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RESEARCH ARTICLE

Affect mediates culture's effects on COVID-19 risk perceptions, behavioral intentions, and policy support among americans

Branden B. Johnson [a*#] and Cameron S. Kay[b#$]

[a]*Decision Research, Springfield, OR, USA;* [b]*Department of Psychology, 1227 University of Oregon, Eugene, OR*

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The Affect Heuristic-Cultural Cognition Theory (AH-CCT) model and the Solution Aversion-based (SA) model both suggest affect, meaning feelings or discrete emotions about a target, mediates associations between 'culture,' such as political ideology or cultural biases, and risk responses, such as risk perceptions, protective behaviours, and supportive attitudes towards protective policy. However, the models differ respectively by defining negative affect as directed towards the hazard ('hazard affect') or a specific behaviour or policy response ('solution aversion,' negative affect about a proposed risk reduction method). We compare these models with longitudinal mediation analysis of U.S. COVID-19 survey data ($n = 866$ in smallest-sample wave). Solution aversion accounted for more associations of culture with risk perceptions, such as personal risk, collective risk, and risk severity; behaviour and behavioural intentions, regarding mask wearing, avoiding large public gatherings, and vaccination; and support for risk mitigation policies, regarding mask mandates, public gathering bans, and vaccination mandates. Statistically significant direct effects were rare and were mainly for egalitarian cultural bias; indirect effects occurred for egalitarians, political conservatives, and individualists. Implications for further research on risk responses are discussed relative to limited previous work on these affect-mediation models.

Keywords: Risk response; pandemic; emotions; values; longitudinal mediation analysis

Introduction

Both cultural and affective factors have long seemed to influence risk responses (e.g., Douglas & Wildavsky, 1982; Johnson & Swedlow, 2021; Loewenstein et al., 2001; Slovic et al., 2002; 2004), yet rarely have their relationships been assessed theoretically or empirically. The value of clarifying these relationships—e.g., is culture or affect more important in determining whether and how people choose to reduce their risks? which kind of culture or affect is more important? – is not just that theorists might construct better models of how and why people respond to hazards, but (potentially) practitioners

*Corresponding author Email: branden@decisionresearch.org
#B. Johnson current affiliation is Decision Research Center, Oregon Research Institute, Springfield, OR, USA. Email: bjohnson@ori.org.
$C. Kay's current affiliation is Department of Psychology, Union College, Schenectady, NY, USA.

have better grasp of which tools they might, or might not, have available to help them achieve a more democratic, equitable, and effective approach to hazard management.

To contextualise this gap's significance, consider the breadth of our central concepts ('culture', 'affect', 'risk responses'). 'Culture' has no single agreed-upon definition even within cultural anthropology, much less across the numerous disciplines applying the concept (e.g., Kuper, 1999; White, 1959; Wilhelms et al., 2009). However, defining culture as learned (non-genetic) 'patterns of behavior, thought, feeling, and artifact' passed among individuals, groups, and generations (Brown, 2004) exemplifies its potential coverage. Anthropologists distinguish material culture (humans' daily relations with the physical world via objects and technologies and associated behaviour), social culture (social relationships and behaviour allowing benefits from living in social groups), and symbolic culture (language, art and all other communication means during social interactions; Boesch, 2012). Some recommend using specific concepts—e.g., 'knowledge, or belief, or art, or technology, or tradition, or even of ideology (though similar problems are raised by that multivalent concept)' (Kuper, 1999, p. x) – rather than the polymorphous term 'culture'.

'Affective' factors, which for risk involve (usually) negative general feelings or specific discrete emotions (e.g., fear, anger) about a particular target (e.g., a specific hazard), have long been of interest to a broader audience. Scholars hotly debate whether basic emotions are evolution-derived responses of humans (and of many other organisms) to particular situations in their environment of evolutionary origin, invariant across cultures (e.g., Ekman, 1999; see criticisms by Scarantino, 2017). Surprisingly, allegedly 'basic' emotions – anger, fear, disgust, happiness, sadness, surprise – differ across taxonomic schemes (e.g., Barrett, 2017; Panksepp, 1998; Tracy & Randles, 2011). Affect – good or bad feelings about a stimulus – has been conceptualised as more basic than mental events such as thoughts, emotions, memories, and beliefs (Barrett & Bliss-Moreau, 2009). These subtleties rarely appear in other fields using affective concepts, as when emotional responses to potential danger seem important predictors of risk responses (e.g., Slovic, 1999; Slovic et al., 2002; 2004), or in a recent risk perception taxonomy including concern, worry, and fear about a given hazard in an 'affect' subscale (Walpole & Wilson, 2021).

Outcome variables associated with cultural or affective expressions have varied widely across literatures, e.g., political behaviour, child-rearing, religious beliefs. Among 'risk responses' similarly diverse concepts occur (Society for Risk Analysis, 2018), including risk perception (e.g., magnitude of perceived danger), risk aversion or risk appetite (tendency to avoid or seek danger), and risk prevention and reduction, including personal self-protective behaviours and collectively protective policies. Each element may feature multiple taxonomies: e.g., policy classifications can stress their institution (e.g., government, corporate, science), form of enactment (e.g., legislation, regulation, informal implementation by street-level bureaucrats), intended outcome (e.g., distributive, redistributive, regulatory, and constituent; Lowi, 1964), topic (e.g., monetary, health, climate change), or tools (e.g., mandate, monetary incentives, insurance), among other variants, despite challenging consistency and objectivity of classification (e.g., Smith, 2005). Survey research has been less varied than qualitative research on culture's associations with policy formulation or implementation (e.g., Johnson & Swedlow, 2021).

As such variety cannot be encompassed in a single paper, we deploy a selected subset of culture, affective, and response variables to test two models of relationships between

culture, affect, and responses. Our analysis presented here builds upon an earlier study regarding the Zika outbreak, which had very limited impact in the U.S., excluding Puerto Rico (Johnson, 2022). In this current study the focus was the COVID-19 pandemic, which affected the U.S. harder than most countries if we consider mortality per capita (the Johns Hopkins University Coronavirus Resource Center mortality per capita data as of 22 June 2024 [https://coronavirus.jhu.edu/data/mortality] placed the U.S. 14th of 192 countries).

Background

Conceptual selections

The few existing studies on culture-affect-risk response relationships emphasise a much narrower conceptual subset than the diversity outlined above. Further elaboration using other theoretical structures or empirical measures would establish boundary conditions (i.e., under which conditions does a posited association among variables hold or not) among other benefits, but the few studies to date, including this one, cannot apply more than a few variations. Listing the measures actually used in empirical studies clarifies to theorists and practitioners what conceptual tools have not (yet) been tested.

For culture, the most common variables in culture-affect-response research have been political ideology (e.g., liberal to conservative) or political partisanship (e.g., Democrat versus Republican in U.S.), unsurprising given actual or potential politicisation of many topics covered (e.g., gun control, immigration, climate change). Others focus on basic values. For example, a theory of universal values yielded 19 scales grouped into higher-order values of conservation, self-enhancement, self-transcendence, and openness to change (Schwartz et al., 2012), while another focused on basic political values of order, freedom, and care (Swedlow & Wyckoff, 2009). The third general category of 'culture' measures derives from Mary Douglas' grid/group cultural theory (e.g., Douglas & Wildavsky, 1982). This theory posits two dimensions of social relations: 'grid,' how much relations are externally prescribed, and 'group,' how much relations are restricted, which combined yield four cultural biases: hierarchism (high grid, high group), individualism (low grid, low group), egalitarianism (low grid, high group), and fatalism (high grid, low group). Beginning in 1990, empirical researchers developed scales of cultural biases based upon existing worldview measures, which eventually one research team refined into a 12-item measure and four multiple-sentence statements each representing a cultural bias (Herron & Jenkins-Smith, 2006; Jenkins-Smith & Smith, 1994). In the mid-2000s an alternative approach – also inspired by Douglas, but again based on worldview measures rather than theory – called cultural cognition theory combined an attempt to measure grid (13 items) and group (17 items) with psychological theory (e.g., Kahan et al., 2007). These cultural-theory-based measures have defects (Johnson & Swedlow, 2021; Swedlow et al., 2020) but have been used often in risk analysis. Such work has focused almost exclusively on direct effects of culture—e.g., are cultural measures correlated with risk perceptions, behavioural intentions, or policy support in cross-sectional data? – which has exhibited mixed results; the study reported here allows for longitudinal analysis of both direct cultural effects and indirect effects via affect mediators, providing a more robust assessment of cultural effects. All of these cultural measures overlap conceptually in some ways (e.g., sharing conservative/hierarchical emphases) but differ in other respects, so using multiple measures provides more robust findings.

Affect measures in these studies have primarily focused on negative feelings or emotions about the hazard; only solution aversion studies, discussed in the next section, have focused on negative feelings or emotions about a proposed behavioural or policy 'solution' to reduce risk. These have variously included risk perceptions (debated as to whether they are affective; Ferrer et al., 2016), discrete emotions and related concepts (e.g., anger, fear, disgust, worry), affect (good/bad feelings), and belief that one's values were threatened.

Finally, risk responses have included personal and collective (e.g., U.S.) risk perceptions, expected outcomes (e.g., higher temperature from climate change; people exposed to unhealthful air pollution), self-protective behavioural intentions, and policy attitudes (mostly measuring support and opposition to specific policies). Other measures included perceived economic impact of policies and judged need for national protective action.

Solution Aversion versus Affect Heuristic-Cultural Cognition Theory

Two recent models – the *Affect Heuristic-Cultural Cognition Theory* model (AH-CCT; Kahan et al., 2017) and the *Solution Aversion*-based model (SA; inspired by the 'solution aversion hypothesis'; Campbell & Kay, 2014) – explicitly addressed joint roles of culture and affect in risk responses. The AH-CCT model posits that culture shapes affective response to a hazard ('hazard affect'), which in turn influences other responses. People with negative affect about a hazard should report higher risk perceptions, more self-protective behaviour, and/or more support for risk reduction policies. The SA model, by contrast, asserts that culture shapes affective response to risk reduction options ('solution aversion'), which then influences other responses. Whether risk reduction supposedly entails a behavioural or policy change, that behaviour or policy can be deemed a 'solution.' Some people may have positive affective responses to such a proposed solution – it seems effective and feasible, or is consistent with one's values – but other people might have the opposite reaction. Those with negative affect about a potential solution should exhibit lower risk perceptions, lower intentions to enact the threatening self-protective behaviour, and less support for threatening risk reduction policies (Figure 1 and Table 1 summarise these premises).

The main difference between these models is the mediator between culture and risk responses. However, a secondary distinction concerns the sign of the path between affect

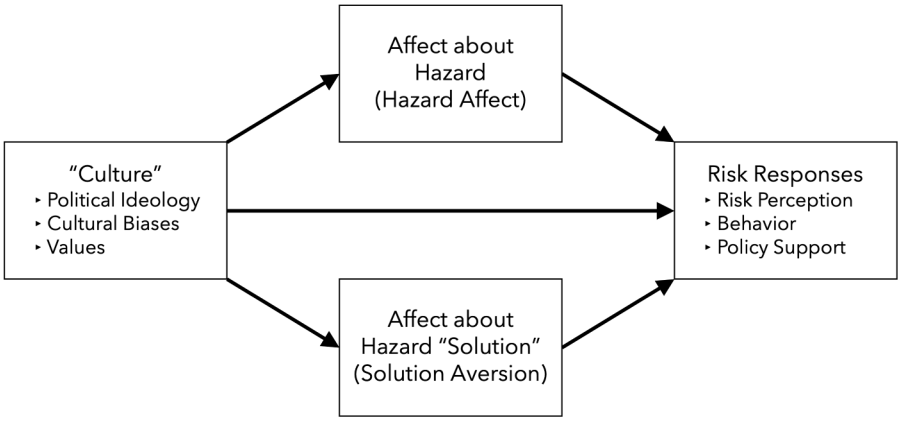

Figure 1. Summary of culture-affect-risk response relationships.

Table 1. Comparison of the solution aversion versus affect heuristic-cultural cognition theory models.

Attributes	Solution Aversion	Affect Heuristic-Cultural Cognition Theory
Origin	(Campbell & Kay, 2014)	(Kahan et al., 2017)
Central Premise	Solution Aversion: negative attitudes towards a presumed solution due to its relationship to their ideology or values will lead motivated sceptics to reduce their perception of the related hazard's risk	On politicised issues, cultural biases that frame that issue as a threat to, or evidence of, one's preferred way of life will then yield negative or positive affect towards the issue, respectively, and thus affect risk responses
Culture Measures	*Conceptual*: political ideology (liberal-conservative); social identity *Empirically*: political partisanship (Democrat-Republican); free market ideology; gun control ideology	Cultural cognition theory (Kahan, 2012): hierarchist-egalitarian (grid) and individualist-communitarian (group) scales to represent grid and group dimensions (Douglas & Wildavsky, 1982), respectively
Affect Mediators	*Conceptual*: negative affect about solution *Empirical*: e.g., beliefs about economic impact of climate change solutions; beliefs about health effects of air pollution	*Conceptual*: positive or negative affect about hazard *Empirical*: perceived health risk, concern about local hazard occurrence

and risk responses: hazard affect is presumed to increase all risk responses, while solution aversion is presumed to *decrease* risk perceptions (there is no original SA hypothesis about other risk responses).

The solution aversion (SA) hypothesis – negative affect about a presumed solution fosters lower perception of the related hazard's risk (Campbell & Kay, 2014) – conflicts with the usual hypothesis that high-risk perceptions increase hazard reduction support (e.g., Slovic, 1999), yet subsequent research largely supports it. For example, on climate change and forest management, the SA hypothesis was deemed consistent with findings of greater liberal and lower conservative support for solutions. The same study found a similar liberal-conservative split on vaccines, yet the authors deemed it inconsistent with the SA hypothesis, as no one would favour adverse vaccine reactions, and opposition stressed child safety, not government mandates (Hamilton et al., 2015). On U.S. inequality, Republicans objected to tax increases to support welfare programmes or racial reparations (Ponce de Leon et al., 2020). Conservatives discounted COVID-19's risks if governmental regulations were proposed, consistent with the original hypothesis, while liberals lowered support for vaccines' emergency use authorisations under market-oriented solutions, thus this was the first study to apply the solution aversion hypothesis to policy support (Chu et al., 2021). In a less direct test of SA effects for climate change and structural racism, moderate policy proposals equalled or bettered extreme policy proposals at evoking desired policy attitudes (Kantack & Paschall, 2022). 'Secondary risk theory,' that perceived risks of adopting a protective behaviour reduce intentions to adopt it, omits the cultural predictor, but otherwise parallels the SA model (Cummings et al., 2021).

The AH-CCT model (Kahan et al., 2017) has had only one added empirical test to our knowledge, detailed below. The Kahan et al. experiments with immigration and climate change manipulations used as a risk response only aggregate support for anti-Zika policies, although conceptually their model was more inclusive. As noted above, the Cultural Cognition Theory (CCT; e.g., Kahan, 2012) measures grid, with a hierarchical-egalitarian scale, and group, with an individualist-communitarian scale. CCT measures have been linked with risk perceptions of climate change, gun control, and nanotechnology, and with perceived scientific consensus, among other findings (e.g., Kahan et al., 2007; 2009; 2011).

Model comparisons for Zika

Johnson (2022) derived the SA model from Campbell and Kay's (2014) work, then used existing U.S. data on Zika responses for the first comparison of the two models. Six measures of culture listed earlier were tested: political ideology; basic political values (order, freedom, caring; Swedlow & Wyckoff, 2009); summary universal values scales (Schwartz et al., 2012); and three cultural-theory measures: 30 items for CCT grid-group scales (Kahan, 2012); 12 items of cultural bias indices (Jenkins-Smith & Smith, 1004); and four multiple-sentence cultural bias statements (Herron & Jenkins-Smith, 2006). The first two measures, most strongly associated with Zika-related candidate affective mediators, were culture variables in model testing. Tested affective mediators for hazard affect included concern and dread about Zika, belief that the Zika outbreak was a near-disaster (3 items), and judged likelihood of a large U.S. outbreak; SA mediators included how much a policy option evoked negative emotions (anger, fear, disgust), good/bad feelings, and belief that this option threatened one's values. An index of concern, dread, near-disaster, and likelihood (hazard affect) and value threat (solution aversion) were the model mediators most strongly associated with candidate risk responses. The latter included personal and collective (U.S.) risk perceptions, support of nine separate policies (versus the aggregate scale of support for six policies in Kahan et al., 2017), and perceived need for U.S. action against Zika (Placer & Delquié, 1999). Inclusion of both risk perceptions (Campbell & Kay, 2014) and policy support (Kahan et al., 2017) preceded the same mix in later testing of SA-only effects (Chu et al., 2021). Johnson (2022) thus first tested both models, while testing more potential measures of each variable than had been the case in previous studies.

Johnson (2022) found (1) direct effects of culture on risk response were few and generally weak; (2) affect usually, but not always, mediated associations between cultural measures and risk responses; (3) mediation of policy support generally exceeded mediation of risk perception; (4) hazard affect mediated risk perception more than solution aversion; and (5) solution aversion mediated policy support more than hazard affect. This study concluded that both models fit with (different subsets of) the data, while including both risk perceptions and policy preferences highlighted that these two kinds of risk responses had some cultural and affective factors in common, while others were unique to one type. However, results might have differed if Zika's objective threat on the mainland U.S. had been higher; the cross-sectional analyses limited causal generalisation; and as this comparison was not foreseen when designing the longitudinal study, model measures elicited weeks or months apart might have dampened observed effects.

Current study

Besides testing the generalisability of the Zika findings (Johnson, 2022) to the COVID-19 pandemic, different results may arise from a more severe hazard, which politicised Americans' risk responses in ways Zika did not. These data also expanded risk responses to self-protective behaviour.

This longitudinal panel survey of Americans entailed six waves of surveys – about two months apart over 14 months, from February 2020 (<50 confirmed SARS-CoV-2 infections in the U.S.) to April 2021, with COVID-19 vaccines available to the general public for a few months – in which the same people were polled in each wave, allowing granular assessment of changes in their views over this extended time. We collected all but two salient measures in each of six waves (excepting political ideology, Wave 1 only, and solution aversion for protective behaviours, unmeasured in Waves 1–3). This avoided potential underestimation of associations from combining measures from different waves, as in Johnson (2022). Longitudinal mediation analysis allowed for stronger causal inferences than Johnson (2022)'s cross-sectional analyses, controlling for cross-wave associations of all variables. Our analysis emphasises data from Waves 1, 2, 5 and 6, featuring culture measures.

We examined hypotheses from the original models:

Hypothesis 1. Hazard affect increases risk responses (AH-CCT model).

Hypothesis 2. Solution value threat decreases risk perceptions (SA hypothesis).

As Campbell and Kay (2014) emphasised risk perception effects, a research question is:

Research Question 1. How does value threat, a measure of negative affect towards a potential solution to the hazard, shape behavioural intentions/actions or policy support?

Hypothesis 3. Affect mediates associations between culture and risk responses, as presumed by both models and by Johnson (2022). Statistically significant indirect effects mediated by affect between cultural and risk response variables can occur in the absence of direct effects of culture (Hayes, 2018).

We also further probed differences between the models. Johnson (2022) found that solution aversion more strongly affected overall Zika risk responses, particularly policy support, while hazard affect more strongly affected risk perception. These findings might reflect the conceptual proximity of mediators and risk responses: hazard affect is often a risk perception measure, even when factoring separately (e.g., Johnson & Kim, 2023; Walpole & Wilson, 2021), and policy support would be plausibly affected by whether someone feels that policy threatens their values. Yet the expected stronger risk responses to the COVID-19 pandemic and our more rigorous longitudinal mediation analysis might alter these associations, which also might not extend to models' behavioural impacts, first explored here. This led us to ask

Research Question 2. Do hazard affect and solution aversion have different magnitude effects on risk perceptions, behaviour, or policy support?

Finally, we examine differential effects of culture by risk response. Marris et al. (1998) suggested that cultural measures should correlate more with policy support than risk perceptions, as cultural theory emphasises preferences for ways of life (Douglas & Wildavsky, 1982). Policies—e.g., indoor COVID-19 masking mandates – seem likely to exemplify ways of life as public expressions of appropriate behaviour, while risk perceptions may not be expressed publicly, and behaviour may not be observable (e.g., in-home). Thus we asked

Research Question 3. Does culture have divergent effects on risk perceptions, behaviour, or policy support?

Methods

Sampling

A six-wave longitudinal panel study of Americans surveyed the Prolific online panel ($N_1 = 2{,}004$, $N_2 = 1{,}613$, $N_3 = 1{,}184$, $N_4 = 1{,}026$, $N_5 = 866$, $N_6 = 1{,}019$). Surveys occurred over 14 months: February 28–29, 2020 (Wave 1), April 27-6 May 2020 (Wave 2), August 5–13, 2020 (Wave 3), October 12–21, 2020 (Wave 4), January 22-11 February 2021 (Wave 5), and March 25-13 April 2021 (Wave 6). To control for attention, all analyses omitted respondents claiming vaccination in Waves 1–4, when vaccines were unavailable excluding clinical trial participants (none of our respondents). This study was labelled exempt (no more than minimal risk to participants) by the Decision Research Institutional Review Board (IRB). Participant consent was obtained with the panel's privacy and participation agreement.

Using 2020 U.S. Census estimates (Decennial Census for gender, age, and ethnicity; American Community Survey data for education), half of Wave 1 respondents were female (49.6% versus 51.5% of adults in the Census), most were non-Hispanic white (72.1% versus 57.8% of total population), relatively young (median 32.0, versus 38.8 for total population; 3.7% versus 21.6% 65+ among adults) and highly educated (54.7% bachelor's degree or higher versus 32.9% among Americans 25+). Household income was <$100,000 for 81.6% of the sample and <$15,000 for 10.8 percent. Half (49.6%) of the sample were Democrats, 15.4% Republican, and 34.9% independent or undeclared political partisans. Two-thirds (61.4%) were liberal, 19.6 percent conservative.

We compared demographic and mediation-analysis variables (culture, affect, risk responses) for those dropping out at some point ($n = 1{,}241$, including 271 who returned in Wave 6 when all Wave 1 respondents were re-invited) to those finishing all surveys ($n = 764$; 38.1%). There were few and weak substantive differences, which we interpreted as meaning that attrition was unlikely to have influenced current results.

Measures

Measures appear in Table 2, a more limited set than those in Johnson (2022). This narrowed focus stems from these earlier findings (e.g., solution aversion operationalised as self-report that the policy threatened one's values ['value threat'] was a more

Table 2. Measures.

Measure	Scale	Source
Cultural Predictors		
Political ideology: 'Here is a 7-point scale on which the political views that people might hold are arranged from extremely liberal to extremely conservative. Where would you place yourself on this scale?'	1 *extremely liberal*, 7 *extremely conservative*	Johnson and Mayorga (2021)
Hierarchist (ω = .76, .75, .77) 'Society would be much better off if the people in charge imposed strict and swift punishment on those who break the rules''Society is in trouble because people do not obey those in authority' 'The best way to get ahead in life is to work hard to do what you are told to do'	1 *strongly disagree*, 6 *strongly agree*	Jones (2011)
Individualist (ω = .80, .80, .81) 'We are all better off when we compete as individuals' 'Even the disadvantaged should have to make their own way in the world' 'Even if some people are at a disadvantage, it is best for society to let people succeed or fail on their own'	Same	Same
Egalitarian (ω = .86, .87, .88) 'Society works best if power is shared equally' 'What society needs is a fairness revolution to make the distribution of goods more equal' 'It is our responsibility to reduce differences in income between the rich and the poor'	Same	Same
Fatalist (ω = .59, .67, .63) 'No matter how hard we try, the course of our lives is largely determined by forces beyond our control' 'It would be pointless to make serious plans in such an uncertain world' 'The most important things that take place in life happen by chance'	Same	Same
Mediators		
Hazard affect: dread ('Where "dread" means to be in terror of, or fear intensely, how much do you dread the coronavirus?')	1 *no dread*, 6 *very high dread*	Johnson and Mayorga (2021)
Value threat (regarding behaviour/policy aversion): e.g., 'This [behaviour/option] ___ my values'	1 *strongly opposes*, 4 *neither supports nor opposes*, 7 *strongly supports* (reversed for analysis)	Johnson (2022)

(*continued*)

Table 2. (*Continued*).

Measure	Scale	Source
Outcomes		
Risk Perception		
Personal, no action: 'How much risk does the coronavirus pose to you or your family, if you or your family don't do anything new to protect yourself against the coronavirus?'	1 *no risk*, 6 *very high risk*	Adapted from Brewer et al. (2004)
Collective: aggregates U.S. ('How much risk does the coronavirus pose to the U.S.?') and global ('How much risk does the coronavirus pose to the world?')	Same	Marris et al. (1998)
Severity: aggregates infection ('About how many people in the U.S. do you think will become infected in this outbreak?') and death ('About how many people in the U.S. do you think will die from the coronavirus in this outbreak?') expectations	Infection (1 *less than 10,000*, 6 *100 million or more*); deaths (1 *less than 100*, 7 *10 million or more*)	
Behavioural Response and Policy Support		
Behavioural response: 'My household . . . '	1 *has never considered taking this action*, 2 *is considering it*, 3 *decided against taking this action*, 4 *decided to take this action*, 5 *has taken this action*, 6 *has taken this action and will continue to take this action as needed*	Johnson and Mayorga (2021)
Policy support: 'I would ___ the government adopting this option'	1 *strongly oppose*, 4 *neither support nor oppose*, 7 *strongly support*	Johnson and Mayorga (2021)

McDonald's omega (ω) is reported as the measure of reliability for the cultural bias subscales for Waves 2, 5 and 6 in order.

parsimonious and effective mediator than other policy-option evaluative items), other comparisons (e.g., cultural theory measures used here factor better than cultural cognition theory measures underlying the AH-CCT model; Johnson et al., 2020), and the need for brevity. The value threat operationalisation of solution aversion occurred for policies in all six waves, and for behaviours in the last three waves.

For 'risk perception' we used measures of collective risk (combining U.S. and global risk perceptions), national severity (combining respondent-expected U.S. infections and deaths by outbreak end), and expected personal risk if one takes no further action to protect oneself (see Brewer et al., 2004 on need for conditional risk perception phrasing). Our three measures of affective risk perceptions (dread, concern, good-bad feelings) were excluded from risk responses as we used dread to measure affect towards the hazard.

For both behavioural responses and policy support we included three protective actions: mask wearing, avoiding large public gatherings, and intention to vaccinate

once COVID-19 vaccines are available. Although the survey included other options (e.g., self-isolation at home; avoiding travel to infected areas), this focus allowed brevity while comparing behaviours to parallel policies for actions which became politicised in U.S. COVID-19 responses. For an ordinal measure of behavioural responses, we omitted respondents who reported being *against* enacting the behaviour.

Analysis

For the longitudinal mediation analysis (LMA) we used the *lavaan* package in R software (Rosseel, 2012), controlling for longitudinal measurements of predictors, mediators, and outcome variables, improving on correlational wave-specific analyses (e.g., Maxwell & Delaney, 2004; Plewis, 1985).

We conducted 45 LMAs, fitting nine models each for political ideology, hierarchism, individualism, egalitarianism, and fatalism. We did not estimate nine models with all five culture measures as predictors in each model, given difficulty interpreting what any variable (e.g., ideology) represents once one partials out its associations with the other four predictors. The nine models for each predictor differed by the outcome variable: three models each for risk perceptions (personal; collective; perceived severity), behaviour (mask wearing; avoiding public gatherings; vaccination intentions), and policy support (mandatory mask wearing; public-gathering bans; mandatory vaccinations). All 45 models had two mediators: (1) dread, operationalising 'hazard affect,' and (2) belief that a given behaviour or policy threatened one's values, operationalising 'solution aversion'. We used only one hazard affect measure here, given the limitations of alternatives. Concern about coronavirus infections coming to one's locality might have been deemed unstable given the pandemic's spread throughout the U.S., although longitudinal mediation analyses can control for such temporal variations and after an increase between Waves 1 and 2, concern exhibited no substantive change. Good or bad feelings (psychologists' 'affect') about the coronavirus failed to factor with dread and concern, thus we did not include it here (Johnson & Kim, 2023). Although use of a single item might increase measurement error, the value threat measure out-performed multi-item alternatives (Johnson, 2022). As risk perception measures did not entail a specific behaviour or policy, we used a latent factor comprising shared variance among the three behavioural-response and three policy-support solution aversion responses as the solution aversion mediator for risk-perception models.

Figures 2–4 provide examples of six models to clarify the longitudinal mediation analyses, with predictors measured in Waves 1 or 2 (labelled A for political ideology; B for the hierarchism cultural bias), mediators from Wave 5 responses, and risk response measured with Wave 6 answers. Figures 2(a,b) exemplify risk perception models with the personal item. Political ideology's measurement only in Wave 1 precluded its predictive use in Waves 5–6. As solution aversion for behavioural responses was unassessed until Wave 4, the SA latent variable for risk perceptions (which includes behavioural solution aversion variables as indicators) was absent from Waves 1–2 analyses.

Figures 3(a,b) exemplify with vaccine intentions the two behavioural models. The solution aversion variable is no longer a latent variable (as in Figure 2's risk perception examples), as now it is a manifest variable assessing solution aversion to a specific behaviour (vaccinating).

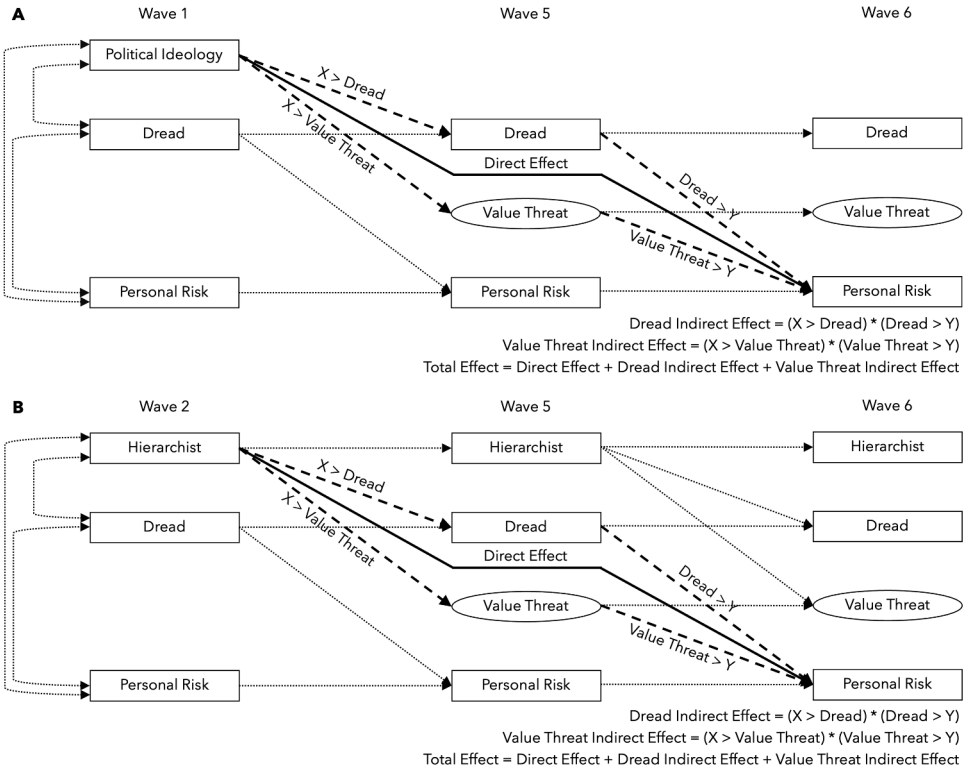

Figure 2. **Overview of longitudinal mediation models: risk perceptions**. Predictors are (a) political ideology and (b) cultural (hierarchist) bias. Personal risk perception is the risk response example. Solid lines indicate direct effects of the predictor on risk response; dashed lines indicate paths for indirect effects via dread and value threat mediators. Dotted lines indicate non-mediation paths controlling for associations between predictors, mediators, and/or risk responses both within and between waves. Correlated residuals among wave 5 variables and among wave 6 variables were estimated but omitted from the figure for legibility.

Finally, Figures 4(a,b) exemplify with support for vaccine mandates the two policy support models; unlike behavioural responses, policy support outcomes were assessed from Wave 1.

Indirect (mediated) effects were calculated using a product of coefficients approach: paths between predictors in Waves 1 or 2 and mediators at Wave 5 were multiplied by paths between mediators (Wave 5) and outcome variables at Wave 6. Direct effects represent paths between predictors and outcome variables after accounting for indirect effects. Total effects sum direct and indirect effects. We excluded covariates as these were lacking a theoretical basis. All analyses included 10,000 bootstrap samples.

Findings

Given the number of analyses we ran, we summarise most results in Table 2 (visual examples in Figures 5–7), with detailed tables of longitudinal mediation analyses in the Supporting Information.

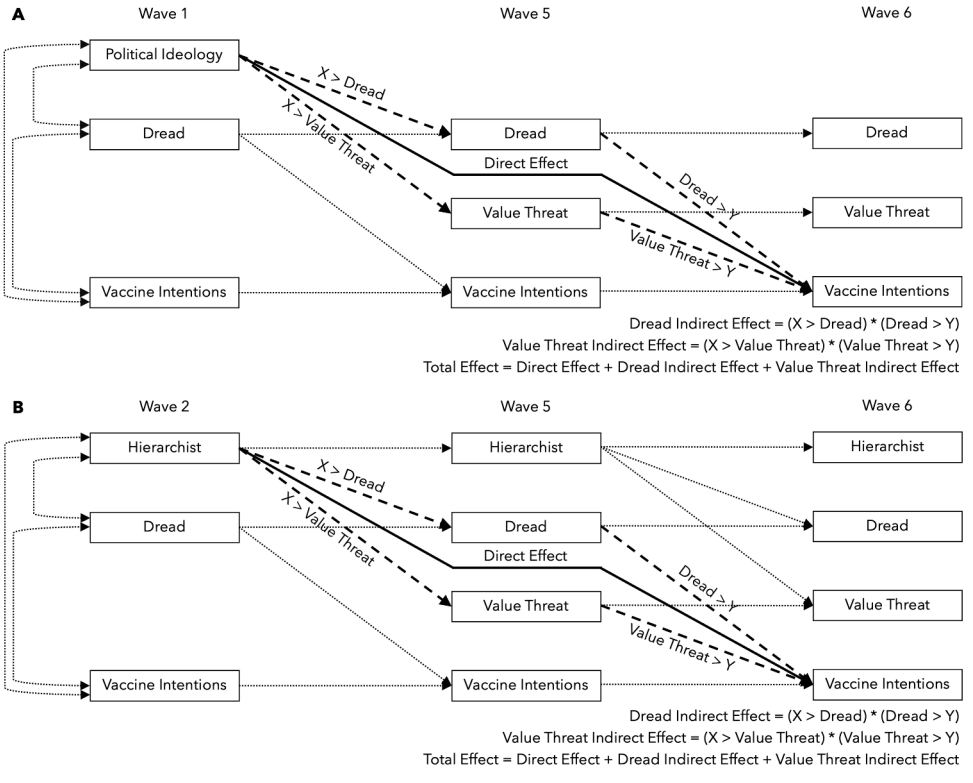

Figure 3. **Overview of longitudinal mediation models: behaviour and behavioural intentions**. Predictors are (a) political ideology and (b) cultural (hierarchist) bias. Vaccination is the risk response example. Solid lines indicate direct effects of the predictor on risk response; dashed lines indicate paths for indirect effects via dread and value threat mediators. Dotted lines indicate non-mediation paths controlling for associations between predictors, mediators, and/or risk responses both within and between waves. Correlated residuals among wave 5 variables and among wave 6 variables were estimated but omitted from the figure for legibility.

Risk perceptions

Table 3 shows explained variance (R^2) for risk perceptions exhibited at least medium effect sizes (≥.25), with strong effects (≥.64) for collective risk perceptions (thresholds from Ferguson, 2009). Hazard affect was higher for egalitarians for all three risk perceptions, lower for conservatives for personal and severity risk perceptions, and lower for individualists for severity. Conservatives and individualists saw higher value threat, and egalitarians lower value threat, for all three perceptions. The effect of hazard affect on personal and collective risk perceptions was positive, consistent with Hypothesis 1, with no significant effect for severity. On Hypothesis 2, the pattern was identical but reversed, as expected: value threat reduced personal and collective risk perceptions, without an effect on severity perceptions. Equal-magnitude effects of hazard affect and solution aversion on risk perceptions partly address our Research Question 2 by indicating there were no differences in magnitude in these mediators' effects on this type of risk response. For Hypothesis 3, indirect effects via hazard affect were statistically significant at $p < .05$ for 3 of 15 risk perception analyses, and via solution value threat for 6 of 15, with none significant for severity. Only egalitarian cultural bias had

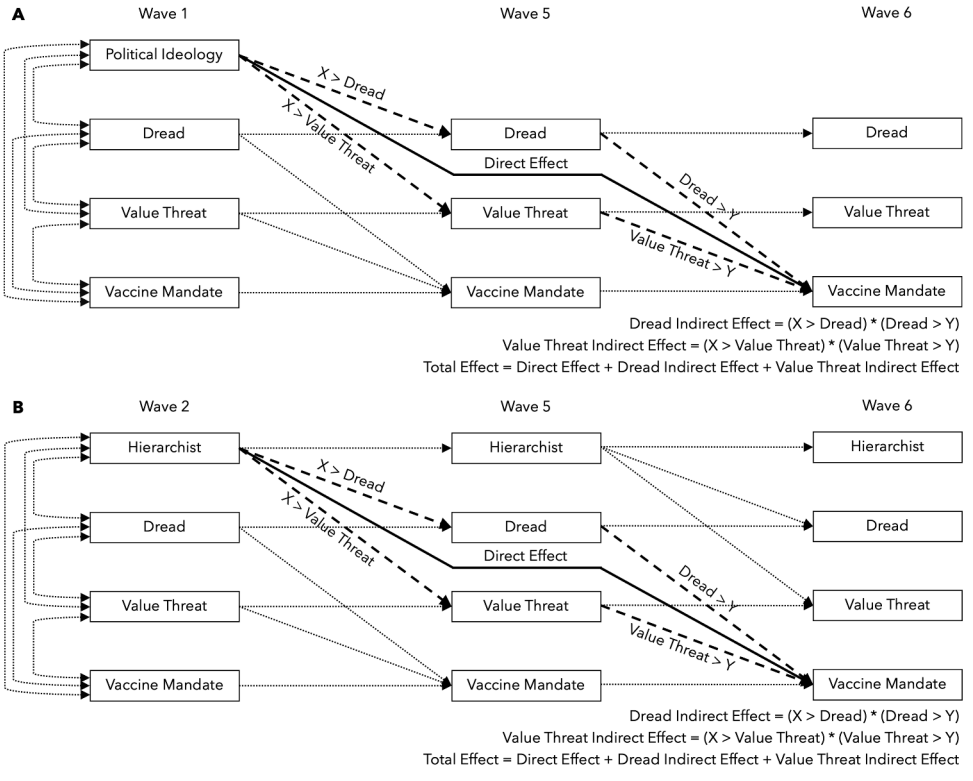

Figure 4. **Overview of longitudinal mediation models: policy support**. Predictors are (a) political ideology and (b) cultural (hierarchist) bias. Support for a hypothetical vaccination mandate policy is the risk response example. Solid lines indicate direct effects of the predictor on risk response; dashed lines indicate paths for indirect effects via dread and value threat mediators. Dotted lines indicate non-mediation paths controlling for associations between predictors, mediators, and/or risk responses both within and between waves. Correlated residuals among wave 5 variables and among wave 6 variables were estimated but omitted from the figure for legibility.

a significant direct effect on collective risk perceptions. Only 5 of 15 mediation analyses had statistically significant differences in the size of indirect effects via the two mediators, all indicating stronger effects for value threat.

Behavioural responses

Explained variance for all three behaviours exhibited medium effects (>.25), substantially weaker than for risk perceptions. Hazard affect was lower for conservatives, and higher for egalitarians, for all three behaviours. Conservatives and individualists saw higher value threat, and egalitarians lower value threat, for all behaviours. The effect of hazard affect on avoiding public gatherings and vaccination was positive, consistent with Hypothesis 1, with no significant effect for mask wearing. All three behaviours were negatively associated with value threat, addressing Research Question 1 about value threat's effect on behaviour. These correlations were substantively greater than for hazard affect, addressing Research Question 2 about differences in the magnitude of effects across the two mediators for behaviour. For Hypothesis 3, indirect effects via hazard

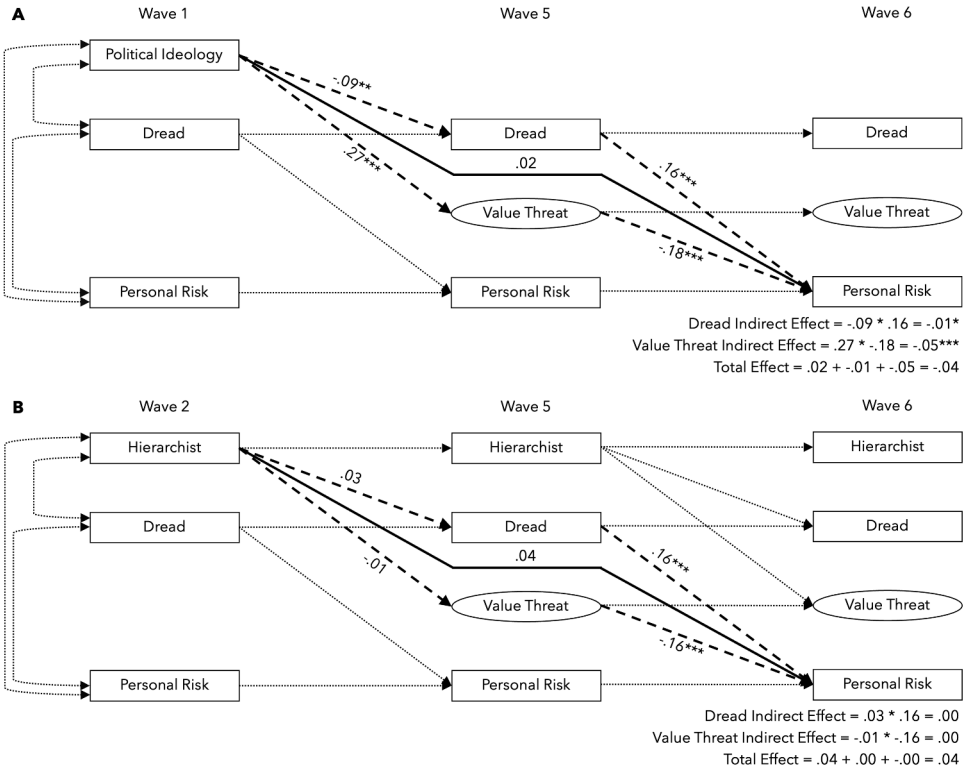

Figure 5. **Example of longitudinal mediation results: personal risk perceptions**. Predictors are (a) political ideology and (b) cultural (hierarchist) bias. Solid lines indicate direct effects of the predictor on risk perception; dashed lines indicate paths for indirect effects via dread and value threat mediators. Dotted lines indicate non-mediation paths controlling for associations between predictors, mediators, and/or risk responses both within and between waves. Correlated residuals among wave 5 variables and among wave 6 variables were estimated but omitted from the figure for legibility.

affect were statistically significant at $p < .05$ for 3 of 15 behavioural analyses, and via solution value threat for 9 of 15; no indirect effects via hazard affect were significant for mask-wearing. Direct effects occurred only for avoiding public gatherings, which were lower for individualists and higher for egalitarians. Only 7 of 15 mediation analyses had statistically significant differences in the size of the indirect effects via the two mediators, all with stronger effects for value threat.

Policy support

Explained variance for support of all policies exhibited strong effects (>.64; Ferguson, 2009), excluding the public-gatherings ban, for which the effect size was just below this threshold. Hazard affect was higher for egalitarians for all three policies, and lower for conservatives and individualists for mandatory vaccination policy. Both egalitarians and hierarchists saw lower value threat, for different policies (mask wearing and public gatherings, respectively), without significant associations between cultural measures and support for mandatory vaccination.

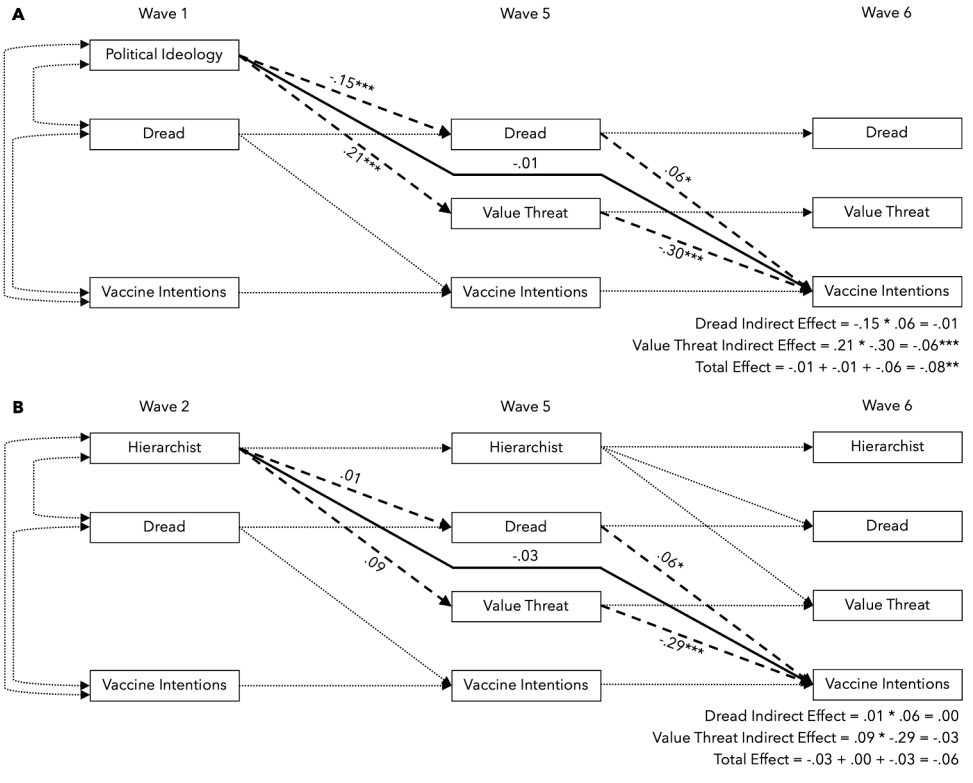

Figure 6. **Example of longitudinal mediation results: vaccination behaviour and behavioural intentions**. Predictors are (a) political ideology and (b) cultural (hierarchist) bias. Solid lines indicate direct effects of the predictor on vaccination; dashed lines indicate paths for indirect effects via dread and value threat mediators. Dotted lines indicate non-mediation paths controlling for associations between predictors, mediators, and/or risk responses both within and between waves. Correlated residuals among wave 5 variables and among wave 6 variables were estimated but omitted from the figure for legibility.

The effect of hazard affect on mask and vaccination policy support was positive, consistent with Hypothesis 1, with no significant effect for attitudes about policy on public gatherings. Value threat reduced support for all three mandates, consistent with Hypothesis 2. Value threat had substantially more association with policy support than did hazard affect, partly addressing Research Questions 1–2, by showing that value threat did affect policy support and had a stronger effect than hazard affect. Value threat's advantage over the other mediator was much greater for policy support than for behaviour. For Hypothesis 3, indirect effects via hazard affect were statistically significant at $p < .05$ for 2 of the 15 policy analyses, and via value threat for 1 of 15. None of the indirect effects via hazard affect were significant for mask-wearing or public gatherings, or for solution value threat for public gathering or vaccination policy. Only the egalitarian cultural bias had a significant direct effect on support for all three policies. None of the 15 mediation analyses for policy support had statistically significant differences in indirect effect sizes via the two mediators.

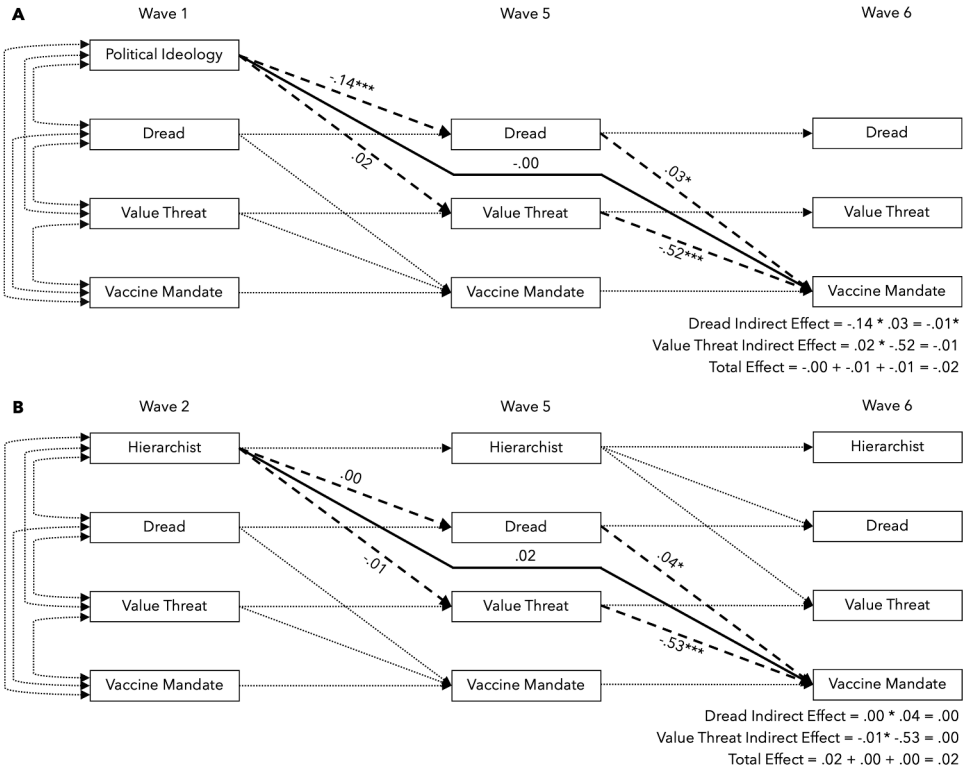

Figure 7. **Example of longitudinal mediation results: vaccination mandate policy support**. Predictors are (a) political ideology and (b) cultural (hierarchist) bias. Solid lines indicate direct effects of the predictor on policy support; dashed lines indicate paths for indirect effects via dread and value threat mediators. Dotted lines indicate non-mediation paths controlling for associations between predictors, mediators, and/or risk responses both within and between waves. Correlated residuals among wave 5 variables and among wave 6 variables were estimated but omitted from the figure for legibility.

Discussion

To summarise our findings, variance explained by these longitudinal mediation models had medium effect sizes for behaviours, and medium-to-strong effect sizes for risk perceptions and policy support. Hypotheses 1–2 and Research Question 1—regarding hazard affect increasing, and solution affect decreasing, risk responses – were mostly supported, apart from measures of severity risk perceptions (neither affect type had significant effects), mask wearing behaviour, and a policy banning gatherings (no significant effect for hazard affect for the latter two). We answer Research Question 1, about value threat's effect on behaviour and policy support, by saying that these risk responses decrease when people think a protective behaviour or policy threatens their values, rather than just having risk perceptions decrease under value threat as originally hypothesised (Campbell & Kay, 2014).

By contrast, there was mixed evidence for Hypothesis 3, about affect mediating culture-risk response relationships, and for Research Question 2, about relative effects of hazard affect and solution aversion. For Hypothesis 3, longitudinally mediated indirect effects for culture-risk response associations were consistent at $p < .05$ with the

Table 3. Summary of longitudinal mediation analysis results.

Risk Perceptions	R^2	*X > Hazard Affect*	*X > Value Threat*	*Hazard Affect > Y*	*Value Threat > Y*	*Direct Effect*	*Indirect Value Threat Effect Stronger*
Personal	.49, .53	Conservatives lower, egalitarians higher	Conservatives & individualists higher, egalitarians lower	All significantly positive (.16)	All significantly negative (−.15, −.18)	ns	3 of 5 (others ns)
Collective	.66, .70	Egalitarians higher	Conservatives & individualists higher, egalitarians lower	All significantly positive (.09, .10)	All significantly negative (−.09, −.13)	Egalitarians higher	2 of 5 (others ns)
Severity	.29, .31	Conservatives & individualists lower, egalitarians higher	Conservatives & individualists higher, egalitarians lower	ns	ns	ns	ns
Behaviours							
Mask Wearing	.29, .32	Conservatives lower, egalitarians higher	Conservatives & individualists higher, egalitarians lower	ns	All significantly negative (−.05, −.06)	ns	2 of 5 (others ns)
Avoiding Public Gatherings	.35, .42	Conservatives lower, egalitarians higher	Conservatives & individualists higher, egalitarians lower	All significantly positive (.05, .06)	All significantly negative (−.13, −.15)	Individualists lower, egalitarians higher	2 of 5 (others ns)
Vaccination	.35, .38	Conservatives lower, egalitarians higher	Conservatives & individualists higher, egalitarians lower	All significantly positive (.06)	All significantly negative (−.27, −.30)	ns	3 of 5 (others ns)

(*continued*)

Table 3. (*Continued*).

Risk Perceptions	R^2	*X > Hazard Affect*	*X > Value Threat*	*Hazard Affect > Y*	*Value Threat > Y*	*Direct Effect*	*Indirect Value Threat Effect Stronger*
Policy Support							
Mask Wearing	.70, .72	Egalitarians higher	Egalitarians lower	All significantly positive (.04)	All significantly negative (−.48, −.52)	Egalitarians higher	ns
Avoiding Public Gatherings	.60, .63	Egalitarians higher	Hierarchists lower	ns	All significantly negative (−.32, −.36)	Egalitarians higher	ns
Vaccination	.70, .71	Conservatives & individualists lower, egalitarians higher	ns	All significantly positive (.03, .04)	All significantly negative (−.52, −.53)	Egalitarians higher	ns

X = culture measure (political ideology; hierarchist, individualist, egalitarian, and fatalist cultural biases). Y = outcome (risk perceptions, behaviour, policy support). ns = non-significant at $p < .05$. Commas separate low and high associations. Analyses exclude missing data and wrong W1–4 vaccination intention responses (see text).

hypothesis in 24 (26.7%) of the 90 tests (5 predictors X 9 outcomes X 2 mediators). The mediation hypothesis was less supported for the hazard affect mediator (8 of 45, 17.8%) than for the solution affect mediator (16 of 45, 35.6%), yet even the latter significantly mediates only a third of the relationships we tested. This gap is partly explained by differences across risk responses: while hazard affect's mediation varied little (2–3 significant of 15 for each risk response type), 9 of 15 (60%) solution-aversion analyses exhibited significant indirect effects for behaviour, 6 of 15 (40%) for risk perceptions, and only 1 of 15 (6.7%) for policy support. For Research Question 2, the effects of affect measures did not differ in magnitude for risk perceptions. However, we found that solution aversion had substantially greater effects than hazard affect for behaviour and (particularly) policy support.

For Research Question 3, about culture's effects on different risk responses, we found that these indeed varied widely by measure. Direct effects on risk responses occurred for egalitarianism (5 of 9 analyses) and individualism (1 of 9), but not at all for political ideology, hierarchism, or fatalism. Egalitarianism (16 of 18), political conservativism (12 of 18), individualism (8 of 18), and hierarchism (1 of 18) had significant direct effects on mediators, but fatalism had none. Another main explanation of the limited proportion of mediation effects is that fatalism and hierarchism were only rarely associated with the mediators. Focusing only on the three partly mediated cultural measures – political ideology, egalitarianism, individualism—24 of 54 (44.4%) analyses exhibited affect mediation (H3), an improvement but still not most analyses.

Implications

Before we detail specific implications, we need to address the general 'so what?' question. We should care about these findings because the bulk of culture-risk response studies have entailed cross-sectional analyses of direct effects of culture, which have limited value for assessing either causality or effect size (e.g., Brewer et al., 2004; Johnson & Swedlow, 2021). By embedding both culture and another (hypothesised) critical factor – affect – in risk responses as a mediator, within a longitudinal mediation analysis, we have provided a more robust analysis of both factors' effects on risk response, providing an initial basis for identifying boundary conditions for their effects. This is only a first step, but we hope this approach will inspire other researchers to use more robust research designs and other competing explanations for risk responses, while also using more sophisticated analytic schemes than (e.g.) multiple regression models, which have weaknesses (e.g., common variance obscuring relative impacts of different 'causal' variables).

Our findings broaden the solution-aversion hypothesis, in which a proposed problem 'solution' which threatens one's values lowers risk perceptions (Campbell & Kay, 2014). In our findings, solution aversion decreased risk perceptions regardless of cultural predictor (including egalitarians, besides hierarchists and individualists). We also confirmed that solution aversion decreases COVID-19 policy support (Chu et al., 2021). We also show for the first time that solution aversion, shaped by cultural biases, also decreases protective behaviour, adding Campbell and Kay's (2014) cultural explanation to the Cummings et al. (2021) claim that solution aversion reduces protective behaviour. Thus, we have helped establish that solution aversion can affect diverse risk responses beyond risk perceptions. Simultaneously, the failure of solution aversion to significantly alter severity risk perceptions (here, respondent estimates of how many Americans would

get infected by or die from the coronavirus), despite decreasing personal and collective risk perceptions, reveals our ignorance of the boundary conditions for this association. Further research is needed here.

The AH-CCT model (Kahan et al., 2017) conceptually predicted effects on diverse risk responses, despite empirically including only policy support, so Johnson's (2022) findings that hazard affect increased risk perceptions, and here that it increased all three risk response types, were not unexpected. We also showed that the cultural cognition theory grid-group measures are not essential to find such indirect effects. Yet severity risk perceptions, mask wearing behaviour, and support for a policy banning large public gatherings failed to exhibit this positive relationship, raising vital questions, once again, about boundary conditions.

Probing boundary conditions for both hazard affect and solution aversion requires probing differences across and within risk responses. Despite acknowledgement that different risk perception measures may factor separately (e.g., Ferrer et al., 2016; Johnson & Kim, 2023; Walpole & Wilson, 2021), researchers rarely use multiple risk perception measures in one study to identify boundary conditions. Thus unexpected findings—e.g., collective and affective risk perception measures, in that order, far outweighed personal risk perception in longitudinally predicting COVID-19 protective behaviour and policy support (Johnson & Kim, 2023) – will be less likely. Similarly, common practice in natural hazards and other research to sum the number of enacted 'hazard adjustments' to measure protective behaviour hinders our grasp of how patterns of association with predictors (including but not limited to affect) might vary across actions (e.g., Johnson, 2019).

The affect-as-mediator assumption underlying both models appeared in only a quarter of analyses here, but rejection of this assumption would be premature given the few affect-mediation studies so far, and the high importance of affect in risk responses (e.g., Slovic, 1999). Yet we should address potential reasons for this low proportion of expected associations. Aside from assuming that (1) affect mediation is wrong, these findings for this COVID-19 dataset may reflect that (2) solution aversion is a much stronger mediator than hazard affect and stronger for behaviour than risk perceptions, and least for policy support,[1] while (3) some cultural predictors were consistently associated with indirect effects (e.g., egalitarianism), with others never or rarely (fatalism; hierarchism). Further, (4) scholars posit multiple factors in behavioural intentions (e.g., threat perceptions, including non-affect measures, action perceptions, and stakeholder perceptions in the Protective Action Decision Model; Lindell & Perry, 2012). While multi-factorial arguments underline the potentially small contribution of affect alone, they also underline that *no* single factor, affect or otherwise, necessarily contributes much to risk responses. By concentrating on affect – particularly its divergent targets – creators of the solution aversion hypothesis and the AH-CCT model did not exclude other associations. Our design – effects of Waves 1–2 cultural measures on Wave 6 risk responses mediated by Wave 5 affect measures – might attenuate indirect effects that were possibly stronger within a particular wave, but cross-sectional designs have their own drawbacks (e.g., Brewer et al., 2004).

Collectively these four potential explanations favour future research continuing to test affect-mediation hypotheses, using multiple measures of both cultural stances and risk responses to probe how and why they might indicate boundary conditions for this mediation, and (possibly) to include other parallel mediators to

test their effect relative to affect. Our Introduction and Background made clear that a far vaster array of options for measuring culture and responses (including but not limited to policy preferences), with less untapped diversity in affective measures, remains to be tested in these and other models. Using other measures of culture, affect or responses might yield stronger or weaker support for the models, clarifying when they do and do not apply. As only the second comparison of these two models, and the first to focus on a major hazard for most of the respondents, this study makes a substantial contribution, but is only the beginning for elucidating the relative influence of cultural and affective factors in risk responses.

Statistically significant direct and indirect effects of cultural measures clustered in the egalitarian, politically conservative, and individualist models, in that order, with expected associations. Political conservatism in the U.S. is usually associated with both hierarchist and individualist biases (Swedlow et al., 2020), but hierarchism's general lack of statistically significant effects here might reflect a COVID-19-related tension for hierarchists between respect for governmental authority and (public health) expertise, and concern for economic and other disorder effects of shutdowns and other policies. This distinction between the politically conservative cultural biases might also reflect U.S. hierarchists' (usually) lesser political conservatism versus individualists (e.g., greater global warming risk perception *and* greater COVID-19 concern; Swedlow & Yuan, 2022), while low support for strict government measures against COVID-19 (solution aversion) occurred among Americans espousing libertarian and anti-egalitarian views (Peng, 2022).

Finally, the few affective mediation studies to date – on climate change and gun control (Campbell & Kay, 2014), Zika (Johnson, 2022; Kahan et al., 2017), and COVID-19 (here; Chu et al., 2021) – leave unanswered whether diverse findings reflect differences in the nature of the hazard (e.g., COVID-19 as more fatal and infectious than Zika), or its magnitude (e.g., Zika incidence far less severe on the U.S. mainland than in Puerto Rico or in Latin America; COVID-19's greater public health impact in the U.S. than in most wealthy nations). More comparative tests across hazards and events are needed.

Study limitations

Causal inferences must be interpreted with caution, despite longitudinal mediation analyses here sharply reducing the drawbacks in non-experimental evidence (experiments–e.g., Campbell & Kay, 2014; Kahan et al., 2017—also have causality weaknesses). Our online opportunity sample's higher education levels, and a skew towards liberal ideology, may have obscured some modelled relationships. All affect-mediation papers cited earlier, and this study, used U.S. samples only, limiting generalisation to other populations. Although left–right ideology and cultural bias measures are not necessarily invalid elsewhere, this cannot be assumed (e.g., a study found only partial overlap in mediation tests of cultural effects on behaviour and policy support via government trust and risk perception for COVID-19 in China and U.S.; Yuan et al., 2024).

Conclusions

Our longitudinal mediation analyses compared two models' application to COVID-19 risk responses: the AH-CCT model, featuring negative affect about the hazard, and the SA model, featuring negative affect (aversion) towards specific policies. Both affect

types accounted for associations of political ideology and cultural biases with risk perception, behaviour, and policy support, but culture was particularly important for behaviour and policy support, while mediators (particularly solution aversion) had their strongest effects on risk perceptions and behaviour. More work is needed to clarify these relationships, including boundary conditions and their associations with other factors in risk responses. Nevertheless, this study provides several important advances for the field, regarding both its empirical findings and its longitudinal approach.

Note

1. This last finding may seem contradictory, as by Campbell and Kay's (2014) definition 'value threat' measures aversion to a specific policy solution. Yet we must distinguish direct effects of value threat on policy support – consistently negative here, as expected – from the indirect effect of cultural measures on policy support via value threat.

ORCID

Branden B. Johnson http://orcid.org/0000-0003-2264-5419

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Supplementary material

Supplemental data for this article can be accessed online at https://doi.org/10.1080/13698575.2024.2429374

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