Supplemental Materials

Factor Structure and Criterion Validity Across the Full Scale and Ten Short Forms of the CES-D Among Chinese Adolescents

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1. Search Strategy for Validated Short Versions of the Center for Epidemiological Studies Depression Scale (CES-D).

A literature search was implemented in August of 2015. In the initial search phase, we conducted searches of several online databases, including PsycINFO (1977 to August 2015), PubMed (May 1980 to August 2015), and China National Knowledge Infrastructure (CNKI, May 1980 to August 2015). For PsycINFO, the search phrases employed were: "the Center for Epidemiological Studies Depression Scale" OR "CES-D" AND "Short Form" OR "Validity" OR "Measure". For PubMed, we conducted an initial basic search with the search phrases "the Center for Epidemiological Studies Depression Scale" OR "CES-D" AND "Short Form", followed by an exact search using an advanced search builder with the search phrases "the Center for Epidemiological Studies Depression Scale" OR "CES-D" AND "Short Form" in all fields, combined with "Validity" OR "Reliability" OR "Measure" as a text word. For CNKI, the search phrases were "the Center for Epidemiological Studies Depression Scale" AND "Short Form" in Chinese.

From the aforementioned database searches, we identified 565 abstracts, which we reviewed to identify studies on sound development of a valid short-form CES-D. Eighteen articles met the criteria for rigorous development and validation for short forms, as follows: (a) exploratory factor analysis (EFA) or confirmatory factor analysis (CFA) were performed on the construction of the short form CES-D for a general population; (b) explicit item loadings for each factor were presented; and (c) publication language of English or Chinese. Ten valid short versions of the CES-D were identified from among the eligible studies (see supplemental Table 1).

Six eligible studies validated the same 10-item version of the CES-D developed by Andresen et al. (1994) in different populations or ethnic groups (i.e., Boey, 1999; Bradley, Bagnell, & Brannen, 2010; Chen & Mui, 2014; Cheng, Chan, & Fung, 2006; O'Halloran, Kenny, & King-Kallimanis, 2014; Powers, Young, Russell, & Pachana, 2003). Three eligible studies (Carpenter et al., 1998; Irwin, Artin, & Oxman, 1999; Kimberlin, Pendergast, Berardo, & McKenzie, 1998) examined Kohout et al.'s (1993) 10-item CES-D (Boston form), or Kohout et al.'s (1993) 11-item CES-D (Iowa form), or both.

Supplemental Table 1

Articles for the Ten Validated Short Forms of the CES-D and their Factor Models

Models / Short forms	References
4-factor: 10-item & 11-item	Kohout, Berkman, Evans, & Cornoni-Huntley, 1993
3-factor: 14-item	Carleton, Thibodeau, Teale, Welch, Abrams, Robinson, & Asmundson, 2013
13-item	Zhang & Li, 2011
10-item	Cheng, Chan, & Fung, 2006 (validating the 3-factor model of the 10-item CES-D by Andresen, Malmgren, Carter, & Patrick, 1994)
2-factor: 10-item	Andresen, Malmgren, Carter, & Patrick, 1994
10-item	Lee & Chokkanathan, 2008
9-item	He, Cheng, Guo, Zhang, Yang, & Wang, 2013
1-factor: 7-item	Levine, 2013
1-factor with correlated errors [a]: 8-item	Van de Velde, Bracke, Levecque, & Meuleman, 2010
Hierarchical Single-factor: 10-item	Cole, Rabin, Smith, & Kaufman, 2004

Note. CES-D = Center for Epidemiologic Studies Depression Scale.
[a] 1-factor model with correlated errors of reverse-scored items.

Supplementary References

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Kohout, F. J., Berkman, L. F., Evans, D. A., & Cornoni-Huntley, J. (1993). Two Shorter Forms of the CES-D Depression Symptoms Index. *Journal of Aging and Health, 5*, 179-193. doi:10.1177/089826439300500202

O'Halloran, A. M., Kenny, R. A., & King-Kallimanis, B. L. (2014). The latent factors of depression from the short forms of the CES-D are consistent, reliable and valid in community-living older adults. European Geriatric Medicine, 5(2), 97-102. doi: doi.org/10.1016/j.eurger.2013.12.004

Powers, J. R., Young, A. F., Russell, A., & Pachana, N. A. (2003). Implications of non-response of older women to a short form of the Center for Epidemiologic Studies Depression Scale. *The International Journal of Aging and Human Development*, 57, 37-54.

2. Supplemental Tables and Figures for Study 1: Factor Structure of the Full Scale and Ten Short-Forms Versions of the CES-D.

Supplemental Table 2

Fit Statistics for the Exploratory Structural Equation Models Tested Using the Full Scale and the Ten Short Forms of the CES-D in Chinese Adolescents (n = 2,717)

Item Set (Model)	Chi-square	*df*	CFI	TLI	RMSEA [90% C.I.]
20-item (Radloff, 1977)					
1F	4941.382**	170	0.837	0.818	0.102 [0.099 - 0.104]
1F-MF	2059.528**	169	0.935	0.927	0.064 [0.062 - 0.067]
1F-MF-$\theta_{15,19}$	1596.259**	168	0.951	0.945	0.056 [0.053 - 0.058]
2F	2053.042**	151	0.935	0.918	0.068 [0.065 - 0.071]
2F-MF	1200.665**	150	0.964	0.954	0.051 [0.048 - 0.053]
2F-MF-$\theta_{15,19}$	928.307**	149	0.973	0.966	0.044 [0.041 - 0.047]
3F	1217.712**	133	0.963	0.947	0.055 [0.052 - 0.058]
3F-MF	683.647**	132	0.981	0.973	0.039 [0.036 - 0.042]
3F-MF-$\theta_{15,19}$	659.060**	131	0.982	0.974	0.039 [0.036 - 0.041]
4F	648.519**	116	0.982	0.970	0.041 [0.038 - 0.044]
4F-MF	545.288**	115	0.985	0.976	0.037 [0.034 - 0.040]
4F-MF-$\theta_{15,19}$	509.478**	114	0.986	0.977	0.036 [0.033 - 0.039]
14-item (Carleton et al., 2013)					
1F	3089.848**	77	0.833	0.803	0.120 [0.116 - 0.124]
1F-MF	734.076**	76	0.964	0.956	0.056 [0.053 - 0.060]
13-item (Zhang & Li, 2011)					
1F	2369.910**	65	0.873	0.848	0.114 [0.110 - 0.118]
1F-MF	655.961**	64	0.967	0.960	0.058 [0.054 - 0.062]
11-item (Kohout et al., 1993)					
1F	1814.697**	44	0.887	0.859	0.122 [0.117 - 0.127]
1F-MF	963.365**	43	0.941	0.925	0.089 [0.084 - 0.094]
1F-MF-$\theta_{15,19}$	501.457**	42	0.971	0.962	0.063 [0.059 - 0.068]
10-item (Kohout et al., 1993)					
1F	1701.423**	35	0.888	0.856	0.132 [0.127 - 0.138]
1F-MF	867.673**	34	0.944	0.926	0.095 [0.090 - 0.101]
1F-MF-$\theta_{15,19}$	414.551**	33	0.974	0.965	0.065 [0.060 - 0.071]
10-item (Andresen et al., 1994)					
1F	929.575**	35	0.909	0.883	0.097 [0.092 - 0.102]
1F-MF	436.262**	34	0.959	0.946	0.066 [0.061 - 0.072]
10-item (Cole et al., 2004)					
1F	1158.290**	35	0.883	0.850	0.109 [0.103 - 0.114]
1F-MF	442.414**	34	0.958	0.944	0.066 [0.061 - 0.072]
10-item (Lee & Chokkanathan, 2008)					
1F	874.257**	35	0.915	0.890	0.094 [0.089 - 0.099]
1F-MF	358.852**	34	0.967	0.956	0.059 [0.054 - 0.065]
9-item (He et al., 2013)					
1F	1319.349**	27	0.897	0.863	0.133 [0.127 - 0.139]

Item Set (Model)	Chi-square	*df*	CFI	TLI	RMSEA [90% C.I.]
1F-MF	440.986**	26	0.967	0.954	0.077 [0.070 - 0.083]
8-item (Van de Velde et al., 2010)					
1F	905.411**	20	0.915	0.880	0.128 [0.121 - 0.135]
1F-MF	183.574**	19	0.984	0.977	0.056 [0.049 - 0.064]
7-item (Levine, 2013)					
1F	400.865**	14	0.947	0.920	0.101 [0.092 - 0.109]

Note. #F = number offactors; MF = method factor; θ = error correlation; *df* = degrees of freedom; C.I. = confidence interval. ** $p < 0.01$.

Supplemental Table 3

Factor Loadings and Factor Correlations for the 1-Factor Exploratory Structural Equation Models Tested Using the Full Scale of the CES-D in Chinese Adolescents of the Working Sample (n = 2,717)

		1-Factor	1-Factor with MF		1-Factor with MF & $\theta_{15,19}$	
TD	Items	F1	F1	MF	F1	MF
DA	1. Bothered	**.55****	**.47****	**.32****	**.47****	**.32****
	3. Blues	**.65****	**.58****	**.32****	**.58****	**.32****
	6. Depressed	**.76****	**.70****	**.32****	**.70****	**.32****
	9. Failure	**.70****	**.64****	**.32****	**.64****	**.32****
	10. Fearful	**.63****	**.55****	**.32****	**.56****	**.32****
	14. Lonely	**.71****	**.63****	**.32****	**.64****	**.32****
	17. Crying	**.39****	**.30****	**.32****	**.30****	**.32****
	18. Sad	**.76****	**.69****	**.32****	**.70****	**.32****
SC	2. Appetite	**.38****	.29**	**.32****	.29**	**.32****
	5. Mind	**.50****	**.42****	**.32****	**.42****	**.32****
	7. Effort	**.63****	**.55****	**.32****	**.56****	**.32****
	11. Sleep	**.46****	**.37****	**.32****	**.37****	**.32****
	13. Talk	**.43****	**.34****	**.32****	**.34****	**.32****
	20. Get going	**.56****	**.48****	**.32****	**.49****	**.32****
ID	15. Unfriendly	**.66****	**.58****	**.32****	**.52****	**.32****
	19. Disliked	**.68****	**.60****	**.32****	**.55****	**.32****
PA	4. Felt good	**.33****	**.46****	**-.32****	**.46****	**-.32****
	8. Hopeful	**.42****	**.55****	**-.32****	**.55****	**-.32****
	12. Happy	**.56****	**.70****	**-.32****	**.70****	**-.32****
	16. Enjoyed	**.58****	**.71****	**-.32****	**.72****	**-.32****
			Factor Correlations		Factor Correlations	
	F1		1.00		1.00	
	MF		.00	1.00	.00	1.00
					Error Correlation $\theta_{15,19}$ = .44**	

Note. TD = theoretical dimension; DA = depressed affect; SC = somatic complaints; ID = interpersonal difficulties; PA = (lack of) positive affect; F = factor; MF = method factor; θ = error correlation. Loadings above .30 in absolute value appear in boldface and underlined.
* $p < 0.05$, ** $p < 0.01$

Supplemental Table 4

Factor Loadings and Factor Correlations for the 2-Factor Exploratory Structural Equation Models Tested Using the Full Scale of the CES-D in Chinese Adolescents of the Working Sample (n = 2,717)

		2-Factors		2-Factors with MF			2-factors with MF & θ15,19		
TD	Items	F1	F2	F1	F2	MF	F1	F2	MF
DA	1. Bothered	**.57****	-.01	.20**	**.33****	**.32****	**.37****	.15**	**.31****
	3. Blues	**.62****	.08**	.20**	**.45****	**.32****	**.41****	.23**	**.31****
	6. Depressed	**.71****	.12**	**.31****	**.48****	**.32****	**.60****	.16**	**.31****
	9. Failure	**.59****	.23**	.11**	**.59****	**.32****	.25**	**.49****	**.31****
	10. Fearful	**.67****	-.03	**.41****	.23**	**.32****	**.58****	.01	**.31****
	14. Lonely	**.72****	.01	**.55****	.18**	**.32****	**.74****	-.08*	**.31****
	17. Crying	**.49****	-.16**	**.40****	-.05	**.32****	**.51****	-.23**	**.31****
	18. Sad	**.77****	.02	**.45****	**.34****	**.32****	**.73****	.00	**.31****
SC	2. Appetite	**.42****	-.06	.05	.27**	**.32****	.22**	.10*	**.31****
	5. Mind	**.49****	.05*	-.11**	**.56****	**.32****	-.04	**.56****	**.31****
	7. Effort	**.57****	.14**	-.01	**.62****	**.32****	.15**	**.50****	**.31****
	11. Sleep	**.49****	-.05	.09*	**.32****	**.32****	.27**	.13**	**.31****
	13. Talk	**.47****	-.06**	.24**	.15**	**.32****	**.39****	-.04	**.31****
	20. Get going	**.50****	.13**	-.07	**.59****	**.32****	.00	**.60****	**.31****
ID	15. Unfriendly	**.70****	-.06*	**.71****	-.04	**.32****	**.54****	.00	**.31****
	19. Disliked	**.73****	-.08**	**.69****	.01	**.32****	**.54****	.04	**.31****
PA	4. Felt good	-.02	**.59****	.17**	**.34****	**-.32****	.25**	.26**	**-.31****
	8. Hopeful	-.01	**.72****	-.01	**.61****	**-.32****	.08	**.57****	**-.31****
	12. Happy	.20**	**.62****	.26**	**.52****	**-.32****	**.50****	.26**	**-.31****
	16. Enjoyed	.18**	**.68****	.25**	**.55****	**-.32****	**.44****	**.35****	**-.31****
		Factor Correlations		Factor Correlations			Factor Correlations		
	F1	1.00		1.00			1.00		
	F2	.37**	1.00	.57**	1.00		.64**	1.00	
	MF			.00	.00	1.00	.00	.00	1.00
							Error Correlation θ15,19 = .42**		

Note. TD = theoretical dimension; DA = depressed affect; SC = somatic complaints; ID = interpersonal difficulties; PA = (lack of) positive affect; F = factor; MF = method factor; θ = error correlation. Loadings above .30 in absolute value appear in boldface and underlined.
* $p < 0.05$, ** $p < 0.01$

Supplemental Table 5

Factor Loadings and Factor Correlations for the 3-Factor Exploratory Structural Equation Models Tested Using the Full Scale of the CES-D in Chinese Adolescents of the Working Sample (n = 2,717)

		3-Factors			3-Factors with MF				3-factors with MF & $\theta_{15,19}$			
TD	Items	F1	F2	F3	F1	F2	F3	MF	F1	F2	F3	MF
DA	1. Bothered	**.51****	.12**	-.05	**.40****	.10*	.02	**.32****	**.45****	.07	.00	**.32****
	3. Blues	**.58****	.09	.05	**.47****	.18**	-.01	**.32****	**.49****	.15**	.03	**.32****
	6. Depressed	**.61****	.15**	.10**	**.69****	.08	-.02	**.32****	**.69****	.06	.02	**.32****
	9. Failure	**.56****	.03	.22**	.15**	**.53****	.09*	**.32****	.11	**.48****	.27**	**.32****
	10. Fearful	**.39****	**.35****	-.03	**.38****	.06	.23**	**.32****	.23**	.06	**.38****	**.32****
	14. Lonely	**.30****	**.48****	.04	**.45****	.00	**.32****	**.32****	.28**	-.01	**.47****	**.32****
	17. Crying	.17**	**.41****	-.15**	**.30****	-.17**	.24**	**.32****	.11	-.14**	**.37****	**.32****
	18. Sad	**.54****	**.31****	.01	**.70****	-.05	.12**	**.32****	**.62****	-.05	.18**	**.32****
SC	2. Appetite	**.48****	.01	-.11**	**.41****	.00	-.14**	**.32****	**.48****	-.01	-.19**	**.32****
	5. Mind	**.72****	-.19**	-.03	.01	**.54****	-.06	**.32****	.13	**.46****	-.02	**.32****
	7. Effort	**.72****	-.13**	.08*	.25**	**.45****	-.08*	**.32****	**.36****	**.39****	-.06	**.32****
	11. Sleep	**.54****	.02	-.10**	**.44****	.04	-.12**	**.32****	**.52****	.02	-.17**	**.32****
	13. Talk	**.33****	.21**	-.08**	**.41****	-.08	.03	**.32****	**.41****	-.08*	.02	**.32****
	20. Get going	**.64****	-.13**	.08*	-.03	**.62****	.00	**.32****	.04	**.53****	.10	**.32****
ID	15. Unfriendly	.00	**.75****	.05	.00	.15	**.66****	**.32****	.01	.10	**.57****	**.32****
	19. Disliked	.10*	**.71****	.01	.01	.19*	**.65****	**.32****	.00	.13*	**.58****	**.32****
PA	4. Felt good	-.22**	.04	**.69****	.09*	**.32****	.15**	**-.32****	.00	.29**	**.32****	**-.32****
	8. Hopeful	.01*	-.20**	**.78****	-.01	**.63****	.05	**-.32****	-.05	**.57****	.26**	**-.32****
	12. Happy	.08*	-.02	**.68****	**.57****	.20**	-.01	**-.32****	**.62****	.16**	.00	**-.32****
	16. Enjoyed	.03	.00	**.76****	**.37****	**.36****	.10**	**-.32****	**.36****	**.30****	.21**	**-.32****
		Factor Correlations			Factor Correlations				Factor Correlations			
	F1	1.00			1.00				1.00			
	F2	.65**	1.00		.66**	1.00			.51**	1.00		
	F3	.54**	.45**	1.00	.53**	.36**	1.00		.72**	.23*	1.00	
	MF				.00	.00	.00	1.00	.00	.00	.00	1.00
										Error Correlation $\theta_{15,19}$ = .33**		

Note. TD = theoretical dimension; DA = depressed affect; SC = somatic complaints; ID = interpersonal difficulties; PA = (lack of) positive affect; F = factor; MF = method factor; θ = error correlation. Loadings above .30 in absolute value appear in boldface and underlined.

* $p < 0.05$, ** $p < 0.01$

Supplemental Table 6

Factor Loadings and Factor Correlations for the 4-Factor Exploratory Structural Equation Models Tested Using the Full Scale of the CES-D in Chinese Adolescents of the Working Sample (n = 2,717)

		4-Factors				4-Factors with MF					4-factors with MF & θ15,19				
TD	Items	F1	F2	F3	F4	F1	F2	F3	F4	MF	F1	F2	F3	F4	MF
DA	1. Bothered	**.41****	.17**	.08*	-.04	.20**	.17**	.04	.17**	**.31****	**.37****	.11*	.01	.09	**.31****
	3. Blues	**.49****	.21**	.04	.04	.27**	.26**	.01	.17**	**.31****	**.41****	.18*	.06	.06	**.31****
	6. Depressed	**.68****	.11**	.04	.09**	.19	.22**	-.01	**.46****	**.31****	**.50****	.13**	-.01	.27**	**.31****
	9. Failure	.21**	**.44****	.16**	.15**	.05	**.56****	.12**	.04	**.31****	.07	**.51****	.21	.04	**.31****
	10. Fearful	**.39****	.08**	.29**	-.03	.15*	.09*	.23**	.25**	**.31****	.17**	.08	.29**	.22**	**.31****
	14. Lonely	**.46****	-.04	**.39****	.05**	**.37****	-.02	**.35****	.14	**.31****	**.33****	-.06	**.49****	.06	**.31****
	17. Crying	**.32****	-.12**	**.30****	-.11**	-.01	-.16**	.22**	**.36****	**.31****	.02	-.12*	.23**	**.35****	**.31****
	18. Sad	**.68****	.01	.18**	.02	.08	.04	.10	**.67****	**.31****	**.43****	.00	.04	**.47****	**.31****
SC	2. Appetite	**.46****	.09*	-.09*	-.08**	**.41****	.06	-.12**	.00	**.31****	**.46****	-.01	-.06	-.11	**.31****
	5. Mind	.03	**.68****	-.01	-.10**	-.15**	**.60****	-.06*	.08	**.31****	.04	**.53****	-.09	.07	**.31****
	7. Effort	.28**	**.49****	-.02	.03	.01	**.54****	-.06**	.16**	**.31****	.24**	**.45****	-.09	.09	**.31****
	11. Sleep	**.48****	.14**	-.07*	-.09**	**.44****	.10	-.10*	.00	**.31****	**.52****	.01	-.04	-.11	**.31****
	13. Talk	**.46****	-.04	.09*	-.05*	**.43****	-.07	.06	.03	**.31****	**.45****	-.13*	.13	-.08	**.31****
	20. Get going	.03	**.62****	.07*	.01	-.08	**.64****	.02	-.02	**.31****	.01	**.57****	.05	.00	**.31****
ID	15. Unfriendly	.04	.04	**.74****	.03	.10	.02	**.71****	-.04	**.31****	.09	.07	**.49****	.06	**.31****
	19. Disliked	-.01	.12**	**.77****	-.02	-.08	.08*	**.67****	.14*	**.31****	-.02	.15	**.41****	.26**	**.31****
PA	4. Felt good	.02	-.02	.11**	**.58****	.17*	**.31****	.19**	-.10*	**-.31****	.04	.28	**.33**	-.08	**-.31****
	8. Hopeful	-.08**	.28**	.00	**.65****	.06	**.64****	.09*	-.14**	**-.31****	-.03	**.59****	.25	-.11*	**-.31****
	12. Happy	**.43****	-.04*	-.07**	**.61****	**.39****	.28**	.03	.16*	**-.31****	**.54****	.19*	.07	.02	**-.31****
	16. Enjoyed	.28**	.05	.03	**.64****	.27**	**.40****	.13**	.06	**-.31****	**.33****	**.32***	.22	.00	**-.31****
		Factor Correlations				Factor Correlations					Factor Correlations				
	F1	1.00				1.00					1.00				
	F2	.59**	1.00			.57**	1.00				.58**	1.00			
	F3	.59**	.46**	1.00		.44**	.48**	1.00			.56*	.38**	1.00		
	F4	.16**	.24**	.16**	1.00	.60**	.55**	.47**	1.00		.44**	.35	.40**	1.00	
	MF					.00	.00	.00	.00	1.00	.00	.00	.00	.00	1.00
											Error Correlation θ15,19 = .37**				

Note. TD = theoretical dimension; DA = depressed affect; SC = somatic complaints; ID = interpersonal difficulties; PA = (lack of) positive affect; F = factor; MF = method factor; θ = error correlation. Loadings above .30 in absolute value appear in boldface and underlined.

* $p < 0.05$, ** $p < 0.01$

Supplemental Table 7

Factor Loadings for the 1-Factor Exploratory Structural Equation Models Tested Using the Short Forms of the CES-D in Chinese Adolescents of the Working Sample (n = 2,717)

TD	Items	14-item Carleton (2013) 1-Factor with MF F1	13-item Zhang (2011) 1-Factor with MF F1	11-item Kohout (1993) 1-Factor with MF θ15,19 F1	10-item Kohout (1993) 1-Factor with MF θ15,19 F1	10-item Andresen (1994) 1-Factor with MF F1	10-item Cole (2004) 1-Factor with MF F1	10-item Lee (2008) 1-Factor with MF F1	9-item He (2013) 1-Factor with MF F1	8-item de Velde (2010) 1-Factor with MF F1	7-item Levine (2013) 1-Factor F1
DA	1. Bothered	**.48****	**.48****			**.48****	**.44****	**.49****			
	3. Blues	**.60****	**.59****				**.56****	**.61****	**.59****		
	6. Depressed	**.73****	**.73****	**.73****	**.73****	**.70****		**.70****	**.74****	**.75****	**.79****
	9. Failure						**.63****				
	10. Fearful		**.53****			**.54****	**.52****	**.54****			
	14. Lonely	**.59****	**.60****	**.66****	**.66****	**.58****	**.59****	**.61****	**.60****	**.61****	
	17. Crying										
	18. Sad	**.68****	**.69****	**.72****	**.72****				**.70****	**.71****	**.77****
SC	2. Appetite	**.31****		**.30****							**.40****
	5. Mind	**.44****	**.44****			**.47****	**.41****	**.44****	**.44****		**.57****
	7. Effort	**.58****	**.58****	**.54****	**.54****	**.60****	**.54****		**.57****	**.55****	**.67****
	11. Sleep	**.38****	**.38****	**.38****	**.36****	**.38****		**.38****		**.38****	**.48****
	13. Talk										
	20. Get going	**.49****	**.49****	**.47****	**.47****	**.51****		**.49****	**.49****	**.47****	**.59****
ID	15. Unfriendly			**.53****	**.53****		**.52****				
	19. Disliked			**.54****	**.55****						
PA	4. Felt good	**.45****					**.53****				
	8. Hopeful	**.55****	**.53****			**.53****	**.65****	**.51****			
	12. Happy	**.70****	**.70****	**.69****	**.69****	**.69****		**.70****	**.69****	**.70****	
	16. Enjoyed	**.71****	**.71****	**.70****	**.71****				**.71****	**.70****	
	|MFL|	**.32****	**.32****	**.30****	**.31****	**.31****	**.36****	**.31****	**.32****	**.31****	
	θ15,19			.44**	.44**						

Note. TD = theoretical dimension; DA = depressed affect; SC = somatic complaints; ID = interpersonal difficulties; PA = (lack of) positive affect; F = factor; MF = method factor; |MFL| = absolute loading in method factor; θ = error correlation. Loadings ≥ .30 in absolute value appear in boldface and underlined.

* $p < 0.05$, ** $p < 0.01$

Supplemental Table 8

Factor Loadings for the 1-Factor Confirmatory Models Tested Using the Short Forms of the CES-D in Chinese Adolescents of the Cross-Validation Sample (n = 2,717)

TD	Items	20-item Radloff (1977) 1-Factor with MF θ15,19 F1	14-item Carleton (2013) 1-Factor with MF F1	13-item Zhang (2011) 1-Factor with MF F1	11-item Kohout (1993) 1-Factor with MF θ15,19 F1	10-item Kohout (1993) 1-Factor with MF θ15,19 F1	10-item Andresen (1994) 1-Factor with MF F1	10-item Cole (2004) 1-Factor with MF F1	10-item Lee (2008) 1-Factor with MF F1	9-item He (2013) 1-Factor with MF F1	8-item de Velde (2010) 1-Factor with MF F1	7-item Levine (2013) 1-Factor F1
DA	1. Bothered	**.45****	**.45****	**.45****			**.43****	**.41****	**.46****			
	3. Blues	**.57****	**.57****	**.57****				**.53****	**.58****	**.57****		
	6. Depressed	**.70****	**.73****	**.72****	**.73****	**.72****	**.68****		**.70****	**.74****	**.75****	**.81****
	9. Failure	**.66****						**.66****				
	10. Fearful	**.53****		**.52****			**.53****	**.51****	**.52****			
	14. Lonely	**.65****	**.61****	**.62****	**.66****	**.66****	**.60****	**.61****	**.62****	**.62****	**.62****	
	17. Crying	**.30****										
	18. Sad	**.71****	**.70****	**.71****	**.72****	**.73****				**.71****	**.73****	**.77****
SC	2. Appetite	**.32****	**.33****		**.33****							**.44****
	5. Mind	**.42****	**.44****	**.44****			**.48****	**.42****	**.45****	**.44****		**.56****
	7. Effort	**.56****	**.56****	**.56****	**.55****	**.54****	**.59****	**.56****		**.56****	**.54****	**.66****
	11. Sleep	**.33****	**.32****	**.33****	**.34****	**.32****	**.34****		**.33****		**.33****	**.45****
	13. Talk	**.33****										
	20. Get going	**.49****	**.51****	**.50****	**.48****	**.48****	**.52****		**.50****	**.50****	**.49****	**.59****
ID	15. Unfriendly	**.53****			**.54****	**.55****		**.53****				
	19. Disliked	**.56****			**.57****	**.57****						
PA	4. Felt good	**.48****	**.46****					**.52****				
	8. Hopeful	**.61****	**.61****	**.59****			**.59****	**.68****	**.57****			
	12. Happy	**.68****	**.68****	**.67****	**.67****	**.67****	**.67****		**.68****	**.67****	**.68****	
	16. Enjoyed	**.70****	**.69****	**.69****	**.67****	**.67****				**.67****	**.66****	
	|MFL|	**.33****	**.34****	**.33****	**.32****	**.32****	**.32****	**.36****	**.32****	**.33****	**.32****	
	θ15,19	.42**			.41**	.41**						

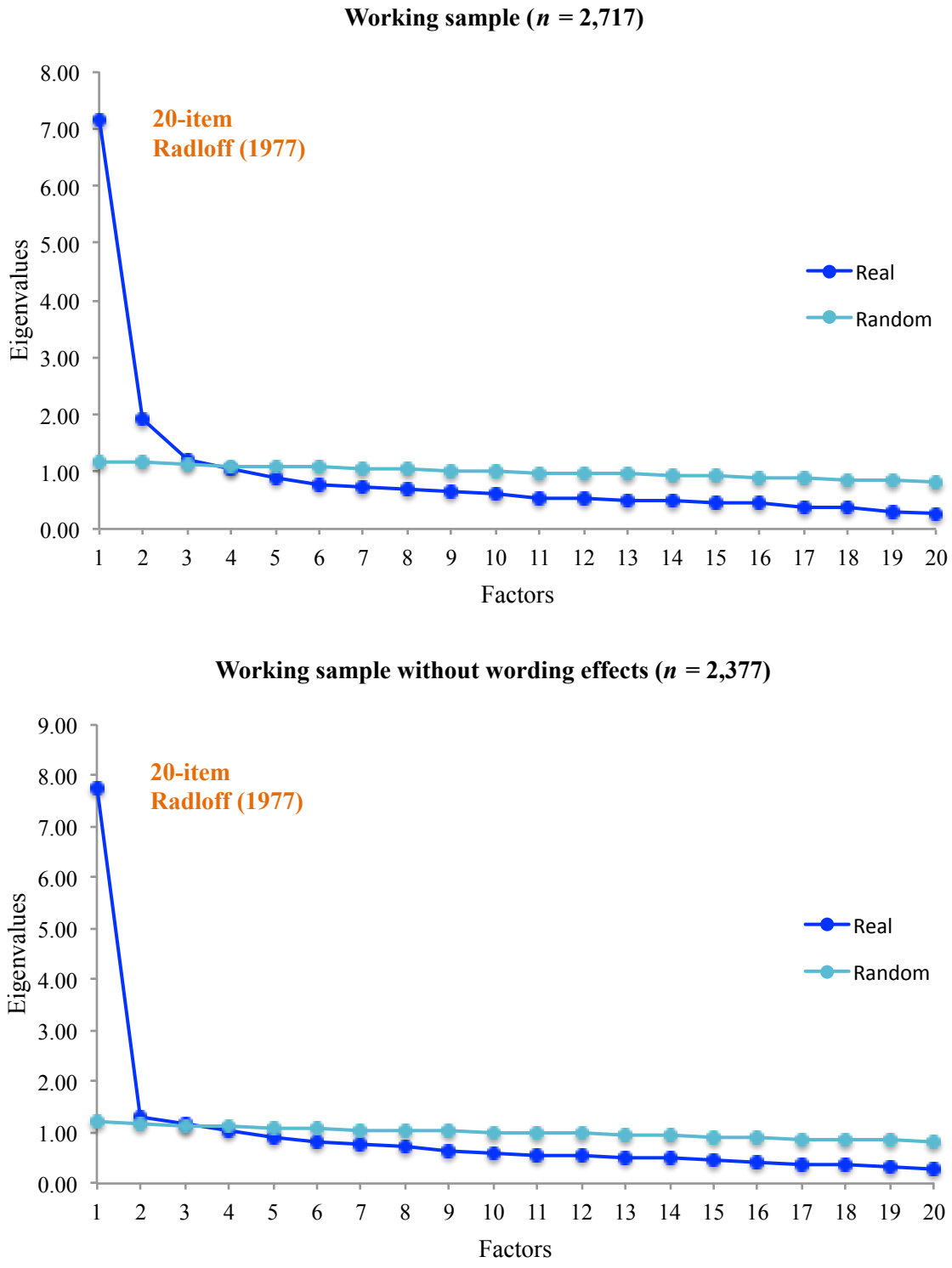
Note. TD = theoretical dimension; DA = depressed affect; SC = somatic complaints; ID = interpersonal difficulties; PA = (lack of) positive affect; F = factor; MF = method factor; |MFL| = absolute loading in method factor; θ = error correlation. Loadings ≥ .30 in absolute value appear in boldface and underlined.
* $p < 0.05$, ** $p < 0.01$

Supplemental Table 9

Parallel Analysis for the 20-item CES-D using the Total Working Sample (n = 2,717) and the Latent Class 1 of the Factor Mixture Analysis of the Working Sample (n = 2,377)

	Working sample (n = 2,717) 20-item Radloff (1977)		*Working subsample without wording effects (n = 2,377)* 20-item Radloff (1977)	
Factor	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}
1	**7.16**	1.19	**7.73**	1.20
2	**1.91**	1.16	**1.28**	1.17
3	**1.21**	1.13	**1.17**	1.14
4	1.06	1.11	1.02	1.12
5	0.88	1.09	0.90	1.10
6	0.79	1.07	0.81	1.08
7	0.74	1.05	0.77	1.06
8	0.69	1.04	0.73	1.04
9	0.64	1.02	0.64	1.02
10	0.60	1.01	0.60	1.01
11	0.55	0.99	0.56	0.99
12	0.55	0.97	0.54	0.97
13	0.51	0.96	0.52	0.95
14	0.50	0.94	0.51	0.94
15	0.46	0.93	0.46	0.92
16	0.44	0.91	0.43	0.90
17	0.37	0.89	0.38	0.88
18	0.36	0.87	0.37	0.86
19	0.31	0.85	0.31	0.84
20	0.27	0.82	0.27	0.81

Note. λ_{Real} = real eigenvalues; λ_{Rand} = random eigenvalues.



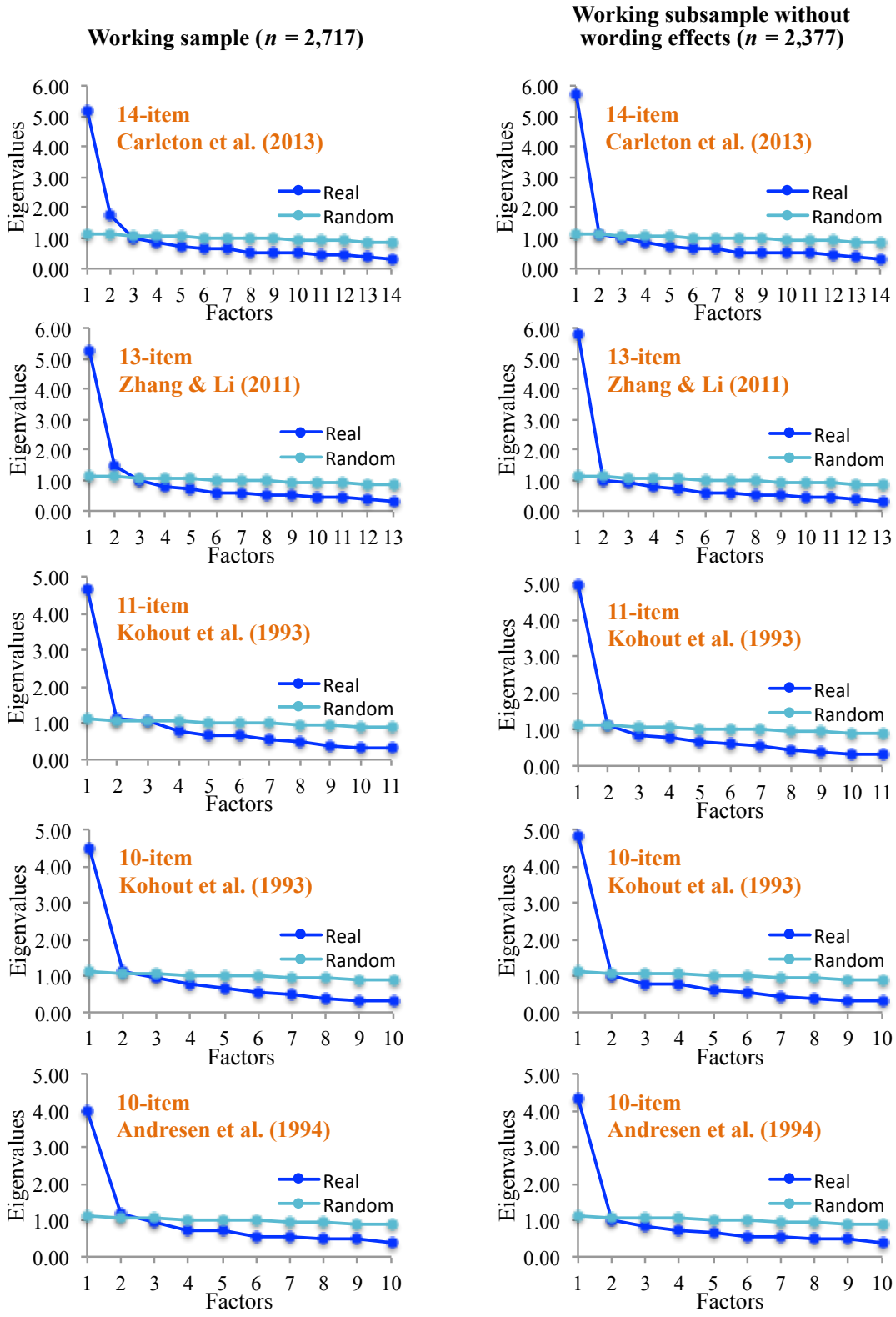
Supplemental Figure 1. Parallel Analysis Eigenvalue Plots for the 20-item CES-D using the Total Working Sample (n = 2,717) and the Latent Class 1 of the Factor Mixture Analysis of the Working Sample (n = 2,377).

Supplemental Table 10

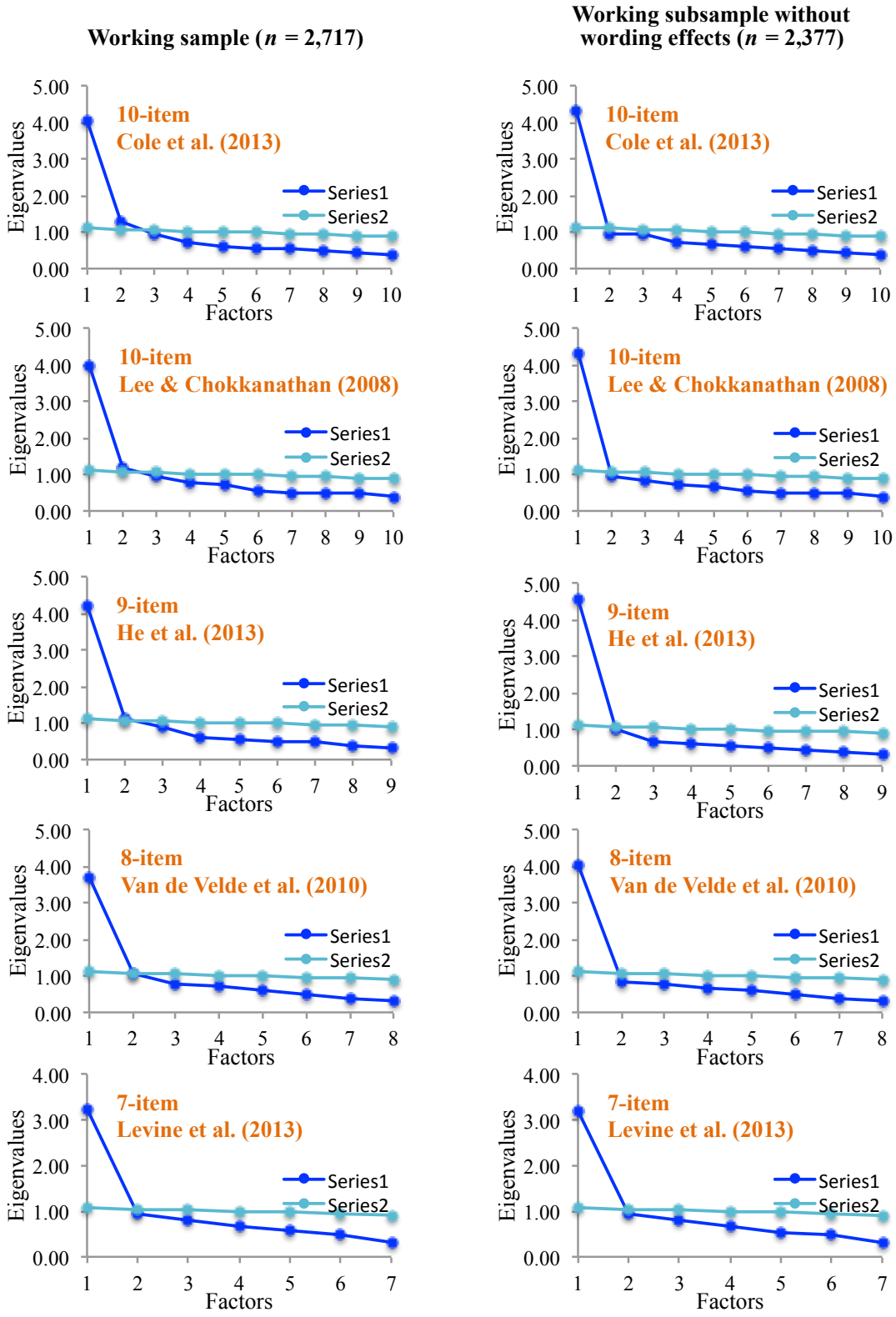
Parallel Analysis for the CES-D Short Forms using the Total Working Sample (n = 2,717) and the Latent Class 1 of the Factor Mixture Analysis of the Working Sample (n = 2,377)

Sample	14-item Carleton (2013)		13-item Zhang (2011)		11-item Kohout (1993)		10-item Kohout (1993)		10-item Andresen (1994)		10-item Cole (2004)		10-item Lee (2008)		9-item He (2013)		8-item de Velde (2010)		7-item Levine (2013)	
Factor	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}	λ_{Real}	λ_{Rand}
Working sample (n = 2,717)																				
1	**5.19**	1.15	**5.29**	1.14	**4.65**	1.12	**4.50**	1.12	**3.99**	1.12	**4.03**	1.12	**4.01**	1.12	**4.20**	1.10	**3.71**	1.09	**3.21**	1.09
2	**1.77**	1.12	**1.47**	1.11	**1.14**	1.09	**1.13**	1.08	**1.18**	1.08	**1.30**	1.08	**1.19**	1.08	**1.12**	1.07	1.04	1.06	0.95	1.05
3	1.01	1.09	1.00	1.08	**1.07**	1.06	0.92	1.06	0.96	1.05	0.93	1.06	0.93	1.05	0.87	1.04	0.76	1.04	0.79	1.02
4	0.87	1.07	0.76	1.06	0.79	1.04	0.76	1.03	0.74	1.03	0.71	1.03	0.75	1.03	0.59	1.02	0.74	1.01	0.66	1.00
5	0.72	1.05	0.71	1.04	0.68	1.02	0.67	1.01	0.70	1.01	0.62	1.01	0.69	1.01	0.55	1.00	0.59	0.99	0.56	0.97
6	0.65	1.03	0.58	1.02	0.66	1.00	0.55	0.99	0.55	0.99	0.57	0.99	0.56	0.99	0.51	0.98	0.47	0.97	0.50	0.95
7	0.63	1.01	0.57	1.00	0.55	0.98	0.47	0.97	0.54	0.97	0.55	0.97	0.52	0.97	0.46	0.96	0.38	0.94	0.32	0.91
8	0.55	0.99	0.52	0.98	0.47	0.96	0.38	0.94	0.50	0.94	0.50	0.94	0.49	0.94	0.38	0.93	0.32	0.90		
9	0.52	0.97	0.51	0.96	0.38	0.93	0.32	0.92	0.47	0.92	0.42	0.92	0.47	0.92	0.32	0.90				
10	0.50	0.95	0.47	0.94	0.32	0.91	0.31	0.89	0.39	0.89	0.38	0.89	0.40	0.89						
11	0.48	0.93	0.44	0.92	0.30	0.88														
12	0.43	0.91	0.38	0.90																
13	0.38	0.89	0.31	0.87																
14	0.31	0.86																		
Working subsample without wording effects (n = 2,377)																				
1	**5.77**	1.16	**5.78**	1.15	**4.97**	1.13	**4.84**	1.13	**4.32**	1.13	**4.34**	1.13	**4.32**	1.12	**4.55**	1.11	**4.05**	1.11	**3.20**	1.09
2	1.12	1.12	1.03	1.11	1.10	1.10	1.00	1.09	0.98	1.09	0.96	1.09	0.96	1.09	0.99	1.08	0.81	1.07	0.95	1.06
3	1.02	1.10	0.93	1.09	0.85	1.07	0.78	1.06	0.85	1.06	0.93	1.06	0.85	1.06	0.66	1.05	0.75	1.04	0.81	1.03
4	0.86	1.07	0.77	1.06	0.77	1.05	0.75	1.04	0.73	1.03	0.70	1.03	0.74	1.03	0.58	1.02	0.65	1.01	0.69	1.00
5	0.73	1.05	0.70	1.04	0.69	1.02	0.63	1.01	0.68	1.01	0.64	1.01	0.67	1.01	0.55	1.00	0.58	0.99	0.54	0.98
6	0.68	1.03	0.59	1.02	0.62	1.00	0.54	0.99	0.56	0.99	0.59	0.99	0.57	0.99	0.51	0.98	0.46	0.96	0.50	0.94
7	0.63	1.01	0.56	1.00	0.54	0.98	0.46	0.96	0.53	0.96	0.55	0.96	0.52	0.96	0.45	0.95	0.39	0.93	0.31	0.91
8	0.54	0.99	0.53	0.98	0.46	0.95	0.39	0.94	0.50	0.94	0.49	0.94	0.51	0.94	0.39	0.92	0.31	0.90		
9	0.53	0.97	0.51	0.96	0.39	0.93	0.32	0.91	0.48	0.91	0.43	0.91	0.47	0.91	0.31	0.89				
10	0.51	0.95	0.48	0.94	0.32	0.90	0.30	0.88	0.38	0.88	0.38	0.87	0.40	0.88						
11	0.50	0.93	0.43	0.91	0.30	0.87														
12	0.43	0.90	0.38	0.89																
13	0.38	0.88	0.31	0.86																
14	0.31	0.85																		

Note. λ_{Real} = real eigenvalues; λ_{Rand} = random eigenvalues.

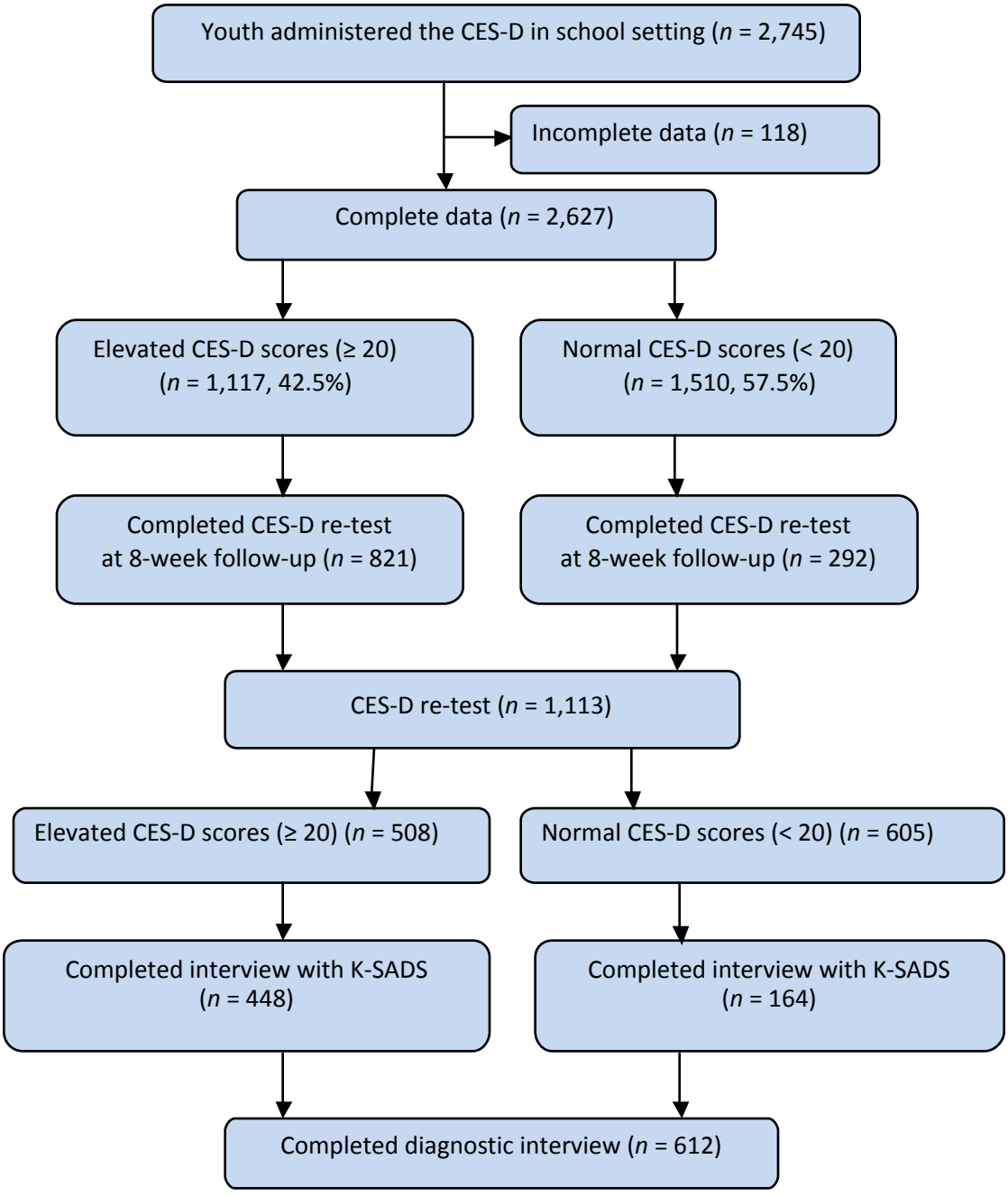


Supplemental Figure 2. Parallel Analysis Eigenvalue Plots for Short Forms of the CES-D using the Total Working Sample (n = 2,717) and the Latent Class 1 of the Factor Mixture Analysis of the Working Sample (n = 2,377).



Supplemental Figure 3. Parallel Analysis Eigenvalue Plots for Short Forms of the CES-D using the Total Working Sample (n = 2,717) and the Latent Class 1 of the Factor Mixture Analysis of the Working Sample (n = 2,377).

3. Supplemental Tables and Figures for Study 2: Criterion Validity of the Full Scale and Ten Short-Forms Versions of the CES-D.



Supplemental Figure 4. Recruitment Flow Chart for Interviewed Adolescents in Study 2. CES-D = Center for Epidemiologic Studies Depression Scale; K-SADS = Kiddie Schedule for Affective Disorder and Schizophrenia for School-age Children.

Supplemental Table 11

Symptoms Associated with Major Depressive Disorder (MDD) Diagnosis for Each Item and Short Form of the CES-D

Items	Symptoms of MDD	7-item Levine (2013)	8-item de Velde (2010)	9-item He (2013)	10-item Andresen (1994)	10-item Cole (2004)	10-item Lee (2008)	10-item Kohout (1993)	11-item Kohout (1993)	13-item Zhang (2011)	14-item Carleton (2013)
1. Bothered	Unrelated item	-	-		X	X	X	-	-	X	X
2. Appetite	Significant weight loss or gain	X	-		-	-	-		X	-	X
3. Blues	Depressed mood	-	-	X	-	X	X	-	-	X	X
4. Felt good	Feelings of worthlessness or inappropriate guilt	-	-		-	X	-	-	-	-	X
5. Mind	Diminished concentration or indecisiveness	X	-	X	X	X	X	-	-	X	X
6. Depressed	Depressed mood	X	X	X	X	-	X	X	X	X	X
7. Effort	Fatigue or loss of energy	X	X	X	X	X	-	X	X	X	X
8. Hopeful	Markedly diminished interest or pleasure	-	-		X	X	X	-	-	X	X
9. Failure	Feelings of worthlessness or inappropriate guilt	-	-		-	X	-	-	-	-	
10. Fearful	Anxiety item	-	-		X	X	X	-	-	X	
11. Sleep	Sleep disturbance	X	X		X	-	X	X	X	X	X
12. Happy	Depressed mood	-	X	X	X	-	X	X	X	X	X
13. Talk	Unrelated item	-	-		-	-	-	-	-	-	
14. Lonely	Unrelated item	-	X	X	X	X	X	X	X	X	X
15. Unfriendly	Unrelated item	-	-		-	X	-	X	X	-	
16. Enjoyed	Markedly diminished interest or pleasure	-	X	X	-	-	-	X	X	X	X
17. Crying	Depressed mood	-	-		-	-	-	-	-	-	
18. Sad.	Depressed mood	X	X	X	-	-	-	X	X	X	X
19. Disliked	Unrelated item	-	-		-	-	-	X	X	-	
20. Get going	Fatigue or loss of energy	X	X	X	X	-	X	X	X	X	X
No. symptoms		5	4		5	5	5		5	5	

Note. CES-D = Center for Epidemiologic Studies Depression Scale.

4. Supplemental MATLAB Code for Parallel Analysis with Ordinal Variables.

Code 1: pa_rule_emprical.m

```
function [PA,EIGENS]=pa_rule_empirical(MSCORES,missingcode,replicates,smoothing)

% Code developed by Luis Eduardo Garrido, Ph.D.
% e-mail: garrido.luiseduardo@gmail.com
% Methods recommended in this code based on
% Garrido, L.E., Abad, F.J., & Ponsoda, V. (2013). A new look at Horn's
% parallel analysis with ordinal variables. Psychological Methods, 18(4),
% 454-474.

% INPUT PARAMETERS

% MSCORES: the MATLAB workspace should contain a data matrix named MSCORES
% with the discrete scores on the variables of interest.

% missingcode: a discrete score used to identify the missing values in the
% MSCORES matrix. Even if there are no missing values a missingcode should
% be given.

% replicates: number of random datasets used to generate the PA criterion
% eigenvalues.

% smoothing: used to specify in the non-positive definite polychoric
% matrices should be smoothed. A value of 1 indicates that smoothing
% will NOT be conduced, while a value of 2 indicates that smoothing
% will be conducted. Smoothing is carried out using the Knol & Berger
% eigenvalue method described in Garrido, Abad, and Ponsoda (2013).

% OUTPUTS

% PA is the number of factors suggested by the method.

% EIGENS is a 2-column matrix that has the real eigenvalues in the first
% column and the criterion eigenvalues in the second column. The criterion
% eigenvalues from the different replicates are combined using the mean
% statistic.

% NOTES

% Missing values are handled using pairwise deletion in order to compute
% the polychoric correlation matrices.

% The random datasets are generated using random column permutations of the
% real dataset. The missing values are included in the random column
% permutations.

% The syntax file polychoric_proc_missing.m is needed to run this code and
% should be placed in the same working folder.

% EXAMPLE

% [PA,EIGENS]=pa_rule_empirical(MSCORES,999,1000,2)
% This syntax indicates that the missing values are coded as 999, that 1000
% replicates should be generated, and that the non-positive definite
% matrices should be smoothed.

% END OF INSTRUCTIONS
```

```
Size = size(MSCORES);
N = Size(1,1);
Var = Size(1,2);

% COMPUTING THE REAL EIGENVALUES

MCORR = polychoric_proc_missing(MSCORES,missingcode);

if min(eig(MCORR))<=0 && smoothing==2
   [V,D] = eig(MCORR);
   D = diag(D);
   D = max(D,0.01);
   D = diag(D);
   BB = V*D*V';
   T = diag(diag(BB))^-0.5;
   MCORR = T*BB*T;
end
EIGEN = -sort(-eig(MCORR));

% COMPUTING THE RANDOM EIGENVALUES

Z = zeros(N,Var);
MEIGENAL = zeros(Var,replicates);
for I=1:replicates
   for J=1:Var
      X = randperm(N);
      Y = MSCORES(:,J);
      Z(:,J) = Y(X);
   end
   MCORRZ = polychoric_proc_missing(Z,missingcode);
   if min(eig(MCORRZ))<=0 && smoothing==2
      [V,D] = eig(MCORRZ);
      D = diag(D);
      D = max(D,0.01);
      D = diag(D);
      BB = V*D*V';
      T = diag(diag(BB))^-0.5;
      MCORRZ = T*BB*T;
   end
   MEIGENAL(:,I) = -sort(-eig(MCORRZ));
   disp(['Replicate = ',num2str(I)])
end
EIGENAL = mean(MEIGENAL,2);
EIGENS = zeros(Var,2);
EIGENS(:,1) = EIGEN;
EIGENS(:,2) = EIGENAL;

% COMPARING THE REAL AND RANDOM EIGENVALUES

PA = 0;
I = 1;
Bien = 0;
while EIGEN(I,1)>EIGENAL(I,1) && Bien==0
   PA = PA+1;
   I = I+1;
   if I>Var
      Bien = 1;
      I = Var;
   end
end
```

Code 2: polychoric_proc_missing.m

```
function [MCORRPOLI]=polychoric_proc_missing(MSCORES,missing)

missingnew=missing;
Size=size(MSCORES);
N=Size(1,1);
Var=Size(1,2);
critconv=0.001;
NumIteraciones_N=10;
NumIteraciones_B=10;

VP=0;
U=unique(MSCORES);
Size=size(U);
numU=Size(1,1);
for I=1:numU
   if U(I)==missing
      VP=1;
   end
end

if VP==1
   missingnew=min(min(MSCORES))-1;
   for J=1:Var
      for I=1:N
         if MSCORES(I,J)==missing
            MSCORES(I,J)=missingnew;
         end
      end
   end
end
U=unique(MSCORES);
if VP==1
   for J=1:Var
      Size=size(U);
      numU=Size(1,1);
   for I=1:N
      K=1; cambio=0;
      while K<=numU && cambio==0
         if MSCORES(I,J)==U(K)
            MSCORES(I,J)=K-1;
            cambio=1;
         end
         K=K+1;
      end
   end
   end
else
   for J=1:Var
      Size=size(U);
      numU=Size(1,1);
      for I=1:N
         K=1; cambio=0;
         while K<=numU && cambio==0
            if MSCORES(I,J)==U(K)
               MSCORES(I,J)=K;
               cambio=1;
            end
            K=K+1;
         end
```

```
      end
   end
end

if VP==0
   Vpuntmax=max(MSCORES);
   puntmax=max(max(MSCORES));
else
   missingnew=min(min(MSCORES));
   puntmax=max(max(MSCORES));
   Vpuntmax=max(MSCORES);
   Vpuntmax=min(Vpuntmax,puntmax);
end

MFREC=zeros(puntmax,Var);
for J=1:Var
   for I=1:N
      if MSCORES(I,J)~=missingnew
         Val=MSCORES(I,J);
         MFREC(Val,J)=MFREC(Val,J)+1;
      end
   end
end

if VP==0
   MPROB=MFREC/N;
else
   MPROB=zeros(puntmax,Var);
   for J=1:Var
      Nnew=N;
      for I=1:N
         if MSCORES(I,J)==missingnew
            Nnew=Nnew-1;
         end
      end
      MPROB(:,J)=MFREC(:,J)/Nnew;
   end
end

MPROBAC=zeros(puntmax,Var);
for J=1:Var
   L=Vpuntmax(J);
   for I=1:L
      for K=1:I
         MPROBAC(I,J)=MPROBAC(I,J)+MPROB(K,J);
      end
   end
end

MUMB=zeros(puntmax-1,Var);
for J=1:Var
   for I=1:Vpuntmax(J)-1
      umbral=-2^0.5*erfcinv(2*MPROBAC(I,J));
      if umbral==-inf
         umbral=-10;
      end
      MUMB(I,J)=umbral;
   end
end

MUMBEX=zeros(puntmax+1,Var);
```

```
MUMBEX(2:puntmax,:)=MUMB;
MUMBEX(1,:)=-10;
for J=1:Var
   L=Vpuntmax(J)-1;
   MUMBEX(L+2,J)=10;
end

MPUNTRED=zeros(N,2);
MCORRPOLI=eye(Var,Var);
numcorr=(Var^2-Var)/2;
MCOMBVAR=zeros(numcorr,2);
K=1;
for I=1:Var
   for J=I+1:Var
      MCOMBVAR(K,1)=I;
      MCOMBVAR(K,2)=J;
      K=K+1;
   end
end
MUMBEXRED=zeros(puntmax+1,2);
CORR=eye(2,2);
AA= [0.3253030 0.4211071 0.1334425 0.006374323];
BB= [0.1337764 0.6243247 1.3425378 2.2626645];
a1= 0.319381530;
a2=-0.356563782;
a3= 1.781477937;
a4=-1.821255978;
a5= 1.330274429;

for KK=1:numcorr
   Iteracion=0; Iteracion1=0;
   II=MCOMBVAR(KK,1);
   JJ=MCOMBVAR(KK,2);
   MPUNTRED(:,1)=MSCORES(:,II);
   MPUNTRED(:,2)=MSCORES(:,JJ);
   puntmax1=Vpuntmax(II);
   puntmax2=Vpuntmax(JJ);
   MUMBEXRED(1:puntmax1+1,1)=MUMBEX(1:puntmax1+1,II);
   MUMBEXRED(1:puntmax2+1,2)=MUMBEX(1:puntmax2+1,JJ);
   combumb=puntmax1*puntmax2*4;
   Vector=zeros(combumb,1);
   X=zeros(combumb,2);
   X2=zeros((puntmax1+1)*(puntmax2+1),5);
   TCONT=zeros(puntmax1,puntmax2);
   for I=1:N
      if MPUNTRED(I,1)~=missingnew && MPUNTRED(I,2)~=missingnew
         A=MPUNTRED(I,1);
         B=MPUNTRED(I,2);
         TCONT(A,B)=TCONT(A,B)+1;
      end
   end
   CatRes=size(unique(MPUNTRED));
   CatRes=CatRes(1,1);
   Cambio=0;
   if CatRes==2
      for I=1:2
         for J=1:2
            if TCONT(I,J)==0
               TCONT(I,J)=0.50;
               TCONT(J,I)=TCONT(J,I)+0.50;
               Cambio=1;
```

```
            end
        end
    end
    if Cambio==1
        for I=1:2
            for J=1:2
                if TCONT(I,J)==round(TCONT(I,J))
                    TCONT(I,J)=TCONT(I,J)-0.5;
                end
            end
        end
    end
end
K=1;
for I=2:puntmax1+1
    for J=2:puntmax2+1
        X1=[MUMBEXRED(I,1)   MUMBEXRED(J,2);
            MUMBEXRED(I-1,1) MUMBEXRED(J,2);
            MUMBEXRED(I,1)   MUMBEXRED(J-1,2);
            MUMBEXRED(I-1,1) MUMBEXRED(J-1,2)];
        X(K:K+3,:)=X1;
        K=K+4;
    end
end
K=1;
for I=1:puntmax1+1
    for J=1:puntmax2+1
        X2(K,1)=MUMBEXRED(I,1);
        X2(K,2)=MUMBEXRED(J,2);
        K=K+1;
    end
end
MCORR=corrcoef(MPUNTRED);
corr=MCORR(2,1);
if corr==1 || corr==-1
    if corr==1
        corr=0.999;
    else
        corr=-0.999;
    end
end
CORR(1,2)=corr; CORR(2,1)=corr; corrdif=1;
corr_final=0; corrinf=-1; corrsup=1; Iteracion2=1;
while corrdif>critconv
    PDF=zeros(combumb,1);
    GUV=zeros(combumb,1);
    CDF=zeros(combumb,1);
    for K=1:(puntmax1+1)*(puntmax2+1)
        X2(K,3)=1/(2*3.14159265*(1-corr^2)^0.5)*exp(-(X2(K,1)^2-2*corr*X2(K,1)*X2(K,2)+...
            X2(K,2)^2)/(2*(1-corr^2)));
        X2(K,4)=X2(K,3)*(X2(K,1)*X2(K,2)*(1-corr^2)+corr*(X2(K,1)^2-...
            2*corr*X2(K,1)*X2(K,2)+X2(K,2)^2)-2*corr*(1-corr^2))/(1-corr^2)^2;

        punt1=X2(K,1);
        punt2=X2(K,2);
        XX=[punt1 punt2];
        corrcorr=corr;
        NN=0;
        pivalue=3.1415926535897932;
        if punt1<=0 && punt2<=0 && corrcorr<=0
```

```
            aprime=punt1/(2*(1-corrcorr^2))^0.5;
            bprime=punt2/(2*(1-corrcorr^2))^0.5;
            for I=1:4
               for J=1:4
                  f=exp(aprime*(2*BB(I)-aprime)+bprime*(2*BB(J)-bprime)+2*corrcorr*(BB(I)-aprime)*(BB(J)-
bprime));
                  NN=NN+AA(I)*AA(J)*f;
               end
            end
            CDFCDF=NN*(1-corrcorr^2)^0.5/pivalue;
         elseif punt1*punt2*corrcorr<=0
            XX2=XX;
            corrcorr1=corrcorr;
            if punt1>=0
               XX2(1,1)=-punt1;
            end
            if punt2>=0
               XX2(1,2)=-punt2;
            end
            if corrcorr>=0
               corrcorr1=-corrcorr;
            end
               aprime=XX2(1,1)/(2*(1-corrcorr1^2))^0.5;
               bprime=XX2(1,2)/(2*(1-corrcorr1^2))^0.5;
            for I=1:4
               for J=1:4
                  f=exp(aprime*(2*BB(I)-aprime)+bprime*(2*BB(J)-bprime)+2*corrcorr1*(BB(I)-
aprime)*(BB(J)-bprime));
                  NN=NN+AA(I)*AA(J)*f;
               end
            end
            NN=NN*(1-corrcorr^2)^0.5/pivalue;
            if punt1<=0 && punt2>=0 && corrcorr>=0
               x=-punt1;
               k=1/(1+0.2316419*x);
               Nprime=(1/(2*pivalue)^0.5)*exp(-x^2/2);
               NCDF=Nprime*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
               CDFCDF=NCDF-NN;
            elseif punt1>=0 && punt2<=0 && corrcorr>=0
               x=-punt2;
               k=1/(1+0.2316419*x);
               Nprime=(1/(2*pivalue)^0.5)*exp(-x^2/2);
               NCDF=Nprime*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
               CDFCDF=NCDF-NN;
            elseif punt1>=0 && punt2>=0 && corrcorr<=0
               x1=punt1;
               k=1/(1+0.2316419*x1);
               Nprime1=(1/(2*pivalue)^0.5)*exp(-x1^2/2);
               NCDF1=1-Nprime1*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
               x2=punt2;
               k=1/(1+0.2316419*x2);
               Nprime2=(1/(2*pivalue)^0.5)*exp(-x2^2/2);
               NCDF2=1-Nprime2*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
               CDFCDF=NCDF1+NCDF2-1+NN;
            end
         elseif punt1*punt2*corrcorr>0
            XX2=XX;
            CDFCDF=0;
            if punt1>=0
               sgn1=1;
```

```
        else
            sgn1=-1;
        end
        if punt2>=0
            sgn2=1;
        else
            sgn2=-1;
        end
        denum=(punt1^2-2*corrcorr*punt1*punt2+punt2^2)^0.5;
        corrcorr1=((corrcorr*punt1-punt2)*sgn1)/denum;
        corrcorr2=((corrcorr*punt2-punt1)*sgn2)/denum;
        if corrcorr1>0.999999 || corrcorr1<-0.999999
            if corrcorr1>0.999999
                corrcorr1=0.999999;
            else
                corrcorr1=-0.999999;
            end
        end
        if corrcorr2>0.999999 || corrcorr2<-0.999999
            if corrcorr2>0.999999
                corrcorr2=0.999999;
            else
                corrcorr2=-0.999999;
            end
        end
        delta=(1-sgn1*sgn2)/4;
        for III=1:2
            NN=0;
            if III==1
                XX2(1,2)=0;
                corrcorr3=corrcorr1;
            else
                XX2(1,1)=0;
                XX2(1,2)=punt2;
                corrcorr3=corrcorr2;
            end
            if XX2(1,1)<=0 && XX2(1,2)<=0 && corrcorr3<=0
                aprime=XX2(1,1)/(2*(1-corrcorr3^2))^0.5;
                bprime=XX2(1,2)/(2*(1-corrcorr3^2))^0.5;
                for I=1:4
                    for J=1:4
                        f=exp(aprime*(2*BB(I)-aprime)+bprime*(2*BB(J)-bprime)+2*corrcorr3*(BB(I)-
aprime)*(BB(J)-bprime));
                        NN=NN+AA(I)*AA(J)*f;
                    end
                end
                CDFF=NN*(1-corrcorr3^2)^0.5/pivalue;
            else
                corrcorr4=corrcorr3;
                XX3=XX2;
                if XX2(1,1)>=0
                    XX3(1,1)=-XX2(1,1);
                end
                if XX2(1,2)>=0
                    XX3(1,2)=-XX2(1,2);
                end
                if corrcorr3>=0
                    corrcorr4=-corrcorr3;
                end
                aprime=XX3(1,1)/(2*(1-corrcorr4^2))^0.5;
```

```
                bprime=XX3(1,2)/(2*(1-corrcorr4^2))^0.5;
                for I=1:4
                   for J=1:4
                      f=exp(aprime*(2*BB(I)-aprime)+bprime*(2*BB(J)-bprime)+2*corrcorr4*(BB(I)-
aprime)*(BB(J)-bprime));
                      NN=NN+AA(I)*AA(J)*f;
                   end
                end
                NN=NN*(1-corrcorr4^2)^0.5/pivalue;
                if XX2(1,1)<=0 && XX2(1,2)>=0 && corrcorr3>=0
                   x=-XX2(1,1);
                   k=1/(1+0.2316419*x);
                   Nprime=(1/(2*pivalue)^0.5)*exp(-x^2/2);
                   NCDF=Nprime*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
                   CDFF=NCDF-NN;
                elseif XX2(1,1)>=0 && XX2(1,2)<=0 && corrcorr3>=0
                   x=-XX2(1,2);
                   k=1/(1+0.2316419*x);
                   Nprime=(1/(2*pivalue)^0.5)*exp(-x^2/2);
                   NCDF=Nprime*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
                   CDFF=NCDF-NN;
                elseif XX2(1,1)>=0 && XX2(1,2)>=0 && corrcorr3<=0
                   x1=XX2(1,1);
                   k=1/(1+0.2316419*x1);
                   Nprime1=(1/(2*pivalue)^0.5)*exp(-x1^2/2);
                   NCDF1=1-Nprime1*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
                   x2=XX2(1,2);
                   k=1/(1+0.2316419*x2);
                   Nprime2=(1/(2*pivalue)^0.5)*exp(-x2^2/2);
                   NCDF2=1-Nprime2*(a1*k+a2*k^2+a3*k^3+a4*k^4+a5*k^5);
                   CDFF=NCDF1+NCDF2-1+NN;
                end
             end
             CDFCDF=CDFCDF+CDFF;
          end
          CDFCDF=CDFCDF-delta;
       end
       [X2(K,5)]=CDFCDF;
    end
    if Iteracion2==1
       for K=1:combumb
          cambio=0;
          I=1;
          while cambio==0
             if X(K,1)==X2(I,1) && X(K,2)==X2(I,2)
                PDF(K)=X2(I,3);
                GUV(K)=X2(I,4);
                CDF(K)=X2(I,5);
                cambio=1;
                Vector(K,1)=I;
             else
                I=I+1;
             end
          end
       end
    else
       for K=1:combumb
          PDF(K)=X2(Vector(K,1),3);
          GUV(K)=X2(Vector(K,1),4);
          CDF(K)=X2(Vector(K,1),5);
```

```
        end
    end
    Derivada1sum=0;
    Derivada2sum=0;
    K=1;
    for I=1:puntmax1
        for J=1:puntmax2
            dens=PDF(K)-PDF(K+1)-PDF(K+2)+PDF(K+3);
            dist=CDF(K)-CDF(K+1)-CDF(K+2)+CDF(K+3)+10^-10;
            guv =GUV(K)-GUV(K+1)-GUV(K+2)+GUV(K+3);
            Derivada1=TCONT(I,J)*dens/dist;
            Derivada1sum=Derivada1sum+Derivada1;
            Derivada2=TCONT(I,J)*guv/dist-TCONT(I,J)*dens^2/dist^2;
            Derivada2sum=Derivada2sum+Derivada2;
            K=K+4;
        end
    end
    if Iteracion<=NumIteraciones_N
        if Derivada2sum==0
            Derivada2sum=0.0000000001;
        end
        corr2=corr-Derivada1sum/Derivada2sum;
        corrdif=abs(corr2-corr);
        if corr2>=1
            L1=0.70;  L2=0.90;
            corr2=(rand)*(L2-L1)+L1;
            corrdif=1;
        elseif corr2<=-1
            L1=-0.70; L2=-0.90;
            corr2=(rand)*(L2-L1)+L1;
            corrdif=1;
        end
        Iteracion=Iteracion+1;
    else
        if Iteracion1==0;
            corrdif=1;
            Iteracion1=Iteracion1+1;
        else
            if Derivada1sum>0
                corr2=(corr+corrsup)/2;
                corrinf=corr;
                Iteracion1=Iteracion1+1;
            else
                corr2=(corr+corrinf)/2;
                corrsup=corr;
                Iteracion1=Iteracion1+1;
            end
        end
    end
    corr=corr2;
    CORR(1,2)=corr; CORR(2,1)=corr;
    if Iteracion1==NumIteraciones_B
        Iteracion1=0;
        Iteracion=0;
        corr_final=corr;
    elseif Iteracion1==1
        corr=corr_final;
    end
    Iteracion2=Iteracion2+1;
end
```

```
    MCORRPOLI(II,JJ)=corr;
    MCORRPOLI(JJ,II)=corr;
end
```