It's all connected: Collectivism, climate change, and COVID-19

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A R T I C L E I N F O	A B S T R A C T
	Societal challenges like climate change and COVID-19 can be interrelated. The present research examines collectivism as a cultural value that is associated with the tendency to perceive such important interconnectedness. We further examine whether collectivism predicts perceiving interconnectedness specifically for scientifically valid relationships, or generally, regardless of their validity. Using an international sample (Study 1; $N = 12{,}955$) and another large U.S. sample (Study 2; $N = 1006$), we found that more collectivistic individuals perceive stronger interconnectedness between climate change and pandemics. However, collectivistic individuals also perceived stronger interconnectedness even for scientifically invalid ones, such as between the discovery of new constellations among stars and the emergence of new viruses. Exploratory analyses examined political orientation as a potential moderator, but the results were inconsistent, highlighting the need for more systematic future research. Together, these findings suggest that collectivistic individuals do not selectively perceive valid interconnectedness, but they tend to perceive stronger interrelations among phenomena in general, whether true or not, which presents both opportunities and challenges for addressing environmental and other social issues confronting humans today.

1. Introduction

Climate change is by many measures the most urgent issue facing humanity today. Climate change does not merely comprise rising temperatures, but also irrevocable changes in natural as well as human systems (IPCC, 2014). Such changes pose serious threats to public health, as more frequent extreme weather events can increase the likelihood of the emergence of new infectious diseases and associated pandemics (IPCC, 2014; Mirski et al., 2012; Patz et al., 2003; Rodó et al., 2021). Conversely, pandemics can worsen climate change by diverting governmental and public resources away from addressing climate issues and postponing the implementation of mitigation and adaptation

measures (Jones & Baumgartner, 2005; Natchez & Bupp, 1973; Sisco et al., 2023).

In the present research, we aim to understand the factors which contribute to the perception of interrelatedness between global challenges such as climate change and pandemics. When the public sees connections between social and global issues, their awareness of potential risks and consequences of these issues can increase, which may lead to greater support for more integrated perspectives to address problems in our interconnected world (McNeely, 2021). For example, when leaders and citizens perceive a connection between climate change and pandemics, they might support more climate-friendly policies and measures in COVID-19 recovery efforts (Bergquist et al., 2023; Drews et al., 2022), such as grants and tax relief toward green energy and transportation or pursuing the transition to more sustainable economic development and growth.

The present research examines whether collectivism is associated with perceiving relationships between the COVID-19 pandemic and climate change. We focus on perceptions of causal interconnectedness, such that the two phenomena are perceived to be causally related. We posit that collectivism predicts perceiving interconnectedness between climate change and pandemics based on research showing that collectivism is associated with a worldview that perceives elements in the world as closely interrelated (Nisbett et al., 2001; Varnum et al., 2010). Recent research has supported the relevance of collectivism to the research question in the present studies by showing that collectivism is a significant factor shaping how people respond to collective challenges, such as climate change (Cardoso-Andrade et al., 2022; Eom et al., 2016, 2019) and COVID-19 (Leong et al., 2022; Lu et al., 2021), and how people perceive implausible interrelations in fake news contexts (Lin et al., 2022).

Two studies, one with samples from seven countries ($N = 12,955$) and the other from the United States ($N = 1006$), tested whether collectivism is associated with perceiving a connection between climate change and pandemics such as COVID-19. We also examined whether collectivism is associated with selectively perceiving valid interrelations between phenomena or whether it is associated with the tendency to perceive interrelations even if there is no valid support and evidence. Together, we aim to advance the understanding of what predicts perceiving connections among interrelated systems, such as climate and health systems, and how this can provide insights for addressing collective challenges such as climate change and pandemics.

1.1. Climate change and pandemics

Climate change and pandemics, two serious collective threats that humans are facing in the contemporary world, may look like separate issues. The former is a change in the climate system, occurring relatively slowly and over a longer period of time. In contrast, the latter is a health issue, occurring rapidly and with large, direct and potentially lethal consequences over a relatively short period of time. However, scientific evidence suggests that climate change and pandemics are two issues that are interconnected through several paths (Joshi et al., 2021). Climate change can make pandemics more likely to happen because it can facilitate a pathogen's survival, development, and dissemination (Gibb et al., 2020; Patz et al., 2003; Rodó et al., 2021). Moreover, the loss of natural habitats caused by climate change and consequently more frequent contact between humans and wildlife can increase transmission of infectious diseases to humans from wild animals (Olivero et al., 2017).

Just as climate change can exacerbate the risk and prevalence of pandemics, pandemics can also affect how climate change proceeds. Pandemics can reduce greenhouse gas emissions at least in the short term due to restricted economic activities and mobility (Chapman & Tsuji, 2020; Malliet et al., 2020). However, pandemics also have considerable negative environmental impacts. First, pandemics can disrupt governmental operations, undermining countries' abilities to

enact collective actions and reach policy agreements. Moreover, recent reports suggest that pandemics can significantly increase the exploitation of natural resources, such as the illegal harvesting of wildlife, which might be taken by people to overcome their economic suffering from the COVID-19 pandemic (e.g., Gardner, 2020). Pandemics can also lead to a dramatic increase in single-use plastic waste (e.g., masks and gloves; Silva et al., 2021). Furthermore, when pandemics harm and kill millions of people, climate change might be considered as less pressing due to its relatively long-term nature (Cole et al., 2022a; Jones & Baumgartner, 2005; Natchez & Bupp, 1973; Sisco et al., 2023). In fact, Blanco et al. (2022) found that people significantly reduced their donations for other sustainability issues, such as climate change, when COVID-19 related funds were introduced as options in donation decisions. This type of substitution can postpone the implementation of climate change mitigation and adaptation measures.

The close association between climate change and pandemics can also be reflected in psychological and behavioural tendencies. For example, Latkin et al. (2022) found that climate change concerns are significantly associated with perceived risk of COVID-19 and related protective behaviors, such as mask-wearing and vaccine-taking intentions. However, research suggests that people significantly differ in their perceptions of the connection between climate change and pandemics (van Wijk et al., 2020), and these varying perceptions can influence their responses to the challenges and related policy preferences. According to van Wijk et al. (2020), approximately one-fourth of their participants did not agree with that climate change influences the spread of infectious diseases. Also, Ruiu et al. (2022) found that younger and more educated individuals in the UK tend to perceive stronger human responsibility for climate change and are more likely to view the COVID-19 pandemic as an opportunity to promote sustainable lifestyles and practices. Despite the significant implications of subjective perceptions, however, little understanding has been gained regarding factors associated with perceptions of interconnectedness between global challenges such as climate change and pandemics.

1.2. Collectivism

We posit that collectivism may be associated with perceived interconnectedness between climate change and pandemics. Collectivism is a cultural orientation that prioritizes achieving collective goals over individual goals (Hofstede, 1980; Hofstede et al., 2010; Triandis, 1989). People who are more collectivistic view themselves as inherently part of a larger group in which social roles and relationships with others are key aspects of self-identities (Markus & Kitayama, 1991). Thus, for those with collectivistic orientations, one's behavior is not simply an expression of their own internal characteristics but rather is understood within a context in which various situational and social factors are key determinants of behavior (e.g., Eom et al., 2016; Kashima et al., 1992; Morris & Peng, 1994; Savani et al., 2012).

Variation in collectivism exists both within and between cultures. That is, just as there are countries (or cultural groups) more collectivistic than others, there are also individuals who are more collectivistic than others within each country (Eom et al., 2016; Kim et al., 2016; Oyserman et al., 2002). Note, however, that cultural-level collectivism and individualism are viewed as two ends of the same spectrum (Hofstede et al., 2010). In contrast, at the individual level, collectivism is regarded as orthogonal from individualism, and thus, collectivism and individualism can be measured separately as person-level orientations (Ballew et al., 2020; Singelis, 1994; Triandis & Gelfand, 1998). Indeed, previous studies have shown that these individual- and country-level collectivistic orientations operate independently in predicting outcomes such as the extent to which people support pro-environmental actions (Eom et al., 2016).

1.3. How collectivism relates to perceptions of interconnectedness

The interconnected view that collectivists hold is not confined to understanding the self and others but extends to how people understand phenomena in the world (Varnum et al., 2010), which could have relevance to seeing connections within the environment such as between COVID-19 and climate change. Collectivism is associated with holistic thinking whose core assumption is that the world consists of interconnected parts in which change occurs in dynamic and complex ways (Nisbett et al., 2001; Varnum et al., 2010; Wang et al., 2022). For example, when asked to identify contributing factors for an event or potential consequences of an event, people with a collectivistic cultural background, such as East Asians, indicate more potential causes and consequences than those with an individualistic cultural background, such as Americans (Choi et al., 2003; Maddux & Yuki, 2006). Similarly, using tasks that assess various aspects of holistic thinking (e.g., global processing, stimulus-context relations, and stimulus-stimulus relations), Wong et al. (2021) found that participants from Asian countries exhibited higher levels of holistic thinking than those from Western countries.

Along with holistic thinking, another key concept relevant to the current research is systems thinking (Ballew et al., 2019; Randle & Stroink, 2018). Holistic thinking has been conceptualized and examined in cultural psychology, whereas systems thinking rooted in cognitive psychology (Randle & Stroink, 2018). Systems thinking involves recognizing that the world works like a system in which ecological, social, and economic phenomena closely interact with one another. Accordingly, people who perceive ecological systems' interconnectedness with other systems tend to hold higher pro-environmental attitudes and behaviors (Ballew et al., 2019; Davis & Stroink, 2016; Lezak & Thibodeau, 2016).

Given that research on these two constructs has developed independently, their similarities and differences have rarely been examined, and not in connection with environmental perceptions. One recent exception was Thibodeau et al. (2016) who compared systems thinking with holistic thinking and collectivism and found positive correlations among them. Given the established conceptual relationships between collectivism, holistic thinking, and systems thinking, we theorized that collectivistic individuals would be more likely to perceive casual connections between climate change and pandemics.

1.4. Valid vs. invalid interconnectedness

We predict that collectivism is associated with perceiving valid and important interrelations, such as between climate change and pandemics. However, collectivists who hold an interconnected worldview (Maddux & Yuki, 2006; Nisbett et al., 2001) may also perceive interconnectedness among phenomena *even if there is no valid basis for those connections*. Indeed, a recent research study found that collectivistic people are more likely to believe in claims in fake news, such that people who use Instagram are more likely to divorce (Lin et al., 2022). This finding is relevant because these claims in fake news commonly take forms of false and invalid causal associations (e.g., between various predictors and quality of sperm; Zaila et al., 2020).

In the present research, therefore, we test two competing hypotheses regarding the type of connections people higher in collectivism are more likely to perceive. The first, which we term the "discernment hypothesis," poses that collectivistic people selectively perceive valid interconnectedness more than invalid interconnectedness. The second, which we refer to as "general connection hypothesis," poses that more collectivistic people perceive greater connections even for those phenomena for which there is no valid scientific support. In Study 2, we specifically examined perceived interconnectedness between the discovery of new constellations among stars in the sky with both climate change and pandemics. Compared to the connection between climate change and pandemics for which scientific evidence is available (i.e., valid

interconnectedness; Patz et al., 2003; Rodó et al., 2021), relations involving star constellations do not have any scientific evidence (i.e., invalid interconnectedness). By including this outcome measure, we investigated whether collectivism is associated with perceptions of both valid and invalid interconnectedness, thereby testing the discernment and general connection hypotheses.

1.5. The present research

While there are significant variations in how individuals perceive the association between climate change and pandemics (Ruiu et al., 2022; van Wijk et al., 2020), little is known about the factors that explain these variations. One relevant yet underexplored factor is collectivism. Prior research suggests that individuals with collectivistic cultural backgrounds tend to perceive interconnectedness among events and objects (Wang et al., 2022; Wong et al., 2021). However, no study, to our knowledge, has directly examined whether collectivism influences perceptions of interconnectedness in the context of contemporary social challenges, such as climate change and COVID-19. Moreover, it remains unclear whether this tendency extends to perceiving scientifically unsupported connections with social issues. By addressing these gaps, the present research investigates the following questions: (1) whether collectivism predicts perceived interconnectedness between climate change and pandemics, (2) whether this tendency differentiates between valid and invalid connections, and (3) whether holistic thinking or systems thinking explains the effect of collectivism.

We hypothesize that collectivism is associated with greater perceptions of a causal connection between climate change and pandemics. In Study 1, by collecting data from seven different countries (Brazil, Israel, Italy, Sweden, South Korea, the United Kingdom, and the United States), we examined whether collectivism is associated with perceptions of interconnectedness between climate change and COVID-19. These countries were selected to cover a wide range of cultures across different continents, including cultural variation in country-level collectivism. Thus, this international sample allowed for testing the hypothesized effect of collectivism at both individual and national levels. In Study 2, we tested the same hypothesis with a large U.S. sample. We also examined whether people higher in collectivism are sensitive to valid interconnectedness. In addition, we explored holistic thinking and systems thinking as potential mediators of the collectivism effect.

Our research adheres to the APA ethical principles and ethical code of conduct for research with human participants, including observing privacy rights of human subjects and obtaining informed consent, and the studies were approved by the institutional ethics committees at the University of Colorado Boulder and Singapore Management University. Data, full materials (including those in the surveys that were not analyzed as part of this paper), analysis code, and results are available on the Open Science Framework (OSF): https://osf.io/v8euj

2. Study 1

Using multinational data, we examined whether collectivism is associated with perceptions of causal interconnectedness between climate change and pandemics. Given the distinct social, economic, and cultural environments as well as differing COVID-19-related situations during the time of data collection across the countries, Study 1 was a robust test of the role of person-level collectivism in explaining the perception of climate change and COVID-19 interconnectedness as a generalizable phenomenon. We collected measures on collectivism and perceived interconnectedness alongside measures that were part of other investigations (Flores et al., 2022; Ramos et al., 2022). We also explored the role of country-level collectivism, examining whether culture-level collectivism operates in the same way as individual-level collectivism such that both levels of collectivism independently predict greater perceptions of the interconnectedness between climate change and COVID-19.

2.1. Method

2.1.1. Respondents

Individuals in Brazil ($N = 1500$), Israel ($N = 1958$), Italy ($N = 1586$), South Korea ($N = 1484$), Sweden ($N = 1589$), the United Kingdom ($N = 1520$) and the United States ($N = 3318$) participated in the study in August 2020. Sample sizes were maximized with available funding with gender and age quotas used to ensure diverse samples. Participants were recruited from different online panels specific to each of the seven countries. For example, American participants were recruited from ROI Rocket's panel, while Korean participants were recruited through PanelNow, managed by the research company dataSpring. Similar panel providers were used for other countries (e.g., UK participants from Prolific). The original survey was written in English and then translated into Portuguese, Hebrew, Italian, Korean, and Swedish for the respective countries where English was not the official national language. Except for those from Sweden, respondents were compensated the typical amount of the panel provider in each country, for example, $4.00 in the United States. Respondents in Sweden were recruited from a voluntary panel of individuals. Further details on the sampling procedure, including specific sample characteristics by each country relative to its census information, panel providers, and recruitment methods, can be found at OSF: https://osf.io/aq2jg.

2.1.2. Measures

We measured the extent to which participants subscribed to collectivistic values and the extent to which they viewed climate change and COVID-19 to be connected. We also measured their political ideology, belief in climate change, individualism, and other basic demographic variables (e.g., gender, age, and education), to be used as covariates in our analyses.[2] Political ideology and belief in climate change in particular were selected as covariates because of their associations with our predictor (i.e., collectivism; association between collectivism and political conservatism: Haidt, 2012; Talhelm et al., 2015) or outcome (i.e., interconnectedness perceptions between climate change and COVID-19). We included individualism to examine whether collectivism and individualism work independently, which would align with the existing research on cultural orientations at the individual level that posit these constructs as orthogonal (Kim et al., 2016; Singelis, 1994). The bivariate correlations between these key and control variables are included in the Supplementary Materials (Table S2).

2.1.2.1. Person-level collectivism and individualism.
Two distinct scales measured participants' collectivistic and individualistic orientations. We used shortened versions of the scales from Kim et al. (2016). Each scale had four items and participants rated their level of agreement to each item on seven-point scales from $-3 = $ *strongly disagree* to $+3 = $ *strongly agree*.

The items for collectivism were: (1) It is important to me to think of myself as a member of my religious, national, or ethnic group; (2) Learning about traditions, values, and beliefs of my family is important to me; (3) In the end, a person feels closest to members of their own religious, national, or ethnic group; and (4) It is important to me to respect decisions made by my family. The items for individualism were: (1) It is important to me to develop my own personal styles; (2) It is better for me to follow my own ideas than to follow those of anyone else; (3) I enjoy being unique and different from others in many respects; and (4) My personal achievements and accomplishments are very important

to who I am. The order of items within each scale was randomized. The items for collectivism ($\alpha = 0.80$) and individualism ($\alpha = 0.81$) were averaged into composite scales for each construct.

2.1.2.2. Country-level collectivism and individualism.
We used Hofstede's collectivism-individualism index (Hofstede et al., 2010). On this index, countries are rated out of 100; higher (lower) numbers indicate more individualistic (collectivistic) cultures. Hofstede's cultural index has been widely used as a valuable framework to explain psychological variation across societies (e.g., Boer & Fischer, 2013; Eom et al., 2016; Lawrie et al., 2020; Lu et al., 2021). We reverse coded the values so that higher scores indicated greater country-level collectivism.[3] The countries included in our sample significantly varied in collectivism (ranging from 9 to 82).

2.1.2.3. Climate change and COVID-19 interconnectedness.
For the key dependent variable, participants rated their level of agreement to two items measuring perceived interconnectedness between climate change and COVID-19 on seven-point scales ($-3 = $ *strongly disagree* to $+3 = $ *strongly agree*). These items were: (1) Climate change made it more likely that a pandemic like COVID-19 would occur; and (2) COVID-19 will make efforts to combat climate change more difficult.[4] The ratings of these two items were averaged to create a composite index ($r(10446) = 0.42$, $p < .001$), given their relatively strong correlation (Lovakov & Agadullina, 2021).[5]

2.1.2.4. Political ideology.
Respondents reported their political ideological leanings by responding to the item, "How much do you identify as being politically liberal or conservative…" on a seven-point scale from $-3 = $ *very liberal* to $+3 = $ *very conservative* for three dimensions: in general, on social issues, and on economic issues. These three items were averaged into a composite score ($\alpha = 0.88$).

2.1.2.5. Belief in climate change.
Participants rated their agreement to two items measuring belief in climate change (Van Boven et al., 2018) on seven-point scales ($-3 = $ *strongly disagree* to $+3 = $ *strongly agree*). These items were: (1) Climate change is happening; and (2) Human activity is largely responsible for recent climate change. The two items were averaged to create a composite measure ($r(12119) = 0.70$, $p < .001$). The items measuring the perceived connectedness between climate change and COVID-19 and belief in climate change were presented together in which the order of these items was randomized.

2.1.2.6. Demographic information.
We collected information on gender, age, and education level. Participants responded to, "What is your gender?" with answer choices of female, male, and other. For analysis, we coded two contrast-coded predictors representing gender: one comparing male ($-\frac{1}{2}$) to female ($+\frac{1}{2}$) with other coded as (0), and one comparing male and female ($-\frac{1}{3}$) to other ($+\frac{2}{3}$). Participants reporting their gender as "other" ranged from 2 (0.1 %) of the sample (in Korea) to 10 (0.7 %) of the sample (in the UK). Finally, participants reported their numerical age and the number of formal years of schooling they had received.

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[2] The measures used in the present research were in an inclusive survey with a range of variables for multiple projects. In terms of the actual order of the measures, interconnectedness perceptions were measured prior to individualism and collectivism. Items assessing belief in climate change were placed in the same question block as the measure of interconnectedness perceptions. Political ideology was placed earlier than the predictor and outcome variables.

[3] Hofstede's individualism-collectivism index was significantly correlated with country-level means of our collectivism scores (i.e., country-level means of difference scores between collectivism and individualism). See SOM for more detailed information on this analysis (Table S1 and Fig. S1).

[4] Participants in Israel were not asked for responses to the second item due to an error in implementing the survey, and accordingly, the score for Israeli participants was based on the first item only.

[5] The two measures show similar patterns of results when analyzed independently. The specific results from the analyses for each item are included in the Supplementary Materials (Tables S6 and S7).

Table 1

Multilevel analyses examining factors that predict perceived interconnectedness between climate change and COVID-19. Responses range from −3 = strongly disagree to +3 = strongly agree.

	B	β	95 % CI [LL, UL]	t
Intercept	0.01	−0.02	−0.29, 0.42	0.34
Key individual-level predictors				
Collectivism	0.08***	0.08	0.06, 0.11	8.13
Individualism	−0.02	−0.01	−0.04, 0.01	−1.26
Individual difference controls				
Political ideology	−0.10***	−0.10	−0.12, −0.08	−11.10
Belief in climate change	0.34***	0.35	0.32, 0.36	34.90
Male vs. female	0.10***	0.03	0.05, 0.15	3.84
Other gender vs. male/female	−0.08	0.00	−0.53, 0.38	−0.33
Age	0.00*	−0.02	0.00, 0.00	−2.45
Education	−0.01	−0.02	−0.02, <0.01	−1.84
Country-level predictor				
Hofstede Country Collectivism Score	0.01	0.23	<0.01, 0.03	2.12
Cross-level predictor				
Individual-level collectivism * Hofstede Country Collectivism Score	<0.01	0.01	0.00, <0.01	1.22

Note. *** indicates $p < .001$; ** indicates $p < .01$; * indicates $p < .05$.

2.2. Results

We used listwise deletion by model, in which the participants with missing data on any of the included variables in a specific model were excluded. In the main model presented in Table 1, the sample size was 12,076. To examine our hypothesis that collectivism predicts perceiving a connection between climate change and COVID-19, we ran a multilevel model with random intercepts by country. Specifically, the perceived interconnectedness between climate change and COVID-19 was regressed on person-level collectivism and individualism and country-level collectivism. We also included in the analyses, on an exploratory basis, the interaction between person-level and country-level collectivism. Belief in climate change, political ideology, and demographic characteristics of age, gender, and education were included as person-level covariates.[6,7] Person-level collectivism and individualism, country-level collectivism, ideology, climate change belief, and continuous demographics were mean-centered in the models. Table 1 presents the results from the regression analyses.

As hypothesized, person-level collectivism ($M = 0.39$, $SD = 1.38$) significantly and positively predicted perceived interconnectedness ($M = 0.07$, $SD = 1.54$; $b = 0.08$, $\beta = 0.08$, $t = 8.13$, $p < .001$; see Table 1 for

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full model results). That is, individuals who were more collectivistic agreed more strongly that climate change and COVID-19 are causally interrelated. This effect of person-level collectivism was significant over and above the effects of ideology ($M = -0.01$, $SD = 1.50$; $b = -0.10$, $\beta = -0.10$, $t = -11.10$, $p < .001$), belief in climate change ($M = 1.59$, $SD = 1.59$; $b = 0.34$, $\beta = 0.35$, $t = 34.90$, $p < .001$), and demographic measures. Person-level individualism was not a significant predictor of perceived interconnectedness ($M = 0.94$, $SD = 1.23$; $b = -0.02$, $\beta = -0.01$, $t = -1.26$, $p = .208$).

For country-level collectivism ($M = 33.62$, $SD = 24.78$), there was a non-significant (with moderate effect size) positive association between country-level collectivism and perceived interconnectedness such that perceived interconnectedness was higher in more collectivistic countries ($b = 0.01$, $\beta = 0.23$, $t = 2.12$, $p = .088$).[8] Country-level collectivism did not significantly moderate the effect of person-level collectivism; that is, no significant (small effect size) cross-level interaction ($b < 0.01$, $\beta = 0.01$, $t = 1.22$, $p = .223$). We note that our study was underpowered to detect country-level effects due to the small number of countries ($n = 7$) (Gelman & Hill, 2006; Stegmueller, 2013). Fig. 1 presents the effect of person-level collectivism by each country. Full results from regression models by country are presented in the SOM (Table S5).

2.3. Discussion

Person-level collectivism was positively associated with perceptions of causal interconnectedness between climate change and pandemics across different countries. Those who were more collectivistic were more likely to perceive that climate change was causally associated with COVID-19. In contrast, person-level individualism was not associated with interconnectedness perceptions. The results for country-level collectivism showed a pattern consistent with the hypothesis. Although it was not statistically significant, country-level collectivism trended toward predicting perceptions of interconnectedness with a moderate sized effect ($\beta = 0.23$), such that those in more collectivistic countries were more likely to perceive that climate change was causally associated with COVID-19. However, our study may lack sufficient statistical power to identify country-level effects, given the small number of countries included in the analysis (Gelman & Hill, 2006; Stegmueller, 2013).

3. Study 2

Study 2 extended Study 1 in theoretically and practically important ways. First, we addressed a key question: whether individuals with higher collectivism are more prone to perceiving potential interrelations between objects or phenomena *even if there is no scientifically valid support for those connections*. Given the interconnected worldview associated with collectivism, it is an important question whether those with higher collectivism were able to discern valid from invalid connections (i.e., *discernment hypothesis*) related to COVID-19 and climate change, or whether they perceive greater connections between events in general, regardless of their validity (i.e., *general connection hypothesis*).

Second, we examined the associations between collectivism, holistic thinking, systems thinking, and perceived interconnectedness, as well as whether holistic thinking or systems thinking mediated the effect of collectivism on perceived interconnectedness. The core aspect of these thinking styles is perceiving interrelations among various objects and phenomena in the world. Research has found that collectivistic values are positively associated with both holistic thinking and systems thinking (Thibodeau et al., 2016; Varnum et al., 2010). Thus, we

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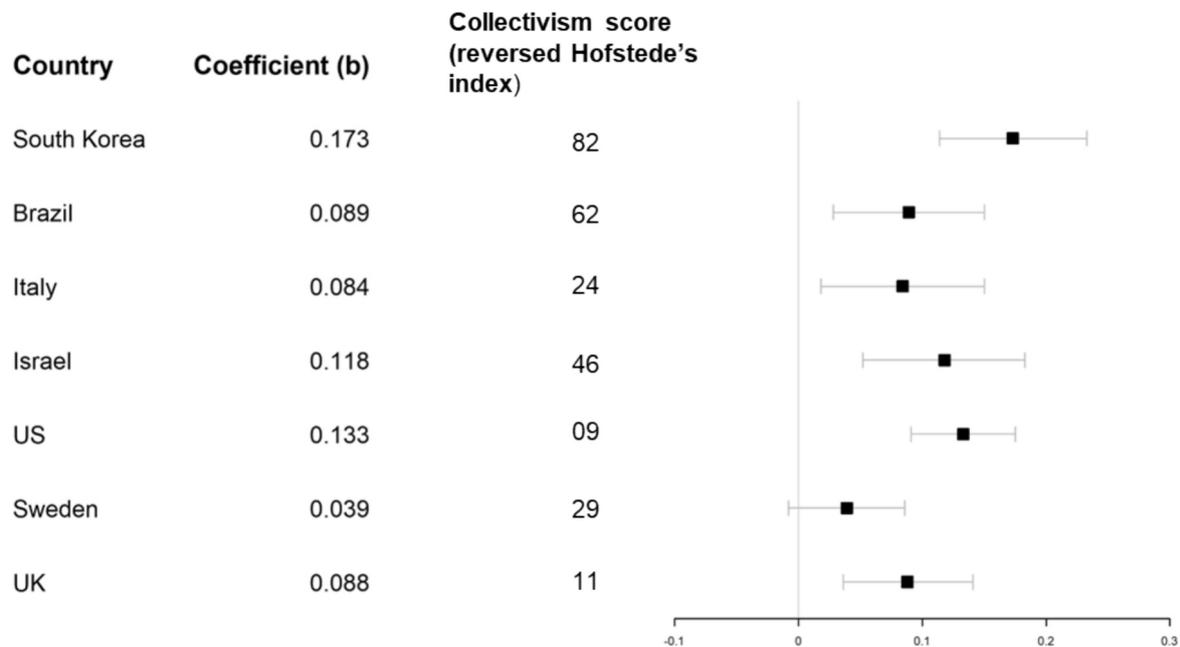| Country	Coefficient (b)	Collectivism score (reversed Hofstede's index)	
South Korea	0.173	82	
Brazil	0.089	62	
Italy	0.084	24	
Israel	0.118	46	
US	0.133	09	
Sweden	0.039	29	
UK	0.088	11	

Fig. 1. Relationship between person-level collectivism and perceived interconnectedness of climate change and COVID-19 by country, controlling for individualism and other individual difference characteristics.
Note. Error bars are 95 % confidence intervals.

considered these two thinking styles as potential mediators of why collectivism is associated with perceiving interconnectedness between climate change and pandemics. Given their conceptual similarities, we explored whether either holistic thinking or systems thinking or both explain perceiving interconnectedness, as we did not have any a priori theoretical reason to posit differences between them in their predictive or incremental validity. We thus examined them in separate mediation models rather than treating them as parallel mediators in the same model because they are considered as two different measures of the same, or very similar, constructs. In addition, we expanded our outcome measure and examined perceived interconnectedness of climate change with pandemics and new viruses in general.

3.1. Method

3.1.1. Respondents

Participants ($N = 1006$) from the United States were recruited in December 2021. Given the absence of cultural moderation observed in Study 1, we opted to focus on the U.S. which is more readily accessible and also encompasses high cultural and political diversity. We used Prolific to collect a sample demographically consistent with national characteristics on age, sex, and ethnicity. Participants received USD 1.50 as compensation. A power analysis suggested a sample size of approximately 500 participants to detect a similar sized effect of collectivism predicting perceived interconnectedness found in Study 1 ($f^2 \sim 0.017$; power = 0.80, α = 0.05). We opted to collect 1000 participants to ensure high power so that the sample size would be large enough to detect indirect effects with paths of small effect sizes (Fritz & MacKinnon, 2007). The sample varied in age ($M = 35.90$, $SD = 14.42$), gender (49.60 % female, 48.80 % male, and 1.60 % other), years of schooling ($M = 14.74$, $SD = 2.38$), and ethnicity (6.72 % Asian or Asian-American, 13.44 % Black or African-American, 6.22 % Hispanic or Latino-American, 0.30 % Native American, 0.10 % Native Pacific Islander, 71.82 % White, and 1.40 % other ethnicity). Participants were 64.66 % Democrats, 15.02 % independents, and 20.32 % Republicans. We excluded five participants not located in the United States and two

participants who failed both attention check items.[9]

3.1.2. Measures

3.1.2.1. Person-level collectivism and individualism.
Study 2 used the full versions of the collectivism and individualism scales from Study 1 (Kim et al., 2016) to improve measurement reliability. The collectivism scale had eight items. Additional items not included in Study 1 were: (5) I will sacrifice my self-interest for the benefit of the group I am in; (6) My happiness depends on the happiness of those around me; (7) When I hear about an event I automatically wonder whether it will be good or bad for my religious, national, or ethnic group; (8) Family is more important to me than almost anything else. The individualism scale had six items. Additional items not included in Study 1 were: (5) For me, hard work and personal determination are the keys to success in life; (6) If I make my own choices I will be happier than if I listen to others. Respondents rated their level of agreement to each item on seven-point scales from $-3 = $ *strongly disagree* to $+3 = $ *strongly agree* and the items were averaged into composite scales for collectivism (α = 0.78) and individualism (α = 0.76).

3.1.2.2. Perceived interconnectedness.
To measure perceived interconnectedness, respondents rated on five-point scales ($1 = $ *not at all interrelated* to $5 = $ *extremely interrelated*) the extent to which pairs of phenomena are related in causal ways, "meaning that each event in the pair can or did cause the other." Events included: (1) new viruses, (2) climate change, (3) new constellations, and (4) pandemics like COVID-19. Each event was compared to each other, resulting in six comparisons.

We averaged responses to the comparisons of climate change with

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[9] One item within the holistic thinking measure stated "This is an attention check. Please select 'Moderately agree' for this item." Another item within the belief in climate change measure stated, "This is an attention check. Please select 'Somewhat disagree' for this item.".

Table 2
Models predicting perceived interconnectedness of climate change with COVID-19 and pandemics and new viruses. Responses range from −3 = strongly disagree to +3 = strongly agree.

	B	β	95 % CI [LL, UL]	*t*
Intercept	2.18***	<0.01	1.99, 2.36	23.10
Key predictors				
Collectivism	0.10**	0.09	0.03, 0.17	2.89
Individualism	−0.03	−0.03	−0.12, 0.05	−0.82
Individual difference controls				
Political orientation	−0.20***	−0.16	−0.29, −0.11	−4.31
Belief in climate change	0.18***	0.21	0.12, 0.24	5.61
Male vs. female	0.05	0.02	−0.09, 0.18	0.64
Other gender vs. male/female	0.10	0.01	−0.44, 0.63	0.35
Age	= 0.00	−0.05	−0.01, <0.01	−1.47
Education	−0.02	−0.03	−0.04, 0.01	−1.03
Minority race vs. White	−0.04	−0.02	−0.19, 0.11	−0.51

Note. *** indicates $p < .001$; ** indicates $p < .01$; * indicates $p < .05$.

both new viruses and pandemics like COVID-19 to represent our key dependent variable of perceptions of valid interconnectedness of climate change with pandemics ($r(996) = 0.81$, $p < .001$). We also averaged responses to the comparisons of new constellations with each climate change, new viruses, and pandemics like COVID-19, to comprise our measure of perceptions of invalid interconnectedness ($\alpha = 0.88$).[10]

3.1.2.3. Holistic thinking. We used a twenty-four-item measure of holistic thinking (Choi et al., 2007). Respondents rated items on seven-point scales from −3 = *strongly disagree* to +3 = *strongly agree* such as, "Everything in the universe is somehow related to each other," and "Everything in the world is intertwined in a causal relationship." Appropriate items were reverse-scored and a composite score was calculated by averaging across all the items ($\alpha = 0.72$).

3.1.2.4. Systems thinking. We used a fifteen-item measure of systems thinking (Thibodeau et al., 2016). Respondents rated items on seven-point scales from −3 = *strongly disagree* to +3 = *strongly agree* such as, "When I have to make a decision in my life I tend to see all kinds of possible consequences to each choice," and "Social problems, environmental problems, and economic problems are all separate issues." Appropriate items were reverse-scored and a composite score was calculated ($\alpha = 0.76$).

3.1.2.5. Political orientation. Respondents reported their political ideological leanings on the same three items used in Study 1 ($\alpha = 0.94$). They also reported their partisan identification, and we standardized and averaged ideology and partisan identification into a composite score representing political orientation ($r(996) = 0.76$, $p < .001$).

3.1.2.6. Belief in climate change. Respondents reported their belief in climate change using the same two items as in Study 1. These items were again averaged into a composite score ($r(995) = 0.80$, $p < .001$).

3.1.2.7. Demographic information. We collected information on gender, age, and education level as in Study 1. We added a measure of race. For

analysis, we coded a predictor representing White or Caucasian ($+\frac{1}{2}$) versus any minority group ($-\frac{1}{2}$).[11]

3.2. Results

The descriptive statistics and bivariate correlations between the key and control variables are included in SOM (Table S6).

3.2.1. Perceived interconnectedness of climate change and pandemics

We ran a regression model to examine whether collectivism ($M = 0.25$, $SD = 1.05$) predicted participants' perceptions of interconnectedness ($M = 2.20$, $SD = 1.13$) between climate change and both new viruses and pandemics like COVID-19 (Table 2). As in Study 1, we controlled for belief in climate change ($M = 2.07$, $SD = 1.33$), political orientation ($M = 0.00$, $SD = 0.94$), and basic demographic variables.[12] Collectivism positively predicted perceptions of valid interconnectedness ($b = 0.10$, 95 % CI [0.03, 0.17], $\beta = 0.09$, $t(994) = 2.89$, $p = .004$; Fig. 2). That is, individuals higher in collectivism were more likely to perceive that climate change is causally associated with pandemics like COVID-19 and new viruses. In contrast, individualism ($M = 1.48$, $SD = 0.83$) did not predict perceptions of valid interconnectedness ($b = -0.03$, 95 % CI [−0.12, 0.05], $\beta = -0.06$, $t(994) = -0.82$, $p = .413$).

3.2.2. Invalid perceptions of interconnectedness

We examined perceptions of invalid interconnectedness ($M = 1.44$, $SD = 0.82$); whether collectivism predicted participants' perceptions of interconnectedness between constellations and climate change, new viruses, and pandemics like COVID-19 (Table 3). The same set of variables were included as covariates. Collectivism positively predicted perceived interconnectedness of new constellations with other phenomena ($b = 0.14$, 95 % CI [0.09, 0.19], $\beta = 0.18$, $t(994) = 5.61$, $p < .001$; Fig. 2). Individualism was not a significant predictor ($b = 0.03$, 95 % CI [−0.03, 0.09], $\beta = 0.03$, $t(994) = 0.98$, $p = .328$). Thus, individuals higher in collectivism perceived more connections even for phenomena that are very unlikely to be interrelated with each other, providing evidence in favor of the general connection hypothesis and against the discernment hypothesis. In addition, there were some notable differences compared to perceptions of valid interconnectedness. While more liberal participants were more likely to perceive valid interconnectedness, more conservative participants were more likely to perceive invalid interconnectedness. We also found a negative association with education, where individuals with higher levels of education were less likely to perceive invalid interconnectedness.

3.2.3. Mediating roles of holistic thinking and systems thinking

Next, we considered whether holistic thinking ($M = 0.82$, $SD = 0.52$) or systems thinking ($M = 1.26$, $SD = 0.68$; correlation with holistic thinking of $r(996) = 0.37$, $p < .001$) mediated the effect of collectivism on perceived valid interconnectedness. We ran two mediation models, one with each holistic and systems thinking included as the mediator, respectively, and with the same set of variables were included as covariates as above. Within these models, collectivism positively predicted

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[10] We did not examine the measure of connectedness between new viruses and pandemics because it was not relevant to our key hypothesis about perceiving distal connections between social issues (as new viruses and pandemics are relatively more directly associated), and it did not serve as a fake connection for comparison.

[11] Race was dichotomously coded as White or non-White given that this contrast often shows significant differences in attitudes regarding social issues including climate change (e.g., McCright, 2010).

[12] The results without covariates are included in SOM (Table S7). In the analysis without covariates, the effect of collectivism was not significant. This appeared to be due to its correlations with belief in climate change (negatively) and political conservatism (positively). Specifically, similar to Study 1, the inclusion or exclusion of political orientation in the model changed the size of the collectivism effect on perceived valid interconnectedness. In a separate model, we also explored moderation of political ideology: whether the effect of collectivism varies by political ideology, and there was a significant moderation. The positive effect of collectivism was stronger for more conservative participants than liberal participants, $b = 0.12$, $p = .001$.
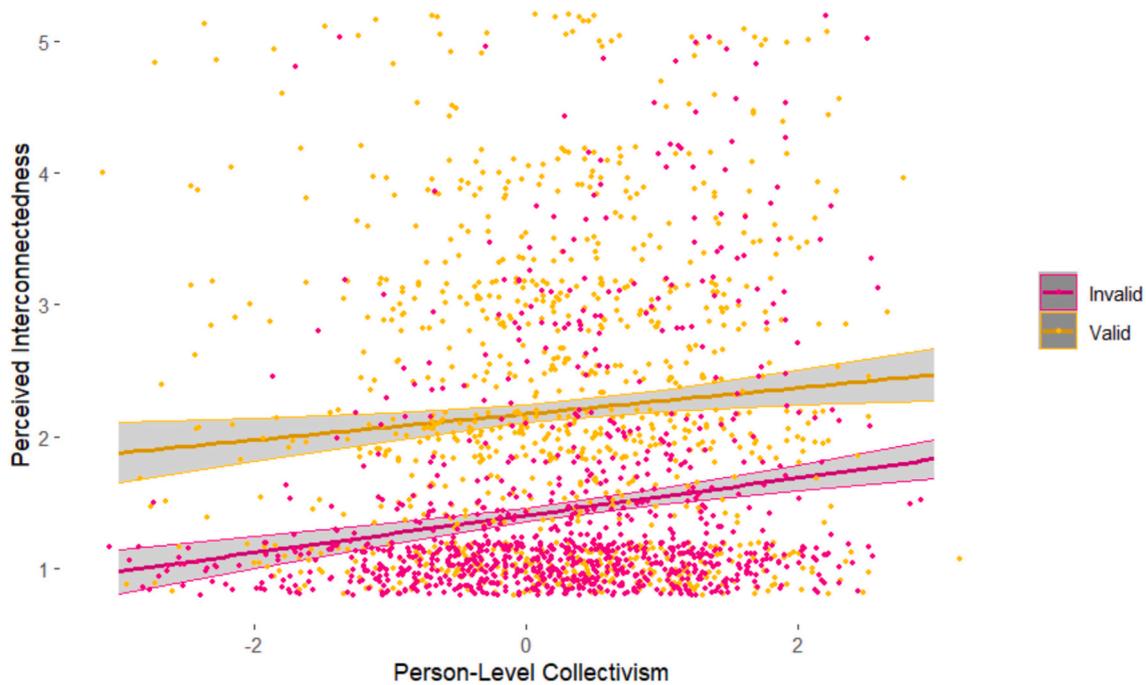
Fig. 2. Relationships between collectivism and perceptions of valid and invalid interconnectedness, controlling for other individual difference characteristics and demographics.
Note. Error bars are 95 % confidence intervals.

holistic thinking ($a_1 = 0.04$, 95 % CI [0.01, 0.07], $z = 2.45$, $p = .014$), whereas counter to our prediction, collectivism negatively predicted systems thinking ($a_2 = -0.12$, 95 % CI [-0.16, -0.08], $z = -5.84$, $p < .001$). Further, neither holistic thinking ($b_1 = -0.10$, 95 % CI [-0.24, 0.03], $z = -1.49$, $p = .137$) nor systems thinking ($b_2 = 0.07$, 95 % CI [-0.05, 0.18], $z = 1.19$, $p = .232$) predicted perceived interconnectedness between climate change and both pandemics and viruses (Figs. S2 and S3). Accordingly, the indirect effects for holistic thinking ($ab_1 = 0.00$, 95 % CI [-0.01, 0.00], $z = -1.27$, $p = .204$) and systems thinking ($ab_2 = -0.01$, 95 % CI [-0.02, 0.01], $z = -1.17$, $p = .242$) were not significant.[13]

3.3. Discussion

Individuals higher in collectivism were more likely to perceive causal interconnectedness between climate change and both new viruses and pandemics. Individualism was not a significant predictor of these interconnectedness perceptions. Importantly, higher scores on collectivism related to perceptions of invalid interconnectedness, such as interconnectedness of constellations with phenomena like climate

change and pandemics. This suggests that people higher in collectivism perceive more connections in the world around them in general, but they do not necessarily discern valid and invalid interconnections.

We did not find support for mediational pathways through holistic or systems thinking. Thus, processes other than holistic or systems thinking may explain the effect of collectivism, a point we return to in the general discussion. Also, while collectivism positively predicted holistic thinking, it negatively predicted systems thinking. This is inconsistent with an existing finding that showed positive relationships of collectivism with both holistic and systems thinking (Thibodeau et al., 2016). Previous research differed from the present research by using a different scale to measure collectivistic orientations (i.e., Singelis, 1994). Previous research also used a sample that included significantly fewer Democrats (41.0 % vs. 64.6 % in the present research). More systematic research is needed to examine whether and how collectivism is associated with holistic thinking and systems thinking.

4. General discussion

4.1. Summary and implications

Using data from seven countries that varied in social, economic, cultural environments (Study 1) and another large sample from the United States (Study 2), the present research examined the role of collectivism in perceptions that climate change and pandemics are causally interconnected. We found that more collectivistic individuals perceived greater interconnectedness such that climate change is seen as causally associated with occurrence of viruses and pandemics such as COVID-19. Our findings advance the recent literature on variations in perceptions of interconnectedness between societal issues (e.g., van Wijk et al., 2020) by identifying collectivism as a key cultural factor that explains these differences beyond demographic factors, such as age and education (Ruiu et al., 2022). More broadly, our research adds to the literature on culture and cognition (Nisbett et al., 2001; Wong et al., 2021), which highlights the role of collectivism in fostering a general tendency to perceive connections between events and objects. Our work shows that this tendency can extend to associations between complex

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[13] We also ran mediation analyses for perceiving invalid interconnectedness. The results suggested that lower systems thinking among people higher in collectivism explained in part why more collectivistic people were more likely to perceive invalid interconnectedness. This result was contrary to our hypothesis that higher systems thinking among more collectivist people would explain the relationship between collectivism and perceived invalid interconnectedness. In this analysis, both holistic thinking ($b_1 = -0.15$, 95 % CI [-0.25, -0.05], $z = -2.97$, $p = .003$) and systems thinking ($b_2 = -0.34$, 95 % CI [-0.42, -0.26], $z = -8.15$, $p < .001$) negatively predicted perceptions of connections between constellations and climate change, new viruses, and pandemics. The indirect effect on perceived invalid interconnectedness via holistic thinking did not reach the standard levels of significance ($ab_1 = -0.01$, 95 % CI [-0.01, <0.01], $z = -1.89$, $p = .059$). The indirect effect via systems thinking was significant such that collectivism negatively predicted systems thinking, which in turn negatively predicted perceptions of invalid interconnectedness ($ab_2 = 0.04$, 95 % CI [0.02, 0.06], $z = 4.75$, $p < .001$).

Table 3

Models predicting perceived interconnectedness of new constellations with each climate change, new viruses, and pandemics like COVID-19. Responses range from −3 = strongly disagree to +3 = strongly agree.

	B	β	95 % CI [LL, UL]	t
Intercept	1.44***	0.00	1.30, 1.58	20.68
Key predictors				
Collectivism	0.14***	0.18	0.09, 0.19	5.61
Individualism	0.03	0.03	−0.03, 0.09	0.98
Individual difference controls				
Political orientation	0.07*	0.08	0.01, 0.14	2.14
Belief in climate change	0.04	0.06	−0.01, 0.08	1.52
Male vs. female	0.07	0.05	−0.03, 0.18	1.45
Other gender vs. male/female	0.16	0.02	−0.24, 0.55	0.79
Age	0.00	−0.04	−0.01, <0.01	−1.33
Education	−0.04***	−0.12	−0.06, −0.02	−3.83
Minority race vs. White	−0.21***	−0.12	−0.33, −0.10	−3.66

Note. *** indicates $p < .001$; ** indicates $p < .01$; * indicates $p < .05$.

social and global issues, such as climate change and COVID-19.

A key goal of the studies presented in this paper was to identify factors that predict perceptions of interrelatedness between societal issues, which would support more comprehensive and, potentially, more efficient solutions to such issues (Bergquist et al., 2023; McNeely, 2021). Our findings suggest the potential as well as the challenges of collectivism as a factor that may promote interconnectedness perceptions. On one hand, to the extent that collectivism is causally associated with interconnectedness perceptions, increasing or emphasizing collectivism may help people to see significant but not readily apparent distal connections, thereby promoting an integrated view to approach social issues. Many social problems facing humanity today, such as climate change, pandemics, as well as social inequality, are distinctly *interconnected* challenges (Hallegatte et al., 2014; McNeely, 2021). Nevertheless, people do not necessarily perceive such connections easily and instead often approach these issues as independent. Therefore, it often leads people to prioritize certain issues over others (Blanco et al., 2022). This type of substitution and non-holistic approach can hinder effective resource distribution to address social issues and change for sustainable development (McNeely, 2021). Collectivism may help people hold a more holistic perspective and promote support for more systematic societal change.

In this regard, our findings add to the recent body of research showing beneficial effects of collectivism in dealing with collective challenges, such as climate change and pandemics. For example, in the context of COVID-19, collectivism was positively associated with outcomes such as mask usage and social distancing (Lu et al., 2021 for group-level collectivism; Leong et al., 2022 and Travaglino & Moon, 2021 for individual-level collectivism). In the context of environmental issues, people higher in collectivism, in particular in horizontal collectivism[14] (Triandis & Gelfand, 1998), had more pro-environmental tendencies, reporting greater environmental concerns and intentions to engage in environmentally-friendly behaviors, such as purchasing green products (Cho et al., 2013; Xiang et al., 2019).

On the other hand, more collectivistic people perceive interconnections for which there is no valid, scientific basis. Lin et al. (2022) similarly found that people higher in collectivism were more likely to believe in misinformation (e.g., drinking alcohol kills coronavirus) and pseudoscience (e.g., astrology, fortune-telling, etc.). Such propensity can constitute a barrier for society to use resources

effectively to address social issues and promote positive change when misinformation and disinformation are highly prevalent in society.

More research is needed to examine how to minimize this potential barrier, to increase discernment among high collectivists. In collectivistic cultural contexts, ensuring public access to reliable information and providing tools (e.g., fact-checking) to differentiate between scientifically valid and invalid interconnections is especially crucial. Moreover, given their heightened social sensitivity, strategies leveraging social norms can be integrated to encourage the use of debunking tools and the correction of false beliefs (Ecker et al., 2023; Gimpel et al., 2021). Governments and institutions can play an active role in these efforts, though their effectiveness depends on public trust, which is essential for minimizing negative reactions. Future research should also investigate how to make less collectivistic individuals more open to perceiving significant and scientifically valid interconnectedness. Perhaps, this can be done by carefully designed communication—for example, delivering the information regarding the interrelations by trustworthy sources, such as respectable experts and leaders (Cole et al., 2022b; Flores et al., 2022).

4.2. Limitations and future research directions

There are some limitations and unanswered questions in the present research. In both studies, we observed a positive association between collectivism and the perceptions of interconnectedness. Our multinational data along with analyses that accounted for various covariates reinforces the robustness of the finding. However, the studies were cross-sectional and non-experimental. While we included a range of variables in our analyses, including political orientations and climate change beliefs, to examine the independent effect of collectivism, we acknowledge that there are various other social and cultural factors that are correlated with collectivism, including cultural tightness (Gelfand et al., 2011). Moreover, at the time of data collection, countries significantly varied in their policy responses to COVID-19, reflecting cultural differences in responses to collective threats, which are also associated with collectivism (Leong et al., 2022; Lu et al., 2021). The present research could not fully address the potential role of these factors. Therefore, an important direction for future research is to examine the causal effect of collectivism and the role of other factors by incorporating direct manipulations (Oyserman & Lee, 2008) and a longitudinal approach.

In addition, although there was suggestive evidence that country-level collectivism relates to perceived interconnectedness between climate change and COVID-19, the number of countries was too small to provide robust examination for country-level effects (Gelman & Hill, 2006; Stegmueller, 2013). Given the moderate effect size for country-level collectivism (β = 0.23), a study across more countries may find a significant relationship between country-level collectivism and perceived interconnectedness. Research based on large-scale international collaborations (e.g., Van Bavel et al., 2022) would be valuable to fully understand psychological implications of collectivism at the culture-level on interconnectedness perceptions. Relatedly, while our sample included countries across different continents, most were WEIRD (Western, Educated, Industrialized, Rich, and Democratic; Henrich et al., 2010) with the exception of one Asian country (South Korea) and one South American country (Brazil). Future research with a more diverse cultural sample, particularly, including more countries from the Global South, is needed to better understand the role of both individual- and cultural-level collectivism.

Lastly, although holistic thinking or systems thinking were theorized as potential mediators that connect collectivism and perceiving interconnectedness between climate change and pandemics, the data in the present research did not support these mediational pathways. This aligns with the findings of Lin et al. (2022) that holistic thinking did not mediate the relationship between collectivism and perceiving fake claims. Why collectivism is associated with perceiving

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[14] Horizontal collectivism refers to a cultural orientation of valuing interdependence based on equal relationships, as compared to vertical collectivism that similarly values interdependence but emphasizes hierarchical relationships within groups (Triandis & Gelfand, 1998).

interconnectedness is an important but unanswered question. One possibility is that collectivists may have a greater propensity to actively construct explanations and meanings to understand claims and information from others. Lin et al. (2022) found that in response to fake claims, participants higher in collectivism were more likely to try to generate reasons why presented claims made sense. In a similar vein, more collectivistic individuals may put more efforts to construct explanations why interrelations between social issues, such as climate change and pandemics, are truthful.

However, this tendency may depend on factors such as the source and type of information. Collectivists' inclination to construct explanations and meanings may be especially pronounced when potential interconnectedness is raised by ingroup members. Building common ground with ingroup members can enhance social cohesion, thereby supporting the achievement of group goals—a core cultural value in collectivism (Hofstede et al., 2010; Triandis, 1989). Moreover, the tendency to perceive interconnectedness may be particularly likely when such perceptions align with (or at least do not contradict) the views of social groups that collectivists identify with. In other words, the perceptions of collectivists may be particularly influenced by the perceived normative views of ingroup members (Riemer et al., 2014). Examining these questions in future research could advance understanding of the processes by which people vary in their perceptions of interconnectedness.

4.3. Final thoughts

Serious challenges such as climate change and pandemics, which threaten society's sustainability, are interconnected. Addressing these challenges efficiently and effectively requires solutions that account for their interrelated nature. The present research highlights that collectivism, which has been associated with actions in support of reducing the effects of pandemics (Leong et al., 2022; Lu et al., 2021), and climate change (Cho et al., 2013; Xiang et al., 2019), holds both significant potential and critical caveats for fostering public responses to the societal and global challenges humanity faces.

CRediT authorship contribution statement

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Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2025.105200.

Data availability

We have shared the link to the data, codes, and study materials in the manuscript.

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