Supplemental Materials

On the Relationship between Valence and Arousal in Samples across the Globe

Supplemental Materials 1

Demographic Characteristics of the 33 Samples

							Age		
Sample	**Language**	**Schwartz's (2006) Region**	**Data Collection**	***N***	**% Female**	**% Native**	***Mdn***	***M***	**(*SD*)**
Australia	English	English-Speaking	Qualtrics	251	60%	96%	29.00	29.86	(8.47)
Belgium	Dutch	West Europe	Qualtrics	190	88%	97%	18.00	19.17	(3.18)
Brazil	Brazilian Portuguese	Latin America	Qualtrics & Paper	220	58%	100%	21.00	22.52	(5.20)
China (Beijing)	Simplified Chinese	Confucian	Qualtrics	220	60%	100%	21.00	21.29	(2.83)
China (Hong Kong)	Traditional Chinese	Confucian	Qualtrics	272	43%	98%	21.00	21.20	(1.03)
Colombia	Colombia Spanish	Latin America	Qualtrics	270	54%	99%	21.00	21.22	(2.42)
Croatia	Croatian	East Europe	Paper	227	54%	98%	21.00	20.76	(1.52)
Czech Republic	Czech	East Europe	Qualtrics	469	71%	87%	23.00	24.74	(6.65)
Estonia	Estonian	East Europe	Qualtrics	227	60%	94%	23.00	26.03	(7.73)
Finland	Finnish	West Europe	Qualtrics	240	63%	97%	26.00	27.35	(6.89)
France	French	West Europe	Paper	272	62%	99%	21.00	21.64	(2.90)
Germany	Germany German	West Europe	Paper	232	70%	96%	22.00	24.03	(7.45)
Greece	Greek	West Europe	Qualtrics	317	56%	97%	19.00	19.74	(3.66)
Iceland	Icelandic	West Europe	Qualtrics	316	73%	96%	28.00	32.73	(12.71)
Indonesia	Indonesian	South Asia	Qualtrics & Paper	349	47%	97%	21.00	21.06	(2.56)
Israel	Hebrew	English-Speaking	Qualtrics	209	59%	99%	25.00	25.09	(4.02)
Italy	Italian	West Europe	Qualtrics	237	61%	97%	22.00	23.64	(5.13)
Japan	Japanese	Confucian	Qualtrics	251	42%	98%	19.00	19.12	(1.15)
New Zealand	English	English-Speaking	Qualtrics	426	57%	98%	19.00	19.74	(3.61)
Nigeria	English	Africa and the Middle East	Paper	190	47%	98%	21.00	21.69	(3.40)
Oman	Arabic	Africa and the Middle East	Qualtrics	245	60%	94%	30.00	32.17	(11.69)
Poland	Polish	East Europe	Qualtrics	404	70%	94%	33.00	33.81	(10.99)
Romania	Romanian	East Europe	Qualtrics	226	57%	95%	21.00	23.71	(7.07)
Russia	Russian	East Europe	Qualtrics	240	63%	98%	20.00	21.67	(5.99)

Serbia	Serbian	East Europe	Qualtrics	228	45%	97%	21.00	22.42	(3.19)
Slovakia	Slovak	East Europe	Qualtrics	246	57%	98%	22.00	23.55	(4.67)
South Korea	Korean	Confucian	Qualtrics	269	65%	98%	20.00	21.14	(3.08)
Spain	Spain Spanish	West Europe	Qualtrics & Paper	202	59%	100%	21.00	21.66	(4.22)
Switzerland	Swiss German	West Europe	Qualtrics	238	65%	93%	28.00	31.05	(10.04)
Uganda	English	Africa and the Middle East	Qualtrics & Paper	206	52%	90%	21.00	21.83	(3.92)
UK (England)	English	English-Speaking	Qualtrics	199	54%	94%	28.50	31.85	(12.33)
United States	English	English-Speaking	Qualtrics	264	53%	95%	20.00	20.74	(1.91)
Vietnam	Vietnamese	South Asia	Paper	238	55%	100%	20.00	20.48	(1.57)
			Full Data Set	**8,590**	**59%**	**96%**	**21.00**	**24.01**	**(7.67)**

Supplemental Materials 2

Reliabilities of the Four Affect Segments Defining Valence and Arousal

Sample	*N*	Pleasant	Unpleasant	Activated	Deactivated
Australia	251	.83	.89	.77	.59
Belgium	190	.92	.91	.74	.01
Brazil	220	.94	.88	.82	.46
China (Beijing)	220	.94	.93	.76	.57
China (Hong Kong)	272	.95	.91	.75	.61
Colombia	270	.90	.91	.84	.50
Croatia	227	.94	.88	.77	.46
Czech Republic	469	.97	.91	.83	.66
Estonia	227	.96	.85	.75	.65
Finland	240	.94	.92	.75	.60
France	272	.95	.88	.81	.24
Germany	232	.94	.91	.64	.42
Greece	317	.95	.94	.75	.41
Iceland	316	.94	.92	.81	.45
Indonesia	349	.88	.76	.66	.62
Israel	209	.93	.89	.80	.67
Italy	237	.92	.89	.87	.43
Japan	251	.88	.88	.76	.50
New Zealand	426	.92	.92	.77	.59
Nigeria	190	.75	.76	.47	.39
Oman	245	.82	.71	.49	.35
Poland	404	.94	.95	.77	.13
Romania	226	.96	.91	.79	.64
Russia	240	.95	.86	.75	.41
Serbia	228	.93	.89	.81	.33
Slovakia	246	.95	.92	.82	.66
South Korea	269	.93	.91	.83	.69
Spain	202	.87	.84	.75	.64
Switzerland	238	.94	.88	.65	.34
Uganda	206	.85	.89	.53	.32
UK (England)	199	.93	.93	.76	.55
United States	264	.92	.90	.72	.62
Vietnam	238	.88	.87	.78	.51
Full Data Set	8,590				
Median α		.93	.89	.76	.50
Weighted average α		.92	.89	.75	.49

Supplemental Materials 3

Testing Measurement Invariance of Valence and Arousal

To define valence, we began with the affect items capturing pleasant, and unpleasant segments of the 12-Point Affect Circumplex (12-PAC; Yik et al., 2011); to define arousal, we began with the affect items capturing activated, and deactivated segments. The configural invariance model (factor loadings and intercepts freely estimated across groups) tested whether the pattern of zero and non-zero loadings for the factors was equal across groups whereas the metric invariance model (factor loadings constrained to be equal across groups) tested whether the meaning of the latent constructs was equal across groups. When the assumptions of metric invariance were satisfied, the valence-arousal relations could be compared across the 33 samples.

To evaluate the goodness of fit for the invariance models, the comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR) statistics were examined. CFI values of at least .95, RMSEA values smaller than or equal to .06, and SRMR values small than or equal to .08 are typically considered good fit (Hu & Bentler, 1999), although Rutkowski and Svetina (2014) showed that a cut-off of .10 is more appropriate for the RMSEA in case of 10 or more groups. When moving from a less restricted (i.e., configural) to a more restricted (i.e., metric) model, Chen (2007) postulated that a difference of less than .01 in CFI (ΔCFI), .02 in RMSEA (ΔRMSEA), or .03 in SRMR (ΔSRMR) indicates invariance. However, Rutkowski and Svetina showed that more liberal criteria should be used when multiple groups are involved, i.e., ΔCFI less than .02 and ΔRMSEA less than .03 for establishing metric invariance.

To assess measurement invariance of valence and arousal, we conducted a series of multigroup confirmatory factor analyses (MGCFA) using the lavaan package (version 0.6-7.1564, Rosseel, 2012) for R software (R Development Core Team, 2005). Missing data were estimated using Full Information Maximum Likelihood estimation. To test the configural model, a two-factor model was examined in which valence was tapped by four pleasant items (“happy”, “pleased”, “content”, “satisfied”) and four unpleasant items (“miserable”, “unhappy”, “troubled”, “dissatisfied”) whereas arousal by five activated items (“determined”, “intense”, “hyperactivated”, “aroused”, “activated”) and three deactivated items (“still”, “quiet”, “sleepy”). This hypothesized model revealed a poor fit in the configural invariance model: CFI = .77, RMSEA = .15, SRMR = .13.

Following Owe et al. (2013), we refined the scales by (1) eliminating items with non-significant loadings, and (2) examining the largest modification indices and correlating pairs of residuals wherever appropriate. To improve the model fit, items with low loadings would be further examined and excluded to simplify the model. After incorporating each of these modifications, model fit was re-examined until an acceptable model fit was reached.

Five items were excluded from the model. The item “still” had non-significant loadings in 11 samples, followed by “intense” (5 samples) and “quiet” (5 samples). These three items were removed together with items “miserable” and “troubled” which had the lowest loadings on the valence factor in 27 and 26 samples, respectively. In addition, the modification indices revealed that large error covariances were found between two pairs of items (“unhappy” and “dissatisfied”, “content” and “satisfied”) and that the correlations between their residuals were estimated in the final models.

The final model consisted of 11 items with two correlated residuals, with a substantial improvement on model fit on the configural invariance model: CFI = .94, RMSEA = .10, SRMR = .08. Each latent construct was defined by its items, with item loadings exceeding |.18| and differed

significantly from zero (*p*s < .05) in all samples except Australia, Japan, Nigeria, and Oman. Using the final model, metric invariance was tested by restricting all item loadings to be equal across groups. The model fit of the metric invariance was then compared with the configural model. The metric invariance model revealed an acceptable fit: CFI = .92, RMSEA = .10, SRMR = .11. The changes of the fit measures between the two models were small (ΔCFI = .018, ΔRMSEA = .003, ΔSRMR = .032) indicating that the factor loadings are equal across groups (metric invariance) and, thus, justifying the comparison of the valence-arousal relation across the 33 samples.

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Supplemental Materials 4

Standardized Maximum Likelihood Estimates for Factor Loadings of the Configural Model

	Valence						Arousal				
Sample	"happy"	"pleased"	"content"	"satisfied"	"unhappy"	"dissatisfied"	"determined"	"aroused"	"hyperactivated"	"activated"	"sleepy"
Australia	.76	.79	.62	.78	–.32	–.29	.56	.61	.78	.62	–.06
Belgium	.81	.86	.88	.90	–.68	–.71	.41	.74	.79	.78	–.32
Brazil	.88	.89	.93	.85	–.64	–.69	.63	.71	.77	.83	–.38
China (Beijing)	.92	.92	.87	.87	–.71	–.73	.54	.84	.56	.78	–.55
China (Hong Kong)	.92	.95	.86	.89	–.52	–.57	.41	.92	.56	.75	–.51
Colombia	.72	.79	.94	.90	–.68	–.75	.45	.79	.92	.72	–.35
Croatia	.92	.89	.90	.82	–.75	–.80	.60	.64	.85	.69	–.49
Czech Republic	.91	.93	.96	.93	–.81	–.82	.71	.71	.84	.84	–.47
Estonia	.91	.95	.89	.90	–.63	–.77	.61	.73	.80	.39	–.35
Finland	.86	.92	.92	.89	–.66	–.65	.31	.71	.92	.49	–.23
France	.89	.92	.94	.87	–.75	–.75	.67	.66	.65	.85	–.50
Germany	.81	.92	.93	.90	–.69	–.73	.56	.56	.90	.48	–.46
Greece	.87	.97	.84	.91	–.80	–.85	.47	.88	.90	.64	–.31
Iceland	.90	.94	.84	.89	–.78	–.82	.55	.55	.79	.77	–.46
Indonesia	.80	.88	.85	.70	–.38	–.47	.47	.51	.71	.82	–.31
Israel	.81	.80	.93	.93	–.65	–.68	.59	.67	.86	.68	–.38
Italy	.82	.82	.95	.90	–.71	–.80	.74	.56	.71	.92	–.35
Japan	.65	.81	.88	.90	–.56	–.60	.11	.85	.80	.70	–.19
New Zealand	.87	.90	.76	.88	–.72	–.69	.54	.71	.87	.48	–.30
Nigeria	.82	.77	.45	.68	–.71	–.56	.32	.30	.81	.40	–.16
Oman	.72	.80	.67	.71	–.38	–.36	.54	.48	.63	.07	–.45
Poland	.87	.93	.82	.89	–.77	–.81	.66	.40	.73	.61	–.46
Romania	.90	.93	.93	.95	–.80	–.85	.61	.79	.84	.63	–.52
Russia	.82	.95	.95	.92	–.73	–.72	.65	.78	.79	.73	–.46

Serbia	.84	.88	.93	.86	–.76	–.80	.67	.70	.89	.73	–.37
Slovakia	.89	.92	.87	.94	–.83	–.85	.69	.74	.87	.52	–.49
South Korea	.89	.95	.77	.88	–.58	–.55	.53	.76	.82	.72	–.23
Spain	.83	.61	.96	.85	–.67	–.70	.64	.58	.72	.71	–.46
Switzerland	.79	.91	.94	.94	–.73	–.84	.49	.49	.90	.56	–.47
Uganda	.89	.76	.74	.84	–.75	–.75	.49	.47	.81	.44	–.42
UK (England)	.83	.94	.84	.89	–.78	–.74	.56	.68	.84	.69	–.33
United States	.82	.91	.74	.93	–.79	–.72	.50	.59	.81	.39	–.34
Vietnam	.81	.87	.71	.83	–.42	–.45	.37	.69	.83	.63	–.18

Note. All *p*s < .05 except for “determined” (Japan), “aroused” (Oman), and “sleepy” (Australia, Nigeria).

Supplemental Materials 5

Standardized Parameter Estimates for Valence–Arousal Covariances

	Valence–Arousal covariance	
Sample	Configural	Metric
Australia	.52	.51
Belgium	.55	.54
Brazil	.67	.64
China (Beijing)	.70	.70
China (Hong Kong)	.61	.63
Colombia	.71	.74
Croatia	.56	.56
Czech Republic	.52	.51
Estonia	.51	.50
Finland	.25	.19
France	.55	.54
Germany	.44	.46
Greece	.59	.60
Iceland	.32	.30
Indonesia	.88	.86
Israel	.53	.55
Italy	.78	.72
Japan	.57	.51
New Zealand	.30	.32
Nigeria	.66	.70
Oman	.66	.55
Poland	.51	.40
Romania	.58	.58
Russia	.39	.38
Serbia	.52	.52
Slovakia	.43	.41
South Korea	.40	.41
Spain	.63	.60
Switzerland	.49	.50
Uganda	.66	.66
UK (England)	.56	.56
United States	.37	.39
Vietnam	.49	.49

Note. All *p*s < .05. A two–factor model was tested in each sample. Valence was defined by “happy”, “pleased”, “content”, “satisfied”, “unhappy”, and “dissatisfied”; Arousal was defined by “determined”, “aroused”, “hyperactivated”, “activated”, and “sleepy”. Two pairs of residual scores, “unhappy” and “dissatisfied”, as well as “content” and “satisfied”, were correlated.