Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Anxiety Disorders 75 (2020) 102290

Contents lists available at ScienceDirect

Journal of Anxiety Disorders

journal homepage: www.elsevier.com/locate/janxdis

The prospective influence of COVID-19 affective risk assessments and intolerance of uncertainty on later dimensions of health anxiety

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ARTICLE INFO

Keywords:
Coronavirus
COVID-19
Health anxiety
Intolerance of uncertainty
Worry

ABSTRACT

The COVID-19 pandemic is likely to increase risk for the development of health anxiety. Given that elevated health anxiety can contribute to maladaptive health behaviors, there is a need to identify individual difference factors that may increase health anxiety risk. This study examined the unique and interactive relations of COVID-19 affective risk assessments (worry about risk for contracting/dying from COVID-19) and intolerance of uncertainty to later health anxiety dimensions. A U.S. community sample of 364 participants completed online self-report measures at a baseline assessment (Time 1) and one month later (Time 2). Time 1 intolerance of uncertainty was uniquely associated with the Time 2 health anxiety dimension of body vigilance. Time 1 affective risk assessments and intolerance of uncertainty were uniquely associated with later perceived likelihood that an illness would be acquired and anticipated negative consequences of an illness. The latter finding was qualified by a significant interaction, such that affective risk assessments were positively associated with anticipated negative consequences of having an illness only among participants with mean and low levels of intolerance of uncertainty. Results speak to the relevance of different risk factors for health anxiety during the COVID-19 pandemic and highlight targets for reducing health anxiety risk.

1. Introduction

Beginning in late 2019, a severe acute respiratory syndrome coronavirus (COVID-19) began to rapidly spread across the globe, becoming an unprecedented public health event (Centers for Disease Control and Prevention [CDC], 2020; World Health Organization [WHO], 2020b). On January 30, 2020, the WHO announced that COVID-19 was a public health emergency of international concern, and in March 2020, pandemic status was reached. Currently, over 14 million confirmed cases of COVID-19 have been reported worldwide, and over 600,000 people have died from the disease (CDC, 2020; WHO, 2020b). Within the U.S. alone, there have been over 3.7 million confirmed cases of COVID-19, with over 140,000 mortalities attributed to the virus (CDC, 2020). Due to COVID-19's long incubation period, ease of transmission, high mortality rate (relative to the seasonal flu), and lack of pharmacological interventions (Linton et al., 2020; Shereen, Khan, Kazmi, Bashir, & Siddique, 2020), governments worldwide have had to implement extraordinary physical distancing interventions in an attempt to slow the spread of the virus, reduce COVID-19 mortality rates, and minimize the burden on the health care system. Within the U.S., implementation of stay-at-home orders began in mid-March 2020, with most states having such orders in place by early April 2020 (Mervosh, Lu, & Swales, 2020). Although no vaccine or established treatments for COVID-19 are currently available, strict stay-at-home orders within the U.S. are beginning to ease. Specifically, all 50 states have taken steps to reopen businesses throughout May 2020, with most moving to rescind stringent stay-at-home orders in favor of more flexible social distancing interventions to stimulate the economy (Mervosh, Lee, Gamio, & Popovich, 2020).

Since the emergence of COVID-19, it has been suggested that the unique features of COVID-19 and the public health interventions aimed at preventing the spread of the virus may be particularly likely to have mental health consequences (e.g., Asmundson & Taylor, 2020a, 2020b; Fiorillo & Gorwood, 2020; Harper, Satchell, Fido, & Latzman, 2020; Reger, Stanley, & Joiner, 2020). For example, the elevated morbidity and mortality associated with COVID-19 may increase anxiety and overall emotional distress, as individuals fear for the physical well-being of themselves and their loved ones (Fiorillo & Gorwood, 2020). In

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https://doi.org/10.1016/j.janxdis.2020.102290
Received 8 June 2020; Received in revised form 20 July 2020; Accepted 8 August 2020
Available online 12 August 2020

addition, reduced access to social support due to social distancing interventions, the shortage of personal protective equipment (e.g., masks), the frequent emergence of new COVID-19 symptoms and syndromes, widespread media coverage of the virus, and conflicting information about the virus and the efficacy of potential COVID-19 treatments (e.g., hydroxychloroquine) may further fuel anxiety and other psychological symptoms (Asmundson & Taylor, 2020a, 2020b; Cao et al., 2020; Gao et al., 2020; Reger et al., 2020; Yazdany & Kim, 2020). In support of these propositions, studies conducted in multiple countries (i.e., China, Germany, Iran, Spain, and the U.S.) have consistently shown elevated rates of anxiety as a result of COVID-19 (Cao et al., 2020; Harper et al., 2020; Huang & Zhao, 2020; Jungmann & Witthöft, 2020; Lee, Mathis, Jobe, & Pappalardo, 2020; McKay, Yang, Elhai, & Asmundson, 2020; Moghanibashi-Mansourieh, 2020; Zhang et al., 2020). Beyond anxiety in general, the unique features of this pandemic (e.g., long incubation period, variable symptom presentation, elevated morbidity and mortality rates, and lack of pharmacological interventions) may also be particularly likely to increase health anxiety (Asmundson & Taylor, 2020b).

Health anxiety is characterized by the experience of anxiety or worry stemming from a perceived threat to one's physical health (Abramowitz, Olatunji, & Deacon, 2007; Asmundson, Abramowitz, Richter, & Whedon, 2010). Cognitive-behavioral models propose that health anxiety stems from the interpretation of potentially benign bodily sensations and/or changes in those sensations (e.g., muscle soreness, shortness of breath, sore throat) as an indication of illness, infection, or some other threat to physical health (Asmundson et al., 2010; Taylor & Asmundson, 2004). At high levels, health anxiety may contribute to increased body vigilance, catastrophic misinterpretation of bodily sensations, and illness behavior (e.g., reassurance seeking on the internet, frequent and unnecessary visits to a doctor or emergency room, excessive collection of personal protective equipment; Asmundson et al., 2010; Asmundson & Taylor, 2020b; Taylor & Asmundson, 2004). In the context of a pandemic, individuals with elevated health anxiety may be particularly likely to experience an increase in awareness and catastrophic misinterpretation of bodily sensations that result in maladaptive safety-seeking behavior (Asmundson & Taylor, 2020b; Taylor, 2019). For example, a recent study found that health anxiety was associated with COVID-19 related anxiety and cyberchondria (i.e., the repeated carrying out of health-related Internet searches in an attempt to obtain reassurance or reduce health-related anxiety; Jungmann & Witthöft, 2020). Given the potential negative consequences associated with health anxiety-related behaviors in the context of a pandemic (e.g., increased doctor visits may overwhelm the health care system, stockpiling of personal protective equipment may decrease or eliminate its availability to others in need), there is a need to identify individual difference factors that may increase risk for health anxiety in the context of the current COVID-19 pandemic.

One such risk factor for health anxiety may be an individual's perceived likelihood of becoming infected with or dying from COVID-19. Past research has found that individuals with elevated healthy anxiety are more likely to cognitively overestimate their risk for illness (Hadjistavropoulos, Craig, & Hadjistavropoulos, 1998; Marcus & Church, 2003). However, health behavior models are increasingly highlighting the relevance of affect-laden risk or vulnerability assessments (vs. more cognitively-based assessments where individuals deliberately estimate the probability or likelihood of a particular health event) to psychological outcomes, emphasizing the relative importance of the extent to which individuals *feel* that they are at risk for or worry about certain health events (i.e., affective risk assessments; Janssen, van Osch, Lechner, Candel, & de Vries, 2012; Janssen, Waters, Van Osch, Lechner, & De Vries, 2014; Loewenstein, Weber, Hsee, & Welch, 2001). For example, Janssen et al. (2012) found that affective risk assessments about cancer risk were more strongly related to cancer-specific health anxiety than cognitive risk assessments. Likewise, affective risk assessments have been found to be more highly related to behavioral intentions and health behaviors than cognitive risk assessments (Janssen et al., 2012, 2014). Given evidence that worry states may increase attentional bias to threatening stimuli (Mogg & Bradley, 2005; Mogg, Mathews, & Eysenck, 1992), individuals who experience greater worry about their perceived risk for COVID-19 infection and mortality may be more likely to notice and attend to bodily sensations that could be indicative of COVID-19 infection (e.g., muscle pain, shortness of breath, cough, chills), resulting in increased health anxiety over time.

Given the unpredictability and variability associated with COVID-19 symptom presentations, as well as the potentially long incubation period associated with this virus (i.e., symptoms may present themselves anywhere from 2 to 14 days following exposure), the association between COVID-19 affective risk assessments and health anxiety may be particularly strong for individuals with high intolerance of uncertainty. Intolerance of uncertainty is broadly defined as a cognitive and emotional tendency to react negatively to uncertain situations or unpredictable future events (Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994), and has been identified as a key factor in the development and maintenance of problematic worry (Buhr & Dugas, 2006; Dugas, Freeston, & Ladouceur, 1997; Freeston et al., 1994). In addition to demonstrating a relationship with numerous anxiety disorders (Boelen & Reijntjes, 2009; Carleton et al., 2012; Gentes & Ruscio, 2011; Holaway, Heimberg, & Coles, 2006), intolerance of uncertainty has been associated with increased health anxiety and catastrophic health appraisals. Inhibitory facets of intolerance of uncertainty (e.g., diminished functioning in the face of uncertainty) have been shown to predict health anxiety among medically healthy community-dwelling adults (Fergus & Bardeen, 2013). Further, intolerance of uncertainty has been found to moderate the relationship between the frequency of Internet searches for health information and health anxiety among medically healthy adults in the community (Fergus, 2013). Research has also found that intolerance of uncertainty moderates the relationship between catastrophic health appraisals and health anxiety among medically healthy college students, with this relationship emerging as significant only among individuals with high intolerance of uncertainty (Fergus & Valentiner, 2011). More recently, Asmundson and Taylor (2020a) identified intolerance of uncertainty as a potential individual difference factor that may increase risk for COVID-19 related anxiety. In the context of the COVID-19 pandemic, high intolerance of uncertainty may further exacerbate worry and negative affect associated with perceived risk for COVID-19 infection and mortality, contributing to heightened health anxiety. Moreover, given that intolerance of uncertainty may increase the likelihood that ambiguous experiences are perceived as threatening (Byrne, Hunt, & Chang, 2015), high COVID-19 affective risk perceptions may be more likely to prompt catastrophic misinterpretations of benign bodily sensations as an indication of illness.

1.1. Present study aims and hypotheses

The goals of the present study were to examine the prospective relations of COVID-19 affective risk assessments and intolerance of uncertainty to health anxiety dimensions one month later, as well as the moderating role of intolerance of uncertainty in the relations of COVID-19 affective risk perceptions to later health anxiety. We predicted that both COVID-19 affective risk perceptions and intolerance of uncertainty would predict later health anxiety dimensions, controlling for health anxiety at baseline. Further, we predicted that the relationship between COVID-19 affective risk assessments and health anxiety would be strongest among individuals with high (vs. mean or low) levels of intolerance of uncertainty.

2. Method

2.1. Participants

Participants were a nationwide community sample of 364 adults

from 44 states in the U.S. who completed a prospective online study of health and coping in response to COVID-19 through an internet-based platform (Amazon's Mechanical Turk; MTurk). Participants completed an initial assessment (Time 1) from March 27, 2020 through April 5, 2020, and a follow-up assessment (Time 2) approximately one month later between April 27, 2020 and May 21, 2020. The study was posted to MTurk via CloudResearch (cloudresearch.com), an online crowdsourcing platform connected to MTurk that allows additional data collection features (e.g., creating selection criteria; Chandler, Rosenzweig, Moss, Robinson, & Litman, 2019; Litman, Robinson, & Abberbock, 2017). MTurk is an online labor market that provides "workers" with the opportunity to complete different tasks in exchange for monetary compensation, such as completing questionnaires for research. Data provided by MTurk-recruited participants have been found to be as reliable as data collected through more traditional methods (Buhrmester, Kwang, & Gosling, 2011). Likewise, MTurk-recruited participants have been found to perform better on attention check items than college student samples (Hauser & Schwarz, 2016) and comparably to participants completing the same tasks in a laboratory setting (Casler, Bickel, & Hackett, 2013). Studies also show that MTurk samples have the advantage of being more diverse than other internet-recruited or college student samples (Buhrmester et al., 2011; Casler et al., 2013). For the present study, inclusion criteria consisted of: (1) U.S. resident, (2) at least a 95 % approval rating as an MTurk worker, (3) completion of at least 5000 previous MTurk tasks (referred to as Human Intelligence Tasks [HITS]), and (4) valid responses on questionnaires (i.e., assessed by accurate completion of multiple attention check items).

Participants (51.4 % women; 47.5 % men; 0.5 % non-binary; 0.3 % transgender, 0.3 % other) ranged in age from 20 to 74 years ($M = 41.45$, $SD = 12.02$) at the initial assessment. All states in the U.S. were represented, with the exception of Delaware, Nebraska, New Hampshire, North Dakota, Vermont, and West Virginia. The most frequently endorsed states of residence were Florida (11.3 %), California (9.1 %), Pennsylvania (6.3 %), Texas (6.0 %), and New York (5.2 %). Most participants identified as White (84.9 %), followed by Black/African-American (9.1 %), Asian/Asian-American (6.3 %), Latinx (3.8 %), and Native American (1.4 %). With regard to other participant demographic characteristics at the Time 1 assessment, 11 % of participants had completed high school or received a GED, 38.2 % had attended some college or technical school, 41.5 % had graduated from college, and 9.3 % had advanced graduate/professional degrees. Most participants were employed full-time (68.1 %), followed by employed part-time (16.5 %) and unemployed (15.3 %). Annual household income varied, with 31.3 % of participants reporting an income of $<$ \$35,000, 31.6 % reporting an income of \$35,000 to \$64,999, and 37.1 % reporting an income of $\geq$ \$65,000. Finally, 19 % of participants reported having a current medical condition (e.g., diabetes, hypertension, asthma) that would increase risk of complications from a COVID-19 infection and 20.9 % reported living alone. Across both assessments, few participants reported having sought out testing for COVID-19 (3%) or having a confirmed COVID-19 infection (0.3 %).

2.2. Measures

A demographic form was completed by all participants at the Time 1 and Time 2 assessments. Information collected from the demographic form included age, sex, gender, racial/ethnic background, income level, highest level of education attained, employment status, the number of people in the household, state of residence, current medical conditions that could increase risk for susceptibility to and/or complications from COVID-19, whether participants had sought out testing for COVID-19, and whether participants had been infected with COVID-19.

COVID-19 affective risk was assessed at Time 1 using a 3-item self-report measure specifically created for this study. Participants responded to questions about COVID-19-related worry about risk (i.e., "How worried are you about your level of risk…") in three domains: (a) contracting COVID-19, (b) dying from COVID-19, and (c) spreading COVID-19 to others (should they have it). Participants responded to each item using a 5-point Likert-type scale ranging from 1 (not at all worried) to 5 (extremely worried). Research using similar self-report items (e.g., Klein, 2002; Rose, 2010) has shown that affective risk assessments are highly correlated with behavioral intentions and health behaviors. Given that few participants in this sample reported having a confirmed COVID-19 infection, as well as our interest in evaluating personal affective risk assessments (vs. assessments of others' risks), only the items pertaining to contracting and dying from COVID-19 were used. These items were summed to create a COVID-19 affective risk index. Internal consistency was acceptable in this sample ($\alpha = .87$).

The Intolerance of Uncertainty Scale-Short Form (IUS-12; Carleton, Norton, & Asmundson, 2007) was used to assess intolerance of uncertainty at the Time 1 assessment. The IUS-12 is a 12-item measure that assesses prospective and inhibitory anxiety. This scale was adapted from the 27-item Intolerance of Uncertainty Scale (Freeston et al., 1994) that was originally designed to measure six elements related to the inability to withstand uncertainty (i.e., emotional and behavioral consequences of being uncertain, beliefs that uncertainty reflects one's character, expectations that the future is predictable, frustration when the future is not predictable, efforts aimed at controlling the future, and inflexible responses during uncertain situations). Example items include, "A small unforeseen event can spoil everything, even with the best of planning," and "I can't stand being taken by surprise." Participants rate the extent to which they agree with each item on a 5-point Likert-type scale (1 = "Not at all characteristic of me;" 2 = "A little characteristic of me;" 3 = "Somewhat characteristic of me;" 4 = "Very characteristic of me;" 5 = "Entirely characteristic of me"). For the present study, responses to each item were summed to create an overall index of intolerance of uncertainty, with possible scores ranging from 12 to 60 and higher scores reflecting greater intolerance of uncertainty. Although Carleton et al. (2007) found that the IUS-12 has a stable two-factor structure, recent studies have demonstrated that the majority of the measure's variance is accounted for by a single latent variable; consequently, it is recommended that a single, overall IUS-12 score is used (Hale et al., 2016; Lauriola, Mosca, & Carleton, 2016; Shihata, McEvoy, & Mullan, 2018). There is evidence for the reliability and construct validity of the IUS-12 within non-clinical and community samples (Carleton et al., 2007; Carleton, Collimore, & Asmundson, 2010; Lauriola et al., 2016). Internal consistency for this measure in this sample was acceptable ($\alpha = .95$).

The Short Health Anxiety Inventory (SHAI; Abramowitz, Deacon, & Valentiner, 2007; Abramowitz, Olatunji et al., 2007; Salkovskis, Rimes, Warwick, & Clark, 2002) is an 18-item measure that was used to assess different dimensions of health anxiety at the Time 1 and Time 2 assessments. The SHAI was modified to assess health anxiety symptoms over the past week (vs. the past 6-months on the original measure). Abramowitz, Deacon et al. (2007), Abramowitz, Olatunji et al. (2007) found that the SHAI assesses three dimensions of health anxiety: (a) illness likelihood (i.e., the perceived likelihood that a serious illness will be acquired, as well as intrusive thoughts about one's health; 10 items); (b) body vigilance (i.e., attention to bodily sensations or changes in bodily sensations; 3 items); and (c) illness severity (i.e., anticipated burden, impairment, or negative consequences associated with having a serious illness; 4 items). For each item, participants choose one response from a group of four statements of increasing severity (e.g., 0 = "I do not worry about my health;" 1 = "I occasionally worry about my health;" 2 = "I spend much of my time worrying about my health;" 3 = "I spend most of my time worrying about my health"). The SHAI has demonstrated good reliability, internal consistency, and construct validity (Abramowitz, Deacon et al., 2007; Abramowitz, Olatunji et al., 2007; Salkovskis et al., 2002). Responses to items were summed for each subscale. Higher scores on each subscale indicate greater illness likelihood, body vigilance, and illness severity. Internal consistency for the illness likelihood ($\alpha = .92$), body vigilance ($\alpha = .70$), and illness severity

(α = .85) health anxiety dimensions were acceptable in this sample.

Depression and anxiety symptom severity at Time 1 were assessed using the 21-item version of the Depression Anxiety Stress Scales (DASS-21; Lovibond & Lovibond, 1995). The current study utilized the depression and anxiety symptom severity subscales as covariates. The DASS-21 is a self-report measure that assesses the unique symptoms of depression, anxiety, and stress. Participants rate the items on a 4-point Likert-type scale indicating how much each item applied to them in the past week (0 = "Did not apply to me at all;" 1 = "Applied to me some of the time;" 2 = "Applied to me a good part of the time;" 3 = "Applied to me most of the time"). This measure has demonstrated good reliability and validity (Antony, Bieling, Cox, Enns, & Swinson, 1998; Roemer, 2001). Internal consistency of the depression (α = .93) and anxiety (α = .89) symptom severity subscales in this sample were acceptable.

2.3. Procedure

All procedures received prior approval from the University of Toledo's Institutional Review Board. To ensure that the study was not being completed by a bot (i.e., an automated computer program used to complete simple tasks), participants responded to a Completely Automatic Public Turing test to Tell Computers and Humans Apart (CAPTCHA) at the Time 1 assessment prior to providing informed consent. Participants were also informed on the consent form that "…we have put in place a number of safeguards to ensure that participants provide valid and accurate data for this study. If we have strong reason to believe your data are invalid, your responses will not be approved or paid and your data will be discarded." Initial data were collected in blocks of nine participants at a time and all data, including attention check items and geolocations, were examined by researchers before compensation was provided. Attention check items included three explicit requests embedded within the questionnaires (e.g., "If you are paying attention, choose '2' for this question"), two multiple-choice questions (e.g., "How many words are in this sentence?"), a math problem (e.g., "What is 4 plus 2?"), and a free-response item (e.g., "Please briefly describe in a few sentences what you did in this study"). Participants who failed one or more attention check items were removed from the study (n = 53 of 553 completers of the Time 1 assessment). Workers who completed the initial assessment and whose data were considered valid (based on attention check items and geolocations; N = 500) were compensated $3.00 for their participation and invited to participate in the one-month follow-up assessment.

One-month following completion of the Time 1 assessment, participants were contacted via CloudResearch (Litman et al., 2017) to complete the Time 2 assessment. This online platform allows researchers to email participants a link to follow-up assessments while maintaining anonymity (i.e., study personnel never see email addresses) by using their Amazon Worker ID numbers (provided by MTurk). Of the 500 participants who completed the initial assessment, 77 % (n = 386) completed the follow-up assessment. There were no significant differences in Time 1 intolerance of uncertainty or health anxiety dimensions between participants who completed (vs. did not complete) the follow-up assessment (*ps* $\geq$ .11); however, participants who completed the Time 2 assessment reported greater affective risk perceptions (*M* = 6.03, *SD* = 2.59) than those who did not complete the Time 2 assessment (*M* = 5.45, *SD* = 2.40; *t* (498) = -2.18, *p* = .030). Time 2 assessments were completed, on average, 32.3 days (*SD* = 5.5) following the Time 1 assessment (*Median* = 30 days; *Range* = 29–53 days; 87 % completed within one week of their scheduled one-month follow-up assessment).

Procedures for assessing the validity of the Time 2 data (i.e., examining attention check items and geolocations) were similar to those used for the Time 1 assessment. Participants who failed two or more attention check items at the Time 2 assessment were removed from the study (*n* = 3); the remainder were compensated $3.00 for their participation. In addition, two participants were excluded for non-reconcilable differences in demographic data between the Time 1 and Time 2 assessments, and 17 additional participants were excluded for incomplete data on the primary variables of interest, resulting in a final sample size of 364.

2.4. Analysis plan

Descriptive statistics for the primary variables of interest (i.e., Time 1 affective risk perceptions, Time 1 intolerance of uncertainty, Time 1 health anxiety dimensions, and Time 2 health anxiety dimensions) were computed. Pearson product-moment correlations were conducted to evaluate zero-order associations among variables. Next, a series of hierarchical linear regression analyses predicting health anxiety dimensions at the Time 2 assessment were conducted to evaluate hypotheses. Baseline levels of the Time 2 health anxiety dimension under investigation was entered in the first step of each model. Time 1 affective risk perceptions and Time 1 intolerance of uncertainty were mean centered and entered in the second step of each model, followed by the product of these variables in the third step. The PROCESS macro version 3.5 for SPSS (Hayes, 2018) was used to evaluate significant interactions by examining simple slopes representing the association between Time 1 affective risk perceptions and each Time 2 health anxiety dimension as a function of Time 1 intolerance of uncertainty (plotted at standard values of -1 SD, mean, +1 SD). To ensure that a significant interaction was not due to demographic or other psychiatric factors, analyses were conducted again with relevant demographic and psychiatric covariates (age, sex [0 = male, 1 = female], racial/ethnic background [0 = racial/ethnic minority, 1 = non-minority], income level [0 = < $50,000/year; 1 = $\leq$ $50,000/year], education level [0 = some college or less, 1 = college graduate or more], number of people in the household, presence of a medical condition that could result in COVID-19 susceptibility and/or complications [0 = yes, 1 = no], depression symptom severity, anxiety symptom severity) included in the first step of regression models.

3. Results

3.1. Preliminary analyses

Primary variables of interest (Time 1 COVID-19 affective risk, Time 1 intolerance of uncertainty, and Time 1 and Time 2 health anxiety dimensions) were found to be normally distributed (skew < |.95|; kurtosis < |1.13|). Descriptive data for and correlations among the primary variables of interest are presented in Table 1. Mean overall Time 2 health anxiety (calculated as the sum of all SHAI subscales) was 13.39 (*SD* = 8.92), which is consistent with average SHAI scores in nonclinical populations as determined by a meta-analysis (*M* = 12.41, *SD* = 6.81; Alberts, Hadjistavropoulos, Jones, & Sharpe, 2020), as well as a recent study of a community sample during the COVID-19 pandemic (*M* = 14.68, *SD* = 6.58; Jungmann & Witthöft, 2020). COVID-19 affective risk at Time 1 was significantly positively associated with Time 1 intolerance of uncertainty and all health anxiety dimensions assessed at Time 1 and Time 2. Likewise, Time 1 intolerance of uncertainty was significantly positively associated with all health anxiety dimensions assessed at Time 1 and Time 2.

3.2. Primary analyses

Results of the hierarchical linear regression analyses examining the main and interactive effects of Time 1 COVID-19 affective risk and intolerance of uncertainty on Time 2 health anxiety dimensions are presented in Table 2.

3.2.1. Health anxiety – illness likelihood

The overall model was significant, accounting for 61 % of the variance in the Time 2 illness likelihood dimension of health anxiety, *F* (4,

Table 1
Descriptive data for and bivariate correlations among primary variables of interest ($N = 364$).

	1	2	3	4	5	6	7	8
1. T1 Affective Risk	—	.17*	.45**	.28**	.23**	.41**	.22**	.26**
2. T1 IUS		—	.36**	.27**	.46**	.41**	.28**	.53**
3. T1 Illness Likelihood			—	.61**	.57**	.77**	.51**	.52**
4. T1 Body Vigilance				—	.34**	.46**	.64**	.29**
5. T1 Illness Severity					—	.49**	.31**	.70**
6. T2 Illness Likelihood						—	.62**	.58**
7. T2 Body Vigilance							—	.40**
8. T2 Illness Likelihood								—
Mean	6.00	32.81	6.88	3.28	3.12	6.40	3.30	3.07
SD	2.59	12.08	5.45	1.98	2.68	5.12	1.98	2.70

Note. T1 = Time 1 Assessment; T2 = Time 2 Assessment; Affective Risk = COVID-19 Affective Risk Assessments; IUS = Intolerance of Uncertainty Scale; Illness Likelihood = Short Health Anxiety Inventory Illness Likelihood Subscale; Body Vigilance = Short Health Anxiety Inventory Body Vigilance Subscale; Illness Severity = Short Health Anxiety Inventory Illness Severity Subscale; SD = Standard Deviation.
* $p < .01$.
** $p < .001$.

359) = 141.14, $p < .001$, $f = 1.24$. The addition of Time 1 COVID-19 affective risk and intolerance of uncertainty in the second step of the model accounted for additional significant variance in Time 2 illness likelihood above and beyond Time 1 illness likelihood, $\Delta R^2 = .02$, F (2, 360) = 11.04, $p < .001$, $f = .24$, with both variables demonstrating a significant unique positive association with Time 2 illness likelihood. The addition of the interaction term did not significantly improve the model, $\Delta R^2 = .001$, F (1, 359) = 1.38, $p = .242$, $f = .03$.

3.2.2. Health anxiety – body vigilance

The overall model was significant, accounting for 42 % of the variance in the Time 2 body vigilance dimension of health anxiety, F (4, 359) = 65.56, $p < .001$, $f = .84$. The addition of Time 1 COVID-19 affective risk and intolerance of uncertainty in the second step of the model accounted for additional significant variance in Time 2 body vigilance above and beyond Time 1 body vigilance, $\Delta R^2 = .01$, F (2, 360) = 3.93, $p = .021$, $f = .13$, with only intolerance of uncertainty demonstrating a significant unique positive association with Time 2 body vigilance. The addition of the interaction term did not significantly improve the model, $\Delta R^2 = .00$, F (1, 359) = .15, $p = .697$, $f = .00$.

3.2.3. Health anxiety – illness severity

The overall model was significant, accounting for 55 % of the variance in the Time 2 illness severity dimension of health anxiety, F (4, 359) = 108.49, $p < .001$, $f = 1.09$. The addition of Time 1 COVID-19 affective risk and intolerance of uncertainty in the second step of the model accounted for significant additional variance in Time 2 illness severity above and beyond Time 1 illness severity, $\Delta R^2 = .06$, F (2, 360) = 23.35, $p < .001$, $f = .35$, with both variables demonstrating a significant unique positive association with Time 2 illness severity. However, these main effects were qualified by a significant interaction in the third step of the model, $\Delta R^2 = .01$, F (1, 359) = 3.90, $p = .049$, $f = .09$ (see Fig. 1). Specifically, results revealed a significant positive association between COVID-19 affective risk and Time 2 illness severity among participants with low ($\beta = .16$, $SE = .05$, $p = .003$, 95 % CI [.056, .264]) and mean ($\beta = .09$, $SE = .04$, $p = .021$, 95 % CI [.014, .164) levels of intolerance of uncertainty, but not high levels of intolerance of uncertainty ($\beta = .02$, $SE = .05$, $p = .744$, 95 % CI [-.086, .120]).

To ensure that the significant interaction could not be attributed to other demographic or psychiatric variables, the regression analysis was rerun with the following covariates included in the first step of the model (along with Time 1 illness severity): age, sex, racial/ethnic background, education level, income level, number of people in the household, the presence of a medical condition that could contribute to COVID-19 susceptibility and/or complications, depression symptom severity, and anxiety symptom severity. As with the previous analysis without the covariates, addition of the interaction term in the third step significantly improved the model above and beyond the previous steps, $\Delta R^2 = .01$, F (1, 350) = 4.00, $p = .046$, $f = .09$. Examination of the simple slopes revealed a similar pattern of associations at low ($\beta = .15$, $SE = .06$, $p = .008$, 95 % CI [.040, .258]), mean ($\beta = .08$, $SE = .04$, $p = .063$, 95 % CI [-.004, .156), and high ($\beta = .003$, $SE = .05$, $p = .958$, 95 % CI [-.103, .109]) levels of intolerance of uncertainty.

4. Discussion

This study sought to examine the unique and interactive prospective relations of COVID-19 affective risk assessments (i.e., worry about risk for contracting or dying from COVID-19) and intolerance of uncertainty

Table 2
Main and interactive effects of Time 1 COVID-19 affective risk assessments and intolerance of uncertainty on Time 2 health anxiety dimensions.

	T2 Illness Likelihood			*T2 Body Vigilance*			*T2 Illness Severity*		
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
Step 1									
T1 DV	.72	.03	< .001	.64	.04	< .001	.70	.04	< .001
Step 2									
T1 DV	.64	.04	< .001	.60	.04	< .001	.56	.04	< .001
T1 COVID-19 Affective Risk	.15	.07	.045	.02	.03	.530	.09	.04	.023
T1 IUS	.06	.02	< .001	.02	.01	.008	.06	.01	< .001
Step 3									
T1 DV	.64	.04	<.001	.60	.04	< .001	.57	.04	< .001
T1 COVID-19 Affective Risk	.15	.07	.047	.02	.03	.528	.09	.04	.021
T1 IUS	.06	.02	<.001	.02	.01	.009	.06	.01	< .001
Interaction	−.01	.01	.242	−.001	.002	.697	−.006	.003	.049

Note. T1 COVID-19 Affective Risk and T1 IUS are mean centered. T1 = Time 1 Assessment; T2 = Time 2 Assessment; T1 DV = scores on the dependent variable within each model as measured at the initial assessment; IUS = Intolerance of Uncertainty Scale; Illness Likelihood = Short Health Anxiety Inventory Illness Likelihood Subscale; Body Vigilance = Short Health Anxiety Inventory Body Vigilance Subscale; Illness Severity = Short Health Anxiety Inventory Illness Severity Subscale; Interaction = Time 1 COVID-19 Affective Risk Perceptions X Time 1 Intolerance of Uncertainty Interaction; SE = Standard Error.

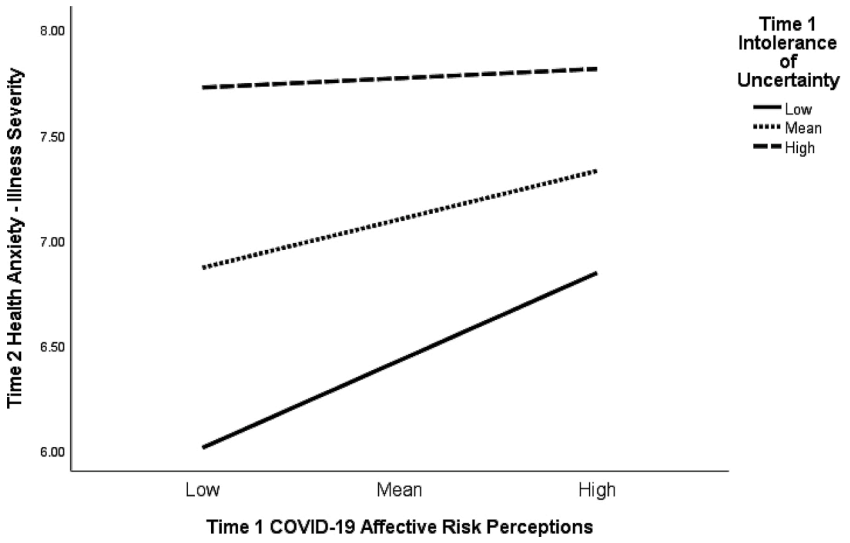

Fig. 1. Interactive effect of Time 1 COVID-19 affective risk assessments and Time 1 intolerance of uncertainty on Time 2 illness severity.

to health anxiety one month later. Hypotheses were partially supported. First, as predicted, COVID-19 affective risk assessments and intolerance of uncertainty at Time 1 were uniquely associated with later perceived likelihood that a serious illness would be acquired (i.e., illness likelihood subscale on the SHAI) and anticipated negative consequences of having a serious illness (i.e., illness severity subscale on the SHAI). These findings are consistent with past research demonstrating relationships between health anxiety and both intolerance of uncertainty (e.g., Abramowitz, Deacon et al., 2007; Abramowitz, Olatunji et al., 2007) and concerns regarding perceived vulnerability to disease (e.g., Duncan, Schaller, & Park, 2009). However, only intolerance of uncertainty at Time 1 was found to be uniquely associated with Time 2 body vigilance. The items assessing body vigilance on the SHAI focus on bodily sensations in general or aches and pains. Although worry and anxiety regarding risk for contracting or dying from COVID-19 would be expected to amplify sensitivity to bodily sensations (consistent with a seek to avoid process; Barlow, 2002), it is possible that this process might be more evident for bodily sensations that are specifically associated with COVID-19 infection (e.g., fever, shortness of breath, headache). However, as an individual difference factor that is not unique to COVID-19, intolerance of uncertainty may be more likely to increase awareness of bodily sensations in general to identify any potential sources of health threat, thus increasing a sense of certainty, control, or predictability.

Contrary to hypotheses, intolerance of uncertainty was not found to moderate the association between Time 1 COVID-19 affective risk assessments and Time 2 illness likelihood or body vigilance. In addition, although intolerance of uncertainty was found to moderate the association between COVID-19 affective risk assessments and Time 2 illness severity, the nature of this interaction was different than what was predicted. Specifically, Time 1 COVID-19 affective risk assessments were significantly positively associated with Time 2 illness severity only at mean and low levels of intolerance of uncertainty. At high levels of intolerance of uncertainty, no significant association was found between COVID-19 affective risk assessments and health anxiety. This finding highlights the multiple ways in which individuals may develop anxiety surrounding the potential negative consequences associated with illness. Even in the absence of an established vulnerability for the development of health anxiety (i.e., intolerance of uncertainty), elevated worry about risk for contracting or dying from COVID-19 appears to be sufficient for the greater anticipation of negative consequences associated with having an illness. The experience of frequent worry thoughts surrounding risk for COVID-19 infection or mortality may increase health anxiety by contributing to the increased generation of potential catastrophic outcomes that could occur if one were infected with the virus. Indeed, in other health conditions (e.g., irritable bowel syndrome), worry has been found to contribute to increased suffering through catastrophizing (Lackner & Quigley, 2005). However, among individuals high in intolerance of uncertainty, COVID-19 affective risk assessments seem less relevant to later health anxiety, providing further evidence that intolerance of uncertainty may be a strong risk factor for the development or exacerbation of health anxiety. Such a finding is consistent with previous research showing that intolerance of uncertainty predicts health anxiety above and beyond other established anxiety risk factors (e.g., anxiety sensitivity, negative affect; Fergus & Bardeen, 2013).

Study limitations warrant consideration. First, all outcomes were assessed using self-report questionnaires, which have the potential to be influenced by social desirability biases or recall difficulties. In addition, we used an unpublished, two-item measure developed specifically for the purposes of this study to assess COVID-19 affective risk assessments. Although this measure demonstrated associations with our other variables in the expected direction, it is possible that our measure did not provide a comprehensive evaluation of COVID-19 affective risk assessments. At the time this study began, other validated measures of COVID-19 affective risk assessments were not available. However, since that time, several measures have been published that may provide a better assessment of COVID-19 affective risk assessments or the stress and anxiety associated with COVID-19 more generally, such as the COVID Stress Scales (Taylor et al., 2020) and the Coronavirus Anxiety Scale (Lee et al., 2020). In addition, our measures of intolerance of uncertainty and health anxiety were not specific to COVID-19; thus, findings cannot speak to the extent to which intolerance of uncertainty surrounding the COVID-19 pandemic in particular influences anxiety surrounding the experience and consequences of COVID-19 related bodily sensations. In addition, given our recruitment methods and sample (i.e., self-selected MTurk workers), results may also not generalize to the larger U.S. population, adults in other countries, or particularly vulnerable populations (e.g., individuals with chronic medical conditions; health care workers; hospitalized patients). Replication of our findings is needed within other samples.

In addition, although COVID-19 affective risk assessments and intolerance of uncertainty were found to predict later health anxiety, it is important to note that average health anxiety levels at Time 2 were not at clinical levels (*mean* SHAI scores among individuals with hypochondriasis = 32.58; Alberts, Hadjistavropoulos, Jones, & Sharpe, 2013). Moreover, it is not clear if the levels of health anxiety observed in this study are associated with engagement in adaptive or maladaptive health behaviors. Health anxiety is conceptualized as a dimensional variable (Taylor & Asmundson, 2004), and moderate levels of health

anxiety may be functional in the context of a pandemic, increasing motivation to engage in protective behaviors such as social distancing, hand washing, and wearing a mask when outside of the home. Studies employing multiple follow-up assessments are needed to determine whether the health anxiety stemming from COVID-19 affective risk assessments and intolerance of uncertainty predicts later engagement in adaptive or maladaptive health behaviors. Likewise, research is needed to examine the impact of the COVID-19 pandemic on health anxiety within more vulnerable populations, such as individuals with pre-existing illness anxiety disorder or generalized anxiety disorder.

Despite limitations, findings lend support to the hypothesis that the COVID-19 pandemic will result in elevated health anxiety (Asmundson & Taylor, 2020b), and add to the growing body of literature on the mental health consequences of this pandemic (Cao et al., 2020; González-Sanguino et al., 2020; Harper et al., 2020; Huang & Zhao, 2020; Jungmann & Witthöft, 2020; Lee et al., 2020; McKay et al., 2020; Moghanibashi-Mansourieh, 2020; Zhang et al., 2020). Specifically, our findings demonstrate that COVID-19 affective risk assessments and intolerance of uncertainty are uniquely associated with various dimensions of health anxiety one month later. Moreover, in addition to providing further evidence that high levels of intolerance of uncertainty may increase risk for later health anxiety, results highlight one pathway (i.e., affective-based risk assessments) through which individuals without high levels of intolerance of uncertainty may still be susceptible to later health anxiety during this time. Specifically, the extent to which individuals feel that they are at risk for COVID-19 infection and death was associated with elevated health anxiety one-month later among individuals with mean and low levels of intolerance of uncertainty. As such, findings highlight a number of potential targets for preventing the development of severe health anxiety that could lead to maladaptive behaviors during the current pandemic. For example, acceptance- and mindfulness-based behavioral interventions (e.g., acceptance-based behavioral therapy for generalized anxiety disorder; Roemer, Orsillo, & Salters-Pedneault, 2008) may be particularly useful for addressing worry about risk for contracting or dying from COVID-19. Psychoeducation on effective behaviors for mitigating risk for COVID-19 infection may also reduce worry, and ultimately health anxiety, by modifying risk assessments and increasing a sense of control. Cognitive-behavioral interventions that specifically target intolerance of uncertainty (e.g., Hebert & Dugas, 2019; Ladouceur et al., 2000) may also have utility in reducing risk for future health anxiety during this particularly stressful and indeed uncertain time.

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