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Confirming the Three-Factor Structure of the Disgust Scale–Revised in Eight Countries

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The current study evaluates the factor structure of the Disgust Scale–Revised (DS-R) in eight countries: Australia, Brazil, Germany, Italy, Japan, the Netherlands, Sweden, and the United States (N = 2,606). Confirmatory factor analysis is used to compare two different models of the DS-R and to investigate the invariance of the factor structure of the DS-R across countries and gender. A three-factor solution consisting of three different but interrelated disgust factors (a 12-item core disgust factor, an 8-item animal-reminder disgust factor, and a 5-item contamination disgust factor) best accounted for the data in all countries except the Netherlands. Relative to the United States, the three-factor solution is invariant in Australia, Brazil, and Japan but not in Germany, Italy, the Netherlands, and Sweden. The three-factor solution is also invariant across gender in most countries. The implications of these cross-cultural findings for promoting a more valid and reliable assessment of disgust dimensions, as assessed by the DS-R, are discussed.

Keywords: *Disgust Scale–Revived; disgust sensitivity; cross-culture; factor structure*

Multidisciplinary research over the last 2 decades has elucidated the important role of disgust in various social and clinical contexts (Olatunji & Sawchuk, 2005). For example, there is now experimental evidence suggesting that some moral judgments are significantly influenced by the experience of disgust (Wheatley & Haidt, 2005). Additionally, the experience of disgust has been implicated in the development of various psychological disorders, particularly contamination-based obsessive–compulsive disorder (OCD; Olatunji, Lohr, Sawchuk, & Tolin, 2007). Darwin (1872/1965) first noted that disgust "refers to something revolting, primarily in relation to the sense of taste, as actually perceived or vividly imagined; and secondarily to anything which causes a similar feeling, through the sense of smell, touch and even of eyesight" (p. 253). However, more recent definitions of disgust have gone beyond its phylogenetic origins of the rejection of bad-tasting foods (Rozin & Fallon, 1987). Contemporary models regard disgust as a multidimensional emotion that functions as an oral defense at its core but has evolved to serve as a reminder of our animal origins, maintain interpersonal boundaries, and influence our sense of morality and social order (Rozin, Haidt, & McCauley, 2000).

Given its diverse implications, the development of a reliable and valid measure of individual differences in disgust is of central importance. The Disgust Scale (DS; Haidt, McCauley, & Rozin, 1994) is currently the most widely used measure of disgust (Olatunji & Sawchuk, 2005) and was developed with a specific goal, "to ascertain the kinds or domains of experience in which Americans experience disgust" (Haidt et al., 1994, p. 702). The DS assesses how disgusting specific experiences are across eight domains, including *food* that has spoiled or is culturally unacceptable; *animals* that are slimy or live in dirty conditions; *body products* including body odors and feces, mucus, and so on; *body envelope violations*, or mutilation of the body; *death* and dead bodies; *sex* involving culturally deviant sexual behavior; *hygiene*, or_violations of culturally expected hygiene practices; and *sympathetic magic*, which involves stimuli without infectious qualities of their own that either resemble contaminants (e.g., feces-shaped candy) or were once in contact with contaminants (e.g., a sweater worn by an ill person).

The DS and its subscales have proven to have predictive utility in a variety of research contexts. For example, research with the DS has shown that disgust levels vary significantly during pregnancy in a manner that compensates for maternal and fetal vulnerability to disease (Fessler, Eng, & Navarrete, 2005). Colostomy patients with higher scores on the DS have also been found to report higher levels of feeling stigmatized, which negatively predicts colostomy adjustment and well-being (Smith, Loewenstein, Rozin, Sherriff, & Ubel, 2007). Research on psychopathology has also yielded significant positive relationships between disgust, as assessed by the DS, and spider phobia (Tolin, Lohr, Sawchuk, & Lee, 1997), blood-injection-injury (BII) phobia (Sawchuk, Lohr, Tolin, Lee, & Kleinknecht, 2000), eating disorders (Troop, Treasure, & Serpell, 2002), and hypochondriasis (Davey & Bond, 2006). Furthermore, there is evidence that some DS subscales (i.e., Envelope Violations, Death) are uniquely associated with some clinical symptoms (i.e., BII phobia) suggesting that the subscales have predictive utility (de Jong & Merckelbach, 1998).

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Despite the widespread use of the DS, some important questions about its psychometric properties remain. The available psychometric research indicates that the DS total score has good reliability and validity (Olatunji & Cisler, in press). However, support for the eight-factor structure of the DS has not consistently been found. For example, Haidt and colleagues (1994) conducted a principal components analysis of the matrix of intercorrelations of the DS items and found 10 factors with eigenvalues greater than 1.00. Varimax rotation of seven factors led to an interpretable solution in which both Death and Envelope Violation items loaded high on the first factor, suggesting that these two domains might be better conceptualized as one. A second principal components analysis of the matrix of item intercorrelations in an independent sample revealed 11 factors with eigenvalues greater than 1.00. Although there was no rotation that was fully interpretable, all rotations from 3 through 11 factors revealed a first factor in which Death and Envelope Violation items loaded high. This wide variation in factor analytic findings suggests that the factor solutions for the DS are unstable and require more structured evaluations.

One study using confirmatory factor analysis (CFA) did find that the eight-factor model of the DS provided satisfactory fit to the data, significantly better than alternative one-factor and five-factor models (Björklund & Hursti, 2004). However, poor reliability for the eight DS subscales has consistently been reported in the literature (i.e., food, $\alpha = .34, .27$; animals, $\alpha = .47, .45$; body products, $\alpha = .55, .49$; sex, $\alpha = .51, .52$; body envelope violations, $\alpha = .60, .63$; death, $\alpha = .59, .61$; hygiene, $\alpha = .46, .42$; and sympathetic magic, $\alpha = .44, .45$; Haidt et al., 1994). In fact, the poor reliability of the DS subscales led its developers to conclude that "the alpha reliabilities of the eight domain subscales are not high enough for interpretation of individual patterns of subscale scores" (Haidt et al., 1994, p. 711). Despite this cautionary note, inferences made based on the DS subscales have been reported in the literature (de Jong, Peters, & Vanderhallen, 2002; Fessler & Navarrete, 2005; Olatunji, Sawchuk, Lohr, & de Jong, 2004; Tolin, Woods, & Abramowitz, 2006).

Although the DS shows considerable promise, refinement of its underlying factor structure in order to yield reliable and interpretable subscales is clearly warranted. Olatunji and colleagues (2007) conducted a converging set of analyses evaluating the item properties and factor structure of the DS. After conducting a series of analyses, these authors recommended removal of seven problematic items (i.e., items that detracted from performance of the DS). Removing these items resulted in an abbreviated DS (DS-R), and CFA revealed three distinct factors of the revised measure: core, animal-reminder, and contamination disgust. These three new disgust factors generally yielded more acceptable internal consistency estimates ($\alpha > .70$). The three factors were also consistent with theoretical models of the structure of disgust outlined in the literature. Rozin et al. (2000) described core disgust as primarily a food-rejection response centered on oral incorporation of offensive stimuli (i.e., rotting foods). They described animal-reminder disgust as any stimulus or behavior that reminds humans of their animalness and their animal origins (i.e., violations of the body envelope). Rozin and colleagues also observed that direct or indirect contact with others can elicit disgust resulting in interpersonal disgust. One key component of interpersonal disgust is disease probability, which bears a striking similarity to the new DS-R contamination disgust factor.

The refinement of the DS may make it more suitable for research purposes in clinical and applied settings. Although the new three-factor model of the DS-R appears to be more reliable and coincides with established theoretical models of disgust (Rozin et al., 2000), the fit of the three-factor model has not yet been replicated. More important, evidence for

the three-factor model of the DS-R exclusively relied on relatively homogenous samples from the United States. Although the DS was developed to examine the experience of disgust in the United States (Haidt et al., 1994), it has become the measure of choice for assessing disgust in several countries (Olatunji & Cisler, in press). Consequently, examination of the validity of the three-factor model of the DS-R in countries other than the United States is clearly needed to inform the growing worldwide interest in the psychological assessment of disgust. Such multinational studies will allow researchers to better understand the relative consistencies and inconsistencies of the nature of disgust between diverse populations using a psychometrically sound instrument.

The major aim of the current study was to further investigate the factor structure and structural equivalence of the DS-R in multiple countries by means of CFA. Drawing on recent work (Olatunji et al., 2007), we examine the fit of a three-factor model of the DS-R consisting of core, animal-reminder, and contamination disgust. Cultural factors affect the stability of the underlying structure of personality traits, making cross-cultural equivalence of such traits difficult to find (Matsumoto & Yoo, 2007; Rossier, 2005). However, evidence of equivalence of the three-factor model in multiple countries would support a universal structure of disgust that could serve as the basis for making more meaningful cross-cultural comparisons. Haidt and colleagues (1994) observed that domains of disgust elicitors all have in common that they remind us of our animality and, especially, of our mortality. Furthermore, de Jong et al. (2002) noted that processes associated with magical thinking (i.e., sympathetic magical laws of contagion and similarity) cut across the different domains of disgust. This suggests that all stimuli that come to elicit disgust may converge to form a coherent unidimensional construct that is marked by either reminders of animal origins or magical thinking. Therefore, the current study examined the fit of the three-factor model of the DS-R relative to a one-factor model. Because the DS-R was designed for general use, the underlying assumption is that it measures the same constructs across males and females. However, gender has been found to influence disgust reactions (Simpson, Carter, Anthony, & Overton, 2006). Thus, it is necessary to evaluate measurement invariance of the DS-R before assuming that it is equivalent between males and females. Accordingly, the current study provided an opportunity to also examine the possibility of differences in the factor structure of the DS-R across gender.

Method

Participants

Participants were volunteers from eight countries: Australia, Brazil, Germany, Italy, Japan, the Netherlands, Sweden, and the United States (See author affiliations for location of data collection). In total, there were 2,606 volunteers. All of the participants in the present study were nonclinical participants. Table 1 provides age and gender information for each country.

Measure

The original 32-item DS was administered to all participants (Haidt et al., 1994). However, we analyzed only the 25 items that comprise the three subscales (a 12-item Core Disgust subscale, an 8-item Animal-Reminder Disgust subscale, and a 5-item Contamination

Table 1
Demographic Characteristics and Internal Consistency for the Disgust Scale–Revised (DS-R) for Each Country

Country	*N*	% Female	Mean Age (*SD*)	DS-R α
Australia	646	71.5	18.86 (4.51)	.80
Brazil	217	80.2	22.64 (3.68)	.82
Germany	221	55.2	26.51 (5.97)	.75
Italy	219	79.0	24.99 (8.23)	.80
Japan	251	56.2	18.82 (1.04)	.77
Netherlands	260	84.2	19.62 (1.87)	.68
Sweden	338	49.4	28.17 (11.70)	.78

N = 451; %female = 50.9; mean age (sd) = 25.79 (11.16); ds-r a = .81 s
Note. N = Sample Size; SD = standard deviation

Disgust subscale) of the DS-R (Olatunji et al., 2007). These items include 13 true/false items (scored 0 or 1) and 12 items that are rated on a 3-point scale (scored 0, 0.5, 1) with regard to the extent that participants find the experience *not disgusting at all*, *slightly disgusting*, or *very disgusting*. Two of the true/false items are reverse scored. For each respondent, two scores were calculated: a mean of the 13 true/false items and a mean of the 12 items on a 3-point scale. A total score for overall disgust sensitivity may be calculated by calculating the mean of these two scores (scores thus range from 0 to 1). The DS-R has demonstrated a high degree of internal consistency and adequate convergent and discriminant validity (Olatunji et al., 2007).

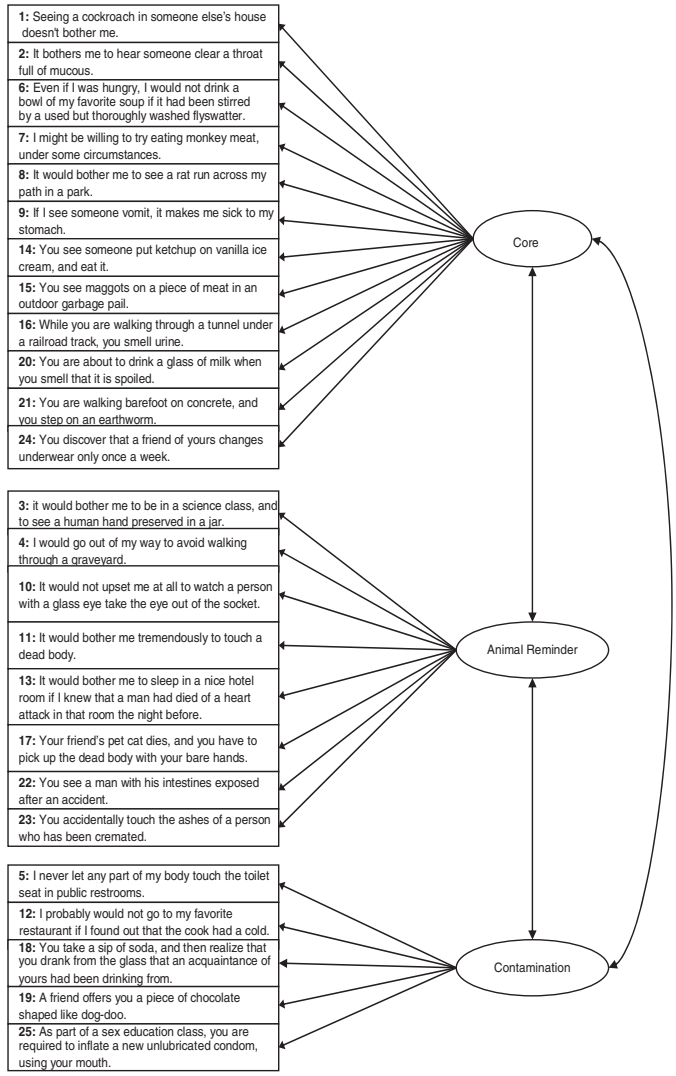
Procedure

Across all sites, participants received the original 32-item DS as a one- or two-page questionnaire.[1] Participants tested at universities completed the scale in large groups, generally during classes. Those tested in hospital or applied settings completed the DS individually.

Data Analytic Strategy

CFA of the DS-R. CFA was conducted on the 25-item DS-R using LISREL 8.80 (Jöreskog & Sörbom, 2006), and two competing models of interest were estimated. A PRELIS system file containing the raw data served as the input data. In the unidimensional model, all 25 DS-R items were loaded onto a latent disgust variable, whereas in the three-factor model depicted in Figure 1, DS-R items were *a priori* loaded onto either a core disgust, animal-reminder disgust, or contamination disgust latent factor based on the results of Olatunji et al. (2007). These two models involved the same 25 manifest indicators of the DS-R. The first indicator for each latent variable was constrained to a factor loading of 1 to serve as a reference variable and set the metric. The following criteria were used to test the models' fit: the root mean square error of approximation (RMSEA), with values less than .08 indicative of an acceptable fit and values less than .05 indicative of a good fit (McDonald & Ho, 2002), and the comparative fit index (CFI), with values close to .95 indicative of a good fit (Hu & Bentler, 1999).

Figure 1
The Hypothesized Three-Factor Model of the Disgust Scale–Revised



Invariance of the three-factor model of the DS-R. Because the U.S. sample in this study represents the "mainstream sample" for which the DS-R was developed (Haidt et al., 1994), the U.S. sample was the comparison group throughout the country invariance analyses. That is, each country was compared with the United States but (to avoid making 28 comparisons) not with the other countries. A multiple group CFA was conducted to determine whether the three-factor structure of the DS-R is invariant across countries and across gender. Three increasingly restrictive tests of measurement invariance were conducted. First, a test of configural invariance was conducted that specifies that the factor structure (i.e., the pattern of free and fixed factor loadings imposed on the items) of the DS-R has to be equivalent across groups (Horn & McArdle, 1992; Stein, Lee, & Jones, 2006). Consistent with suggested procedures

(Jöreskog, 1971), we estimated a baseline model (i.e., a three-factor model without constraints) and then compared it with the model with factor loadings constrained to be equal across the cultural groups as a test of weak metric invariance (Widaman & Reise, 1997). The most common means of comparison of CFA models is the chi-square difference test (CSDT), which is also known as the likelihood ratio test (Brown, 2006). The chi-square statistic and the degrees of freedom for the baseline (parent) model are subtracted from those of the nested (i.e., more restricted) model. The resulting chi-square value is evaluated for the difference of the degrees of freedom from the two models to determine whether there has been improvement or loss of fit given the new constraints. If the chi-square is significant, the nested model is considered to have lost its goodness of fit attributable to the restrictions, and it is determined that the parent model evidences a significantly better fit than the nested model. A nonsignificant difference in chi-square suggests equivalent factor loadings and thus evidence for weak metric invariance. A test of strong metric invariance, or scalar invariance, was also conducted. This is a stronger test of measurement invariance than the previous one in that in addition to specifying invariant factorial loadings, the indicator intercepts (τ) are now constrained to be equal across groups (Horn & McArdle, 1992; Widaman & Reise, 1997). This test requires a comparison of the fit between the weak metric invariance model and the scalar invariance model. Traditionally, the null hypothesis of scalar invariance (i.e., there is no difference between the models) is accepted if the difference in the chi-square test statistic between the weak metric invariance model and the scalar invariance model is not statistically significant.

Results

Preliminary Analysis

Table 1 shows that the DS-R total score demonstrated adequate internal consistency (alphas ranged from .68 to .82) in all eight countries with the possible exception of the Netherlands. As shown in Table 2, mean DS-R total score for the eight countries ranged from 0.35 (SD = 0.16) for Sweden to 0.55 (SD = 0.17) for Italy. The DS-R total score and the core disgust, animal-reminder disgust, and contamination disgust factors were significantly correlated in all eight countries (ps < .01). As shown in Table 3, gender comparisons revealed that DS-R scores were significantly higher among women than among men in all eight countries (ps < .001).

Table 4 shows that the mean DS-R item-total correlations were acceptable for all eight countries (range = .33-.43). However, DS-R items from the Australia (3 items), Germany (6 items), Italy (3 items), Japan (5 items), Netherlands (6 items), and Sweden (2 items) samples demonstrated item-total correlations below the acceptable criterion of .30 recommended by Nunnally and Bernstein (1994). Item 12 ("I probably would not go to my favorite restaurant if I found out that the cook had a cold") appeared to be most divergent from the total score, with an item-total correlation <.30 in four of the eight countries.

CFA of the DS-R

Unidimensional model. First, we tested a unidimensional (i.e., one-factor) model of the DS-R in each of the eight countries. As shown in Table 5, the one-factor model yielded an acceptable fit for only Italy (RMSEA = 0.04, CFI = 0.92) and Sweden (RMSEA = 0.05,

Table 2
Means, Standard Deviations, and Pearson Correlation Coefficients of the Disgust Scale–Revised (DS-R) and Its Three Factors for Each Country

Country	Core	AR	Cont	Mean (*SD*)
Australia				
DS-R total	.80	.83	.67	0.41 (0.16)
Core	—	.54	.34	0.55 (0.19)
AR		—	.28	0.49 (0.25)
Cont			—	0.19 (0.19)
Brazil				
DS-R total	.81	.82	.80	0.44 (0.18)
Core	—	.57	.47	0.59 (0.19)
AR		—	.41	0.49 (0.23)
Cont			—	0.25 (0.24)
Germany				
DS-R total	.78	.79	.65	0.41 (0.15)
Core	—	.49	.28	0.55 (0.18)
AR		—	.20	0.43 (0.23)
Cont			—	0.26 (0.19)
Italy				
DS-R total	.82	.85	.73	0.55 (0.17)
Core	—	.54	.44	0.64 (0.21)
AR		—	.42	0.60 (0.25)
Cont			—	0.41 (0.17)
Japan				
DS-R total	.72	.78	.67	0.49 (0.16)
Core	—	.42	.26	0.60 (0.18)
AR		—	.19	0.56 (0.27)
Cont			—	0.30 (0.23)
Netherlands				
DS-R total	.73	.80	.76	0.52 (0.12)
Core	—	.46	.31	0.57 (0.14)
AR		—	.36	0.39 (0.17)
Cont			—	0.61 (0.18)
Sweden				
DS-R total	.80	.82	.67	0.35 (0.16)
Core	—	.54	.35	0.43 (0.18)
AR		—	.25	0.43 (0.24)
Cont			—	0.20 (0.20)
United States				
DS-R total	.81	.75	.75	0.50 (0.18)
Core	—	.48	.45	0.61 (0.20)
AR		—	.24	0.55 (0.25)
Cont			—	0.33 (0.26)

Note: All correlations significant at $p < .01$; Core = core disgust; AR = animal-reminder disgust; Cont = contamination disgust.

Table 3
Gender Differences on the Disgust Scale–Revised for Each Country

Country	Male	Female	*df*	*t*	*d*
Australia	0.34 (0.16)	0.44 (0.16)	617	6.79	0.60
Brazil	0.31 (0.15)	0.48 (0.17)	215	5.83	0.99
Germany	0.35 (0.15)	0.46 (0.15)	219	5.82	0.79
Italy	0.44 (0.20)	0.58 (0.15)	217	5.06	0.83
Japan	0.44 (0.16)	0.52 (0.16)	245	3.76	0.48
Netherlands	0.45 (0.12)	0.54 (0.12)	256	4.13	0.70
Sweden	0.31 (0.14)	0.40 (0.16)	336	5.42	0.59
United States	0.43 (0.17)	0.56 (0.17)	423	7.32	0.71

Note: All *t*-values significant at $p < .001$; Cohen's *d* was calculated as the difference between the mean scores in each group divided by the pooled standard deviation.

CFI = 0.91) based on the combination of all preestablished criteria used to evaluate model fit. Although the fit of the one-factor model was reasonably good (RMSEAs < 0.08 in all eight countries), the finding that only two of the eight countries fit the data well when considering all the criteria used to evaluate model fit suggests that a unidimensional interpretation of the DS-R may oversimplify its true factor structure.

Three-factor model. The three-factor model of the DS-R depicted in Figure 1 (correlations were allowed between the three factors) was then fit to the data.[2] As shown in Table 5, the three-factor model yielded a good fit in all the countries with the exception of Germany (RMSEA = 0.04, CFI = 0.88), Japan (RMSEA = 0.04, CFI = 0.88), and the Netherlands (RMSEA = 0.04, CFI = 0.79) based on the combination of all preestablished criteria used to evaluate model fit. Direct comparison of the one-factor model versus the three-factor model via the CSDT revealed that the three-factor solution fit the data significantly better than the one-factor model in Australia, CSDT(3) = 199.87, $p < .001$; Brazil, CSDT(3) = 78.87, $p < .001$; Germany, CSDT(3) = 55.29, $p < .001$; Italy, CSDT(3) = 66.32, $p < .001$; Japan, CSDT(3) = 142.59, $p < .001$; Sweden, CSDT(3) = 111.06, $p < .001$; and the United States, CSDT(3) = 354.58, $p < .001$. However, the three-factor model did not fit the data significantly better than the one-factor model in the Netherlands, CSDT(3) = 0.61, $p > .05$. Standardized values for the three-factor model of the DS-R are presented in Table 6.

Invariance of the Three-Factor Model

Country invariance. As shown in Table 7, a model in which factor loadings were constrained to be equal across groups was compared with a baseline model specifying no constraints. As indicated by the nonsignificant difference in the chi-square test statistic between the baseline model and the weak metric invariance model, the three-factor structure of the DS-R in Australia, CSDT(22) = 23.03, $p = .40$; Brazil, CSDT(22) = 26.50, $p = .23$; and Japan, CSDT(22) = 29.87, $p = .12$, were found to have weak metric invariance relative to the three-factor structure of the DS-R in the United States. The significant difference in the chi-square test statistic between the baseline model and the configural model

Table 4
Disgust Scale–Revised Item-Total Correlations for Each Country

DS	Item	Item Theme	Australia	Brazil	Germany	Italy	Japan	Netherlands	Sweden	U.S.
1.	Core	Seeing cockroach in house	.39	.35	.36	.33	.30	.24	.33	.35
2.	Core	Seeing mucus	.50	.37	.38	.42	.33	.32	.30	.42
3.	AR	Seeing severed hand in jar	.42	.52	.40	.44	.52	.41	.51	.43
4.	AR	Walking through graveyard	.39	.37	.28	.37	.44	.38	.25	.44
5.	Cont	Touching toilet in public restroom	.44	.39	.27	.36	.26	.41	.30	.38
6.	Core	Drinking soup stirred with clean flyswatter	.49	.46	.36	.47	.45	.40	.47	.39
7.	Core	Eating monkey meat	.45	.43	.42	.29	.42	.30	.34	.44
8.	Core	Seeing rat run across path	.57	.42	.40	.38	.44	.09	.38	.48
9.	Core	Seeing someone vomit	.38	.46	.30	.39	.42	.29	.40	.43
10.	AR	Seeing glass eye being removed	.28	.31	.31	.39	.46	.32	.42	.39
11.	AR	Touching dead body	.39	.54	.61	.47	.45	.36	.52	.54
12.	Cont	Going to restaurant and cook has cold	.47	.49	.23	.17	.28	-.01	.34	.34
13.	AR	Sleeping in a dead person's room	.24	.46	.44	.50	.45	.43	.53	.45
14.	Core	Eating vanilla ice cream with ketchup	.26	.39	.29	.42	.23	.41	.33	.39
15.	Core	Seeing maggots on piece of meat	.36	.40	.45	.50	.32	.27	.53	.39
16.	Core	Smelling urine	.43	.48	.43	.60	.37	.33	.43	.52
17.	AR	Picking up a dead cat	.48	.46	.53	.53	.45	.30	.56	.54
18.	Cont	Drinking from the glass of an acquaintance	.43	.47	.29	.28	.28	.33	.28	.31
19.	Cont	Eating chocolate shaped like dog-doo	.44	.53	.36	.45	.31	.34	.32	.45
20.	Core	Drinking spoiled milk	.52	.44	.24	.40	.19	.37	.31	.31

Table 4 (continued)

DS Item	Item Theme	Australia	Brazil	Germany	Italy	Japan	Netherlands	Sweden	U.S.
21. Core	Stepping on earthworm	.56	.54	.47	.51	.43	.43	.49	.54
22. AR	Seeing intestines exposed	.28	.38	.38	.51	.51	.42	.50	.38
23. AR	Touching cremated ashes	.38	.55	.56	.49	.59	.28	.53	.45
24. Core	Friend wearing dirty underwear	.40	.38	.41	.47	.42	.41	.43	.44
25. Cont	Inflating condom with mouth	.41	.37	.34	.50	.35	.44	.30	.42
M		.41	.43	.38	.42	.38	.33	.40	.42

Note: *r*s > .17, $p < .01$. Bold items have item-total correlations below the criterion of .30 recommended by Nunnally and Bernstein (1994). Core = core disgust; AR = animal-reminder disgust; Cont = contamination disgust.

Table 5
Summary Statistics of Confirmatory Factor Analyses of Three-Factor Model of Disgust Compared With a One-Factor Model for Each Country

Country	Model	χ^2	RMSEA	CFI
Australia	Three-factor[a]	624.67[(FIML)]	0.04	—
	One-factor[b]	824.56	0.05	0.90
Brazil	Three-factor[a]	450.48	0.05	0.91
	One-factor[b]	529.35	0.06	0.88
Germany	Three-factor[a]	409.20	0.04	0.88
	One-factor[b]	464.49	0.05	0.84
Italy	Three-factor[a]	350.35	0.03	0.95
	One-factor[b]	416.67	0.04	0.92
Japan	Three-factor[a]	420.72	0.04	0.88
	One-factor[b]	563.31	0.06	0.81
Netherlands	Three-factor[a]	421.42	0.04	0.79
	One-factor[b]	422.03	0.04	0.80
Sweden	Three-factor[a]	406.51	0.03	0.95
	One-factor[b]	522.57	0.05	0.91
United States	Three-factor[a]	545.83	0.03	0.93
	One-factor[b]	900.41	0.07	0.87

Note: The full information maximum likelihood (FIML) method was used to determine the fit of the proposed structural equation models to the data for this sample. All other models used the least squares method for determining fit. *df* = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index.
a. df = 272, ps < .001. b. df = 275, ps < .001.

suggests that the three-factor structure of the DS-R is not invariant for data from Germany, CSDT(22) = 48.59; $p < .01$; Italy, CSDT(22) = 41.46, $p < .01$; the Netherlands, CSDT(22) = 110.16, $p < .01$; and Sweden, CSDT(22) = 67.77, $p < .01$; relative to the three-factor structure of the DS-R for data from the United States. Further constraining the three-factor model, a test of scalar invariance specifying that both invariant factorial loadings of like

Table 6
Standardized Values for the Three-Factor Model of Disgust for Each Country

DS Item	Australia	Brazil	Germany	Italy	Japan	Netherlands	Sweden	U.S.
1. Core	.38	.33	.27	.29	.33	.20	.23	.32
2. Core	.33	.36	.35	.39	.30	.25	.24	.37
6. Core	.32	.37	.26	.39	.40	.29	.42	.34
7. Core	.32	.39	.33	.21	.35	.18	.26	.38
8. Core	.47	.36	.36	.31	.46	.02^{ns}	.36	.41
9. Core	.38	.43	.22	.30	.42	.21	.31	.35
14. Core	.39	.36	.27	.46	.19	.44	.33	.39
15. Core	.46	.45	.53	.55	.33	.22	.53	.39
16. Core	.47	.52	.46	.67	.41	.29	.49	.59
20. Core	.30	.47	.19	.42	.18	.35	.33	.35
21. Core	.48	.55	.51	.58	.41	.43	.51	.54
24. Core	.39	.42	.43	.48	.48	.38	.45	.48
3. AR	.47	.51	.37	.46	.54	.31	.51	.52
4. AR	.34	.35	.23	.32	.41	.31	.19	.43
10. AR	.42	.28	.21	.43	.52	.25	.40	.43
11. AR	.61	.57	.65	.53	.60	.26	.58	.64
13. AR	.43	.36	.42	.47	.40	.38	.51	.45
17. AR	.59	.46	.63	.53	.53	.41	.65	.58
22. AR	.50	.43	.40	.62	.61	.28	.54	.50
23. AR	.60	.64	.67	.46	.63	.27	.60	.51
5. Cont	.23	.39	.23	.26	.22	.37	.22	.40
12. Cont	.25	.60	.21	.10^{ns}	.36	.00^{ns}	.42	.37
18. Cont	.38	.61	.45	.40	.42	.38	.50	.43
19. Cont	.54	.60	.48	.58	.43	.36	.51	.56
25. Cont	.53	.41	.58	.64	.57	.48	.44	.56

Note: Core = core disgust; AR = animal-reminder disgust; Cont = contamination disgust; *ns* = not significant. All other standardized values significant at $p < .05$.

items within the factor pattern and intercepts be constrained to be equal across groups resulted in a statistically significant increase in the chi-square for all seven countries relative to the United States (ps < .01; see Table 7).

Gender invariance in the three-factor model. Because of the small sample size for some countries as well as an unequal gender distribution for other countries, we opted to examine gender invariance of the three-factor structure of the DS-R for the following countries only: the United States, Australia, Germany, Japan, and Sweden. As shown in Table 8, in nearly all of the countries tested, there was evidence for weak metric invariance between men and women. Specifically, there was evidence for weak metric invariance for Australia, CSDT(22) = 22.45, $p = .43$; Japan, CSDT(22) = 13.43, $p = .92$; Sweden, CSDT(22) = 21.35, $p = .50$; and the United States, CSDT(22) = 19.12, $p = .64$. The significant difference in the chi-square test statistic between the baseline model and the metric invariance model for the German sample suggests that the three-factor structure of the DS-R is not metrically invariant for males and females, CSDT(22) = 37.02, $p = .02$. Furthermore, there was evidence for scalar invariance between men and women in the Japanese sample, CSDT(31) = 27.59, $p = .64$. There was a statistically significant increase in chi-square for the test of scalar invariance relative to the weak metric

Table 7
Multiple Groups Analyses: Invariance of the Three-Factor Model of the Disgust Scale–Revised

Model	χ^2	*df*	RMSEA	χ^2_{diff}	Δdf	*p*
Australia–U.S. comparison						
Baseline two-group model, no constraints	1159.55	544	0.045	NA		
Factor loadings constrained to be equal across groups	1182.58	566	0.045	23.03	22	.4
Intercepts constrained to be equal across groups	1545.40	597	0.054	362.82	31	0
Brazil–U.S. comparison[a]						
Baseline two-group model, no constraints	988.20	544	0.050	NA		
Factor loadings constrained to be equal across groups	1014.70	566	0.050	26.5	22	.23
Intercepts constrained to be equal across groups	1091.65	597	0.051	76.95	31	0
Germany–U.S. comparison[a]						
Baseline two-group model, no constraints	946.92	544	0.048	NA		
Factor loadings constrained to be equal across groups	995.51	566	0.048	48.59	22	0
Italy–U.S. comparison[a]						
Baseline two-group model, no constraints	888.07	544	0.044	NA		
Factor loadings constrained to be equal across groups	929.53	566	0.045	41.46	22	.01
Japan–U.S. comparison						
Baseline two-group model, no constraints	982.68	544	0.048	NA		
Factor loadings constrained to be equal across groups	1012.55	566	0.047	29.87	22	.12
Intercepts constrained to be equal across groups	1075.58	597	0.048	63.03	31	0
Netherlands–U.S. comparison						
Baseline two-group model, no constraints	959.82	544	0.046	NA		
Factor loadings constrained to be equal across groups	1069.98	566	0.050	110.16	22	0
Sweden–U.S. comparison[a]						
Baseline two-group model, no constraints	944.24	544	0.044	NA		
Factor loadings constrained to be equal across groups	1012.01	566	0.045	67.77	22	0

Note: RMSEA= root mean square error of approximation; χ^2_{diff} = nested χ^2 difference; NA = not applicable.
a. These comparisons were performed using a U.S. data file obtained by performing list-wise deletion for missing values (N = 429). LISREL multiple group comparisons must be performed with two data files that either both contain or do not contain missing values.

invariance model for the remaining countries (ps < .01; see Table 8), which suggests scalar noninvariance between men and women in Australia, Sweden, and the United States.

Discussion

Cross-cultural examination of personality traits is considered central to their construct validity (van de Vijver & Leung, 2001). This study is the first large-scale investigation of the structure of disgust across cultures. The CFA results revealed that the three-factor model fit the DS-R data significantly better than the one-factor model in all countries except the Netherlands. This finding is consistent with recent work suggesting that three dimensions, labeled as core, animal-reminder, and contamination disgust, generally form the underlying structure of the DS-R (Olatunji et al., 2007). This is also consistent with existing theory. For example, Rozin and colleagues (2000) described a dimensional model of disgust that consists of core disgust that is marked by concerns of oral incorporation of offensive stimuli, animal-reminder disgust that is marked by concerns of the animal origins

Table 8
Gender Invariance of the Three-Factor Model of the Disgust Scale–Revised

Model	χ^2	*df*	RMSEA	χ^2_{diff}	Δdf	*p*
U.S. male–female comparison						
Baseline two-group model, no constraints	786.76	544	0.045	NA		
Factor loadings constrained to be equal across groups	805.88	566	0.043	19.12	22	.64
Intercepts constrained to be equal across groups	878.53	597	0.046	72.65	31	0
Australia male–female comparison						
Baseline two-group model, no constraints	948.26	546	0.048	NA		
Factor loadings constrained to be equal across groups	970.71	568	0.047	22.45	22	.43
Intercepts constrained to be equal across groups	1027.29	597	0.047	56.58	29	.002
Germany male–female comparison						
Baseline two-group model, no constraints	665.28	546	0.045	NA		
Factor loadings constrained to be equal across groups	702.30	568	0.046	37.02	22	.02
Japan male–female comparison						
Baseline two-group model, no constraints	785.15	544	0.059	NA		
Factor loadings constrained to be equal across groups	798.58	566	0.057	13.43	22	.92
Intercepts constrained to be equal across groups	826.17	597	0.055	27.59	31	.64
Sweden male–female comparison						
Baseline two-group model, no constraints	715.87	544	0.043	NA		
Factor loadings constrained to be equal across groups	737.22	566	0.042	21.35	22	.50
Intercepts constrained to be equal across groups	893.74	597	0.054	156.52	31	0

Note: RMSEA= root mean square error of approximation; χ^2_{diff} = nested χ^2 difference; NA = not applicable.

of humans, and interpersonal disgust that is based on concerns of contamination and disease via direct or indirect contact with others.

The present findings offer potentially novel insight into the nature of disgust sensitivity, as indexed by the DS-R. As suggested by Cronbach and Meehl (1955), "learning more about a theoretical construct is a matter of elaborating the nomological network in which it occurs, or of increasing the definiteness of its components" (p. 290). There is descriptive (Marzillier & Davey, 2004) and experimental (Simpson et al., 2006) evidence that disgust is not a homogenous construct. The present study shows that disgust is multidimensional in several cultures. The fit of the lower order factors of core, animal-reminder, and contamination disgust in several countries suggests that these three factors may function generally as an internally consistent and theoretically distinct universal class of disgust-relevant stimuli. However, future research is needed to examine the fit of the core, animal-reminder, and contamination disgust factors to data from other areas of the world (i.e., Africa) that differ from the predominantly Western (American and European) cultures examined in the present study. The degree to which the three disgust factors correspond to distinct outcomes in different countries should also be explored.

The present findings also show that the three disgust dimensions are significantly related. This provides support for the notion that all disgust domains share a common underlying psychological feature (Haidt et al., 1994). However, the DS was developed in the United States and has been subsequently translated into several different languages (Olatunji & Cisler, in press). Although some stimuli that elicit disgust (i.e., feces) are similar across cultures (Curtis, & Biran, 2001; Davey et al., 1998), a central concern is for any measure is its portability to different cultures, where discrepancies may emerge that manifest as important differences in the underlying structure of the construct (Ritsher, Struening, Hellman, & Guardino, 2002). Consequently, evaluating structural equivalence across cultures is an important step in examining the general validity of the three-factor model of the DS-R (van de Vijver & Leung, 1997). The present findings showed that the three-factor structure of the DS-R in Australia, Brazil, and Japan had weak metric invariance relative to the three-factor structure of the DS-R in the United States. However, the three-factor structure of the DS-R was not invariant for data from Germany, Italy, the Netherlands, and Sweden.

Although the three-factor structure of the DS-R best accounted for the data in the different countries, the present findings suggest that the three-factor structure is not equally stable across cultures. The instability of the three-factor structure of the DS-R across the countries not surprising. Indeed, it has been noted that culturally specific factors will affect the stability of underlying structure of various measures of emotion and personality traits (Matsumoto & Yoo, 2007; Rossier, 2005). Although the scale metrics were found not to be the same for all the countries sampled when compared with the United States, the factor loadings of the three-factor structure of the DS-R based on data from the United States were generally similar to those of data from Australia, Brazil, and Japan but not Germany, Italy, the Netherlands, and Sweden. These analyses suggest that the DS-R items represent three latent constructs to which they contribute equally in some countries. However, in Germany, Italy, the Netherlands, and Sweden, some items of the DS-R do not appear to provide equivalent measurement of the core, animal-reminder, and contamination disgust latent constructs. This interpretation of these findings is in line with prior research. For example, although disgust reactions to unusual sexual practices are related to animal-reminder disgust among U.S. participants, this does not appear to be the case among participants from the Netherlands (Olatunji, Sawchuk, de Jong, & Lohr, 2006).

It has been shown that there are important cross-language differences in the meaning of disgust (Haidt, Rozin, McCauley, & Imada, 1997), and one major source of variation arises from cultural differences in conceptions of disgust toward the body and its products (Shweder, Mahapatra, & Miller, 1987). The noninvariance of the three-factor model of the DS-R may reflect true cross-cultural differences in the structure and meaning of disgust in respondents from Germany, Italy, the Netherlands, and Sweden when compared with U.S. respondents. Interestingly, unique interpretations of disgust may be attributable to regional effects, because invariance was not found in the European countries. For example, the German word for disgust, *Ekel*, may have a different semantic range. The meaning of *Ekel* (etymologically) is "what provokes/leads to vomiting." Thus, it is quite similar to the theoretical meaning of *disgust* (bad taste). However, there is evidence that among participants in the United States, the common understanding of the word *disgust* reflects a combination of the conceptual meanings of disgust and anger whereas the slang term "grossed out" more closely captures the theoretical meaning of disgust (Nabi, 2002). The Swedish word for *disgust* appears to be related to *Ekel*, yet this is

not so for the Dutch word for *disgust*. So the lack of invariance in the structure of disgust may be related to important differences in Germanic culture, rather than the language per se. There is evidence that disgust responses largely reflect social influence and cultural shaping (Bixler & Floyd, 1997; Rozin & Fallon, 1987). For example, although spiders are often appraised as disgusting in Western cultures, in many other areas of the world (e.g., Indo-China, the Caribbean, and Africa) spiders are eaten as a delicacy (Bristowe, 1932, 1945). Different cultural factors (i.e., language, social institutions, urbanization) in conjunction with variability in cultural beliefs may account for the noninvariance of the three-factor model of the DS-R in some countries.

Applying the three-factor structure of the DS-R based on data from the United Stated to data from other countries represents an etic approach. Future investigations may wish to assume a more emic (i.e., cultural-specific) approach in examining the extent to which the three-factor structure represents the underlying structure of the DS-R in other countries. The importance of using an emic approach in the assessment of disgust is best captured by the linguist Anna Wierzbicka (1986):

> One of the most interesting and provocative ideas that have been put forward in the relevant literature is the possibility of identifying a set of fundamental human emotions, universal, discrete, and presumably innate. . . . I experience a certain unease when reading claims of this kind. . . . How is it that these emotions are all so neatly identified by means of English words? For example, Polish do not have a word exactly corresponding to the English word *disgust.* What if psychologists working on the "fundamental emotions" happened to be native speakers of Polish rather than English? (p. 584)

Specific sample characteristics in the present study may also account for the noninvariance of the three-factor model in Germany, the Netherlands, and Sweden. Examination of DS-R item-level differences may also provide some insight into the distinctiveness of data from Germany, the Netherlands, and Sweden. Examination of the standardized factor loadings of the three-factor model outlined in Table 6 shows that 4 to 13 items from Germany, the Netherlands, and Sweden data loaded <.30 onto the respective three factors, whereas only 0 to 3 items from Australia, Brazil, Japan, and the United States loaded <.30 onto the respective three factors. This suggests that the items that constitute the core, animal-reminder, and contamination disgust factors in some countries (Germany, the Netherlands, Sweden) are not equally related to the same group of items in the United States.

Prior research has highlighted important gender differences in disgust, with women consistently reporting higher levels than men (Olatunji, Sawchuk, Arrindell, & Lohr, 2005). The present findings revealed that the previously reported gender difference in disgust is also observed in many different countries. Given the robust gender differences in disgust, the present study also examined the invariance of the three-factor structure of the DS-R across gender. The findings revealed that the three-factor structure of the DS-R evidenced weak metric invariance in samples of men and women from Australia, Japan, Sweden, and the United States. These findings suggest that the group of items that represent the core, animal-reminder, and contamination disgust factors represent a set of constructs that seem to be equally viable across gender in different countries.

The present study also highlights important areas of further refinement of the DS. For example, item-total correlations for Item 12 ("I probably would not go to my favorite restaurant if I found out that the cook had a cold") and Item 18 ("You take a sip of soda, and then

realize that you drank from the glass that an acquaintance of yours had been drinking from") appear to be problematic as indicated by an item-total correlation below the criterion of .30 recommended by Nunnally and Bernstein (1994) in four of the eight countries sampled. These two items assess basic rules of disgust appraisal labeled "the laws of sympathetic magic" (Rozin & Nemeroff, 1990). The first rule, the law of contagion, dictates that the properties of one object are transferred by contact to another and remain after contact is broken. The second rule, law of similarity, dictates that things that are similar in some properties are felt to be fundamentally similar or even identical (Haidt et al., 1997). Although Items 12 and 18 appear to assess the laws of sympathetic magic or an irrational understanding of how contagion is transmitted which may be related to disgust, the low item-total correlation in four countries suggests that these items deviate from the experience of disgust in some countries. In some countries, these items may more directly be related to concerns of improbable contamination rather then disgust per se.

The contamination disgust factor consists of Items 12 and 18; thus, the low item-total correlation of these items may have implications for the psychometric integrity and distinctiveness of the contamination disgust factor. In fact, it is possible that core and contamination disgust factors may not be separable in some cultures given the conceptual overlap of avoidance of contaminants either orally (core disgust) or via contact (contamination disgust). Although the three-factor solution appears to fit the DS-R data generally well, invariance of the three-factor solution was only observed for some countries. To continue to justify claims for the three-factor solution, it will be necessary to rule out translation artifacts on the DS-R (which to our view was adequately done in the present study) because there are important cross-language differences in the semantic domains of words for disgust (Haidt et al., 1997). Nonetheless, further research is needed to investigate the replicability and correlates of culture-specific factors. It also will be useful to explore other psychometric properties of the DS-R in different countries, including test–retest reliability, criterion validity, and incremental predictive validity. Additionally, the use of more behaviorally oriented methods of disgust assessment that is more cross-culturally stable (i.e., facial expressions) may provide a useful avenue to further explore possible cross-cultural similarities and differences on the convergence of self-reported disgust across multiple dimensions and disgust-relevant behavioral outputs.

There has been a recent emergence of research interest on the role of disgust sensitivity in the anxiety disorders (Olatunji & Sawchuk, 2005). Although research has begun to address cross-cultural issues in the assessment of some anxiety disorder risk factors (e.g., anxiety sensitivity; Zvolensky et al., 2003), such research on disgust sensitivity is noticeably absent in the literature. It may be useful for future research to address the extent to which specific dimensions of disgust sensitivity relate to typical and culturally specific manifestations of anxiety pathology. Core disgust (oral incorporation), animal-reminder disgust (mortality defense), and contamination disgust (disease avoidance) appear to be governed by distinct behavioral inhibition systems. Accordingly, core disgust, animal-reminder disgust, and contamination disgust should be differentially related to specific anxiety disorder symptoms (de Jong & Merckelbach, 1998). Preliminary cross-cultural research has shown that OCD-related contamination fear among participants from the Netherlands is best predicted by core and animal-reminder disgust, whereas OCD-related contamination fear among participants from the United States is best predicted by only core disgust (Sawchuk, Olatunji, & de Jong, 2006). It remains to be seen whether a differential

pattern of associations between the disgust dimensions and anxiety disorder symptoms is observed in other countries. Finally, research that addresses how disgust sensitivity facilitates the transition from normal functioning to anxiety pathology in different countries will be an important next step (Davey, Bickerstaffe, & MacDonald, 2006).

Disgust has been conceptualized as one of the basic, universal emotions that may be elaborated into complex emotional reactions that vary from one culture to the next (Oatley & Johnson-Laird, 1987). These findings demonstrate that the underlying factor structure of the DS-R in several different countries is best captured by a three-factor solution. Although initially developed for participants in the United States, the DS-R appears to have some utility across cultures. Such a universal structure for disgust may have important implications for understanding the intersection of human emotion and culture. For example, theories of disgust developed in Western empirical traditions may be applicable to other cultural context. This is not to say that cross-cultural factors do affect the structural integrity of disgust. Perhaps a more parsimonious view is that there may be culture-specific modulations of content that are appraised with disgust (particularly in Germanic countries) that converge around a universal theme.

The present investigation illustrates the factorial structure of disgust but does not necessary encompass the full range of possible disgust dimensions. For example, the present findings do not address the morality dimension of disgust, which may vary in content and structure across cultures (Haidt et al., 1997; Scherer, 1997). Another limitation of the current study is that only the DS-R was administered, which places limitations on the psychometric information that may be obtained from the present study. Nonetheless, this study serves as an important reference point for future research aimed at elucidating issues related to disgust sensitivity across cultures.

Notes

1. For the non-English-speaking countries in the present investigation, translation of the DS from English to the native language was made by the following methods. *Brazil*: The DS was translated into Portuguese by a bilingual fellow, and an independent bilingual fellow translated it back into English. Both versions were compared, and both translators had a high agreement (100%). *Germany*: The DS was translated into German by A. Schienle. Subsequently, the German DS-R was translated back into English by an independent translator, a native English speaker. This process was checked to make sure that both English versions were comparable, which was the case. *Italy*: DS was translated into Italian by two bilingual clinical psychologists, for one of which English was the second language and Italian the first and vice versa for the other translator. The translators made the translation, in a first phase, independently one from the other, and in a second phase, they shared and reviewed the translations. Very minor differences were found between the two translations and were solved with a discussion between the translators. *Japan*: The DS was translated into Japanese by S. Imada. Back-translation was conducted by an independent investigator, and recommended adjustments were made. *Netherlands:* the DS was translated into Dutch by P. de Jong and colleagues. Although a backward translation procedure was not used for the measure used in the present study, a recent back-translation resulted in a satisfactory outcome. *Sweden*: The DS was translated into Swedish by a professional translator. One change was made to the scale: The word *cockroach* in one item was changed into *mjölbagge* (mealworm, *Tenebrio molitor*) because cockroaches are rarely seen in Swedish homes. A bilingual (English and Swedish) graduate student in psychology then independently translated the Swedish version back to English. and both versions were judged to be remarkably similar.

2. The missing data in these samples constrained the analysis to the FIML method in LISREL, and therefore, access to some of the popular types of fit indices was limited. Although we were not able to obtain several popular goodness-of-fit indices, FIML estimation has been shown to be a good analysis procedure. Enders and Bandalos (2001) demonstrated that FIML estimation is the best option for analyzing data sets with missing values, yielding more unbiased and efficient estimates than list-wise deletion, pair-wise deletion, and similar response pattern imputation.

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