The role of anxiety in mediating the relationship between information consumption and COVID-19 protective behaviours

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Throughout the COVID-19 pandemic, concerns have been raised about an ‘infodemic’, with information and misinformation being spread across multiple channels and mediums. Information consumption has also been associated with increased anxiety throughout the pandemic. Thus, the present study investigates the mediating role of state anxiety on the relationship between information consumption (defined as mean frequency of information consumption multiplied by number of information sources) and COVID-19 protective behaviours. We compare results across Australian and United States samples and account for personal risk perception and belief in misinformation about COVID-19. Cross-sectional data collected between 28 and 30 April 2020 were analysed using Bayesian structural equation modelling among participants from Australia (N = 201), and the United States (N = 306). State anxiety scores were above the conventional clinical cut-off. Information consumption was positively associated with state anxiety, personal risk perception, and COVID-19 protective behaviours in the Australian and the United States samples. Additionally, the relationship between information consumption and COVID-19 protective behaviours was positively mediated by state anxiety in both nations, suggesting some functional benefits of anxiety. Differences in risk perception and belief in misinformation existed between the Australian and United States sample. Findings provide support for current guidance from organisations such as the WHO, APA, and APS on limiting information consumption to reduce anxiety. To effectively communicate critical public health messaging while minimising potential burdens on mental health, there is a need to develop and test interventions that assist people in calibrating the extent and nature of their information consumption.

Keywords: COVID-19; infodemic; anxiety; misinformation; protective behaviours

Literature has established relationships between COVID-19 information consumption and mental health, particularly anxiety (Gao et al., 2020; Ko et al., 2020; Yao, 2020). Given findings on disaster-related media and mental health, including anxiety and post-traumatic stress

(Pfefferbaum et al., 2014), and relationships between information consumption, fear, and anxiety in past disease outbreaks (Jones & Salathé, 2009; Oh et al., 2020), institutions including the Australian Psychological Society (APS) and American Psychological Association (APA) have recommended reducing news consumption—in frequency and numerosity of sources—to alleviate mental health concerns (APS, 2020; Garfin et al., 2020). However, during crises people become more dependent upon media (Ball-Rokeach & DeFleur, 1976), which can communicate health information and appropriate behaviour (Wakefield et al., 2010). Accordingly, we investigated the mediating role of state anxiety on the relationship between information consumption and COVID-19 protective behaviours in Australia and the United States.

Anxiety is associated with a pessimistic appraisal tendency and has been positively associated with risk perceptions (Lerner & Keltner, 2001; Yang & Chu, 2018), and COVID-19 protective behaviours (Riad et al., 2020). However, the inverted-U hypothesis suggests anxiety increases protective behaviour to a point, beyond which it becomes immobilizing (Janis, 1967). Anxiety can also increase willingness to accept and seek out information that contradicts one's views, including in the context of misinformation (Weeks, 2015). However, anxiety can increase belief in misinformation and conspiracy theories - commonly proliferated during disasters, providing an explanation equal to the event (van Prooijen & Douglas, 2017). Šrol et al. (2020) demonstrated a relationship between COVID-19 related anxiety and belief in COVID-19 conspiracy theories, which have been associated with reduced protective behaviours (Allington et al., 2020). The nature and consequences of the relationship between information consumption, anxiety, and protective behaviours during pandemics are, therefore, not well understood.

Media coverage of COVID-19 is complicated by the contemporary media landscape, with a range of mediums and channels, whose nature may influence anxiety and behaviour. During

COVID-19, social media consumption has positively predicted markers of anxiety and depression (Gao et al., 2020), and other online sources have predicted reduced well-being (Ko et al., 2020), while traditional media sources (e.g., newspapers and television news) have less consistently predicted outcomes measuring anxiety and well-being (Ko et al., 2020). The proliferation of information through various mediums has raised concerns about an ‘infodemic’; an overload of information and prevalence of misinformation (WHO, 2020b).

The potential negative influence of information consumption on mental health and positive influence on adoption of protective behaviours during a pandemic (e.g., social distancing) presents a trade-off. Thus, there is a need to better understand the potential benefits *and* costs of media communications to public health throughout COVID-19. Accordingly, the present study investigated the role of anxiety as a mediator between information consumption and protective behaviours in the context of COVID-19 while considering belief in misinformation and personal risk perception.

While the contemporary media landscape enables information to be accessed globally, cross-national differences in pandemic responses could influence associations between information consumption and public health outcomes. We examine responses in samples from Australia and the United States, as two nations with differing responses to the pandemic at the population and leadership level, and different media landscapes (Tabari et al., 2020). As the impact of COVID-19 encompassed health, social, and economic concerns, not solely related to the virus, we investigated state anxiety, rather than fear of COVID-19, as a measure of anxiety during COVID-19.

Drawing on the appraisal tendency framework (ATF), which describes anxiety as high uncertainty emotion with high situational control and a pessimistic appraisal tendency (Lerner &

Keltner, 2001), and previous findings, we hypothesised positive relationships between anxiety, risk perception, and protective behaviours, as in Figure 1. While cross-sectional data precludes the possibility of causal inference, prior research and theory provided grounds to conduct mediation analysis. Accordingly, we examined information consumption across a wide range and frequency of sources, state anxiety, and protective behaviours, while considering personal risk perception and belief in misinformation, within an Australian and a United States sample, providing a comparison between two nations with different responses to the pandemic.

Figure 1. Hypothesized model. Mediation analyses are shown through darker arrows, while other arrows demonstrate expected associations.

Method

Sample

Participants were recruited using Prolific, an online crowdsourcing platform (Prolific, 2019), between 28 and 30 April 2020, seven weeks after COVID-19 was declared a pandemic (WHO, 2020b). A nationally representative United States sample (N = 306) was recruited using quota

sampling stratified by age ($M = 44.78$, $SD = 15.91$), gender, and ethnicity. Quota sampling was not available for the Australian sample ($N = 201$), which was approximately gender-balanced, though younger ($M = 31.28$, $SD = 10.23$) and more educated than the general population (Australian Bureau of Statistics, 2016). Demographic details are presented in Figures 2 and 3, and at <https://osf.io/n3yqd/>. The study was approved by the University of Adelaide Human Research Ethics Committee (approval 20/17).

Over the survey period Australia was in nationwide lockdown, with a daily increase between seven and 15 cases, approximately 6,700 cumulative cases, and 90 fatalities. The United States had approximately 1.04 million cumulative cases, over 57,000 fatalities, and a daily increase between 22,541 and 27,326 cases (WHO, 2020c).

Figure 2. Demographics of the Australian sample plotted against state anxiety scores, females being green and males orange, with the size of each point reflecting education scores.

Figure 3. Demographics of the United States sample plotted against state anxiety scores, females being green and males orange, with the size of each point reflecting education scores.

Measures

State anxiety

Participants responded to a six-item short form of the State-Trait Anxiety Index state subscale (STAI-S) (Marteau & Bekker, 1992; Spielberger, 1989), rating statements such as ‘I am tense’ on a four-point scale from *not at all* (1) to *very much* (4). Within both samples, mean scores were above the conventional cut-off; equivalent to a score of 12 on the short-form (Emons et al., 2019; see Table 1).

Belief in misinformation about COVID-19

Misinformation items were adapted from WHO (2020a), and fact-checking sites NewsGuard (2020) and FactCheck.org (2020). Participants rated their agreement with ten statements such as ‘The coronavirus was purposefully engineered’ from *completely disagree* (1) to *completely agree*

(5). All items are at <https://osf.io/n3yqd/>.

Personal risk perceptions

Participants rated their perceived likelihood of contracting COVID-19 between now and the end of the year on a sliding scale from *very unlikely* (1) to *very likely* (100), and the perceived severity of a COVID-19 infection for their health from *not at all serious* (1) to *extremely serious* (100). The risk items were combined, but given low correlations (Table 1), results for models separating risk items are at <https://osf.io/n3yqd/>.

Information consumption

Participants reported usage across 39 sources in the past week, including mass media, social media, interpersonal, institutional, and government sources, for COVID-19 updates from *never* (0) to *every day* (7). Information consumption was operationalized by multiplying participants' mean frequency across reported sources by the number of sources reported to provide an overall snapshot of individual self-reported media consumption habits considering variability and frequency. The full list of sources with means and standard deviations is at <https://osf.io/n3yqd/>, as are models using a mean index, which produced qualitatively similar results.

COVID-19 protective behaviours

Behaviours were measured using the YouGov Blue (2020) behaviour change scale. Participants responded to seven items about their behaviour change due to COVID-19 over the last week, including: hand washing, changed travel, working from home, stockpiling food, stockpiling medicine, child and elder care, and social distancing on a four-point scale from *has not changed at all* (1) to *has changed completely* (4).

Table 1

Means and Standard Deviations of Key Measures for the United States (N = 306) and Australian (N=201) sample.

Measure	United States			Australia			Range	
	<i>M</i>	<i>SD</i>	α	<i>M</i>	<i>SD</i>	α	<i>Possible</i>	<i>Actual</i>
<i>Information consumption score</i>	19.18	21.50	.84	15.52	21.9	.88	0-273	0-194
<i>State Anxiety</i>	13.53	4.55	.91	13.25	3.78	.88	6-24	6-24
<i>Personal risk perception</i>	10.09	4.70	$r_{xy} = .55$	7.98	3.95	$r_{xy} = .29$	0-20	0.20-18.7
<i>Belief in misinformation about COVID-19</i>	15.28	6.11	.89	14.70	5.30	.85	10-50	10-38
<i>COVID-19 protective behaviour</i>	16.24	4.23	.70	14.63	4.03	.70	6-24	6-24
<i>CRT scores</i>	1.42	1.20	.75	1.55	1.21	.75	0-3	0-3

Note: Variables were scaled using the scale function in base R (R Core Team, 2019) prior to analysis, means and standard deviation show the unscaled variables.

Data Analysis

All analyses were conducted using R 3.6.2 (R Core Team, 2019). Table 1 shows descriptive analyses of the sample and key variables, which were aggregated using scale items. Hypothesized relationships were tested using blavaan (Merkle & Rossell, 2018), and rjags (Lunn et al., 2009), to conduct Bayesian structural equation modelling. Bayesian methods were used as they are better suited to complex models, particularly in small samples (Depaoli & van de Schoot, 2017). Bayesian methods enable the inclusion of prior information about variables and

relationships, as noninformative, weakly informative, or informative priors, which are updated by the data.

Models were run with information consumption as a predictor of COVID-19 protective behaviours, mediated by belief in misinformation about COVID-19 and anxiety, with personal risk perception serially mediated through anxiety. Age, ethnicity, gender, religion, and education were controlled at each step; as was preference for analytical thinking (measured using the CRT; Frederick, 2005), which has been associated with discernment of misinformation and protective behaviours during COVID-19 (Swami & Barron, 2020). All variables were scaled before analysis.

The larger United States sample was analysed first using weakly informative priors based on previous data on COVID-19 and disease outbreaks where available (see <https://osf.io/n3yqd/> for priors and references). Non-informative priors used a beta coefficient estimate of 0, and deviation of $8e-2$ to account for more variation than rjags default $1e-2$ (Lunn et al., 2009). The Australian model was run using posterior distributions from the United States model as weakly informative priors with deviations of $5e-2$.

Models were checked and reported using the WAMBS (When to worry and how to Avoid the Misuse of Bayesian Statistics) checklist; including assessments of convergence using trace plots and Gelman diagnostics (Depaoli & van de Schoot, 2017). Both models were run for 25,000 burn-ins and 50,000 samples. The PPP value was used as a measure of model fit; consistent with Cain and Zhang (2019) we used a cut-off of $PPP < .10$ as indicating poor fit, and $.50$ indicating excellent fit. As Oh et al. (2020) suggested investigating fear as distinct from anxiety in disease outbreaks and information consumption, exploratory analysis included fear of

COVID-19. As models demonstrated better fit for anxiety only, exploratory models are not reported, but are available at <https://osf.io/n3yqd/> along with all models, scripts, plots, and data.

Results

United States

The United States model was an acceptable fit for the data ($PPP = .500$). Table 2 shows the posterior estimates, standard deviations, and 95% credible intervals for the predictors of each pathway in the model, and total variance explained by each outcome variable.

Information consumption was positively associated with state anxiety and personal risk perception (see Figure 4). Personal risk perception, state anxiety, and information consumption were positively associated with COVID-19 protective behaviours, with credible intervals above zero. Belief in misinformation about COVID-19 was negatively associated with COVID-19 protective behaviours, with the credible interval below zero. State anxiety was associated negatively with belief in misinformation about COVID-19, and positively with personal risk perception.

As hypothesized, state anxiety mediated the relationship between information consumption and COVID-19 protective behaviours, and the relationship was serially mediated by personal risk perception through anxiety (see Table 3). The relationship between information consumption and COVID-19 protective behaviours was not mediated by belief in misinformation about COVID-19.

Figure 4. Results of the hypothesized model for the United States sample (N = 306) with posterior estimates and upper and lower credibility intervals. Darker arrows indicate mediation analyses.

Australia

The Australian model was an acceptable fit for the data (PPP=.498). Table 2 shows posterior estimates, standard deviations, and 95% credible intervals for the predictors of each pathway in the model, and total variance explained by each outcome variable.

Information consumption was positively associated with state anxiety, and state anxiety and information consumption were positively associated with COVID-19 protective behaviours (see Figure 5). State anxiety mediated the relationship between information consumption and COVID-19 protective behaviours (see Table 3). Unlike the United States model, personal risk perception did not serially mediate the relationship, and was not associated with COVID-19 protective behaviours. Belief in misinformation about COVID-19 did not mediate the

relationship between information consumption and COVID-19 protective behaviours and was not associated with COVID-19 protective behaviours.

Figure 5. Results of the hypothesized model for the Australian sample (N = 201) with posterior estimates and upper and lower credibility intervals. Darker arrows indicate mediation analyses.

Table 2

Posterior estimates, standard deviations, and 95% credibility (confidence) intervals for hypothesized predictors in the United States (N = 306) and Australian (N=201) sample.

		United States			Australia		
		95% CI			95% CI		
Predictor	estimate (SD)	Lower	Upper	estimate (SD)	Lower	Upper	
<i>Belief in</i>							
<i>Misinformation about</i>							
<i>COVID-19</i>							
Anxiety	-.16 (.05)	-.26	-.05	.03 (.07)	-.11	.17	
Information	.06 (.05)	-.04	.17	.08 (.08)	-.07	.23	

consumption						
R ²	.21			.12		
<i>Anxiety</i>						
Information	.14 (.06)	.03	.25	.24 (.07)	.10	.38
consumption						
R ²	.09			.09		
<i>Personal Risk</i>						
<i>Perception</i>						
Anxiety	.36 (.05)	.26	.47	.28 (.07)	.15	.42
Information	.13 (.05)	.03	.24	.18 (.07)	.04	.32
consumption						
R ²	.20			.20		
<i>COVID-19 Protective</i>						
<i>Behaviours</i>						
State anxiety	.13 (.06)	.01	.24	.17 (.07)	.03	.31
Belief in COVID-19	-.16 (.06)	-.28	-.05	-.06 (.07)	-.19	.08
Misinformation						
Risk perception	.20 (.06)	.08	.31	-.03 (.07)	-.18	.11
Information	.23 (.05)	.12	.33	.39 (.07)	.24	.53
consumption						
R ²	.25			.22		

Note: R-square includes demographic variables and CRT scores. A table with all covariates is included in the supplementary material. Effects with non-zero credibility intervals are indicated in bold.

Table 3

Mediation Effects of State Anxiety, Personal Risk Perception, and Belief in Misinformation about COVID-19 on COVID-19 Preventative Behaviours for the United States (N=306) and Australia (N=201).

	United States			Australia		
	estimate (SD)	95% CI		estimate (SD)	95% CI	
		Lower	Upper		Lower	Upper
Indirect effects						
Via belief in misinformation about COVID-19	-.010 (.010)	-.032	.008	-.004 (.009)	-.024	.011
Via state anxiety	.031 (.015)	.004	.063	.093 (.034)	.029	.160
Via state anxiety and personal risk perception	.010 (.005)	.001	.021	-.002 (.005)	-.014	.008

Discussion

Given concerns around information consumption and mental health throughout COVID-19 we investigated state anxiety as a mediator of information consumption and COVID-19 protective behaviours within an Australian and United States sample. We further explored associations with belief in misinformation about COVID-19 and personal risk perception.

Within both samples, state anxiety was above the conventional clinical cut-off, suggesting anxiety was high in the general population. Accordingly, mental health advice around COVID-19 should consider both general and clinical populations and reinforce messages which

de-stigmatise anxiety and mental health, and encourage mental health literacy; particularly as references to COVID-19 as the ‘new normal’ may stigmatise discussion of anxiety and distress.

Consistent with previous studies, greater information consumption was positively associated with anxiety in both samples (Ko et al., 2020; Yao, 2020). As predicted, state anxiety mediated the relationship between information consumption and COVID-19 protective behaviours in both samples.

Across all mediations, information consumption had a direct relationship with COVID-19 protective behaviours, indicating it shared a relationship with protective behaviours beyond that accounted for by anxiety and personal risk perception. Further consideration of messaging strategies promoting the relationship between information consumption and protective behaviours without also increasing anxiety may be beneficial. Such an approach might leverage self-efficacy or perceived control to promote protective behaviours (see for example Chong et al., 2020). Given national differences, tailored communication strategies, and research specific to national contexts would be beneficial to provide evidence-based recommendations of information consumption.

While the results provide support for guidelines from public bodies including the WHO (2020a), APA (Garfin et al., 2020), and APS (2020), recommending limiting information consumption to reduce anxiety, they also demonstrate a positive relationship between information consumption and state anxiety and protective behaviours; suggesting a need to balance communications which increase protective behaviours and those which increase anxiety. While broad recommendations to limit information consumption may be beneficial for reducing anxiety, such messaging should be tempered with the need for clear guidance and social

connection. Further research into optimal use of information sources during COVID-19 would be beneficial in providing more calibrated guidance.

Greater attention to anxiety and its relationship with information consumption may also improve public informativeness about important events and protective behaviour, as negative emotion is a common reason for news avoidance (Newman et al., 2019). Given high proportions of participants across various studies report using mass media for COVID-19 updates, and concerns of mass media coverage contributing to anxiety, particularly during crises, investigation of alternative methods of reporting, such as ‘constructive’ journalism approaches (Hermans & Gyldensted, 2019), may be beneficial in addressing the relationship between news media and anxiety; particularly among those less likely to engage with organisations outside of mass and social media.

In both samples, information consumption did not demonstrate a relationship with belief in misinformation about COVID-19. As previous studies have found differing relationships between information sources, particularly social media and online sources, and belief in misinformation about COVID-19 (e.g. Bridgman et al., 2020), this may indicate a need for more fine-grained measurement of media sources in the context of COVID-19 misinformation.

The lack of association between belief in misinformation about COVID-19 and anxiety or COVID-19 protective behaviours in the Australian sample may be due to lower belief in and exposure to misinformation throughout the pandemic (Park et al., 2020; YouGov Cambridge Globalism, 2020). Consistent with past literature, belief in misinformation about COVID-19 demonstrated a negative association with COVID-19 protective behaviours in the United States (Allington et al., 2020). However, contrary to predictions, a negative association was observed between state anxiety and belief in misinformation about COVID-19 in the United States sample.

While anxiety has been related to belief in conspiracy theories during COVID-19 (Šrol et al., 2020), anxiety can also increase deliberative processing of and prompt searching for information, which may decrease the belief in misinformation where accurate facts are available (Weeks, 2015). Additionally, as a large body of COVID-19 misinformation has downplayed the disease, those with greater belief in misinformation may exhibit less anxiety (Nielsen et al., 2020). Further research could aim to elucidate the role of anxiety in COVID-19 misinformation belief.

Information consumption and anxiety were positively associated with personal risk perception in both samples. However, personal risk perception was positively associated with COVID-19 protective behaviours, and serially mediated the relationship between information consumption, state anxiety, and COVID-19 protective behaviours in the United States sample only. As United States participants reported higher risk perception, differences may be due to national contexts at the time. Given Australian and United States participants reported similar levels of concern in the YouGov (2020) assessment of COVID-19 fears, which included social, economic, and health fears, similar levels of anxiety may have been driven by concerns other than infection.

Consistent with the ATF (Lerner, 2001), our results suggest anxiety is to some extent functional within the pandemic context – being positively related to protective behaviours in both samples, and to reduced belief in misinformation in the United States sample. However, these benefits should be considered in conjunction with the negative consequences of anxiety (e.g. debilitating thoughts). Considering the inverted-U hypothesis, that anxiety will be functional to a point after which it becomes debilitating (Janis, 1967), communication strategies could be calibrated to the level of anxiety, to ethically balance its benefits with its negative consequences. Such strategies should consider the burden of anxiety on individual mental health,

particularly given the duration of the pandemic, and the possibility anxiety may encourage avoidance rather than constructive protective behaviours (Chong et al., 2020; Garfin et al., 2020).

While existing theory and findings provide grounds for mediation analysis, our study employs observational data, and does not provide evidence of causation. The investigated relationships, particularly between information consumption and anxiety, are likely to be self-reinforcing – some evidence being the approximately equal fit considering a model with anxiety and information consumption interchanged (see <https://osf.io/n3yqd/>).

Our information consumption variable was created in the absence of an existing measure combining frequency and diversity of sources, and there may be alternative ways of conceptualising information consumption. Additionally, frequency may not account for participants' attentiveness to information sources. Due to survey timing, our protective behaviour scale omitted mask-wearing and other protective devices now in frequent use. Results are also likely influenced by situational factors at the time of the survey. Longitudinal research on information consumption, mental health, and protective behaviours would provide beneficial insight into causal patterns and fluctuations throughout the progress of the disease. Also beneficial would be studies focused on populations at greater risk of developing anxiety in response to disease outbreak information, such as those with pre-existing mental health conditions and health care workers.

Overall, until a balance between mental health and informativeness in media communications can be met, recommendations to reduce overall news exposure seem an appropriately conservative response to concerns about the negative consequences of COVID-19 coverage on mental health.

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