Psychometric Validation of the Brief Coronavirus Threat Scale (BCTS) Across Nine Countries

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Ethical Compliance Section

The authors have no funding to disclose.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

Abstract

In this paper, we report the development of the five-item *Brief Coronavirus Threat Scale (BCTS)* to assess perceived coronavirus threat. Using exploratory (Study 1, N = 735) and confirmatory (Study 2, N = 3,977) factor analysis, we substantiate the structural validity of the scale with North American, European, Israeli, and Chinese adults. Additionally, we provide evidence for the criterion validity of the scale by examining its association with theoretically and practically important variables (e.g., mask wearing). In sum, we argue that the BCTS is a parsimonious, valid, reliable, and unidimensional measure of coronavirus threat, with psychological implications and international application.

Keywords: COVID-19, threat, scale validation, prevention, individual differences, coping, distress

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Threat – the anticipation of harm or loss (Lazarus & Folkman, 1987) – is a term that has frequently followed COVID-19 in public discourse (e.g., Higgins-Dunn, 2021 January 12; Reuters, 2021 January 11; Schulte, 2020 March 16); an unremarkable fact, considering the virus has upended almost every aspect of life, including health (Braun, 2020 November 19; Pfefferbaum & North, 2020), entertainment and leisure (Hancock, 2020 December 20; Kaczmarek et al., 2021), education (United Nations, 2020), and the economy (Bierman et al., 2021; Slaughter, 2020 November 11). Importantly, COVID-19 has demonstrated that its potential to cause harm or loss is unequivocal. With more than 375 million global cases and over five and a half million deaths (Dong et al., 2020), COVID-19 has proven more deadly than SARS, cancer, and heart disease (Parkinson, 2020 September 26; Petersen et al., 2020). Even for those who become infected and recover, symptoms – most notably fatigue and difficulty breathing – may be present for months after they first appeared (Carfi et al., 2020; del Rio et al., 2020). In short, the evidence is overwhelming: COVID-19 is a salient threat, directly and indirectly affecting our health and our livelihoods.

Given that the effects of COVID-19 are global and ubiquitous, it is important to have an instrument that can measure perceived threat due to COVID-19 that can be used in an international context. In this paper, we report the development of the *Brief Coronavirus Threat Scale (BCTS)* to assess perceived coronavirus threat, defined as the anticipation of harm or loss due to the novel coronavirus.

Theoretical Orientation

Coronavirus threat is based on the threat construct from the transactional theory of stress and coping (Lazarus & Folkman, 1984). According to the theory, stressors (e.g., COVID-19) are indirectly related to emotional outcomes, such as anxiety, through cognitive appraisal and coping. Specifically, stressors are *primarily appraised* by evaluating whether or not the stressor has the potential to cause harm or loss (i.e., threat). If stressors are appraised as threatening, they are then *secondarily appraised* through an evaluation of one's resources to manage the stressor (i.e., coping). If one perceives that the stressor is threatening and that the demands of the encounter exceed one's resources to overcome the stressor, negative emotions (e.g., anxiety) ensue. In this way, *coronavirus threat* can be construed as a form of primary appraisal by which individuals evaluate whether or not they anticipate harm or loss due to COVID-19.

The BCTS was also inspired by existing threat related measures (e.g., the *Threat* subscale of the *Stress Appraisal Measure*; Peacock & Wong, 1990) and was adapted from the *Financial Threat Scale* (Marjanovic et al., 2013; Marjanovic et al., 2015). The *Financial Threat Scale* was developed and validated within the context of the financial recession of 2008 and financial threat been found to mediate the effect of economic stressors on anxiety (Chiacchia et al., 2018), protest behaviour (Lemoine et al., 2016), and a willingness to change one's financial behaviour (Fiksenbaum et al., 2017). Considering that previous research has supported its unidimensionality, reliability, as well as its psychological and behavioural correlates, the *Financial Threat Scale* was adapted to the context of COVID-19 and validated in a similar way in this research.

Previous Research

Since March of 2020, there has been a surge of research that has developed and validated self-report COVID-19 stress-related measures. The BCTS is distinct from the extant measures in

the following ways. Firstly, the BCTS is theoretically different in its focus and application of the transactional theory of stress and coping, as opposed to other measures that center around fear (Ahorsu et al., 2020), anxiety (Lee et al., 2020; Nikčević & Spada, 2020), phobia (Arpaci et al., 2020), distress (Kira et al., 2020; Taylor et al., 2020), intergroup threat theory (Kachanoff et al., 2020), or measures that are atheoretical (Conway et al., 2020). In this way, *coronavirus threat* can be theoretically conceptualized as a mediator of COVID-19 stressors (e.g., Tambling et al., 2021) on both coping and emotional outcomes. Secondly, the scale can be used as a general threat measure due to its unidimensional nature, in which threat is not distinguished by domain (e.g., Taylor et al., 2020). In this way, it is more parsimonious than other COVID-19 related stress measures. Lastly, the BCTS is presently validated within an international context, whereby most of the previous validation research for other COVID-19 scales has been conducted with North American samples only. In this way, we provide evidence that the BCTS can be used internationally, an important feat considering the boundless nature of the virus.

Overview of Present Research

Using a cross-sectional design, we conducted two studies (N = 4,712) to examine the factor structure and criterion validity of the *Brief Coronavirus Threat Scale* across adult samples in nine countries: Canada, the United States, the United Kingdom, Germany[1], Italy, Greece, Spain, China, and Israel. All data and *R* code have been posted on the Open Science Framework[2].

STUDY 1

The purpose of Study 1 was to assess the factor structure of the *Brief Coronavirus Threat Scale* using exploratory factor analysis. This research is part of a larger international research project looking at stress and coping with COVID-19. However, since the purpose of this study

was to explore the factor structure of the BCTS, other variables that were investigated are not reported (but can be viewed on our open science repository).

Participants

Participants (N = 784) were adults from Canada, the United States, the United Kingdom, Italy, and Germany, recruited from Amazon Mechanical Turk (MTurk) to take part in a study on "How People React to Coronavirus". They were paid $1.00 US for participation, and data were collected between March 28 and May 10, 2020. Data collection stopped at N = 784 due to financial resource constraints. Participant data were removed if they were younger than 18 years of age (n = 3), did not provide online informed consent (n = 1) or did not pass attention checks (n = 13). Missing data were removed via pairwise deletion. All survey materials were written and completed in English.

The final sample (N = 735) consisted of adults from Canada (n = 148), the United States (n = 154), the United Kingdom (n = 150), Italy (n = 142), and Germany (n = 141). In every sample, the majority of participants were single, adult males with a university education (see Table 1).

Measures

Brief Coronavirus Threat Scale (BCTS). All five items (see Table 2) were framed with the opening: "Indicate how you feel about the coronavirus by answering the following questions" and were rated on a scale from 1 (*Not at all*) to 5 (*Extremely/A great deal*). The items were adapted from the *Financial Threat Scale* (Marjanovic et al., 2013), and reflect the quintessence of threat: uncertainty (i.e., it is about the potential for harm or loss), risk (i.e., it is about being vulnerable to harm or loss), worry (i.e., it involves apprehension), and cognitive preoccupation (i.e., it is salient), as well as a face valid item.

Table 1
Descriptive statistics of demographic variables (Study 1)

	Canada *n* (%)	USA *n* (%)	UK *n* (%)	Italy *n* (%)	Germany *n* (%)
Gender					
Female	65 (43.9)	59 (38.3)	59 (39.3)	46 (32.4)	28 (19.9)
Male	83 (56.1)	94 (61.0)	90 (60.0)	96 (67.6)	113 (80.1)
Other	0 (0.0)	1 (0.6)	1 (0.7)	0 (0.0)	0 (0.0)
Education					
Elementary	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	0 (0.0)
High school	22 (14.9)	35 (22.7)	30 (20.0)	59 (41.5)	45 (31.9)
Trade school	4 (2.7)	11 (7.1)	7 (4.7)	2 (1.4)	6 (4.3)
Undergraduate	95 (64.2)	88 (57.1)	83 (55.3)	52 (36.6)	62 (44.0)
Post-graduate	27 (18.2)	20 (13.0)	29 (19.3)	29 (20.4)	28 (19.9)
Marital Status					
Married	81 (54.7)	66 (42.9)	65 (43.3)	49 (34.5)	35 (24.8)
Separated	1 (0.7)	10 (6.5)	4 (2.7)	3 (2.1)	3 (2.1)
Single	65 (43.9)	75 (48.7)	80 (53.3)	90 (63.4)	103 (73.0)
Widowed	1 (0.7)	3 (2.0)	1 (0.7)	0 (0.0)	0 (0.0)
Age					
M	32.99	37.66	31.35	30.97	29.48
SD	9.36	11.85	10.24	9.66	8.09
Minimum	18	23	18	18	18
Maximum	64	68	66	64	58

Table 2
Factor loadings, communality estimates, reliability coefficients, and descriptive statistics of the BCTS across country (Study 1).

	Canada (N=148)		US (N=154)		UK (N=150)		Italy (N=142)		Germany (N=141)	
Item	λ	h^2	λ	h^2	λ	h^2	λ	h^2	λ	h^2
How uncertain do you feel?	.46	.21	.71	.51	.60	.36	.49	.24	.80	.63
How much do you feel at risk?	.79	.62	.85	.72	.83	.69	.78	.61	.88	.78
How much do you feel threatened?	.84	.71	.83	.70	.77	.60	.81	.66	.80	.64
How much do you worry about it?	.94	.88	.84	.71	.82	.67	.88	.78	.82	.67
How much do you think about it?	.71	.50	.82	.67	.65	.42	.60	.36	.62	.38
ω		.87		.91		.86		.84		.89
M (*SD*)	3.53 (.78)		3.34 (.89)		3.28 (.89)		3.39 (.78)		2.97 (.85)	

Note. λ = completely standardized factor loading for the corresponding item, h^2 = communality estimate (i.e., percentage of variance in the item explained by the coronavirus threat construct), ω = omega.

Conscientious Responders Scale (CRS). Marjanovic et al.'s (2014) CRS was used to detect participants who had responded randomly to the measures. The scale consists of 5 items that instruct responders how to answer a particular question (e.g., please answer this question by choosing number 1, "Strongly disagree"). Responding incorrectly to more than 2 of the 5 items indicates a random response pattern and as such these participants were excluded from further analyses.

Procedure and Analytic Plan

Once recruited through MTurk, participants proceeded to the study questionnaire posted on Qualtrics where they received a randomly generated ID which allowed for identification for payment purposes. Informed consent was obtained online. All study procedures were approved by the University's Human Participants Review Sub-Committee Ethics Review Board (Certificate number: 2020-102).

In all analyses, model fit statistics were estimated via *Ordinary Least Squares (OLS)* and all analyses were conducted separately for each country in order to determine if the results were robust and replicable. Since the BCTS was measured on a five-point Likert-Type scale, the items were treated as ordinal and therefore, the polychoric correlations of the items were factor analyzed. Prior to conducting an exploratory factor analysis on the BCTS, the bivariate polychoric relationships between the five items were inspected to see if a one-factor model was suitable to the data. To explore the structural validity of the scale, we examined scree plots; conducted parallel analyses with 100 iterations of the reduced polychoric correlation matrix; and estimated standardized root mean square residuals (SRMR), factor loadings, and communality estimates. Considering that the reliability coefficient omega outperforms alpha under conditions of tau-equivalence (see Dunn et al., 2014), omega coefficients, rather than Cronbach's α, were calculated to examine the internal consistency of the scale. We did not evaluate the Root Mean

Square Error of Approximation (RMSEA) as it may not be appropriate with small degrees of freedom (e.g., $df = 5$) and small sample sizes (e.g., $N = \sim200$; Kenny et al., 2015). All analyses were conducted using the *psych* package in the R Programming Language (Revelle, 2021).

RESULTS

Overall, results of exploratory factor analyses with factor loadings estimated by OLS suggested that the one-factor model fit adequately to the data in all five countries (see Table 2). Scree plots and parallel analyses with 100 iterations of the reduced polychoric correlation matrix indicated a one-factor solution was acceptable in Canada, the US, the UK, Italy, and Germany: Eigenvalues = 3.26, 3.64, 3.17, 3.05, 3.46, respectively. Additionally, the coronavirus threat construct accounted for $58.25\%_{\text{Canada}}$, $66.08\%_{\text{United States}}$, $54.91\%_{\text{United Kingdom}}$, $52.81\%_{\text{Italy}}$, and $62.15\%_{\text{Germany}}$ of the variance of the scale. Factor loadings ranged from 0.46 to 0.94 and communality estimates ranged from 0.21 to 0.88. Except for the United Kingdom (*SRMR* = .14), the *df* corrected *SRMR*s were acceptable (Hu & Bentler, 1999) in Canada (.07), the United States (.05), Italy (.08), and Germany (.08). Internal consistency evidenced via omega coefficients were above .80 in all five countries (ωs ranged from .84 to .91). Except for Germany, all of the means were above the mid-point of the scale, which may reflect the salient nature of coronavirus threat.

Study 1 Discussion

Results of exploratory factor analyses suggested that the BCTS is a unidimensional and reliable measurement of the coronavirus threat construct. Specifically, across all countries, coronavirus threat explained more than 50% of the BCTS, factor loadings were above .40 (however, item 1 had a communality estimate lower than .50 in the Canada, United Kingdom, and Italy samples and item 5 had a communality estimate lower than .50 in the United Kingdom, Italy, and German samples), and reliability coefficients exceeded .80, providing preliminary

evidence that the BCTS is a valid and reliable measurement of coronavirus threat in both North American and European adults.

STUDY 2

The purpose of Study 2 was to confirm the structural validity of the BCTS in Canadian students, as well as adults from China, Greece, Spain, Israel, and an additional German sample. In addition to confirming the structural validity of the scale, the purpose of Study 2 was to examine the criterion validity of the construct by examining the association between coronavirus threat and COVID-19 related variables (i.e., monitoring of symptoms, avoidance of situations where transmission is possible, preventative behaviours, and occupational risk), individual differences (i.e., self-efficacy, self-reported health, worry, gender, and age), coping (i.e., self-distraction, active coping, denial, substance use, behavioral disengagement, positive reframing, and self-blame), and psychological distress about the coronavirus (i.e., anxiety, depression, anger, and fatigue).

From both the transactional model (Lazarus & Folkman, 1984) and the anxiety-to-approach model of threat and defence (Jonas et al., 2014), the COVID-19 and coping variables were included as a form of secondary appraisal, or defense, against the possibility of becoming infected with COVID-19. That is, in order to cope with or defend oneself against the threat of COVID-19, we expected that individuals higher in coronavirus threat would be more likely to engage in behaviours that monitor their own risk of transmission, reduce the possibility of infection, and that help one to overcome the stressor of COVID-19 (e.g., positive reframing). In terms of individual differences, we hypothesized that greater self-efficacy would predict lower levels of coronavirus threat, as people with high self-efficacy tend to construe stressors as a challenge to be mastered rather than a threat to be avoided (Bandura, 1997). We also expected that poor health and greater age would predict greater coronavirus threat as COVID-19 is more

fatal for older individuals and for those with pre-existing health conditions (Jordan et al., 2020). Additionally, the pandemic has been marked by a sense of persistent uncertainty (Wu et al., 2021). Considering that individuals who worry tend to be intolerant of uncertainty (Freeston, et al., 1994), we also expected that greater worry would be associated with greater coronavirus threat. Furthermore, since women have reported worsened mental health since the onset of the pandemic compared to men (Moyser, 2021), we also expected that women would report greater levels of coronavirus threat. Lastly, based on the transactional theory of stress and coping (Lazarus & Folkman, 1984), we also hypothesized that higher levels of threat would predict more negative emotion (i.e., anxiety, depression, and fatigue) as it relates to COVID-19.

The data, code, and back and forth translated BCTS have been posted on the Open Science Framework.

Participants

Participant data were removed if participants were under 18 years of age (n = 65) or did not pass attention checks (n = 172). The final sample (N = 3,977) consisted of Canadian students (n = 291), as well as adults from China (n = 398), Greece (n = 2,137), Germany (n = 274), Spain (n = 719), and Israel (n = 165). Data collection cessation was based on resource capability and constraints. Missing data were removed via pairwise deletion. Overall, the majority of participants across all six countries were adult females, with more than one-half educated at the university level (see Table 3).

Measures

See Table 4 for descriptive statistics of the continuous variables measured in Study 2.

COVID-19 Related

Coronavirus Threat was measured via the same 5-item *Brief Coronavirus Threat Scale* (*BCTS*) as in Study 1.

Table 3
Descriptive statistics of demographic variables by country (Study 2)

	Canada *n* (%)	China *n* (%)	Greece *n* (%)	Germany *n* (%)	Spain *n* (%)	Israel *n* (%)
Gender						
Female	237 (81.4)	249 (62.6)	1617 (75.7)	192 (70.1)	504 (70.1)	117 (70.9)
Male	53 (18.2)	148 (37.2)	518 (24.2)	82 (29.9)	214 (29.8)	48 (29.1)
Other	1 (0.3)	1 (0.3)	2 (0.1)	0 (0.0)	1 (0.1)	0 (0.0)
Education						
Elementary	1 (0.3)	3 (0.8)	2 (0.1)		7 (1.1)	2 (1.2)
High school	109 (37.5)	53 (13.3)	72 (3.4)		91 (14.2)	20 (12.1)
Trade school	1 (0.3)	77 (19.3)	230 (10.8)	--	98 (15.3)	12 (7.3)
Undergraduate	178 (61.2)	199 (50.0)	1077 (50.4)		331 (51.8)	131 (79.4)
Post-graduate	2 (0.7)	66 (16.6)	756 (35.4)		112 (17.5)	0 (0.0)
Marital Status						
Married	33 (11.3)	197 (49.5)	772 (36.1)	83 (30.9)	356 (49.5)	108 (65.5)
Separated	3 (1.0)	19 (4.8)	138 (6.5)	115 (42.8)	62 (8.6)	22 (13.3)
Single	255 (87.6)	179 (45.0)	1218 (57.0)	12 (4.5)	292 (40.6)	33 (20.0)
Widowed	0 (0.0)	3 (0.8)	9 (0.4)	59 (21.9)	9 (1.3)	2 (1.2)
Age						
M	22.99			36.94	41.43	44.18
SD	6.42	--	--	14.82	14.59	12.59
Minimum	18			18	18	19
Maximum	65			83	81	86

Note. In China, 15.1% (*n* = 60) were under 20 years of age, 33.4% (*n* = 133) were between 20-29 years old, 18.3% (*n* = 73) were between 30-39 years old, 18.6% (*n* = 74) were between 40-49, 12.3% (*n* = 49) were between 50-59, and 2.3% (*n* = 9) were 60 years of age or older. In Greece, 29.0% (*n* = 620) were between 18-27 years old, 33.5% (*n* = 711) were between 28-37 years old, 23.0% (*n* = 488) were between 38-47 years old, 11.4% (*n* = 243) were between 48-57, and 2.9% (*n* = 61) were 58 years of age or older. The data are not displayed in Table because age was measured categorically, rather than continuously, in both countries. For highest education in Germany, 3.5% (*n* = 9) completed *Hauptschule* (general secondary), 8.5% (*n* = 22) completed *Realschule* (practical secondary), 17.0% (*n* = 44) completed trade school or a vocational diploma, 18.9% (*n* =49) completed *Gymnasium* (academic secondary), and 52.1% (*n* = 135) completed *Fachhochschul-/Hochschulabschluss* (university education).

Monitoring of Symptoms was measured by seven items on a scale from 1 (*Not at all*) to 5 (*A great deal*) that assessed how often participants engaged in a number of COVID-19 related monitoring behaviours. Four items captured a *Self-Monitoring* factor (e.g., "Paid attention to any coughing I might do"), ωs ranged from .87 to .93, and three items captured a *Professional-*

Monitoring factor (e.g., "Gone to a doctor or other health care professional"), ωs ranged from .79 to .92. Inter-factor correlations ranged from .66 to .77.

Table 4. Descriptive statistics of continuous variables by country (Study 2)

		Canada (N = 291)		China (N = 398)		Greece (N = 2137)		Germany (N = 274)		Spain (N = 719)		Israel (N = 165)	
	Range	*M* (*SD*)	ω	*M* (*SD*)	ω	*M* (*SD*)	ω	*M* (*SD*)	ω	*M* (*SD*)	ω	*M* (*SD*)	ω
Self-Monitoring	1-5	2.70 (1.09)	**.90**	3.14 (1.15)	**.91**	2.02 (1.02)	**.87**	1.64 (0.85)	**.87**	2.12 (0.87)	**.87**	2.31 (0.98)	**.90**
Professional-Monitoring	1-5	1.30 (0.73)	**.84**	1.88 (1.06)	**.83**	1.71 (0.48)	**.62**	1.13 (0.40)	**.59**	1.21 (0.56)	**.72**	1.29 (0.60)	**.65**
Avoidance	1-5	4.36 (0.88)	**.94**	3.94 (0.96)	**.93**	4.22 (0.92)	**.92**	4.06 (0.71)	**.80**	4.02 (0.81)	**.69**	3.31 (1.28)	**.93**
Hygienic Prevention	1-5	4.11 (0.90)	**.77**	4.16 (0.80)	**.81**	4.06 (0.85)	**.77**	2.74 (0.73)	**.58**	3.59 (0.96)	**.70**	3.74 (0.80)	**.73**
Health Prevention	1-5	3.09 (0.99)	**.73**	3.55 (0.90)	**.76**	3.08 (1.01)	**.71**	2.76 (1.04)	**.76**	2.80 (0.90)	**.68**	2.46 (0.97)	**.57**
Occupational Risk	1-4	--	--	1.93 (0.98)	--	2.97 (1.01)	--	2.72 (1.46)	--	2.48 (1.08)	--	2.28 (1.08)	--
Self-Efficacy	1-4	2.91 (0.52)	**.78**	2.73 (0.80)	**.90**	2.55 (0.69)	**.77**	2.99 (0.54)	**.68**	2.56 (0.63)	**.78**	2.76 (0.74)	**.87**
Health	1-5	2.12 (0.98)	--	1.79 (0.91)	--	1.84 (1.02)	--	1.73 (1.08)	--	2.01 (0.74)	--	1.66 (0.70)	--
Worry	1-5	3.25 (1.18)	--	3.81 (1.09)	--	2.99 (1.11)	--	2.19 (0.85)	--	2.16 (1.08)	--	2.82 (1.14)	--
Self-Distraction	1-4	2.91 (0.84)	**.65**	2.47 (0.85)	**.76**	3.12 (0.87)	**.65**	2.65 (0.85)	**.79**	2.86 (0.84)	**.51**	2.52 (0.96)	**.68**
Active Coping	1-4	2.66 (0.75)	**.68**	2.63 (0.84)	**.85**	2.99 (0.86)	**.72**	--	--	2.51 (0.87)	**.70**	2.35 (1.02)	**.81**
Denial	1-4	1.42 (0.70)	**.83**	1.53 (0.78)	**.86**	1.34 (0.69)	**.85**	1.32 (0.56)	**.65**	1.40 (0.69)	**.81**	1.77 (1.03)	**.88**
Substance use	1-4	1.36 (0.75)	**.95**	1.62 (0.81)	**.85**	1.12 (0.33)	**.56**	1.21 (0.50)	**.92**	1.10 (0.36)	**.84**	1.33 (0.67)	**.91**
Behavioral Disengagement	1-4	1.60 (0.76)	**.87**	1.32 (0.68)	**.90**	1.20 (0.46)	**.60**	1.46 (0.56)	**.62**	1.18 (0.46)	**.81**	1.35 (0.73)	**.94**
Positive Reframing	1-4	2.83 (0.85)	**.78**	2.54 (0.79)	**.71**	2.80 (0.89)	**.71**	2.71 (0.84)	**.87**	2.62 (0.88)	**.77**	2.60 (0.87)	**.72**
Self-Blame	1-4	1.56 (0.71)	**.68**	1.43 (0.70)	**.87**	1.84 (0.58)	**.51**	1.22 (0.44)	**.69**	1.26 (0.48)	**.64**	1.66 (0.62)	**.53**
Distress about COVID-19	1-5	2.35 (0.93)	**.94**	1.90 (0.82)	**.98**	2.36 (0.80)	**.95**	1.85 (0.63)	**.94**	2.07 (0.78)	**.96**	2.07 (0.93)	**.97**

Avoidance of COVID-19 transmission was assessed with ten items on a scale from 1 (*Not at all*) to 5 (*A great deal*) that examined the extent to which individuals avoided situations where virus transmission was possible (e.g., "To avoid getting coronavirus, I have avoided...

People who were coughing or sneezing"). Exploratory factor analyses suggested that a one-factor model fit the data well across countries, ωs ranged from .80 to .96.

Preventative Behaviours consisted of eight items[3] measured on a scale from 1 (*Not at all*) to 5 (*A great deal*) that captured the extent to which individuals engaged in both hygienic and healthy behaviours to avoid COVID-19 transmission. Four items captured a *Hygienic-Focused* factor (e.g., "To avoid getting coronavirus, I have…worn a mask"), ωs ranged from .65 to .86, and four items captured a *Health-Focused* factor (e.g., "To avoid getting coronavirus, I have…taken vitamins/herbal supplements), ωs ranged from .75 to .82. Inter-factor correlations ranged from .10 to .77.

Occupational risk was measured by one item that asked participants, on a scale from 1 (*Not at all)* to 4 (*Very much so*), the extent to which their occupation presented risks for getting coronavirus[4].

Individual Differences

Self-efficacy, operationalized as optimistic self-beliefs to overcome COVID-19, was adapted from Schwarzer and Jerusalem's (1995) 10-item *General Self-Efficacy Scale* (GSE). Four items, endorsed on a scale from 1 (*Not at all true*) to 4 (*Exactly true)*, assessed the extent to which individuals believed they could overcome the demands that COVID-19 imposed (e.g., "I can remain calm when facing [the coronavirus] because I can rely on my coping abilities"). The scale had acceptable reliability across all countries, ωs ranged from .68 to .90.

Health was measured by one item that asked participants to describe their general health on a scale from 1 (*Excellent*) to 5 (*Poor*).

Worry was measured by one item that asked participants, "In general, would you say you are a worrier? That is do you worry all the time?". Participants rated their agreement on a scale from 1 (*Not at all*) to 5 (*Extremely*).

Demographics, such as age and gender, were also measured to explore if there were gender differences in coronavirus threat, and to examine if older adults reported greater levels of coronavirus threat than younger adults.

Coping

Coping with COVID-19 was measured by Carver's (1997) Self-Distraction (e.g., "I've been turning to work or other activities to take my mind off things"), ωs ranged from .51 to .79; Active Coping (e.g., "I've been taking action to try to make the situation better"), ωs ranged from .68 to .85; Denial (e.g., "I've been refusing to believe that it has happened"), ωs ranged from .65 to .88; Substance Use (e.g., "I've been using alcohol or other drugs to help me get through it"), ωs ranged from .56 to .95; Behavioural Disengagement (e.g., "I've been giving up the attempt to cope"), ωs ranged from .60 to .94; Positive Reframing (e.g., "I've been looking for something good in what is happening"), ωs ranged from .71 to .87; and Self-Blame (e.g., "I've been blaming myself for things that happened"), ωs ranged from .51 to .87, subscales of the Brief COPE. All subscales contained two items each. Instructions asked participants to indicate how they have been coping with the coronavirus specifically. Items were endorsed on a scale from 1 (*I haven't been doing this at all*) to 4 (*I've been doing this a lot*).

Emotion

Psychological distress was a 26-item composite variable comprised of the 6-item *Anxiety*, 8-item *Depression*, 7-item *Anger*, and 5-item *Fatigue* subscales of the *Profile of Mood States – Short Form* (Shacham, 1983). Participants were asked to indicate their recent feelings about coronavirus on a scale from 1 (*Not at all*) to 5 (*Extremely*), ωs ranged from .94 to .98.

Procedure and Analytic Plan

Data were collected online from April 2nd to September 1st, 2020 using a variety of recruitment methods, such as posts on social media (i.e., Facebook, Twitter, and Instagram),

flyers on university homepages, and through online participant recruitment tools (i.e., E-Poll Surveys, Questionstar, and SoSci). Prior to data collection, survey protocols were translated by a researcher fluent in the applicable language and then translated back into English. Informed consent was obtained online. Where applicable, all study procedures were approved by each institution's Ethics Review Board.

Considering that the scale points of the BCTS ranged from 1 to 5, the items were treated as ordered and categorical and thus, polychoric correlations, rather than product-moment correlations, were estimated to fit the models. Parameter estimates and model fit indices were obtained via robust weighted least squares estimation, whereby Satorra-Bentler-type adjustments to the fit statistics and standard errors were applied (Rhemtulla et al., 2012). Prior to running the CFAs across country, the polychoric correlations among the scale items and their residual correlations, as well as scree plots and parallel analyses with 100 iterations of the reduced polychoric correlations, were examined. Analyses for the CFAs were conducted using the *lavaan* (Rosseel, 2012) and *semTools* (Jorgenson et al., 2021) packages in the R Programming Language (R Core Team, 2020). Omega coefficients from CFAs (i.e., for the BCTS) and EFAs (i.e., for the supplementary analyses) were conducted using the *psych* package (Revelle, 2021), whereas omega coefficients from extant scales (e.g., coping variables) were conducted using the *MBESS* package (Kelley, 2020).

To evaluate the convergent validity of the scale, we conducted a series of bivariate correlations between coronavirus threat and COVID-19 related, individual difference, coping, and distress variables across country. We meta-analyzed the bivariate associations across all six countries using random-effects models. We used a random-effects approach to the internal meta-analysis to account for study heterogeneity, because the effect sizes were obtained from different populations. Study heterogeneity, or τ^2, was calculated using a restricted maximum-likelihood

estimator. All correlations were Fisher's *z* transformed for analyses and converted back to Pearson correlations for presentation. Data were analyzed using the *metafor* (Viechtbauer, 2010), *robumeta* (Fisher et al., 2017) and *correlation* (Makowski et al., 2019) packages for R. For point-biserial relationships (i.e., the relationship between coronavirus threat and gender), Cohen's *d* was calculated using the *psych* package (Revelle, 2021) and converted to *r* using the *effect size* package (Ben-Shachar et al., 2020). The analytic plan for the meta-analysis was guided by Quintana (2015).

RESULTS

CFA

Overall, the model fit statistics for the one-factor model (see Table 5), suggested that the model fit well to the data in all seven countries, *CFI* = .96 to .99, *TLI* = .92 to .99. Except for Spain (*SRMR* = .09), all of the *SRMRs* were acceptable, and ranged from .03 to .07. Generally speaking, *CFIs* and *TLIs* greater than .95 are indicative of good fit, and *SRMRs* below .08 are indicative of acceptable fit (Hu & Bentler, 1999). Factor loadings ranged from .51 to .97. Additionally, the scale had acceptable reliability across all samples: ωs ranged from .85 to .94. Therefore, the evidence suggests that the BCTS is an acceptable, unidimensional, and reliable measure of the coronavirus threat construct.

To determine if the BCTS was equivalent across country (Chen et al., 2007; Putnick & Bornstein, 2016), we also estimated and compared the fit of configural, metric, scalar, and strict invariance models. Firstly, the configural model fit the data well, *CFI* = .99, *TLI* = .99, *SRMR* = .05, which means that the same number of factors holds for each country and the same variables define the factor across country. Imposing equality constraints on all factor loadings (i.e., metric invariance) did not result in worse model fit, ΔCFI = -.004, ΔTLI = .004, $\Delta SRMR$ = .023. Although imposing equality constraints on both factor loadings and intercept parameters (i.e.,

scalar invariance) lead to worse fit according to the *CFI*, Δ*CFI* = -.018, other indices slightly improved or remained unchanged, Δ*TLI* = .001, Δ*SRMR* = -.022. Lastly, imposing equality constraints on all factor loadings, intercepts, and observed variable error variances (i.e., strict invariance) did not result in worse fit when compared to the scalar invariance model, Δ*CFI* = .010, Δ*TLI* = .006, Δ*SRMR* = .001. Therefore, the BCTS is sufficiently equivalent for individuals in Canada, China, Greece, Spain, and Israel.

Table 5: Results of the confirmatory factor analyses by country (Study 2).

	Canada (N = 286)		China (N = 398)		Greece (N = 2137)		Germany (N = 274)		Spain (N = 719)		Israel (N = 163)	
Item	λ	ε	λ	ε	λ	ε	λ	ε	λ	ε	λ	ε
How uncertain do you feel?	.51	.74	.68	.54	.62	.62	.80	.36	.81	.34	.89	.21
How much do you feel at risk?	.81	.35	.86	.27	.94	.13	.87	.24	.91	.17	.97	.07
How much do you feel threatened?	.87	.24	.92	.16	.95	.10	.87	.24	.83	.31	.96	.08
How much do you worry about it?	.85	.28	.92	.16	.90	.19	.75	.43	.85	.27	.88	.24
How much do you think about it?	.75	.43	.77	.40	.80	.37	.58	.67	.82	.33	.87	.24
M (*SD*)	2.90 (0.81)		3.36 (0.92)		2.82 (0.90)		2.73 (0.76)		2.80 (0.92)		2.53 (1.02)	
CFI	.96		.99		.99		.97		.96		.99	
TLI	.92		.98		.99		.94		.92		.99	
SRMR	.07		.03		.03		.06		.09		.06	
ω	.85		.90		.90		.86		.91		.94	

Note. λ = completely standardized factor loading for the corresponding item, ε = standardized error variance (i.e., percentage of variance in coronavirus threat *not* explained by the corresponding item), *CFI* = robust comparative fit index; *TLI* = robust Tucker-Lewis index; *SRMR* = *df* corrected standardized root mean square residual; ω = omega. Estimates were obtained via robust diagonally weighted least squares estimation.

Criterion Validity

COVID-19 Related Variables

Results of a random-effects meta-analysis (see Table 6) suggested that coronavirus threat was strongly positively correlated with self-monitoring behaviours. A Baujat plot (Baujat et al.,

2002), as well as an analysis of outliers and influential cases (Viechtbauer & Cheung, 2010), suggested that the relationship was smallest in China, r = .21, 95% CI [.11, .30]. In addition to self-monitoring behaviours, coronavirus threat was also significantly and modestly positively associated with being monitored by a professional, with no indication of sample heterogeneity or influential cases. Further supporting the convergent validity of the BCTS, coronavirus threat was moderately positively associated with the avoidance of situations where virus transmission was possible. Importantly, there was statistically significant sample heterogeneity, in which the relationship was weakest for Canadian students, r = .10, 95% CI [-.02, .22]. Coronavirus threat was also quite strongly positively associated with engaging in hygienic-based preventative behaviours, in which the relationship was smallest in China, r = .14, 95% CI [.04, .24]. The relationship between coronavirus threat and engaging in health-based preventative behaviours was negligible, with no evidence of sample heterogeneity. Lastly, those who worked in occupations where one was at risk for getting coronavirus were also more likely to feel threatened by the virus, whereby the relationship was strongest in Israel, r = .41, 95% CI [.27, .53].

Individual Differences

Individuals who felt more efficacious in coping with COVID-19 were moderately less likely to feel threatened by the virus, but the effect was weakest in China, r = -.04, 95% CI [-.14, .06]. As expected, individuals who self-reported poor health were more likely to report greater levels of coronavirus threat, whereby the relationship was weakest in Greece, r = .14, 95% CI [.10, .18]. Self-reported worriers were much more likely to score higher on the BCTS, but there was substantial sample heterogeneity. Although none of the samples were identified as outliers, the relationship between worry and coronavirus threat was weak in China, r = .09, 95% CI [-.01, .19], but strong in Germany, r = .62, 95% CI [.54, .69] and Israel, r = .61, 95% CI [.50, .70].

Lastly, age and gender were weakly associated with coronavirus threat, with older adults and women reporting slightly greater levels of coronavirus threat. We found no evidence of sample heterogeneity for gender and age.

Table 6
Pearson correlations of coronavirus threat and study variables (Study 2)

	Canada (N = 286)	China (N = 398)	Greece (N = 2137)	Germany (N = 274)	Spain (N = 719)	Israel (N = 163)	Random Effects Correlation [95% CI]
COVID-19 Related							
Self-Monitoring	.39***	.21***	.44***	.38***	.35***	.44***	.37 [.30, .44]
Professional-Monitoring	.15*	.03	.16***	.13*	.16***	.30***	.15 [.10, .20]
Avoidance	.10	.27***	.32***	.18**	.28***	.18*	.24 [.17, .30]
Hygienic Prevention	.28***	.14**	.38***	.29***	.30***	.38***	.30 [.22, .37]
Health Prevention	.01	.05	.06**	.02	.01	.06	.04 [.01, .07]
Occupational Risk	--	.21***	.08***	.05	.19**	.41***	.18 [.06, .30]
Individual Differences							
Self-Efficacy	-.24***	-.04	-.28***	-.36***	-.26***	-.26***	-.24 [-.32, -.16]
Health	.20***	.16*	.14***	.26***	.23***	.16	.18 [.14, .23]
Worry	.37***	.09	.43***	.62***	.27***	.61***	.41 [.24, .56]
Age	.03	--	--	.21***	.10**	.05	.10 [.03, .17]
Gender	.14	.03	.11***	.14*	.10**	-.03	.10 [.07, .13]
Coping							
Self-Distraction	.11	.22***	.17***	.16**	.11**	.23**	.16 [.13, .19]
Active Coping	.16**	.23***	.09***	--	.21***	.27***	.18 [.11, .25]
Denial	.06	.07	.05*	.18**	.25***	.47***	.18 [.05, .30]
Substance use	.12*	.18***	.07***	.02	.11**	.13	.10 [.06, .14]
Behavioral Disengagement	.10	.10*	.14***	-.04	.18***	.26***	.12 [.06, .19]
Positive Reframing	.09	.25***	-.02	-.26***	-.06	.11	.04 [-.10, .17]
Self-Blame	.26***	.13**	.10***	.16**	.12**	.20*	.14 [.10, .19]
Emotion							
Distress about COVID-19	.51***	.29***	.57***	.52***	.42***	.70***	.51 [.39, .61]

Note. * $p < .05$, ** $p < .001$, *** $p < .001$
A positive coefficient for gender indicates that females scored higher, whereas a negative coefficient indicates that males scored higher

Coping

Supporting the transactional theory of stress and coping, individuals who reported greater threat due to COVID-19 were more likely to cope by engaging in self-distraction, active coping, denial,

substance use, self-blame, and by behaviourally disengaging with COVID-19, but not by engaging in positive reframing. Although there was no evidence of sample heterogeneity in coping via self-distraction, substance use, or self-blame, there was evidence of sample heterogeneity for active coping and denial, whereby the relationship was weakest in Greece, r = .09, 95% CI [.05, .13] and r = .09, 95% CI [.05, .13], respectively; for behavioural disengagement, in which the relationship was weakest in Germany, r = -.04, 95% CI [-.16, .08]; and for positive reframing, where the relationship was positive and modest in China, r = .25, 95% CI [.16, .34], but negative and modest in Germany, r = -.26, 95% CI [-.37, -.15].

Psychological Distress

Coronavirus threat was strongly positively associated with distress (i.e., anxiety, depression, anger, and fatigue) about the virus, but there was statistically significant sample heterogeneity. A Baujat plot as well as analysis of outliers and influential cases suggested that the relationship was largest in Israel, r = .70, 95% CI [.61, .77].

Study 2 Discussion

The purpose of study 2 was to evaluate the structural and convergent validity of the BCTS across six countries: Canada, China, Greece, Germany, Spain, and Israel. Incremental fit indices (CFIs > .95, TLIs > .92, SRMRs <= .09), factor loadings (λs ranged from .51 to .97), reliability estimates (ωs ranged from .85 to .94), and correlations with variables that are theoretically and practically important, provided strong evidence that the BCTS is a valid, reliable, and useful measurement of the coronavirus threat construct.

General Discussion

Across two studies, over 4,700 adults, and nine countries, the current research provides support that the *Brief Coronavirus Threat Scale* is a valid and reliable tool that can be measured in an international context. Results of exploratory and confirmatory factor analyses demonstrated

that the coronavirus threat construct explained between 53% to 66% of the variance in the BCTS, factor loadings ranged from .51 to .97, *CFI*s and *TLI*s were greater than .90, and reliability coefficients ranged from .84 to .94 across all nine countries. In this way, the BCTS can be used in an international context to help understand and predict how people appraise and cope with the effects of COVID-19.

Theoretical Implications

According to the anxiety-to-approach model of threat and defence (Jonas et al., 2014), a threat is perceived if a discrepancy exists between one's expectations (e.g., "I need to feel safe") and one's life circumstances (e.g., "My safety is at risk for loss"). Importantly, through the behavioural inhibition system, people are motivated to reduce the anxiety created from this discrepancy through cognitively and/or behaviourally attending to the threat (i.e., hypervigilance) and/or avoiding the threat. In study 2, random effects meta-analytic models demonstrated that the BCTS was strongly associated with self-monitoring of one's symptoms, a form of COVID-19 related vigilance; weakly correlated with being monitored by a professional, a stronger form of being vigilant about COVID-19; strongly correlated with avoiding situations where virus transmission was possible; and strongly correlated with being distressed about COVID-19. These theoretically important relationships provide support for the convergent validity of the BCTS.

In addition to hypervigilant and avoidant behaviour, the anxiety-to-approach model of threat and defence (Jonas et al., 2014) also posits that individuals will engage in approach-oriented behaviour (via the behavioural activation system) if the discrepancy between one's expectations and their life circumstances appears manageable and/or a solution is obvious. Considering that activities such as handwashing and mask wearing have been shown to be effective in mitigating the infection and spread of COVID-19 (National Center for Immunization

and Respiratory Diseases, 2021 March 8) and are relatively accessible solutions in solving one's discrepancy of needing safety and feeling safe, a measure of COVID-19 threat should have also predicted COVID-19 preventative behaviour (e.g., using hand sanitizer, wearing a mask). Importantly, a random effects meta-analysis suggested that coronavirus threat was associated with hygienic-based, but not health-based, preventative behaviour, and the relationship was quite strong in magnitude.

The transactional theory of stress and coping (Lazarus & Folkman, 1984) postulates that individuals will vary in the extent to which they perceive a stressor as having the potential to cause harm or loss. As noted by Lazarus and Folkman (1987), the perception of threat "requires the conjunction of an environment having certain attributes with a particular kind of person who will react with threat when exposed to those environmental attributes" (p. 142). In study 2, we examined whether an individual's sense of self-efficacy in overcoming COVD-19, self-reported health, and a tendency to worry were associated with coronavirus threat. Considering that people with high self-efficacy tend to construe stressors as a challenge to be mastered rather than a threat to be avoided, and they approach threats with a sense of control over them (Bandura, 1997), individuals with a high sense of self-efficacy in regard to COVID-19 should feel less threatened by the virus. Additionally, since the effects of COVID-19 are often more severe in people with health conditions, such as lung or heart disease (Jordan et al., 2020), individuals who report poor health should also report more threat related to COVID-19. Lastly, since worriers are intolerant of uncertainty (Freeston et al., 1994), often remembering threat-related words in memory tasks better than neutral words (Friedman et al., 2000), individuals who report a tendency to worry should also report greater coronavirus threat as measured by the BCTS. Results of random effects meta-analyses demonstrated that self-efficacy was moderately and negatively related to coronavirus threat while poor health was sufficiently positively related to

coronavirus threat, and worry was strongly positively related to coronavirus threat, thereby providing further support for the validity of the BCTS.

Lastly, in line with the transactional theory of stress and coping, if a stressor is appraised as threatening, people will engage in a secondary appraisal process by which they employ "cognitive and behavioral efforts to master, reduce, or tolerate the internal/external demands that are created by the stressful encounter" (Folkman, 1984, p. 843). Supporting the transactional theory of stress and coping, individuals who reported greater levels of coronavirus threat were more likely to engage in self-distraction, active coping, denial, substance use, and blame themselves in order to overcome the demands that COVID-19 elicited. They were also more likely to behaviourally disengage from the stressor (i.e., giving up the attempt to cope). Although the correlations between coping and coronavirus threat were small in magnitude, it is important to note that there are likely a number of moderators that influence the relationship between coronavirus threat and coping behaviours (e.g., perceived control; Folkman, 1984). Also, a small effect is practically important when one considers the negative consequences that can arise from engaging in maladaptive forms of coping, such as substance use (Wardell et al., 2020).

Practical Implications

In study 2, we found that occupational risk of contracting COVID-19 was positively associated with coronavirus threat. Previous research suggests that individuals who work in jobs where contact with others is frequent, proximity to others is close, and exposure to disease and infection is likely, are much more likely to develop severe COVID-19 (Hawkins, 2020). In a national UK sample of 120,000 participants, healthcare workers were almost seven and a half times more likely to develop severe COVID-19 relative to non-essential workers (Mutambudzi et al., 2020). To reduce the high levels of threat that may be present for essential workers, the current research suggests that employees may benefit if organizations take a number of steps to

prevent the spread of the virus at their worksites, including ensuring physical distancing and hygienic practices, ensuring proper ventilation and air conditioning, transparent communication with staff about workplace changes, and supporting workers in higher-risk groups (e.g., see www.hse.gov.uk/coronavirus).

In addition to occupational challenges, we also found that individuals who felt more threatened by COVID-19 were also more likely to cope by engaging in substance use. In fact, one in four Canadian adults have been drinking more since the start of the pandemic (Canadian Centre on Substance Use and Addiction, 2020) which is problematic, considering the long-term health consequences of alcohol misuse (e.g., see Center for Disease Control and Prevention, 2021). Perhaps more alarmingly, substance abuse could make individuals more susceptible to infection (e.g., by leaving one's home to purchase substances) or severe COVID-19 (Ornell et al., 2020). In this way, reducing threat associated with COVID-19 (e.g., by offering practical solutions to seek social support) may prevent individuals from engaging in substance misuse, which may in turn, prevent individuals from also contracting and spreading COVID-19.

In this research we also found that the strength of the relationship between coronavirus threat and relevant psychological variables differed by country. It is important to note that national differences in these relationships may reflect responses to national policy to deal with the pandemic, and not cultural differences *per se*. For example, in the face of a surge in infections, governments often implement lockdowns and shutdowns to restrict social interaction and non-essential travel in an effort to control the spread of the virus. Since surges in infection as well as government policies varied not only over time but within countries, this may explain the heterogeneity in the meta-analyses. Future research could be directed to linking shutdowns and lockdowns with key psychological variables.

Limitations and Future Directions

In the current research, the relationship between coronavirus threat and coping was small in magnitude. Considering that the subscales of the Brief COPE are only two-items each, a few of the subscales had poor reliability (see Table 4) and thus, the relationships between coronavirus threat and coping should be interpreted cautiously. To better capture the process-oriented nature of stress and coping, future research should examine the extent to which perceptions of threat, coping, and distress change over time. Considering that the context of COVID-19 changes frequently (e.g., with lockdowns, restrictions, cases, vaccines), such a longitudinal and within-person approach would provide ecological and externally valid evidence of the day-to-day changes in threat and coping with COVID-19.

Results of random effects meta-analyses suggested that the correlations between coronavirus threat and a number of theoretically and practically important variables differed across country. There was also substantial sample heterogeneity in the meta-analytic relationship between coronavirus threat and coping variables. Future research should examine the extent to which context-specific, governmental policy, and culturally relevant variables may explain the moderative effects of country on the relationship between coronavirus threat and relevant variables.

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Footnotes

[1] There were two German samples in the current research: One collected through MTurk (Study 1) and one collected through SoSci (Study 2).

[2] All data, code, and supplementary files/analyses can be viewed here: https://osf.io/98xyk/?view_only=1c1596efdfda4f0a9c68f8f837a25531

[3] The original scale had an additional item, "Googled coronavirus symptoms to see if I have it". Considering that the item is not theoretically a preventative behaviour, and due to its poor fit with the overall scale across most countries (λs = .32, .67, .31, .20, .12, and .35 for Canada, China, Greece, Germany, Spain, and Israel, respectively), the item was removed from the overall scale.

[4] Occupational risk was assessed on a five-point scale in Germany.