Cross-Cultural and Gender Invariance of Transdiagnostic Processes in the United States and Singapore

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Abstract

The research domain criteria (RDoC) define cognitive and emotional processes (e.g., rumination, intolerance of uncertainty, anxiety sensitivity, emotion-dysregulation) as key transdiagnostic elements of psychopathology (Cuthbert, 2015). However, there is currently a dearth of construct equivalence studies on measures of these processes. We thus aimed to validate the latent structures of five transdiagnostic constructs using established and newer measures: two-factor Rumination-Reflection Questionnaire (Trapnell & Campbell, 1999), six-factor Perseverative Cognitions Questionnaire (Szkodny & Newman, in press), two-factor Intolerance of Uncertainty Scale (Buhr & Dugas, 2002), three-factor Anxiety Sensitivity Index-3 (Taylor et al., 2007), two-factor Cognitive and Behavioral Processes Questionnaire (Patel, Mansell, & Veale, 2015). Measurement equivalence was examined across 292 American and 144 Singaporean undergraduates. Cross-cultural confirmatory factor analyses revealed strict invariance for all measures, with inter-factor association differences on the PCQ and CBPQ. Across gender, full invariance was found on all measures except the CBPQ. Theoretical and clinical implications are discussed.

Keywords: RDoC, transdiagnostic, culture, multi-group confirmatory factor analyses

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The Research Domain Criteria (RDoC) framework articulated by the National Institute of Mental Health reflects efforts to move toward dimensional (vs. categorical) definitions of psychopathology (Cuthbert, 2015; Insel et al., 2010). Dimensional conceptualizations capture more precisely the patterns (or mechanisms) of action that cause and prolong various mental illnesses defined by artificial boundaries. Notably, the RDoC negative valence systems domain prioritizes constructs of perseverative thinking (e.g., rumination), intolerance of uncertainty, and anxiety sensitivity as transdiagnostic processes. Emotion dysregulation processes (e.g., avoidance, non-acceptance, mindlessness) have also been proposed to be part of a separate RDoC matrix given their centrality in mental disorders (Fernandez, Jazaieri, & Gross, 2016). Passive brooding, worrying, or ruminating generate distress (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) and are connected to a host of psychopathologies, cardiorespiratory, and somatic pain symptoms (Sansone & Sansone, 2012). Intolerance of uncertainty, the tendency to fear the unknown, is also intertwined with psychiatric disorders and functions as a transdiagnostic treatment mechanism (McEvoy & Erceg-Hurn, 2016). Anxiety sensitivity, the fear of negative repercussions of anxiety-linked physiological arousal, is a susceptibility factor observed in panic and other anxiety disorders (e.g., specific phobia) and borderline personality disorder (Naragon-Gainey, 2010). Emotion dysregulation (e.g., habitual avoidance of internal and external experiences) is another major component that puts people at risk of mental disorders (Aldao, Gee, De Los Reyes, & Seager, 2016). Improving our understanding of these negative valence systems and emotion dysregulation constructs is thus essential.

Process models posit that these constructs reflect a pervasive sense of pessimism and
uncontrollability in heightened anxiety and depression (see meta-analysis by Hong & Cheung, 2015). Moreover, transdiagnostic theories propose that aberrant cognitive (e.g., attentional avoidance) and behavioral processes (e.g., task avoidance, safety behaviors) feed into clinically significant emotion dysregulation patterns (Mansell, Harvey, Watkins, & Shafran, 2009). Collectively, these constructs are theorized to contribute to the etiology or maintenance of psychopathology (Beck & Haigh, 2014; Tolin, 2016).

To refine transdiagnostic assessment and treatment, clinical science can benefit from further investigating five relevant measures of these constructs. Of the five measures tested in the present study, there are three established measures, namely the 24-item Rumination-Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999), 27-item Intolerance of Uncertainty Scale (IUS; Buhr & Dugas, 2002), and 18-item Anxiety Sensitivity Index–3 (ASI-3; Taylor et al., 2007). To date, these widely used scales have been highly cited in the literature (e.g., by more than 1,500 reports since their formation based on Google Scholar citations). Also, the RRQ is a purer measure of rumination than other more widely utilized rumination scales (Response Styles Questionnaire, Rumination Responses Scale; Nolen-Hoeksema & Morrow, 1991; Treynor, Gonzalez, & Nolen-Hoeksema, 2003) as it is not cross-contaminated with depression symptoms.

Further, consistent with the mission of RDoC, the field can also benefit from refining two newer transdiagnostic measures, such as the 45-item Perseverative Cognitions Questionnaire (PCQ; Szkodny & Newman, in press) and 15-item Cognitive and Behavioral Processes Questionnaire (CBPQ; Patel et al., 2015). These scales directly tap into various trait-level facets of negative repetitive thought (e.g., cognitions discordant from ideal self, expecting the worst) and emotion dysregulation processes (e.g., perpetual avoidance of major tasks or unpleasant internal events). Newer tools tend to be subject to greater empirical scrutiny (e.g., creation of the
PCQ included both exploratory factor analysis and confirmatory factor analysis; Szkodny & Newman, in press). Moreover, the PCQ captures different aspects of repetitive thinking without any bias by sidestepping the use of ‘worry’ or ‘rumination’, terms that can be construed idiosyncratically. Importantly, these five transdiagnostic assessments (RRQ, PCQ, IUS, ASI-3, CBPQ) have strong internal consistency, retest reliability, convergent, and discriminant validity (Cai et al., 2018; Gillett, Bilek, Hanna, & Fitzgerald, 2018; Norton, 2005; Patel et al., 2015; Szkodny & Newman, in press; Teasdale & Green, 2004; Trapnell & Campbell, 1999). Probing these tools further can thus move the RDoC transdiagnostic agenda forward.

Two major limitations of these measures are that psychometric data have been mainly derived from Caucasian populations and the degree to which these tools are equal across men and women is unclear. Comparisons of transdiagnostic constructs across countries and gender offer new knowledge with respect to the universality of disorder-generating constructs. Such studies enable future research to include these validated measures within diverse settings (e.g., treatment). Remarkably, despite recent proliferation of transdiagnostic studies across nations (e.g., McEvoy & Erceg-Hurn, 2016), the field has neglected to attend to the extent to which these constructs are equal across culture and gender. Whisman, Judd, Whiteford, and Gelhorn (2013) and Sue (1999) highlighted that the field should not assume that findings found in one sample are generalizable to another, as such presumptions do not reflect best scientific practices. Malgady (1996) asserted that clinical researchers should assume that these tools differ across culturally distinct samples unless shown otherwise, a stark contrast to conventional null hypothesis testing.

Construct compatibility (measurement invariance) refers to the mathematical equality of related assessment parameters for a specified latent factor (thresholds and loadings of indicators of a latent construct) across different samples. Measurement equivalence is essential to ensure
that the constructs of rumination, intolerance of uncertainty, anxiety sensitivity, perseverative thinking, and emotion dysregulation are operating equivalently across distinct groups (Byrne, 2012; Gregorich, 2006). As an example, only after establishing construct compatibility and partialling out measurement error across gender can we be more confident that true latent means of depression and rumination constructs are higher among women than men (Whisman et al., in press; Whisman et al., 2013). Also, culture can influence ruminative styles, as shown in a recent study conducted on United States (US) and Argentina samples (Arana & Rice, in press).

Cultural context and sense of self as independent or interdependent may impact patterns of interpretation and endorsement of items on transdiagnostic measures (Markus & Kitayama, 2010). For instance, the pressure to foster harmonious social ties and engage in community-level problem-solving in collectivistic (vs. individualistic) cultures may promote more perseverative thought in Asian (vs. Western) samples (Chang, Tsai, & Sanna, 2010; Jose, Kramar, & Hou, 2014). Without establishment of measurement invariance, any between-group variation in mean scores or bivariate relations may hence be misleading.

Cross-cultural and gender research has shown that rumination and emotion dysregulation concepts share the same meaning in North American, European, and East Asian cultures, as well as in men and women (Kwon, Yoon, Joormann, & Kwon, 2013; Liu, Chen, & Tu, 2017). Further, anxiety sensitivity is a construct that repeatedly presents with a comparable definition across gender and more than 15 countries (Ghisi et al., 2016). For intolerance of uncertainty, although studies have shown that the concept functions equally across gender (Bottesi et al., 2015; Hong & Lee, 2015), no studies have tested if the ideas underlying IU are the same across various nations. Inquiring on the extent to which transdiagnostic concepts operate in parallel ways across unique contexts constructively adds to the discourse on the value of tailoring
assessments and treatments to diverse gender and cultural orientations (Huey Jr., Tilley, Jones, & Smith, 2014; Owen, Wong, & Rodolfa, 2009).

At the same time, cross-national measurement equivalent studies need to reflect the nuanced understanding that other non-Western cultures and geographical regions (e.g., South America, Africa, Pacific Islands, Asia) are highly complex and diverse in terms of language, customs, tradition, prevailing philosophies, and institutional structures. A case-in-point in the present study is East Asia. Whereas East Asian countries such as China, Japan, and South Korea conduct their daily affairs in government, industry, and academia in their respective native languages, Singapore (SG) offers a unique perspective as English is the official language of communication. The education policy stipulates the necessity for all Singaporeans to be bilingual and adequately proficient in both English and their native ethnic languages (Zhang, Gu, & Hu, 2008). English is thus the primary medium of instruction at all levels of schooling and is widely used in the spheres of family and society in terms of reading, writing, listening, and speaking. Taken together, the level of English language competency in SG permits sidestepping the additional complexity of establishing linguistic equivalence of assessments across the US and SG as language differences may contribute to measurement non-equivalence.

Without research on measurement equivalence across cultures and gender, we are unable to infer if differences across groups on such tools reflect true differences or differences due to psychometric variations in item responses. To date, work on measurement invariance of these five instruments (RRQ, PCQ, IUS, ASI-3, CBPQ) has not been done comparing the US and SG. However, such efforts for some of these assessments or other measures of the same constructs have been conducted in other countries. Across the US and South Korea, the Rumination Reflection Scale (Treynor et al., 2003) showed strong measurement invariance (Kwon et al.,
As South Korea and SG are highly Westernized East Asian countries, it is plausible that the RRQ and PCQ (instruments capturing facets of repetitive thinking) would be largely equivalent across the US and SG. Next, as the IUS has recently been psychometrically validated in SG (Hong & Lee, 2015), the odds that the IUS would display equal assessment features across the US and SG is high. For the ASI–3, measurement invariance consistently exists across nations in diverse continents (US, Canada, France, The Netherlands, Spain, Mexico, Italy; Ghisi et al., 2016; Taylor et al., 2007). Thus, the ASI-3 would likely show similar measurement properties across the US and SG. However, no studies have examined gender invariance for these measures comparing two separate countries. At the same time, strong gender equivalence within the same countries was found for the RRQ (Carter, 2010; Whisman et al., in press), IUS (Dekkers, Jansen, Salemink, & Huizenga, 2017; Roma & Hope, 2017), and ASI-3 (Ghisi et al., 2016). Taken together, one inference from these studies is that the RRQ, PCQ, IUS, ASI-3, and CBPQ would be invariant across the US and SG as well as gender to a large extent.

Accordingly, the current study aimed to examine the latent factor structures of transdiagnostic constructs in the US and SG. First, we explored the degree of cross-cultural equivalence in terms of the two-factor RRQ (Trapnell & Campbell, 1999), six-factor PCQ (Szkodny & Newman, in press), two-factor IUS (Buhr & Dugas, 2002), three-factor ASI-3 (Taylor et al., 2007), and two-factor CBPQ (Patel et al., 2015). Across the US and SG, other psychopathology-linked measures of stress over academic expectations (Ang et al., 2009), self-efficacy (Klassen et al., 2009), negative affect (Scollon, Koh, & Au, 2011), anxiety (Lowe & Ang, 2016), and cognitive looming vulnerability style (Hong et al., 2017), have illustrated at least strong measurement invariance. As these tools have some overlap with instruments in the current study, and given the highly Westernized nature of the English-fluent Singaporean society
(Suyi, Meredith, & Khan, 2017; Zhang, 2002), we hypothesized that these measures would be invariant to a large degree. A final aim was to determine gender invariance of the factor models.

**Method**

**Study Design and Populations**

College students enrolled in introductory psychology courses at two large research-oriented universities in the US and SG participated in this study in exchange for course credits. To be eligible, participants had to be at least 18 years old. The US sample comprised 292 participants with a mean age of 18.77 (SD = 1.85), 79.79% female, and 80.14% White, 14.73% African Americans, and 5.32% Hispanics. The SG sample included 144 respondents with an average age of 21.02 years (SD = 1.96), 69.44% female, as well as 83.33% Chinese, 9.03% Indian, 7.64% Malays, Eurasian, and other ethnicities. Ethics approval from the institutional review boards was obtained from both participating universities. Compared to the US sample, the SG sample was on average older by 2.25 years (t(434) = 11.406, p < .001) and comprised of more males (χ²(df = 1) = 5.726, p = .017). Tables 1 and 2 present the correlation matrices and descriptive statistics of study variables based on country and gender.

**Measures of Transdiagnostic Processes**

**Rumination-reflection questionnaire (Trapnell & Campbell, 1999).** The RRQ is a 24-item scale that distinguishes between maladaptive self-focus on past negative events (rumination; 12 items) and introspective self-awareness (reflection; 12-item). Participants rated items on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Examples include, “I spend a great deal of time thinking back over my embarrassing or disappointing moments” (item 12; rumination) and “I’m very self-inquisitive by nature” (item 21; reflection). Preliminary exploratory factor analysis found two factors: rumination and reflection (Trapnell & Campbell,
Across both gender and countries, on all subscales, Cronbach’s αs ranged from .89 to .93 herein. Likewise, Macdonald’s ωs ranged from .90 to .94 on all subscales in the present study. The RRQ showed strong convergent validity with measures of self-consciousness (Trapnell & Campbell, 1999) and other rumination measures as well as discriminant validity with tests of non-theoretically-relevant constructs (e.g., motivation; Siegle, Moore, & Thase, 2004).

**Perseverative cognitions questionnaire—45-item (Szkodny & Newman, in press).** The PCQ-45 is a 45-item measure of perseverative cognitive styles related to depressive, anxiety, and obsessive-compulsive symptomology. Participants rated items on a 6-point Likert scale (0 = *strongly disagree* to 5 = *strongly agree*). Exploratory and confirmatory factor analysis revealed six factors: lack of controllability (5 items; e.g., “It’s hard for me to let a thought go once it enters my head”); preparing for the future (7 items; e.g., “I repeatedly think about things to reduce the risk of danger”); expecting the worst (4 items; “I usually find it likely that things will turn out poorly”); searching for causes and meanings (4 items; “I become absorbed in trying to understand my thoughts, feelings, and actions”); dwelling on the past (14 items; e.g., “I repeatedly think about things that are over and done with”); and thoughts discrepant with ideal self (11 items; e.g., “My thoughts are shameful”). Internal consistency was strong on all subscales (αs = .84–.95 in the original study; Szkodny & Newman, in press). In the current study, αs ranged from .86 to .97 on all subscales in the US and SG samples as well as within both genders. Similarly, Macdonald’s ωs ranged from .86 to .97 on all subscales herein. Further, the PCQ showed strong convergent validity with measures of worry, rumination, obsessive

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1 Due to the limitations of Cronbach’s α (e.g., assumes items’ true scores have uniform variances and are perfectly associated, and error variances are unrelated), we also used Macdonald’s omega (ω) (Dunn, Baguley, & Brunsden, 2014) to index reliability. ω is suitable for latent variable analyses as it is based on parameters from the factor model (Crutzen & Peters, 2017).
cognitions, and depressive and anxiety symptoms ($rs > .50$) (Szkodny & Newman, in press). Discriminant validity was shown by the PCQ scales displaying significantly higher relations with similar constructs than with measures of theoretically unrelated constructs ($rs = .29–.48$; Szkodny & Newman, in press). Strong two-week retest reliability was attained ($rs = .74–.86$).

**Intolerance of uncertainty scale (English translation; Buhr & Dugas, 2002; French version; Freeston, Rheaume, Letarte, Dugas, & Ladouceur, 1994).** This 27-item self-report tool assesses maladaptive cognitions about uncertainty and their perceived repercussions. Respondents rated items on a 5-point Likert scale ($1 = not at all characteristic of me to 5 = entirely characteristic of me$). Higher scores reflected greater intolerance of uncertainty. Exploratory and confirmatory factor analyses revealed two factors pertaining to maladaptive beliefs about uncertainty (Sexton & Dugas, 2009): (1) *uncertainty is unfair and spoils everything* (15-item); (2) *uncertainty has negative behavioral and self-referent implications* (12-item). In the initial study, the $\alpha$ values were .92 and .90 for Factors 1 and 2 respectively (Buhr & Dugas, 2002). In subsamples based on country and gender, on all subscales, $\alpha$s ranged from .90 to .93. Macdonald’s $\omega$s ranged from .92 to .95. Also, the IUS has excellent 5-week test-retest reliability ($r = .74$) (Buhr & Dugas, 2002). Convergent validity was evidenced by high correlations with depression, anxiety, and worry measures for both factors (Sexton & Dugas, 2009). Discriminant validity was shown by the fact that relations with theoretically unrelated constructs (e.g., personal mastery; $rs = -.21–.09$) were substantially smaller than with conceptually related constructs (e.g., worry and perceived constraints; $r = .50–.63$; Buhr & Dugas, 2006).

**Anxiety sensitivity index–3 (Taylor et al., 2007).** The 18-item ASI-3 measures the extent to which individuals experience fear of anxiety-linked arousal sensations due to beliefs about its negative consequences. Respondents endorsed items on a 5-point Likert scale ranging
from 0 (very little) to 4 (very much). Higher scores indicate greater anxiety sensitivity. Factor analytical studies across cultures suggested that the ASI-3 taps into three theory-based factors (Mantar, Yemez, & Alkin, 2010; Taylor et al., 2007; Wheaton, Deacon, McGrath, Berman, & Abramowitz, 2012): cognitive concerns, physical concerns, and social concerns. Each scale includes 6 items. Such items include, “It scares me when I am unable to keep my mind on a task” (item 5; cognitive concerns), “When my stomach is upset, I worry that I might be seriously ill” (item 4; physical concerns), and “I think it would be horrible for me to faint in public” (item 17; social concerns). Prior studies showed acceptable internal consistency for the subscales (αs = .73–.91 across six countries; Taylor et al., 2007; Wheaton et al., 2012). In the current study, αs ranged from .83 to .90 on all subscales in the US and SG samples, as well as in males and females. Macdonald’s ωs ranged from .83 to .91 on all subscales in all of the current study subsamples. The ASI-3 exhibited strong convergent validity (rs = .70–.82 with other anxiety sensitivity measures; Reiss, Peterson, Gursky, & McNally, 1986; Taylor et al., 2007) and discriminant validity (rs = .22 to .43 with dissimilar constructs of anxiety and negative affect; Osman et al., 2010). Last, the ASI-3 showed high one-month temporal stability in multiple cultures (e.g., US, Italy, Brazil, Korea, Turkey; Sandin, Valiente, Chorot, & Santed, 2007).

**Cognitive behavioral processes questionnaire (Patel et al., 2015).** The CBPQ is a transdiagnostic 15-item self-report assessment that measures a range of cognitive and behavioral emotion dysregulation processes tied to the respondent’s present difficult situations. Each item presents two opposite ends of a process e.g., for feeling bad, “How much have you done something negative to stop yourself feeling bad, rather than just experienced feeling bad?” Respondents answered on a 9-point (0–8) Likert scale that reflected the extent to which they partook in the process depending on the item (0 = always just experienced feeling bad, 2 =
mostly just experienced feeling bad, 4 = both equally, 6 = mostly done something negative to stop feeling bad, 8 = always done something negative to stop feeling bad). Initial exploratory factor analysis suggested the CBPQ comprised two factors (Patel et al., 2015). The first 8-item factor, internal experiences, focused on the cognitive aspects of a person’s internal experiences (e.g., thoughts, feelings, somatic sensations, mental images). The second 7-item factor, behavioral processes, reflected individuals’ behaviors and responses toward their immediate surroundings. Examples of items include, “How much have you worried about bad things that might happen in the future, rather than doing the things that are important to you?” (internal experiences) and “How much have you avoided dealing with an actual problem when feeling bad, rather than doing something to solve the problem?” (behavioral processes). The CBPQ had satisfactory internal consistency (α = .90 in the initial study) and high one-week temporal stability (r = .74) (Patel et al., 2015). In the present study, Cronbach αs ranged from .70 to .87. In parallel, Macdonald’s αs varied from .71 to .88 herein. In student, clinical, and community samples, the CBPQ showed good convergent validity with theoretically-related constructs (e.g., cognitive intrusions, rumination) and symptoms (worry, anxiety, depression; all rs ≥ .41; Patel et al., 2015). It also displayed good discriminant validity as convergent validity associations were higher than associations with unrelated constructs (e.g., positive meta-cognitive beliefs; rs = .02 to .29; Patel et al., 2015). Further, the CBPQ showed strong known-groups (criterion-related) validity between clinical and community samples (Patel et al., 2015).

Cultural Measure

Singelis’ self-construal scale (SSC; Singelis, 1994). This is a 24-item self-report measure of the degree to which respondents adopt cultural values of independence/individualism (12-item) and interdependence/collectivism (12-item). Factor analyses offered evidence for the
validity of this two-factor structure (Singelis, 1994). Participants rated items on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree), and scores on each scale can range from 7 to 84. Example items include, “I enjoy being unique and different from others in many respects” (individualism) and “My happiness depends on the happiness of those around me” (collectivism). The SSC showed good construct validity by strongly differentiating between ethnic groups embracing unique self-construals, as well as predictive validity for situational attribution independent of cultural grouping (Singelis, 1994). Internal consistency was satisfactory in the original study (αs = .70–.74; Singelis, 1994). In all subsamples of the current study based on country and gender, acceptable internal consistencies were observed (αs ≥ .76 on all subscales).

**Procedures**

Participants in the US and SG completed the following questionnaires online in one sitting. They first responded to the demographic questionnaire, and all other questionnaires were counterbalanced using the ‘Randomization’ function on Qualtrics. We used the same survey platform when collecting data from both institutions. All assessments were administered in the same laboratory rooms at both universities to standardize the setting and prevent any extraneous factors (e.g., location, weather) from affecting the results of the study.²

**Data Analyses**

All analyses were carried out using R Software (R Development Core Team, 2008). We performed demographic comparisons using independent t-tests for continuous variables (age and cultural self-construals) and Chi-square (χ²) analyses for categorical variables (gender). All latent variable modeling analyses used the Lavaan package (Rosseel, 2012). All indicators of the

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² The distribution of time to survey completion was within normal limits (M = 47.03 ± 17.06 minutes). No outliers were detected. Thus, we can reasonably infer that participants were putting forth their full and undivided attention to finishing the surveys within one period of seating.
data were rank-ordinal in nature. Therefore, we used diagonally-weighted least square (WLS) estimators with mean and variance adjusted (WLSMV) \( \chi^2 \)-statistic with theta parametrization that inputs the polychoric correlation matrix (Rhemtulla, Brosseau-Liard, & Savalei, 2012; Wang & Cunningham, 2005) to examine the latent factor structures of the RRQ, PCQ, IUS, ASI-3, and CBPQ. Pearson product-moment associations may underestimate the strength of relations among variables that may attenuate factor loading estimates (Muthén & Muthén, 2013). Moreover, the WLSMV estimator does not require the assumption of multivariate normality but rather calculates optimal weights and provides robust standard errors. Simulation studies showed that WLSMV (vs. standard WLS estimator) operated well across a wide range of sample sizes and a variety of manifest indicators (Flora & Curran, 2004; Nussbeck, Eid, & Lischetzke, 2006). Also, for rank-ordinal variables, WLSMV offers more accurate and stable estimates than maximum likelihood estimators for small sample sizes (Kim & Yoon, 2011; Millsap & Yun-Tein, 2004).

To judge each model’s goodness-of-fit, we used practical goodness-of-fit indices with heuristic cut-offs (Kline, 2016a, 2016b): confirmatory fit indices (CFI; Bentler, 1990; McDonald & Marsh, 1990; CFI ≥ .95); root mean square error of approximation (RMSEA; Browne & Cudeck, 1993; Steiger, 1990; RMSEA ≤ .08); square root mean residual (SRMR; Hu & Bentler, 1999; SRMR ≤ .080). For the metric of latent constructs, we specified one of the unstandardized factor loadings to 1.0. Missing data was not a concern in this dataset as participants had the option to withdraw from the study if they did not wish to provide complete survey responses. No participants chose to withdraw.

We first tested for configural invariance (i.e., same factor structure without placing between-group constraints on any parameter estimates) by conducting CFAs in each country and gender separately (Muthén & Muthén, 2013). To test gender invariance, data were pooled across
the US and SG, following others (Hong et al., 2017; Taylor et al., 2007; Whisman et al., in press). Similarly, when testing cross-cultural equivalence, data from the US and SG were pooled. Subsequently, we performed multiple-group CFAs across countries and gender concurrently based on the factor structures specified according to the original validation studies: two-factor RRQ (Trapnell & Campbell, 1999), six-factor PCQ (Szkodny & Newman, in press), two-factor IUS (Buhr & Dugas, 2002), three-factor ASI-3 (Taylor et al., 2007), and two-factor CBPQ (Patel et al., 2015). Next, we progressively tested the more restrictive multiple-group CFAs to determine if factor loadings ($\lambda$s) were equal across groups (weak metric invariance) and if both $\lambda$s and item thresholds ($\tau$s) were equal across groups (strong scalar invariance). We then examined if $\lambda$s, $\tau$s, and item residual variances ($\varepsilon$s) were equal across groups (strict invariance). If scalar or strict invariance was attained for any scale, we assessed for equality of factor variance and covariance as well as factor means (Steenkamp & Baumgartner, 1998).

A statistically significant WLSMV $\Delta \chi^2$ difference test ($\chi^2$ for the constrained model is greater than the unconstrained model) indicated the data fit substantively worse than the unconstrained model (Bollen, 1989). However, as $\Delta \chi^2$ is sensitive to sample size despite trivial misfit changes, we used change in practical fit indices to evaluate measurement invariance at each step (Cheung & Rensvold, 2002; Meade, Johnson, & Braddy, 2008). As we used WLSMV estimators, we exercised caution by ensuring that our models were correctly specified when using the change in fit indices to determine measurement invariance (e.g., all variance-covariance matrices were non-singular and positive definite; Sass, Schmitt, & Marsh, 2014).

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3 When pooling data, we did not mean-deviate the measures within country or gender as this omits important data on any potential differences in parameter estimates across groups. Also, mean-deviating within samples was not needed given the high level of homogeneity across pooled samples (e.g., large similarities between US and SG students when conducting gender invariance analyses).
Values of $\Delta CFI \leq .01$, $\Delta RMSEA < .015$, and $\Delta SRMR < .03$ from the unconstrained to constrained model indicated multiple-group measurement invariance (Chen, 2007; Cheung & Rensvold, 2002). Further, model fit differences were judged to be non-significant if they had overlapping 90% RMSEA CIs (Wang & Russell, 2005).

**Results**

**Cultural orientation in the US and SG.** After adjusting for age and gender, both groups were not significantly different in their independent (individualistic) cultural orientation as indexed by the Singelis self-construal scale (US: $M = 70.993$, $SD = 12.535$; SG: $M = 68.476$, $SD = 12.190$; $t(432) = 1.289$, $p = .198$, $d = 0.126$). However, the SG sample ($M = 74.685$, $SD = 12.409$) adopted more interdependent (collectivistic) self-construals than their US peers ($M = 70.461$, $SD = 10.608$) ($t(432) = 3.447$, $p = .001$, $d = 0.336$).

**Multiple-group CFA across countries.** Tables 3 presents the tests of each step of measurement invariance analyses for the five transdiagnostic process measures in the US and SG. We first established baseline models with no equality constraints across both samples. Based on the pattern of fit indices, the RRQ, PCQ, IUS, and ASI-3 showed good configural model fit in both samples. However, for the CBPQ, we removed item 6 as it showed low standardized $\lambda$s on the *behavioral processes* factor in both samples (US: .052; SG: .206). Afterwards, good model fit was found for the two-factor CBPQ. Further, on all of the measures, most of the standardized $\lambda$s exceeded .60 and all surpassed .40 in both groups (all $p$ values were < .001; see supplementary materials to obtain information on all the values of the $\lambda$s and inter-factor correlations in Tables S1 to S5). Table 4 displays the comparison of measurement invariance models shown in Table 3. Based on the multiple-group CFA across countries, for the RRQ, PCQ, IUS, and CBPQ, we found *strict* measurement invariance in terms of equivalence of $\lambda$s, $\tau$s, and $\varepsilon$s across samples.
Only the three-factor ASI-3 showed full measurement invariance (equivalence of \(\lambda_s\), \(\tau_s\), \(\varepsilon_s\), factor variances, factor covariances, and factor means). Factor variances, factor covariances, and factor means of the other four measures across countries were not invariant, implying that the relations among latent factors within each of the four measures were not equivalent across groups. Latent inter-factor correlations \((r_s)\) within each measure were as follows: RRQ (US: \(r = .096\); SG: \(r = .069\)); IUS (US: \(r = .916\); SG: \(r = .889\)); ASI-3 (US: \(r = .778–.851\); SG: \(r = .656–.813\)); PCQ (US: \(rs = .106–.778\); SG: \(rs = .170–.710\)); CBPQ (US: \(r = .657\); SG \(r = .833\)).

Across nations, inter-factor relations did not differ on the RRQ, IUS, and ASI-3, but varied substantially for the PCQ (see Table 7) and CBPQ. In the US sample, PCQ lack of controllability was more positively related to searching for causes and meaning \((r = .641)\) than thoughts discrepant with ideal self \((r = .462)\). In contrast, in the SG sample, PCQ lack of controllability showed higher connection with thoughts discrepant with ideal self \((r = .669)\) than searching for causes and meaning \((r = .519)\). Further, preparing for the future was less associated with dwelling on the past in the US \((r = .508)\) compared to SG \((r = .688)\). The connection between expecting the worst and searching for causes and meaning was stronger in the US \((r = .505)\) than SG \((r = .384)\), as with the relation between dwelling on the past and searching for causes and meaning (US: \(r = .721\); SG: \(r = .529\)). Last, the CBPQ link between internal experiences and behavioral processes was larger in the US \((r = .833)\) than SG \((r = .657)\).

Multiple-group CFA across gender. Tables 5 and 6 display gender invariance findings. Overall, global fit indices showed good fit in both males and females for all measures. For the CBPQ, we again removed item 6 as it showed unacceptably low standardized \(\lambda_s\) with the CBPQ behavioral processes factor in females (.114). On all the measures, most standardized \(\lambda_s\) exceeded .60 and all surpassed .40 in both samples (all \(p\) values < .001; see Tables S6 to S10 in
the supplementary materials). Based on the multiple-group CFA, across gender, we found full strict measurement invariance for all tools (equivalent λs, τs, εs, factor variances and covariances, and factor means) except for the CBPQ. Based on ΔRMSEA = .017, the CBPQ failed to display metric gender invariance. This was due to gender differences in factor loadings for CBP–behavioral processes item 1 (“How much have you looked for possible harm or threats in your surroundings when feeling bad, rather than just noticing things around you?”; Males: λ = .504; Females: λ = .630) and item 7 (“How much have you used alcohol, drugs, food or an activity to reduce or prevent unpleasant internal experiences, rather than just ‘‘be with them’’”; Males: λ = .550; Females: λ = .424). For each tool, the inter-item relations among the latent factors were as follows: RRQ (Males: r = .194; Females: r = .110); IUS (Males: r = .882; Females = .923); ASI-3 (Males: rs = .693–.822; Females: r = .754–.847); PCQ (Males: r = .196–.784; Females: r = .194–.756) (refer to Table 8); CBPQ (Males: r = .910; Females: r = .760).

Discussion

This is the first study to examine cross-cultural invariance of three established (RRQ, IUS, ASI-3) and two novel instruments (PCQ, CBPQ) of direct interest and benefit to the RDoC framework across college samples in the US and SG. Establishing cross-cultural and gender measurement equivalence of transdiagnostic constructs is an essential yet often overlooked part of the RDoC agenda, despite the growth of cross-national collaborations on these topics (e.g., Norton & Paulus, 2017). The configural factor models provided good and parsimonious representation of the data. Across countries, invariant factor loadings, item thresholds, and item residual variances were established for the RRQ, PCQ, IUS, ASI-3, and CBPQ. The high degree

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4 When we repeated these analyses using robust maximum likelihood (MLR) estimators to test for cross-national and gender measurement invariance based on the same a priori specified factor structures, we arrived at the same conclusions with a similar pattern of findings.
of construct compatibility is likely to be due to the highly Westernized aspect of the SG society that adopted many European American cultural ethos and values into its institutions while still embracing traditional Asian collectivistic principles (Luo, Hogan, & Paris, 2011). Moreover, our findings are aligned with research across US and SG in the past decade (e.g., Hong et al., 2017).

Nonetheless, only the three-factor ASI-3 achieved full cross-cultural invariance. This result is unsurprising. Full measurement equivalence is an exceedingly stringent criterion that may not be applicable to diverse cultural contexts (De Beuckelaer & Swinnen, 2011). Indeed, although both groups were similar in their individualistic orientation, the SG students were on average more interdependent than the prototypical American student. Moreover, latent inter-factor associations within the recently designed PCQ and CBPQ differed across nations. In the US sample, perceived uncontrollability was tied more strongly with seeking to better understand thoughts, emotions, and behaviors than train of thought being discordant with best possible self. The SG sample showed the opposite pattern. This may be due to greater societal pressure and competition to attain the cultural ideal of outstanding scholastic achievement in SG than the US (Lowe & Ang, 2012), rendering students in SG more vulnerable to feeling less in charge when appalling thoughts cross their mind. Preoccupation over preparing for the future was more strongly related to dwelling on the past in SG than the US. This is possibly due to the risk averse, progress-focused, and fast-paced nature of the small, resource-scarce, Singaporean city-state that emphasizes learning from past mistakes (Lee & Morris, 2016). Anticipating worst-case scenarios was notably more related to being absorbed with one’s thoughts, actions, and emotions in the US than SG. Additionally, the tendency to avoid tolerating uncomfortable sensations, thoughts, and emotions was more strongly linked to behavioral inactivity among US (vs. SG) students. Perhaps Americans are more averse to negative affect and prefer to feel good (Curhan et al., 2014; Wirtz,
Chiu, Diener, & Oishi, 2009). Alternatively, more self-focused attention in Western (vs. Eastern Asian) cultures (Boehm, Lyubomirsky, & Sheldon, 2011) may explain these results. These ideas offer ample material for future cross-cultural transdiagnostic studies.

We also found full gender invariance across four measures (RRQ, PCQ, IUS, ASI-3), which confers strong confidence in these assessments producing equal measurement properties across men and women. It also parallels and extends prior research that found gender equivalence for the RRQ (Arana & Rice, in press; Whisman et al., in press), IUS (examined in other student samples in SG and the Netherlands; Dekkers et al., 2017; Hong & Lee, 2015), and ASI-3 (Ebesutani, McLeish, Luberto, Young, & Maack, 2014; Ghisi et al., 2016). Thus, these instruments could be incorporated into therapists’ routine assessments in order to delineate the perseverative thinking patterns that engender and maintain clients’ depressive, anxious, and worry symptoms. Therapists can help patients monitor, identify, and modify aspects of their patterns of attention and interpretations that lead to more adaptive emotion regulation.

However, on the CBPQ behavioral processes scale, item 6 (“How much have you done something negative to stop yourself feeling bad, rather than just experienced feeling bad?”) should be removed in clinical practice, given its repeatedly low factor loadings across gender and culture. Further, the tendency to scan for potential threats in the environment was more salient in women (vs. men), whereas the opposite pattern was found for using substances or physical activity to suppress difficult emotions. In general, women are more hypervigilant as they are more vulnerable to assaults (Tjadens & Thoennes, 2000). Socialization pressures that discourage men from expressing negative affect and higher tendency for women to perceive and interpret danger (McLean & Anderson, 2009) may also account for this findings. The result also mirrors data showing higher rates of alcohol use in men than women in English-speaking nations (Wilsnack,
Wilsnack, Kristjanson, Vogeltanz-Holm, & Gmel, 2009). Thus, clinical work using the CBPQ should keep in mind the differential patterns of responding across gender.

This study is tempered by several limitations. First, findings from university undergraduates may not generalize to other US and SG populations. Second, the sample sizes were relatively small for both groups. However, the high number of factor loadings, item-to-factor ratios, and reliable assessments used here may compensate for the relatively small sample (Meade & Bauer, 2007). Moreover, the small sample precluded us from ideally comparing across nations and gender concurrently. Future cross-cultural studies are hence encouraged to use larger samples. Also, SG is a multicultural parliamentary-based Southeast Asian country that operates primarily in English that may not be representative of relatively homogeneous Asian contexts (e.g., communist China, democratic South Korea). Ongoing research on the applicability of latent factor structures in transdiagnostic measures across other Eastern cultures that communicate mainly in their own native languages are thus important. Limitations notwithstanding, the present study had multiple strengths. This is the first study to offer preliminary support for measurement invariance for the RRQ, PCQ, IUS, ASI-3, and CBPQ across the US and SG. Noteworthy is that no other research group has conducted cross-cultural invariance studies on the PCQ and CBPQ to date. The hope is that this study will catalyze ongoing investigation in juxtaposing transdiagnostic processes across distinct cultural groups to contribute to the goals of NIMH RDoC strategy (Cuthbert, 2015). A next logical step for future research is to determine if transdiagnostic treatments incorporating cognitive behavioral therapy principles (Boswell et al., 2013) show a similar pattern of responses across cultures as indexed by these measures.
References


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