitively processed efficacy information, but they also benefited even more from the high-efficacy information than their low-anxiety counterparts. Our results differed from De Meulenaer et al. (2015), but this may be traced back to a major difference in contextual background: COVID-19 is a real-life massive health crisis affecting the entire population on a global scale and carrying high levels of uncertainty, under which anxiety – especially health anxiety – not only escalated worldwide, but its functional protective role has also been more emphasized than usual. From this perspective, our results again support the recent voices (e.g., Asmundson & Taylor, 2020) of an “optimal-dosage” perspective of health anxiety under such a global health crisis as COVID-19.

On a practical level, several take-home messages are inferable from this moderation effect. First, media-based health communications should adopt a high-efficacy frame so as to best achieve the influence to encourage its audience to uptake desired health behaviors. Second, clinicians as well as the general public could reconsider and normalize health anxiety if it is seated within the justified boundaries under the pandemic context, because it may be a pre-requisite for behavioral change intentions. Finally, it usually takes the right combination of high-efficacy and health anxiety to achieve the best outcomes.

With the above being said, it should be acknowledged that when a more conservative criterion was chosen following multiplicity correction, the outcomes were mainly associated only with traits (i.e., health anxiety) and developed habits (i.e., pre-manipulation COVID-19-related precautionary measures), whereas framing effects were nullified to a large extent. On a general level, citizens likely already formed some beliefs about the COVID-19 (e.g., how dangerous the virus is) prior to joining our study. Their traits and habits may have long-lasting effects and serve as stronger predictors for cognitive and behavioral patterns, as
opposed to one-off experimental inductions.

Relatedly, our findings should be interpreted in light of several limitations of the framing procedure. First, a lack of distraction control group reading articles irrelevant to COVID-19 has made it difficult to confirm whether participants in the high-efficacy condition nonetheless showed elevated intentions to engage in protective behaviors compared to people who were not thinking about COVID-19 at all. Second, we did not directly measure perceived efficacy. Instead, our manipulation check questions on perceived positivity-negativity and optimism-pessimism at best indirectly tapped into participants’ perceived efficacy. However, discrepancy may exist between the intention of the news reporters and how information is actually received by readers. Many factors play a role here, such as trust in media, or perceived media hostility against one’s pre-existing stance (Cairns et al., 2013; Romer & Jamieson, 2020). Instead of being passive recipients of information, media consumers in fact actively assess information based on their own knowledge and values too (Tsfati & Cohen, 2013). In response, we explored this issue in our supplemental analyses, which revealed a small subsample who would perceive reassuring (or threatening) information in a negatively (positively) biased fashion, and this pattern may be further related to their trait health anxiety levels. Notably, our results remained largely comparable when we included/excluded this subsample, supporting the general reliability of our conclusions. Still, we encourage future studies to formally investigate how readers’ subjective interpretations interact with the intended framing effects, perhaps using stimuli with more ambiguous framings that allow for greater variation in interpretations.

As a third issue, while our experimental design may provide some insights, it does suffer from ecological and conceptual validity issues. For instance, our manipulation articles were one-off in nature and might not perfectly represent how information consumers usually receive news (i.e., reading a “flood” of news stories progressing over time and gradually
establishing the understanding of a topic under the cumulative effects of such continuous information input). We also could not disentangle the more specific factors underlying the so-called high- or low-efficacy qualities, which may include frequency, duration and diversity of media consumption (Bendau et al., 2020). And finally, our manipulation news articles differed from some conventions of traditional news articles, and the high- and low-efficacy articles differed in content. Therefore, caution needs to be taken when generalizing findings to real-world media contexts.

Interpretations of results would equally benefit from a full consideration of the features of the sample and the context of this particular study. First, the high education level of our participants could influence the efficacy framing effects, because highly-educated individuals could, one might expect, hold a more critical stance when evaluating any new information, therefore giving less credit to one-sided claims, than less well-educated people, although it is possible to imagine that the opposite might also be true. Nevertheless, an examination of whether any of the effects observed here are moderated by education levels in a sample of people with greater diversity of educational backgrounds is warranted. Second, our participants displayed a general tendency to report relatively high levels of risk perception and behavioral change intentions. While the levels of skewness fell within acceptable boundaries, this could remain a second restriction for our current results. Third, it is also worth noting that our results might reflect temporal specificity given that our study took place during Hong Kong’s third wave of the virus. Even when media framing does play a role, predictive effects of perceived efficacy on health behaviors, alongside that of perceived threat, could be dynamic over time (Rui et al., 2021). It is possible that fatality risk perception and the resulting fear (Garfin et al., 2020; Harper et al., 2020) were more salient upon the first outbreak of the pandemic when people were still ignorant of the severity of coronavirus, but as the pandemic progressed, their important role was gradually replaced by
psychological encouragers for the public to stay positive and continue with their fight against the pandemic. Interestingly, this may have extended the EPPM into a larger temporal scale, where perceived threat activates the model in earlier stages of the pandemic, after which perceived efficacy determines people’s actual response patterns as time goes by. Another possibility worth noting is that the occurrence of three waves (by the time of data collection) or the fact that the pandemic has already lasted for more than a year (by the time this manuscript is written) may have led some people to think that the pandemic is uncontrollable, experience diminished perceived efficacy, and so efficacy information might be particularly important at later stages. Future health crises would continue to benefit from longitudinal studies that examine the changing effects of different forms of framing on behaviors and behavioral intentions across the lifespan of the pandemic.

In conclusion, we observed an inverse experimental effect of high-efficacy framing on risk perceptions and the interpretation of ambiguous scenarios related to COVID-19. Furthermore, high-efficacy framing was generally more likely than low-efficacy framing to elicit intentions to engage in behaviors to protect oneself from COVID-19, particularly for individuals with elevated health anxiety symptoms. These results have implications for clinicians, policy makers, media, and the general public alike. On top of alerting the public to the surrounding danger and their own vulnerability, it is more important to reassure media consumers that they can cope with the pandemic, physically and mentally, and that there are active behavioral steps they can take to manage the risk. This, especially when coupled with health anxiety within the acceptable boundaries, would likely contribute to the greatest willingness to adopt behavioral changes. We therefore call for a more balanced narrative in news information involving not only danger of the disease but also reassuring the public that this crisis can be managed.
References

Materials, data and supplementary analyses are available in OSF: 10.17605/OSF.IO/VZUFC


Leung, G. M., Ho, L. M., Chan, S. K. K., Ho, S. Y., Bacon-Shone, J., Choy, R. Y. L., Hedley,


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https://doi.org/10.1080/03637759209376276


https://doi.org/10.2147/NDT.S83501
Table 1

Differences Between the High- and Low-Efficacy Framing Groups in Pre-Manipulation

Characteristics (N = 193)

<table>
<thead>
<tr>
<th>Variable</th>
<th>High efficacy (n = 112)</th>
<th>Low efficacy (n = 81)</th>
<th>p 1</th>
<th>ES 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>28.27 (10.26)</td>
<td>26.44 (10.71)</td>
<td>.084</td>
<td>0.124</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>.872</td>
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</tr>
<tr>
<td>Male</td>
<td>32 (28.57%)</td>
<td>22 (27.16%)</td>
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<tr>
<td>Female</td>
<td>80 (71.43%)</td>
<td>59 (72.84%)</td>
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</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>.015*</td>
<td>0.175</td>
</tr>
<tr>
<td>University or above</td>
<td>105 (93.75%)</td>
<td>67 (82.72%)</td>
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<td></td>
</tr>
<tr>
<td>Others</td>
<td>7 (6.25%)</td>
<td>14 (17.28%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health anxiety 3</td>
<td>14.59 (6.87)</td>
<td>16.69 (7.26)</td>
<td>.017*</td>
<td>0.172</td>
</tr>
<tr>
<td>Precautionary measures</td>
<td>2.29 (0.53)</td>
<td>2.30 (0.50)</td>
<td>.957</td>
<td>0.004</td>
</tr>
<tr>
<td>Information seeking behaviors</td>
<td>3.12 (1.11)</td>
<td>3.21 (1.14)</td>
<td>.440</td>
<td>0.056</td>
</tr>
</tbody>
</table>

Notes. * p < .050. One missing data for age. Bold text indicates significant results. Unless specified below, results were generally comparable in a parallel set of analyses where no participants were excluded based on their perceived article orientations (for details, see Supplemental Table S6). ES = Effect Size; M = Mean; SD = Standard Deviation.

1 p-values were based on either independent-samples Mann-Whitney U tests (for continuous variables) or χ² tests (for categorical variables).

2 Effect sizes included $r = Z / √N$ (for independent-samples Mann-Whitney U tests) and $φ$ (for χ² tests).

3 The between-group difference in health anxiety was not significant in the parallel analyses where no participants were excluded based on their perceived article orientations.
Table 2

Hierarchical Linear Regression Results for COVID-19-Related Cognitions (N = 193)

<table>
<thead>
<tr>
<th></th>
<th>Risk perception</th>
<th></th>
<th>Behavioral change intentions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β [95% CI]</td>
<td>SE</td>
<td>p</td>
<td>β [95% CI]</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>F change</td>
<td></td>
<td>R²</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.108***</td>
<td>4.517***</td>
<td></td>
<td>.165***</td>
</tr>
<tr>
<td>Age</td>
<td>-.231 [-.375, -.087]</td>
<td>.073</td>
<td>.002**</td>
<td>-.082 [-.221, .058]</td>
</tr>
<tr>
<td>Gender</td>
<td>.003 [-.137, .142]</td>
<td>.071</td>
<td>.971</td>
<td>-.100 [-.235, .035]</td>
</tr>
<tr>
<td>Education level</td>
<td>-.124 [-.268, .019]</td>
<td>.073</td>
<td>.090</td>
<td>-.058 [-.197, .081]</td>
</tr>
<tr>
<td>Precautionary measures</td>
<td>.089 [-.054, .232]</td>
<td>.073</td>
<td>.223</td>
<td>.352 [.214, .491]</td>
</tr>
<tr>
<td>Information seeking behaviors</td>
<td>.187 [.045, .329]</td>
<td>.072</td>
<td>.010*</td>
<td>.082 [-.056, .219]</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.298***</td>
<td>24.889***</td>
<td></td>
<td>.175***</td>
</tr>
<tr>
<td>Age</td>
<td>-.125 [-.257, .007]</td>
<td>.067</td>
<td>.063^</td>
<td>-.077 [-.220, .066]</td>
</tr>
<tr>
<td>Gender</td>
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<td>.063</td>
<td>.644</td>
<td>-.098 [-.233, .037]</td>
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<tr>
<td>Education level</td>
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<td>.067</td>
<td>.707</td>
<td>-.064 [-.207, .080]</td>
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<tr>
<td>Precautionary measures</td>
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<td>.065</td>
<td>.394</td>
<td>.349 [.211, .488]</td>
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<tr>
<td>Information seeking behaviors</td>
<td>.127 [-.001, .255]</td>
<td>.065</td>
<td>.052^</td>
<td>.073 [-.065, .212]</td>
</tr>
<tr>
<td>Framing ¹</td>
<td>-.164 [-.290, -.038]</td>
<td>.064</td>
<td>.011*</td>
<td>.082 [-.054, .219]</td>
</tr>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
<td>t-Value</td>
<td>p-Value</td>
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<tr>
<td>------------------------------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Health anxiety (^2)</td>
<td>.406</td>
<td>.278, .534</td>
<td>.065</td>
<td>&lt;.001***</td>
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<tr>
<td></td>
<td>.078</td>
<td>-.060, .217</td>
<td>.070</td>
<td>.267</td>
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<td><strong>Step 3</strong></td>
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</tr>
<tr>
<td></td>
<td>.298</td>
<td>.007</td>
<td></td>
<td>.192***</td>
</tr>
<tr>
<td></td>
<td>3.786(^^)</td>
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</tr>
<tr>
<td>Age</td>
<td>-.125</td>
<td>-.257, .008</td>
<td>.067</td>
<td>.065(^^)</td>
</tr>
<tr>
<td></td>
<td>-.065</td>
<td>-.208, .077</td>
<td>.072</td>
<td>.366</td>
</tr>
<tr>
<td>Gender</td>
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<td>-.097, .153</td>
<td>.063</td>
<td>.662</td>
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<td>-.225, .044</td>
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<td>-.158, .107</td>
<td>.067</td>
<td>.708</td>
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<td></td>
<td>-.063</td>
<td>-.206, .079</td>
<td>.072</td>
<td>.381</td>
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<td>Precautionary measures</td>
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<td>-.073, .185</td>
<td>.065</td>
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<td>.361</td>
<td>.223, .499</td>
<td>.070</td>
<td>&lt;.001***</td>
</tr>
<tr>
<td>Information seeking behaviors</td>
<td>.127</td>
<td>-.001, .256</td>
<td>.065</td>
<td>.052(^^)</td>
</tr>
<tr>
<td></td>
<td>.082</td>
<td>-.056, .220</td>
<td>.070</td>
<td>.241</td>
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<tr>
<td>Framing (^1)</td>
<td>-.176</td>
<td>-.480, .129</td>
<td>.154</td>
<td>.257</td>
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<td></td>
<td>-.211</td>
<td>-.538, .116</td>
<td>.166</td>
<td>.204</td>
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<td>Health anxiety (^2)</td>
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<td>.211, .590</td>
<td>.096</td>
<td>&lt;.001***</td>
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<tr>
<td></td>
<td>-.070</td>
<td>-.273, .134</td>
<td>.103</td>
<td>.500</td>
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<tr>
<td>Framing (×) Health anxiety (^3)</td>
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<td>-.303, .329</td>
<td>.160</td>
<td>.936</td>
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<tr>
<td></td>
<td>.335</td>
<td>.005, .674</td>
<td>.172</td>
<td>.053(^^)</td>
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</table>

**Notes.** \(^\text{^1}\) For framing manipulation, conclusions regarding statistical significance did not change after multiplicity corrections.
For health anxiety, conclusions regarding statistical significance did not change after multiplicity corrections.

For framing × health anxiety interaction, the marginal significance for COVID-19-related behavioral change intentions was nullified following multiplicity corrections; the interaction term became statistically significant in the parallel analyses where no participants were excluded based on their perceived article orientations.
### Table 3

Hierarchical Linear Regression Results for Interpretation Biases (N = 193)

<table>
<thead>
<tr>
<th></th>
<th>IB (Illness)</th>
<th>IB (COVID-19)</th>
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<tr>
<td></td>
<td>$\beta$ [95% CI]</td>
<td>$SE$</td>
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<tr>
<td><strong>Step 1</strong></td>
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<tr>
<td>Age</td>
<td>-.009 [-.160, .143]</td>
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<tr>
<td>Gender</td>
<td>-.017 [-.164, .130]</td>
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<tr>
<td>Education level</td>
<td>-.112 [-.263, .040]</td>
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<td>Precautionary measures</td>
<td>-.001 [-.152, .149]</td>
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<tr>
<td>Information seeking behaviors</td>
<td>.008 [-.141, .158]</td>
<td>.076</td>
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<tr>
<td><strong>Step 2</strong></td>
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<td></td>
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<tr>
<td>Age</td>
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<td>.070</td>
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<tr>
<td>Gender</td>
<td>.008 [-.123, .140]</td>
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<tr>
<td>Education level</td>
<td>-.030 [-.170, .109]</td>
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<tr>
<td>Precautionary measures</td>
<td>-.035 [-.170, .100]</td>
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<td>Information seeking behaviors</td>
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<td>.068</td>
</tr>
<tr>
<td>Framing (^1)</td>
<td>-.035 [-.167, .098]</td>
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<tr>
<td>Variable</td>
<td>Estimate</td>
<td>CI</td>
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<tr>
<td>--------------------------------</td>
<td>-----------</td>
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<td>Health anxiety</td>
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<td>[.338, .608]</td>
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<tr>
<td>Age</td>
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<td>[-0.049, 0.231]</td>
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<tr>
<td>Gender</td>
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<td>[-0.125, 0.139]</td>
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<tr>
<td>Education level</td>
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<td>[-0.170, 0.109]</td>
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<tr>
<td>Precautionary measures</td>
<td>-0.037</td>
<td>[-0.172, 0.099]</td>
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<tr>
<td>Information seeking behaviors</td>
<td>-0.059</td>
<td>[-0.194, 0.076]</td>
</tr>
<tr>
<td>Framing (^1)</td>
<td>0.011</td>
<td>[-0.309, 0.332]</td>
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<tr>
<td>Health anxiety</td>
<td>0.496</td>
<td>[.297, .696]</td>
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<tr>
<td>Framing × Health anxiety (^3)</td>
<td>-0.052</td>
<td>[-0.385, 0.280]</td>
</tr>
</tbody>
</table>

**Notes.** \(^\text{\textsuperscript{1}}\) For framing manipulation, the marginal significance for COVID-19-related interpretation bias was nullified following multiplicity corrections;
it was also nullified in the parallel analyses where no participants were excluded based on their perceived article orientations.

2 For health anxiety, conclusions regarding statistical significance did not change after multiplicity corrections.

3 For framing × health anxiety interaction, conclusions regarding statistical significance did not change after multiplicity corrections.
Figure 1

Framing Effect on Behavioral Change Intentions by Health Anxiety

Notes. Adjusted covariates include: age, gender, education level, pre-induction precautionary measures, and pre-induction information seeking behaviors.