



The Impact of Interpretation Biases on Psychological Responses to the COVID-19 Pandemic: a Prospective Study

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Abstract

Background This study investigates the longitudinal role of interpretation biases in the development and maintenance of health anxiety during the pandemic. Individual differences in behavioural responses to the virus outbreak and decision-making were also examined.

Methods Two hundred seventy-nine individuals from a pre-pandemic study of interpretation bias and health anxiety completed an online survey during the third wave of the COVID-19 pandemic in Hong Kong. Participants' health anxiety, interpretation biases, and COVID-specific behaviours (i.e. practice of social distancing, adherence to preventive measures, information seeking), and health decision-making were assessed.

Results Pre-pandemic tendencies to interpret ambiguous physical sensations as signals for illness did not predict health anxiety during the pandemic, $b = -0.020$, $SE = 0.024$, $t = -0.843$, $p = .400$, 99% CI $[-0.082, 0.042]$, but were associated with a preference for risky treatment option for COVID-19, $b = 0.026$, $SE = 0.010$, Wald = 2.614, $p = .009$, OR = 1.026, 99% CI $[1.001, 1.054]$. Interpretation biases and health anxiety symptoms during the pandemic were associated with each other and were both found to be significant predictors of practice of social distancing, adherence to preventive measures, and information seeking behaviour.

Conclusions This study adds to the growing evidence of the role of interpretation biases in health anxiety and the way that people respond to the ongoing pandemic.

Keywords COVID-19 · Health anxiety · Interpretation bias · Prospective · Decision-making

Introduction

The 2019 coronavirus disease (COVID-19) pandemic is a global health threat [1] and is causing a wide range of psychological symptoms including anxiety, depression, and

stress [2–6]. During a viral outbreak, health anxiety, the preoccupation with the belief that one has a serious disease [7], is of particular relevance. Recent research has shown that health anxiety is associated with various psychological consequences of the pandemic, such as traumatic stress symptoms, fear of the dangerousness of COVID-19, sleep problems, and high levels of distress [8–10]. Health anxiety is also associated with COVID-related behaviours including excessive internet searching, excessive hand washing, social withdrawal, panic purchasing, and reassurance and preventive behaviours [6, 10–12].

Contemporary models suggest that catastrophic misinterpretations of benign bodily sensations as signs of serious disease may be a core cognitive mechanism underlying the course and severity of health anxiety [7, 13]. A recent systematic review has also confirmed the presence of this illness-related interpretation bias in health-anxious individuals [14]. During the COVID-19 pandemic, it is possible that individuals with a tendency to misinterpret ambiguous symptoms such as coughing as signs of infection may

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either develop health anxiety or experience an exacerbation of existing health anxiety symptoms [6, 11]. Illness-related interpretations and health anxiety may also fuel specific virus-related behaviours and decisions. For example, negative interpretations for illness information may prompt more frequent hand washing and social withdrawal behaviours [11]. Existing theories also suggest that cognitive bias may play an important role in health decision-making, such that people may have a tendency to focus on avoiding losses, even if this means that they will engage in risky behaviours and that people's decisions oftentimes may not be the most beneficial in the long term [15]. It is therefore important to improve our understanding of factors influencing one's health behaviours and decisions during the pandemic.

There has been some research on the association between cognitive biases and COVID-related responses. One study found that people with higher health anxiety during the pandemic preferentially attended towards virus-related pictures [16], and another study found that preferential attention for COVID-related words was associated with increased COVID-specific anxiety [17]. However, these studies have primarily focused on attentional biases but not interpretation biases. As such, in this study, we aimed to investigate the role of interpretation biases in health anxiety and COVID-related behaviours using a longitudinal study design. Specifically, participants who had taken part in a study on health anxiety and interpretation biases conducted prior to virus outbreak [18] were invited to complete an online survey of health anxiety, interpretation biases, COVID-related behaviours, and decision-making. Both current and previous interpretation biases were hypothesised to contribute to health anxiety symptoms during the pandemic. Health anxiety and interpretation biases were also expected to be positively associated with COVID-specific behaviours such as social distancing and information seeking. Finally, the study aimed to identify cross-sectional and longitudinal predictors of decision-making processes related to COVID-19.

Methods

Participants

Ethical approval was obtained from the Human Research Ethics Committee of the corresponding author's institute (reference number: EA2005009). Participants who participated in a previous study between 3rd and 22nd July 2019 in Hong Kong [18] were recontacted. Interpretation bias and health anxiety data in this previous study was used (i.e. pre-pandemic data). All these participants were invited by email to complete an online survey that lasted from 3rd to 24th July 2020. At this time, Hong Kong was hit by a third wave of new local COVID-19 transmission. The third wave

reached its peak of 149 new cases per day on 30 July 2020 and lasted for more than 2 months from early July to early September. As vaccinations were not yet available during this period, social distancing was the main countermeasure recommended by the government. From 10 July 2020 onwards, a series of regulations were imposed, including school suspensions, restricted social gatherings of no more than 4 people, and mandatory mask-wearing with violations leading to HK\$5,000 fines.

Only participants who were based in Hong Kong during the third wave were eligible. All participants provided online informed consent before they started the survey and were entered into a lucky draw with a chance to win cash rewards upon completion. The survey collected 287 full responses. One participant's pre-pandemic data was missing, and seven respondents completed the survey measures twice. The remaining 279 participants ($n = 206$ females, 73.8%) were included in the analysis. Participants' ages ranged from 18 to 64 years ($M = 27.35$, $SD = 9.40$). Data collected in the current study is referred to as 'pandemic data'.

Interpretation Bias Task

In our pre-pandemic study [18], the psychometric properties of the Interpretation Bias Task (IBT) were evaluated. The IBT consists of 23 vignettes describing ambiguous situations in four different domains of daily life (i.e. bodily injury, illness, social interaction, and performance). In the IBT, participants were first presented with each ambiguous situation and were instructed to imagine themselves in the situation. They were then offered words that resolve the situation in a benign or negative manner. Participants were asked to rate how likely each resolution would actually happen on a scale from 1 to 100 (1 = not at all likely; 100 = extremely likely). Each participant had a benign interpretation score and a negative interpretation score for each domain, ranging from 1 to 100. A larger benign/negative interpretation score reflects a more benign/negative interpretation for ambiguous scenarios. Only the scores for the illness domain (six items) were used in the current study as we had no specific hypotheses for the other three domains. The illness domain of the IBT was assessed again in the current survey. In addition, we created a new COVID domain which contains five ambiguous scenarios specifically related to the ongoing pandemic. This domain was also assessed in the online survey and resulted in a benign and a negative COVID interpretation scores.

An example of a long-term illness scenario is 'You take a pill every morning at breakfast. The pill is a ...', followed by the two resolutions 'vitamin' and 'medicine'. Higher ratings for the word 'vitamin' reflect a more benign interpretation, while higher ratings for the word 'medicine' indicate a more negative interpretation. Similarly, an example of a

COVID-19 scenario is ‘You begin to breathe heavily. Your chest is quickly going up and down. This shortness of breath is due to ...’ followed by ‘exercises’ (benign) and ‘COVID-19’ (negative).

The benign interpretation scores for the illness domain have a Cronbach’s alpha of 0.531 pre-pandemic and 0.368 during the pandemic. For negative illness interpretation scores, Cronbach’s alpha was 0.721 pre-pandemic and 0.760 during the pandemic. For the COVID domain, Cronbach’s alpha was 0.462 for benign and 0.732 for negative scores. Since all the benign scores had unacceptable alphas (<0.700) [19], only the negative interpretation scores were included in the analyses.

Questionnaires

The Chinese version of the Health Anxiety Inventory (HAI) was used to measure participants’ health anxiety symptoms [20, 21]. A higher total score on HAI indicates a higher level of health anxiety symptoms. The Cronbach’s alpha was 0.837 at baseline and 0.868 at follow-up.

Several questions regarding participants’ COVID-specific behaviours were also asked [22]. First, six yes-or-no questions regarding whether participants practiced social distancing in the past week to prevent themselves from contracting COVID-19 were asked (e.g. avoid going to crowded places, avoid using public transportation). Practice of social distancing was quantified by the frequency of ‘yes’ responses. Six questions regarding participants’ adherence to preventive measures in the past week on a four-point Likert scale (0 = never, 3 = always) were also asked (e.g. use facemasks when going outside, use liquid soap when washing hands). Adherence to preventive measures was quantified by the average of these six questions. Finally, four questions about participants’ information seeking behaviour on a six-point Likert scale (1 = never, 6 = very frequently/always) were asked (e.g. actively search online for health information related to COVID-19). Information seeking was quantified by the average of these four questions. The Cronbach’s alphas were 0.768, 0.773, and 0.922 for practice of social distancing, adherence to preventive measures, and information seeking, respectively.

Decision-Making Task

We created a decision-making task (DMT) to assess COVID-specific decision-making. Participants read a scenario in which they were diagnosed with COVID-19 and needed to choose one of the two available treatments: treatment A ensures that participants will survive the COVID-19 but will lose 30% of their lung function, which is likely going to have a negative impact on their daily lives after the treatment, and treatment B is a riskier

option because there is only 70% chance that the COVID-19 will be cured and an intact lung will be preserved and 30% chance that patients will die. Participants were asked to select one option. Those who chose treatment A were deemed to be more risk-averse.

Procedure

After providing informed consent, participants were instructed to complete the IBT, the HAI, and to answer questions related to their COVID-specific behaviours. Participants then completed the DMT, after which they were debriefed.

Analyses

Data analyses were conducted using the ‘stats’ package in R 3.5.1 [23]. Correlation tests were performed to examine linear relations between health anxiety, interpretation biases, and COVID-specific behaviours. To examine the impact of interpretation biases on health anxiety symptoms during the pandemic, a multiple regression analysis was conducted with pandemic HAI scores as the outcome variable. Potential predictor variables included pre-pandemic HAI scores, negative illness interpretation scores (pre-pandemic and pandemic), negative COVID interpretation scores (pandemic), and age and gender. To identify significant predictors of COVID-specific behaviours, we performed three multiple regressions with practice of social distancing, adherence to preventive measures, and information seeking as the outcome variables. Predictors included HAI scores (pre-pandemic and pandemic), negative illness interpretation scores (pre-pandemic and pandemic), negative COVID interpretation scores (pandemic), and age and gender. Finally, a binary logistic regression was performed with participants’ decisions in the DMT as the outcome. Predictors included HAI scores (pre-pandemic and pandemic), negative illness interpretation scores (pre-pandemic and pandemic), negative COVID interpretation scores (pandemic), COVID-specific behaviours (pandemic), and age and gender.

Due to the number of tests performed, the threshold of declaring statistical significance in the current paper was set to 0.010 instead of 0.050. Accordingly, 99% confidence intervals of the effect sizes were calculated.

Results

Correlational Analyses

Correlational results between health anxiety, interpretation biases, and COVID-specific behaviours are presented in Table S1 (see [Electronic Supplementary Material](#)). Means

and standard deviations of these variables are also reported in the same table.

Impact of Interpretation Bias on Health Anxiety

A multiple regression analysis identified four significant predictors of health anxiety symptoms during the pandemic, including pre-pandemic health anxiety symptoms, $b=0.472$, $SE=0.055$, $t=8.591$, $p<0.001$, 99% CI [0.329, 0.614]; negative illness interpretations during the pandemic, $b=0.082$, $SE=0.026$, $t=3.153$, $p=0.002$, 99% CI [0.015, 0.150]; negative COVID interpretations during the pandemic, $b=0.071$, $SE=0.024$, $t=2.973$, $p=0.003$, 99% CI [0.009, 0.133]; and younger age, $b=-0.122$, $SE=0.035$, $t=-3.501$, $p=0.001$, 99% CI [-0.212, -0.032]. However, pre-pandemic illness interpretation was not a significant predictor, $b=-0.020$, $SE=0.024$, $t=-0.843$, $p=0.400$, 99% CI [-0.082, 0.042]. Gender was not a significant predictor either, $b=-0.865$, $SE=0.746$, $t=-1.159$, $p=0.247$, 99% CI [-2.800, 1.071]. Together, these measures explained adjusted $R^2=0.350$ of the total variance in health anxiety symptoms during the pandemic, $F(6, 270)=25.760$, $p<0.001$. In summary, younger participants with higher pre-pandemic health anxiety symptoms, and those who endorsed more negative interpretations for illness- and COVID-19-related situations during the pandemic, were more health-anxious during the third wave of the pandemic in Hong Kong.

Predictors of COVID-Specific Behaviours

Three multiple regressions for COVID-specific behaviours (practice of social distancing, adherence to preventive measures, and information seeking) were performed (see Table S2 in Electronic Supplementary Material). Results showed that practice of social distancing was predicted by health anxiety during the pandemic, $b=0.075$, $SE=0.020$, $t=3.713$, $p<0.001$, 99% CI [0.022, 0.127], and negative COVID interpretations during the pandemic, $b=0.030$, $SE=0.008$, $t=3.754$, $p<0.001$, 99% CI [0.009, 0.051]. The adjusted R^2 was 0.109, $F(7, 269)=5.802$, $p<0.001$. Adherence to preventive measures was also predicted by health anxiety during the pandemic, $b=0.017$, $SE=0.006$, $t=2.853$, $p=0.005$, 99% CI [0.002, 0.032], and negative COVID interpretations during the pandemic, $b=0.007$, $SE=0.002$, $t=2.845$, $p=0.005$, 99% CI [0.001, 0.013]. The adjusted R^2 was 0.066, $F(7, 269)=3.773$, $p=0.001$. In contrast, information seeking was only predicted by health anxiety during the pandemic, $b=0.032$, $SE=0.012$, $t=2.686$, $p=0.008$, 99% CI [0.001, 0.062]. The adjusted R^2 was 0.064, $F(7, 269)=3.708$, $p=0.001$.

To summarise, health anxiety symptoms and negative COVID interpretation biases assessed during the pandemic were found to be the strongest predictors of social

distancing, preventive measure adherence, and information seeking. However, interpretation biases in the general illness context did not predict these variables.

Predictors of COVID-Specific Decision-Making

To identify predictors of participants' responses to the DMT, a binary logistic regression was performed (see Table S3 in Electronic Supplementary Material). Overall, 186 participants chose treatment A (survive with 30% lung function loss), and 93 chose treatment B (30% chance of death). Pre-pandemic negative illness interpretations were a significant predictor of choosing treatment B, $b=0.026$, $SE=0.010$, Wald = 2.614, $p=0.009$, OR = 1.026, 99% CI [1.001, 1.054]. Practice of social distancing was also a significant predictor of choosing treatment B, $b=0.220$, $SE=0.082$, Wald = 2.669, $p=0.008$, OR = 1.246, 99% CI [1.012, 1.550]. No other variable was statistically significant. Nagelkerke's R^2 was 0.111, indicating that these measures accounted for 11.1% of the variance in the DMT. In sum, those with more negative illness interpretations prior to the pandemic and those who practiced social distancing more often during the pandemic tended to choose treatment B, the riskier treatment option, if diagnosed with COVID-19.

Discussion

This prospective study examined both cross-sectional and longitudinal effects of interpretation biases on health anxiety during the COVID-19 pandemic. This study also investigated how these factors might influence participants' behaviours and decision-making in response to the virus outbreak.

One of the main findings was that during the pandemic, adults who endorsed more negative illness and COVID interpretations reported higher health anxiety symptoms. This supports contemporary models that highlight the association between catastrophic misinterpretations of benign bodily sensations as indicative of serious illness and anxiety about one's health [7, 13]. There was also a significant correlation between pre-pandemic negative illness interpretations and health anxiety symptoms during the pandemic. However, this association became non-significant after controlling for pre-pandemic health anxiety and other covariates. Taken together, these findings suggest that interpretation bias may be a concurrent maintenance factor, rather than a precursor, of health anxiety. It is noteworthy, however, that these associations between IBT scores and health anxiety symptoms were, although statistically significant, rather weak as indicated by the regression coefficients. One possible explanation for this is that the IBT has some limitation in its validity as seen in the pre-pandemic study where IBT scores had inconsistent correlations with health anxiety measures [18]. Also,

the illness domain of the IBT focuses primarily on minor diseases (e.g. cold) rather than serious life-threatening illnesses. Some previous research suggests that people with high and low levels of health anxiety do not differ significantly in their interpretations for minor illness information [24, 25]. Future research may need to include scenarios with serious diseases in the assessment of illness interpretation biases.

Another main finding was that individuals who were more health-anxious during the pandemic reported more frequent practice of social distancing, greater adherence to preventive measures, and more frequent health information seeking. In contrast, a more negative COVID interpretation bias only predicted greater adherence to social distancing and preventive measures but not information seeking. Originally we expected that a negative interpretation bias would be associated with more frequent information seeking, but it is also probable that for some participants, their negative interpretation bias remained because they did not seek for more up-to-date or positive information about COVID-19. This explanation is in line with a recent study which showed that information about the pandemic may be a buffering factor for anxiety during the COVID-19 pandemic [6]. Future research should determine whether an adaptive amount of information provision may have an anxiety-reducing or cognitive bias-reducing effect. Moreover, one interesting observation was that the COVID-specific behaviours were only influenced by interpretation bias in the COVID domain but not that in the general illness domain. This relates to the content specificity of interpretation bias. The COVID domain of the IBT can therefore be adopted in future research because it may account for individual differences that are not explainable by the general illness domain of the IBT. Also, the finding that COVID-specific behaviours were only associated with health worries and interpretation biases assessed during the pandemic but not with those assessed pre-pandemic suggests that these behaviours may be pandemic-specific and less influenced by pre-pandemic factors.

It is important to acknowledge that all the COVID-specific behaviours assessed in the current study (e.g. avoid using public transportation, hand washing, mask-wearing) are consistent with public health recommendations for managing viral outbreaks [11] and therefore are not necessarily maladaptive. Instead, these coping behaviours have an adaptive value when the execution of such behaviours prevents negative outcomes (i.e. contraction). Nevertheless, it may be important to identify individuals with higher health anxiety and more negative interpretation biases who might take these measures to an extreme that can impact the social and occupational functioning of individuals and their community [11].

Regarding decision-making, our findings indicated that a more negative pre-pandemic illness interpretation bias and a higher frequency of social distancing practice during the pandemic were associated with risk-seeking decisions.

These findings could be interpreted in relation to the mood maintenance [26, 27] and affect regulation [28, 29] models of risk-seeking behaviour. More specifically, participants with a more negative illness interpretation bias may have imagined a more severe consequence of contracting COVID-19, which in turn made the less risky treatment option (i.e. 100% survival with 30% loss of lung function) less appealing as the residual symptoms are less tolerable. Put otherwise, participants with negative illness interpretations may have perceived the consequences of sacrificing lung function as more adverse compared to those with fewer negative interpretations, and so they were motivated to choose a riskier option in order to avoid any symptom of COVID-19. In terms of the positive association between social distancing and risk-seeking, both constructs may reflect a desire to minimise (or even eliminate) the chance of negative consequences and to improve one's current situation. Indeed, some theories suggest that avoidant coping and risk-taking may share similar functions of emotion regulation, both aiming to manage negative emotions [30, 31]. In the context of the pandemic, avoidance behaviour such as social distancing may reflect a desire to minimise the chance of contracting COVID-19, and the selection of a riskier treatment plan for COVID-19 (i.e. 30% death vs. 70% full recovery) may reflect a preference to eliminate any symptom of COVID-19. Social distancing and risk-taking decisions may therefore both be seen as emotion regulation strategies.

It is of note that the present study was conducted during the third wave of the COVID-19 pandemic in Hong Kong, and therefore, participants' health anxiety symptoms may not be as severe as when the virus was first spread to this city. It is also questionable whether results of this study can be generalised to other countries experiencing other stages of the pandemic. Despite the limitations, the current findings add to the growing evidence of the important role of interpretation biases in health anxiety. This study also revealed differential effects of health anxiety and interpretation biases on participants' COVID-specific behaviours and decision-making. Future work that extends to clinical samples, includes multiple times of assessments, and incorporates more comprehensive assessments for cognitive biases is warranted.

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Data Availability The authors have full control of all study materials and primary data and agree to allow the journal to review the materials and data if requested.

Declarations

Ethics Approval and Consent to Participate Informed consent was obtained from all individual participants included in the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Conflict of Interest The authors declare no competing interests.

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