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The Factorial Invariance of the CES-D during Adolescence:

Are Symptom Profiles for Depression Stable across Gender and Time?

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Abstract

This study examined the factorial invariance of the Center for Epidemiologic Studies of Depression Scale (CES-D) across gender and time during adolescence. The factor structure of the CES-D was compared at four annual measurement waves in a community sample of 2,650 Australian adolescents. Confirmatory factor analyses showed that the factor structure of the CES-D was generally invariant across gender and time. However, gender differences were found on three items: for all waves the item 'I had crying spells' was a stronger indicator for depressive affect in females than males. On the final three waves the item 'people were unfriendly' loaded significantly higher on the factor 'Interpersonal Relations' for males than females. On Wave 2 and 3 males interpreted the item 'everything I did was an effort' with a positive connotation, whereas females interpret it with a negative association. These gender-differences are discussed from both a theoretical and a methodological perspective.

Keywords: depression, factorial invariance, adolescence, gender, CES-D

The Factorial Invariance of the CES-D during Adolescence: Are Symptom Profiles for Depression Stable across Gender and Time?

In both the DSM-IV and ICD-10, the symptom criteria for Major Depressive Disorders are the same for males and females (APA, 2000; WHO, 1992), assuming that the presentation of depression is equivalent across genders. Furthermore, although DSM-IV identifies symptoms such as somatic complaints, irritability, and social withdrawal as being particularly common in children (APA, 2000, page 354), the same criteria are generally utilized to identify Depressive Disorders in all age groups. Similar issues apply to self-report questionnaires designed to identify and track changes in the level of depressive symptoms experienced by individuals in the general population (e.g., Radloff, 1977). Typically, individual items on questionnaires are summed and the total score is used to rate levels of depressive symptoms. Although some questionnaires provide different cutoff scores for classifying severe depression in males and females, this approach does not address the possibility that profiles of depressive symptoms may vary for different gender or age groups.

If valid comparisons are to be made across genders, or over time using results from a measure of depressive symptoms, then it is essential that the psychometric characteristics of the measurement instrument are the same for males and females, and at different points in time. In particular, it is important to establish that the instrument is factorially invariant across gender and time in terms of the number of underlying factors, the items that load upon those factors and the pattern of relationships among the underlying factors (Byrne, Baron, & Campbell, 1993). If construct measurement varies across gender and/or age, comparisons between different groups and time points cannot be unambiguously interpreted, as different constructs may have been measured. Despite the fundamental importance of factorial invariance, few studies have examined this issue for depressive symptoms, especially in adolescents (Motl, Dishman, Birnbaum, & Lytle, 2005).

There are, however, indications that depression might be best described by different symptoms for males and females. To illustrate, depressed girls reported more guilt, body image dissatisfaction, self-blame, self-disappointment, concentration problems, difficulty working, sadness/depressed mood, sleep problems, fatigue, and health worries than depressed boys in a study among adolescents referred to a pediatric depression clinic. Depressed boys, on the other hand, tended to report higher rates of anhedonia, depressed morning mood, and morning fatigue (Bennet, Ambrosini, Kudes, Metz, & Rabinovich, 2005). A study by Fu-I and Wang (2008) among clinically depressed children (5-9 years old) and adolescents (10-17 years old) established that female adolescents had lower self-esteem, whereas males showed more decreased concentration. There is also evidence for gender differences in symptoms of depression in non-clinical populations. A previous study using a self-report questionnaire on depressive symptoms reported that in a community based sample of adolescents, males more commonly reported symptoms such as social withdrawal, insomnia, and somatic preoccupation, whereas females tended to endorse crying, body image distortion, self-blame, self-dislike and loss of appetite (Baron & Joly, 1988). Similar results were found in a study on mildly to moderately depressed sample of 18-19 years-old students (Hammen & Padesky, 1977).

In addition, there are indications that profiles of depression symptoms may change over time. To illustrate, the DSM-IV identifies certain depressive symptoms as being particularly common in children, compared to adolescents and adults (APA, 2000; p. 354). For example, Fu-I and Wang (2008), found that compared to clinically depressed children (5-9 years), clinically depressed adolescents (10-17 years) reported significantly more depressed mood, lower self-esteem, and more concentration problems. Differences in the patterns of depressive symptoms are also evident during the adolescent years. Kovacs et al., (2003) found that, from early to late adolescence, reduced appetite was increasingly likely across time as a symptom of depression both in girls and boys and was more prevalent among girls. In contrast, negative body image became less likely as a symptom of depression with age. There was also an age-related rise in the prevelance of hypersomnia as a depressive symptom among adolescents.

Not only do the adolescent years coincide with known increases in the prevalence of depressive symptoms (e.g., Garber, Keiley, & Martin., 2002), significant cognitive and neuropsychological development also take place during this developmental phase. This has the potential to change the ways in which adolescents construct complex and generalized perceptions of 'self' (Ashman & Dawson, 2002; Harter, 1999, 2003; Huttenlocher & Dabholkar, 1997). Frontal lobe development, the capacity for more integrative thought, and the ability to generalize beyond specific times and events all progress well into adolescence and may underlie the emergence of more stable self-perceptions (Cole & Martin, 2005). In addition, changes in autonomy and the way in which adolescents perceive and experience relationships (within the family, peers, and romantic; e.g., Connoly & Goldberg, 1999; Steinberg, 2001), biological changes associated with puberty and maturation including sexual maturation and interest (Ellis, 2004; Graber & Sontag, 2006), and cognitive development changes in perspective taking (Eisenberg, Cumberland, Guthrie, Murphy, & Sheppard, 2005), all occur at a rapid pace during adolescence. These cognitive developmental changes are likely to influence the way adolescents experience and report on depressive symptoms and thus impact upon the factorial invariance of the measurement tool.

Moreover, it is well established that gender differences in developmental trajectories of depression emerge in adolescence, with increases in depression in females versus stability or decreases in males (e.g., Garber et al., 2002; Ge, Conger, & Elder, 2001). It could be that symptom profiles of depression develop differently in males and females during adolescence. For example, Fu-I and Wang (2008) found that gender differences in depressive symptoms of clinically depressed children did not emerge until adolescence, with females having a lower self-esteem and males reporting more difficulties concentrating (Fu-I & Wang, 2008). In addition, following a sample of 183 clinically referred children from childhood (ages 8-13) to young adulthood (up to age 21), Kovacs and colleagues (2003) detected gender-differences in the development of depressive symptom patterns. They found that irritability as a symptom of depression in girls was age-related: depressed girls were most likely to experience irritability

during mid-adolescence (13-15 years), and less so as they got older, whereas irritability appeared as a consistent feature of depressed males' experiences. During mid-adolescence, girls were at peak risk for attempting suicide, whereas the peak rate of suicide attempts for boys occurred during late adolescence (16-18 years).

Despite these findings of gender-, and time differences in the occurrence of specific symptoms of depression, little is known about the extent to which these symptoms are actually indicators of depression in males and females across adolescence. The present study examines the factorial invariance of the Center for Epidemiologic Studies of Depression Scale (CES-D) in adolescents. The CES-D is a 20 item questionnaire describing a wide range of depressive symptoms which was developed to identify depression among adults in the general population (Radloff, 1977). Several studies have examined the factor structure of the CES-D in adults, generally identifying four specific factors described as depressive affect, well being, somatic symptoms, and interpersonal relations that together load on the common factor Depression (Motl et al., 2005; Radloff, 1977; Shafer, 2006).

Although originally developed to identify depressive symptoms among adults, the CES-D has been widely used to examine depressive symptoms in adolescents (Garrison, Addy, Jackson, McKeown, & Waller, 1991; Rushton, Forcier, & Schectman, 2002). Studies examining the validity and reliability of the CES-D have concluded that this instrument is adequate for screening purposes for depression in this age-range (Garrison et al., 1991; Manson, Ackerson, Dick, Baron, & Fleming, 1990; Roberts, Andrews, Lewinsohn, & Hops, 1990; Schoenbach, Kaplan, Grimson, & Wagner, 1982). Recently, Philips and colleagues (2006) examined 12 different, previously reported factor-structures of the CES-D in a large sample of 7th Grade students and concluded that the four-factor model reported by Radloff (1977) and others (see Shafer, 2006) had the strongest support. They did not compare this factor-model for males and females. However, despite good evidence that the factor-structure of the CES-D in adolescents is comparable to that in adults, little is known about whether the factor structure is invariant across gender and time in adolescents.

To the best of our knowledge, only three previous studies have investigated the longitudinal and gender-invariance of the CES-D in adolescents. Roberts and colleagues (1990) examined the factor structure of the CES-D in 4 cohorts of students in Grade 9-12. The study identified a four-factor model among adolescents and found factor loadings of the CES-D items were equivalent for males and females with the exception of two items: 'I had crying spells' and 'lost appetite'. 'I had crying spells' had a higher loading for females; the item 'lost appetite' had a lower loading for females. This indicates that crying was more characteristic of depression in girls, whereas loss of appetite was more characteristic of depression in boys. In addition, they examined the factorial invariance of de CES-D across a period of one month, and found the CES-D to be invariant across within this short time frame.

Dick, Beals, Keane, and Manson (1994) examined gender invariance of the CES-D in a minority sample of American Indian adolescents with a widespread age range (13 to 20 years of age). They identified a three-factor solution to be the most appropriate, with the items of the depressive affect factor and the somatic symptoms factor comprising a single factor. There were no gender differences in the factor loadings of the CES-D items, or in the interrelatedness of the three factors.

More recently, Motl and colleagues (2005) examined the gender- and longitudinal invariance of the CES-D. They identified the high-order model with four first-order and one second-order factor. The factor structure coefficients were invariant across gender at the age of 13, and the authors decided to combine males and females in one sample to examine factorial invariance over time. For this combined sample of adolescents, they found longitudinal invariance of the CES-D over a three year period. Although this study provides us with insight in the factorial invariance of the CES-D in early adolescence across gender and time, no information regarding the longitudinal cross-gender factorial invariance of the CES-D was provided.

The present study will examine the factorial invariance of the CES-D in a large, normative sample of 2,650 Australian adolescents. The factor model consisting of four first-

order factors with an underlying second-order factor (Motl et al., 2005) will be tested across four waves of data, given that this factor structure has most commonly been found in the literature. The aim of the current study is two-fold; firstly to replicate findings regarding the factorial invariance of the CES-D of previous studies, but using a large cohort, and secondly to expand existing knowledge by examining the longitudinal cross-gender factorial invariance of the CES-D across four annual measurement waves.

Method

Participants

The *beyondblue* Schools Research Initiative is a longitudinal study of Australian secondary school students which evaluated the effectiveness of a universal intervention designed to reduce depressive symptoms among high-school students (see also Sawyer, et al., 2010; Spence, et al., 2005). Prior to survey administration, active consent was obtained from 5,634 adolescents enrolled in Year 8 in 50 participating secondary schools and their parents. The original study involved a randomized controlled trial examining the impact of an intervention designed to prevent the development of depression. The 50 schools were matched and paired in terms of SES and enrollment size and then randomly allocated to either the intervention or control group. In line with the ethics approval and written informed consent, when a clinically high score was detected the guidance officer or counselor at the school was advised of the situation.

The present study included data from the 25 control group schools only, and included 2,650 Year 8 adolescents (M_{age} = 13.02 years at baseline, SD = 0.82), representing approximately 64% of adolescents from the total Year 8 school enrolment in control schools. Data were collected at four time points; baseline in May, 2003 and October, 2004, October, 2005 and October, 2006. Data at one or more waves were missing for 1240 (46%) adolescents. At baseline, 93.4% were born in Australia, 3.2% identified with Aboriginal or Torres Strait Islander background, and 71% lived with both of their parents (Table 1).

Measure

Center for Epidemiological Studies Depression Scale (CES-D: Radloff, 1977). The CES-D consists of 20 items describing a wide range of depressive symptoms (see Appendix I for a full description). Respondents rate their experience of each symptom in the past week on a 0 to 3 scale from "Rarely or none of the time (less than 1 day)" to "Most or all of the time (5-7 days)". The total summed score can range from 0-60. Internal consistency (Crohnbach's alpha) was good for the present sample, ranging from .78 to .80 for females and from .79 to .82 for males.

Statistical Procedures

Confirmatory factor analyses were conducted using MPlus version 6.0 (Muthén & Muthén, 2011). The goodness of fit of the models was assessed by multiple criteria: the chi-square likelihood ratio statistic, root mean squared error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker Lewis index (TLI). A RMSEA value less than .08 and CFI and TLI values greater than .90 indicate are considered an acceptable fit (Hu & Bentler, 1999; Kline, 2005). We used the full information maximum likelihood (FIML) estimation within MPlus version 6.0 (Muthén & Muthén, 2011) to handle missing data.

Analyses were conducted in three stages. First, data for males and females were examined separately for each of the four measurement waves to establish baseline models of the factor structure of the CES-D. Second, the invariance of the factor structure was tested across gender for each of the four measurement waves. Third, the invariance of the factor structure of the CES-D was tested across time for males and females separately.

Stage 1: Determine baseline models. Before examining factorial invariance across different groups (i.e., gender, age), it is important to establish a well-fitting baseline model for each group separately (Byrne et al., 1993). The factor model with four first-order and one underlying second-order factor as proposed by Motl and colleagues (2005; Figure 1) was tested separately for goodness-of-fit to male and female data for each of the four measurement Waves. First-order factor loadings were assessed in the pattern-matrix Lambda (LY), second-order factor loadings in Beta (BE). Once the baseline model was determined for each gender, at each of the

four waves the similarity of item measurements (i.e., factor loadings) and theoretical structure (i.e., relatedness between depressive factors) was tested.

Stage 2: Factorial invariance across gender. A multi-group model was used to examine whether the first-order factor loadings and second-order factor loadings were similar for males and females for each of the four measurement waves. The test for gender differences involved the comparison of a model in which the factor loadings for the female sample were allowed to be different from the factor loadings for the male sample (unconstrained model), to a model in which these loadings were constrained to be equal across gender (constrained model). A significant ($p<.01$) difference in the chi-square of these two models would indicate that there were significant differences in the factor structures for males and females.

Because a chi-square test is sensitive to sample size, we also examined the $\Delta\chi 2/\Delta df$ ratio. A ratio greater than 5 is considered evidence of differences in the factor structure for males and females (Rosay, Gottfredson, Armstrong, & Harmon, 2000). If both the chi-square test and the ratio $\Delta\ \chi 2/\Delta df$ indicated differences in the factor structure for males and females, subsequent analyses were conducted to examine which of the factor loadings gave rise to these differences. One by one, the first-order factor loadings were constrained to be equal across gender. When non-invariant first-order factor loadings were identified and unconstrained, the same procedure was followed for factor loadings on the higher-order factor.

Stage 3: Factorial invariance across time. Longitudinal invariance was examined for males and females separately. For both genders, a model was constructed with 16 first-order factors (i.e. 'Depressive Affect', 'Well Being', 'Somatic Symptoms', and 'Interpersonal Relations' for each measurement wave) and four higher order factors ('General Depression' for each measurement wave). The four higher-order factors of 'General Depression' were allowed to correlate across time. However, the first-order factors were not allowed to correlate across time (Motl et al., 2005). Subsequent steps examined whether the factor loadings and the theoretical structure were invariant across time.

Results

Baseline Models

The model outlined in Figure 1 was examined, for males and females separately at each of the four measurement waves. Model fit indices showed that the higher-order, four factor model (Radloff, 1977; Motl et al, 2005) fitted the data reasonably well for both genders on each occasion with χ^2 ranging from 540.74 to 969.86 ($df = 166$), RMSEA between .05 and .07, CFI between .91 and .96, and TLI between .90 and .95.

However, the residual variance of Depressive Affect was negative on T1, T2, and T3 for females, and on all four waves for males. Thorough examination learned that there were no misspecifications in our models. As model complexity might be the cause of negative residual variances (Dillon, Kumar, & Mulani, 1987), we decided to run a simpler model by omitting the higher-order factor of Depression. This leads to a four factor model in which the factors of Depressive Affect, Wellbeing, Somatic Symptoms, and Interpersonal Relations were allowed to correlate. In these four factor models the correlations between Somatic Symptoms and Depressive Affect were high (r>.83; see Table 4). However, a three-factor model in which the indicators of these two factors loaded on one factor reduced model fit. We therefore decided to continue with the four factor model resembling the standard factor structure of the CES-D specified by Radloff (1977). All following results are based on the four factor model.

The four factor model fitted the data well for both males and females at all four waves (Table 2) and did not produce negative residual variance. Factor loadings and correlations between the four factors of the unconstrained four factor models are presented in Table 3 and Table 4 respectively. Modification indices for these four factor models indicated that at Wave 1 for both males and females, the item 'effort' cross-loaded on the factor 'Well Being' ($\lambda_{Males} = .47$, $p<.001$; $\lambda_{Females} = .38, p<.001$). For males this cross-loading was also statistically significant on Wave 2 ($\lambda = .34, p<.001$) and Wave 3 ($\lambda = .25, p<.001$). Consistent with the procedure described by Byrne (1989), this cross-loading was not maintained in the subsequent tests of factorial invariance.

Multigroup Models: Factorial Invariance across Gender

For each of the four waves, multigroup models were used to examine whether the factor structure of the CES-D was invariant across gender. First, the four factor structure of the CES-D was assessed to see if it was equivalent for males and females (unconstrained four factor multigroup model). Table 4 shows that all four unconstrained multigroup models showed acceptable fit measures, indicating that the four factor structure of the CES-D was similar for males and females at each of the four measurement waves.

In order to test factorial invariance across gender, the factor loadings were constrained to be equal for males and females. These cross-gender constraints reduced the extent to which the model fitted data from all four measurement waves (Table 5). Further examination of these constraints revealed that on all four measurement waves, the factor loading for the item 'I had crying spells' was significantly higher on the factor 'Depressive Affect' for females than for males (Table 3). Also, the item 'I felt that I could not shake off the blues' showed a stronger loading on the 'Depressive Affect' factor for females than for males at waves 2 and 3. In addition, on wave 1, 2, and 3 the item 'people were unfriendly' had a significantly higher loading on the interpersonal factor for males than for females (Table 3). At wave 2 the item 'I had poor appetite' had a significantly higher loading on Somatic Symptoms for females than males.

Factorial Invariance across Time

To test longitudinal invariance, a model was constructed for males and females separately with 16 factors (i.e., 'Depressive Affect', 'Well Being', 'Somatic Symptoms', and 'Interpersonal Relations' for each measurement wave). Stability paths were estimated for each factor from T1 to T2, T2 to T3, and T3 to T4. In addition, within each measurement wave the four factors were allowed to correlate. These models showed reasonably acceptable fit for both males and females (Table 6). Constraining the factor loadings to be equal across the four measurement waves did not reduce the model's fit for males or females, indicating that the four-factor structure was invariant from early to middle adolescence for both males and females.

Discussion

This paper investigated whether the factor structure of the CES-D was invariant across gender and time from early to middle adolescence in a large sample of young people. Consistent with previous studies, the four factor model of the CES-D was broadly supported for both genders and at each time point. However, there is some evidence of slight variability with respect to specific questionnaire items at particular time points.

Factorial Invariance across Gender

At all four measurement waves the item 'I had crying spells' had a higher loading on the factor 'Depressive Affect' for females than males. This is consistent with previous findings (Byrne et al., 1993; Roberts et al., 1990). As suggested by Byrne and colleagues (1993), it may reflect the impact of social values which make it more acceptable for females than males to acknowledge crying in response to depressive affect. Alternatively, it may reflect a genuine difference in the way that depression is manifest across the genders. Either way, this effect has the potential to make crying spells a better indicator of depressive affect in females than in males. Similarly the item 'I felt that I could not shake off the blues' was a stronger indicator of 'Depressive Affect' for females than for males at waves 2 and 3 for girls than for boys.

In addition, on the last three waves, the item 'People were unfriendly' was a better indicator of depression (i.e., manifested in 'Interpersonal Relations') for males than for females. There are various explanations that could be proposed for this effect, but they can only be speculative. It is possible that depressed young males are particularly sensitive to interpersonal difficulties compared to their non-depressed counterparts. Alternatively, the other symptoms of depression manifest in young males may place them at increased risk for receiving unfriendly responses from others, particularly if peers are less tolerant of depression among males than females. A recent study indeed found that depressive symptoms can make a child seem more vulnerable and thereby make the child an easy target for unfriendly responses from others (Fekkes, Pijpers, Fredriks, Vogels, & Verloove-Vanhorick, 2006; Reijntjes, Kamphuis, Prinzie, & Telch, 2010). Future studies should examine whether this association between being depressed and peer relationship difficulties is moderated by the child's gender.

Another notable finding was that modification indices at the first wave showed that the item 'I felt everything that I did was an effort' cross-loaded positively on the factor 'Well Being' in addition to the 'Somatic Symptoms' factor, for adolescent males and females. This cross-loading became weaker over time, but was statistically significant on the second and third measurement waves for males. Thus, it appeared that males, particularly when younger, tended to interpret this item ambiguously, in that it was not only reflecting a somatic symptom of depression, but was also being seen by boys in general as suggesting that the experience of effort was a positive thing, associated with better well being. The ambiguity in the item is understandable, although females did not tend to make this dual interpretation. The finding is, however, consistent with result of previous studies (Dick et al., 1994; Motl et al., 2005; Phillips et al., 2006). It has been suggested that adolescents might perceive the term 'effort' as a positive quality in relation to being goal oriented (Motl et al., 2005).

Factorial Invariance across Time

The results from the present study provide support for the hypothesis that generally the symptom manifestation of depression is relatively stable across time in younger adolescents, and indeed is equivalent to the way in which depressive symptoms are presented in adults. Our results show strong evidence of factorial invariance over time for the individual questionnaire items and are in line with previous findings (Motl, et al., 2005). This means that the pattern and strength of factor loadings of individual symptoms upon the four factors of depression, namely 'Depressive Affect', 'Well Being', 'Somatic Symptoms', and 'Interpersonal Relations' showed a consistent patterns and strength of associations over time.

Limitations

Before considering the implications of the findings of this study, some limitations should be mentioned. First, the retention rate of the current study was an issue, particularly by the final wave, although this is a common problem in longitudinal research of this type. Approximately 46% of the adolescents who participated at the first wave failed to take part in at least one of the following measurement waves. It is possible that those who failed to continue in this study were

at elevated risk for developing depression and the possibility that the factor structure may have differed for those who dropped out versus those who were retained cannot be discounted. In line with this, it would be interesting to examine longitudinal and gender invariance of the CES-D in a clinical sample of adolescents. Second, the data rely on self reports of symptoms and as such are subject to a range of reporting biases and other sources of error which limit the conclusions that can be drawn.

Conclusion

The current study extended previous knowledge regarding the longitudinal factorial invariance of the CES-D by testing for the equivalence of the CES-D factor structure across gender and time for a large normative sample of Australian adolescents across a period of four years. Findings from the present study are of substantial importance to our understanding of the manifestation of depression in adolescence, and of the factorial structure of the CES-D in particular. First, the factorial structure of the CES-D in the adolescent sample generally mirrored that found in adults, with four related factors of 'Depressive Affect', 'Well Being', 'Somatic Symptoms' and 'Interpersonal Relations'. Furthermore, with only one exception ('I felt that everything I did was an effort'), the individual symptoms that loaded on these four factors generally reflected the pattern of results found in adults. This suggests that the CES-D, which was originally developed for adults, is also an appropriate measurement instrument for depression throughout adolescence.

Second, although this factor structure fitted the data for both males and females, gender differences related to the functioning of CES-D items nonetheless existed for a very small number of items ('I had crying spells'; 'I felt that I could not shake off the blues'; 'I felt that everything I did was an effort'; 'People were unfriendly'). It is recommended that researchers and clinicians working with adolescent samples take into account gender differences in the way in which these symptoms relate to the construct of depression. For example, for adolescent females self-reported 'crying' may be a better marker of high levels of depressive symptoms for than it is for males, whereas having the feeling that 'people are unfriendly' may be a better indicator of

depression in adolescent males. It should be noted, however, that although there were slight gender differences in factor structure, the original proposed four factor structure (Radloff, 1977) provided a relatively good fit to the data for both genders, on all occasions.

In conclusion, although there were some minor differences in factor loadings across the genders, results from the present study suggest that the profile of symptoms identified by the CES-D is very similar for male and female adolescents, and for adolescents of different ages. This provides support for the approach used in DSM-IV and ICD-10, and commonly used self-report questionnaires which assume that the symptom profile of depression is invariant across gender and time.

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Table 1

Gender, Ethnicity, and Family Status for Our Sample

	n	%
Gender		
Male	1273	48
Female	1377	52
Australian origin		
Yes	2461	93.4
No	173	6.6
Identifies with Aboriginal/Torres Strait Island		
Yes	83	3.2
No	2539	95.8
Family Status		
Lives with both parents	1834	71
Live apart/divorced	651	25.2
One or both parents passed away	46	1.8
Different	52	2

Table 2

Summary of Fit Statistics for the Four Factor Models for Males and Females at Wave 1-4

		Fit of Model				
		χ2	*df*	RMSEA	CFI	TLI
Males	Wave 1	961.72	164	.06	.91	.90
	Wave 2	812.38	164	.06	.93	.92
	Wave 3	832.02	164	.07	.93	.92
	Wave 4	547.58	164	.06	.94	.93
Females	Wave 1	740.45	164	.05	.95	.94
	Wave 2	761.06	164	.05	.95	.94
	Wave 3	754.18	164	.06	.95	.95
	Wave 4	537.67	164	.05	.96	.95

Table 3

Standardized and Unstandardized (Standard Errors) Factor Loadings for the CES-D Items for Males and Females Based on the Unconstrained Four Factor Model

		Wave 1				Wave 2				Wave 3				Wave 4			
		Males		Females		Males		Females		Males		Females		Males		Females	
Depressive Affect																	
1	Blues	.62	.77(.04)	.71	.80(.03)	.70	.80(.03)	.78[a]	.88(.03)	.71	.78 (.03)	.83[a]	.89(.03)	.74	.81(.04)	.80	.95(.03)
2	Depressed	.77	1.00	.80	1.00	.81	1.00	.83	1.00	.82	1.00	.87	1.00	.82	1.00	.84	1.00
3	Failure	.71	.91(.04)	.71	.75(.03)	.69	.81(.03)	.72	.75(.03)	.75	.85 (.03)	.77	.76(.02)	.70	.77(.04)	.69	.68(.03)
4	Fearful	.60	.69(.03)	.61	.60(.03)	.66	.71(.03)	.66	.64(.03)	.74	.77(.03)	.67	.63(.02)	.65	.70(.04)	.66	.66(.03)
5	Lonely	.77	.96(.04)	.75	.88(.03)	.75	.92(.03)	.76	.85(.03)	.77	.66(.04)	.81	.90(.03)	.79	1.01(.04)	.74	.89(.04)
6	Crying	.58	.55(.03)	.70[a]	.78(.03)	.54	.44(.02)	.73[a]	.84(.03)	.58	.49(.03)	.75[a]	.81(.03)	.59	.54(.03)	.73[a]	.86(.04)
7	Sad	.78	.93(.03)	.83	.94(.03)	.80	.93(.03)	.85	.97(.03)	.83	.95(.03)	.87	.94(.02)	.83	.97(.04)	.85	.99(.03)
Wellbeing																	
8	Good	.55	.80(.05)	.52	.69(.04)	.52	.74(.05)	.60	.79(.04)	.59	.83(.05)	.65	.87(.04)	.64	.93(.06)	.65	.90(.04)
9	Hopeful	.54	.72(.04)	.46	.60(.04)	.54	.72(.04)	.54	.69(.04)	.61	.79(.04)	.60	.76(.04)	.68	.92(.05)	.66	.84(.04)
10	Happy	.80	1.00	.86	1.00	.82	1.00	.87	1.00	.82	1.00	.86	1.00	.80	1.00	.88	1.00
11	Enjoyed	.78	1.01(.04)	.82	.98(.03)	.81	1.00(.04)	.84	1.03(.03)	.83	1.05(.04)	.87	1.07(.03)	.87	1.12(.05)	.88	1.04(.03)
Somatic Symptoms																	
12	Get going	.70	1.00	.74	1.00	.72	1.00	.75	1.00	.71	1.00	.76	1.00	.69	1.00	.70	1.00
13	Sleep	.58	.90(.05)	.62	.97(.05)	.57	.88(.05)	.62	.96(.05)	.65	1.05(.06)	.60	.88(.05)	.62	1.05(.07)	.57	.90(.06)
14	Bothered	.51	.64(.04)	.58	.74(.04)	.54	.65(.04)	.62	.77(.04)	.60	.74(.04)	.63	.78(.04)	.61	.77(.05)	.64	.83(.05)
15	Appetite	.43	.56(.04)	.51	.73(.04)	.50	.61(.04)	.56[a]	.81(.04)	.60	.73(.04)	.60	.81(.04)	.66	.86(.05)	.55	.80(.06)
16	Mind	.53	.89(.05)	.62	.94(.04)	.50	.83(.05)	.58	.85(.04)	.55	.91(.06)	.59	.83(.04)	.54	.91(.07)	.59	.86(.06)
17	Effort	.22	.40(.06)	.18	.27(.05)	.29	.50(.06)	.43	.60(.04)	.45	.75(.06)	.51	.67(.04)	.42	.67(.06)	.53	.76(.05)
18	Talked	.52	.84(.05)	.58	.82(.04)	.57	.86(.05)	.59	.78(.04)	.60	.87(.05)	.59	.73(.04)	.68	1.00(.06)	.60	.81(.05)
Interpersonal Relations																	
19	Unfriendly	.75	.82(.03)	.74	.74(.03)	.75	.85 (.05)	.66[a]	.63(.04)	.78	.87(.04)	.66[a]	.59(.03)	.71	.81(.04)	.59[a]	.53(.04)
20	Disliked	.86	1.00	.87	1.00	.85	1.00	.90	1.00	.86	1.00	.89	1.00	.83	1.00	.88	1.00

Note: All factor loadings are significantly different from zero ($p<.001$).

[a] Factor loading differs from that in males at $p<.001$

Table 4

Standardized and Unstandardized (Standard Errors) Correlations between Factors of Depressive Symptoms for Females and Males in the Unconstrained Four Factor Model at Wave 1-4

	1. Depressive Affect		2. Wellbeing		3. Somatic Symptoms		4. Interpers. Relations	
				Wave 1				
1. Depressive Affect			-.52	-.28(.02)	.91	.36(.02)	.79	.42(.02)
2. Wellbeing	-.76	-.52(.03)			-.40	-.20(.02)	-.41	-.27(.03)
3. Somatic Symptoms	.93	.52(.03)	-.68	-.38(.02)			.73	.35(.02)
4. Interpers. Relations	.81	.59(.03)	-.61	-.45(.03)	.76	.45(.03)		
				Wave 2				
1. Depressive Affect			-.50	-.27(.02)	.93	.37(.02)	.87	.42(.02)
2. Wellbeing	-.76	-.53(.03)			-.41	-.20(.02)	-.43	-.25(.02)
3. Somatic Symptoms	.92	.56(.03)	-.67	-.39(.03)			.79	.34(.02)
4. Interpers. Relations	.72	.53(.03)	-.54	-.37(.03)	.66	.41(.03)		
				Wave 3				
1. Depressive Affect			-.51	-.28(.02)	.93	.39(.03)	.83	.43(.03)
2. Wellbeing	-.78	-.56(.03)			-.41	-.20(.02)	-.38	-.23(.03)
3. Somatic Symptoms	.92	.59(.03)	-.72	-.42(.03)			.79	.35(.02)
4. Interpers. Relations	.79	.60(.03)	-.61	-.42(.03)	.73	.45(.03)		

Note: Females are below diagonal, males are above diagonal. All factor correlations are significantly different from zero (p<.001).

Table 4 *(Continued)*

	1. Depressive Affect		2. Wellbeing		3. Somatic Symptoms		4. Interpers. Relations	
				Wave 4				
1. Depressive Affect			-.51	-.27(.03)	.89	.34(.03)	.86	.37(.03)
2. Wellbeing	-.75	-.44(.03)			-.38	-.17(.02)	-.39	-.20(.03)
3. Somatic Symptoms	.89	.45(.03)	-.67	-.34(.03)			.78	.30(.03)
4. Interpers. Relations	.74	.42(.03)	-.53	-.31(.03)	.69	.34(.03)		

Note: Females are below diagonal, males are above diagonal. All factor correlations are significantly different from zero ($p<.001$).

Table 5

Summary of Test for Gender Invariance of the Four Factor Model at Wave 1-4

	Fit of Model							
	$\chi 2$	*df*	RMSEA	CFI	TLI	$\Delta\chi^2$	Δdf	$\Delta\chi^2$/ Δdf
Wave 1								
1. Unconstrained Four Factor Model	1702.18	328	.06	.93	.92			
2. Pattern of item loadings invariant	1865.70	348	.06	.93	.92	163.52	20	8.18
3. Item loadings invariant except item 6	1794.73	347	.06	.93	.92	92.55	19	4.87
Wave 2								
1. Unconstrained Four Factor Model	1573.44	328	.06	.94	.93			
2. Pattern of item loadings invariant	1876.34	348	.06	.93	.92	302.90	20	15.15
3. Item loadings invariant except item 1, 6, 15 & 19	1654.67	344	.06	.94	.93	81.24	16	5.08
Wave 3								
1. Unconstrained Four Factor Model	1586.20	328	.06	.94	.93			
2. Pattern of item loadings invariant	1867.39	348	.07	.93	.92	281.19	20	14.06
3. Item loadings invariant except item 1, 6 & 19	1662.27	345	.06	.94	.93	76.07	17	4.47
Wave 4								
1. Unconstrained Four Factor Model	1085.25	328	.05	.95	.94			
2. Pattern of item loadings invariant	1243.32	348	.06	.94	.94	158.07	20	7.90
3. Item loadings invariant except 6 & 19	1148.65	346	005	.95	.94	63.40	18	3.52

Note: item 1= 'blues'; item 6= 'crying'; item 20= 'disliked'; DA= Depressive Affect; WB= Well Being.

Table 6

Summary of Test for Longitudinal Invariance of the Four Factor Model for Males and Females

	Fit Indices							
	χ^2	*df*	RMSEA	CFI	TLI	$\Delta\chi^2$	Δdf	$\Delta\chi^2/\Delta df$
Males								
1. Comparison Model	7717.65	3044	.04	.88	.87			
2. Item loadings invariant	7816.55	3092	.04	.87	.87	98.9	48	2.06
Females								
1. Comparison Model	7885.12	3044	.03	.90	.90			
2. Item loadings invariant	8069.04	3092	.03	.90	.90	183.92	48	3.83

Appendix 1

Item Content of the CES-D

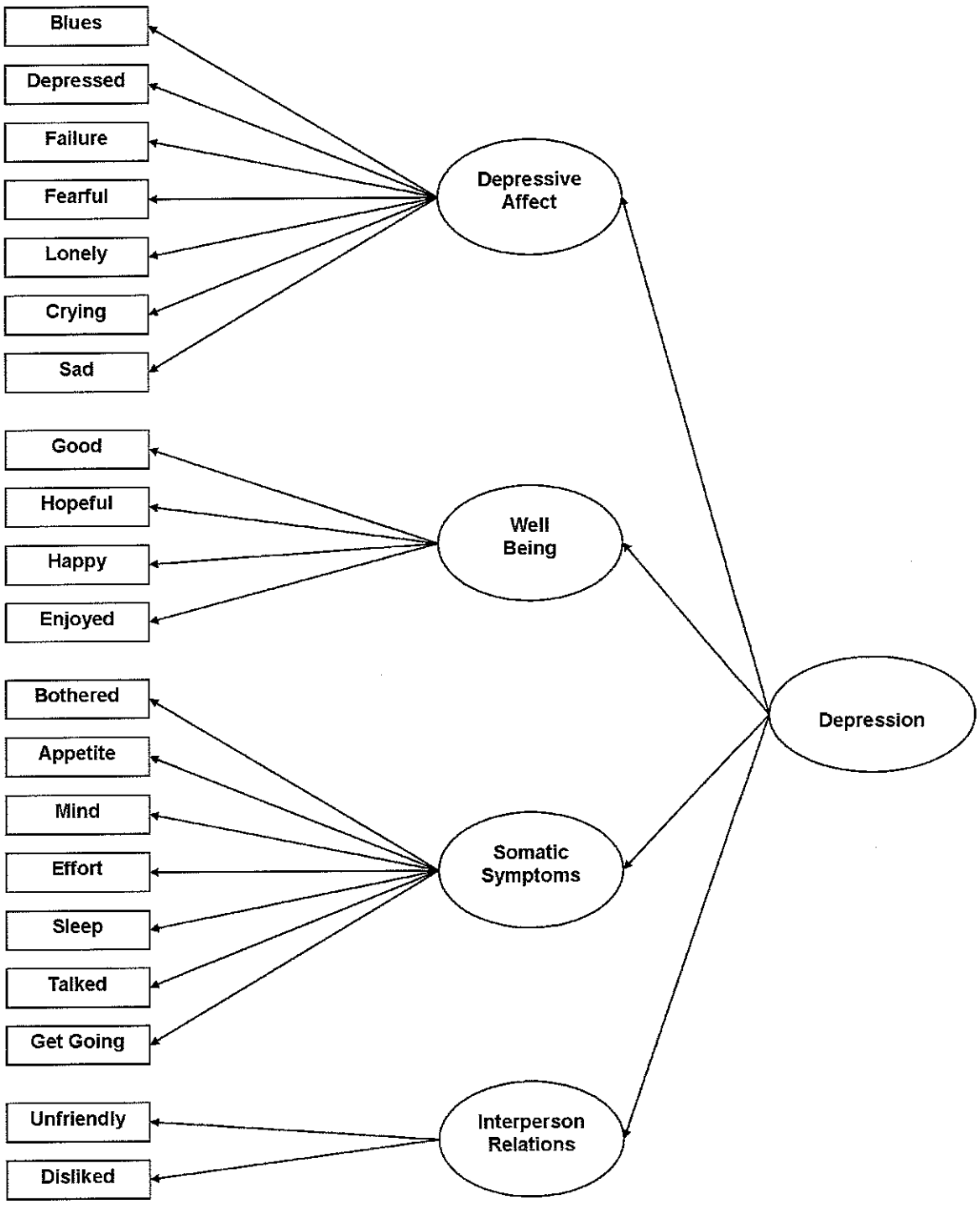
	Item Content	Key Word[1]
1.	I felt that I could not shake off the blues even with help from my family and friends	Blues
2.	I felt depressed	Depressed
3.	I thought my life had been a failure	Failure
4.	I felt fearful	Fearful
5.	I felt lonely	Lonely
6.	I had crying spells	Crying
7.	I felt sad	Sad
8.	I felt I was just as good as other people	Good
9.	I felt hopeful about the future	Hopeful
10.	I was happy	Happy
11.	I enjoyed life	Enjoyed
12.	I was bothered by things that usually don't bother me	Bothered
13.	I did not feel like eating; my appetite was poor	Appetite
14.	I had trouble keeping my mind on what I was doing	Mind
15.	I felt that everything I did was an effort	Effort
16.	My sleep was restless	Sleep
17.	I talked less than usual	Talked
18.	I could not 'get going'	Get Going
20.	I felt that people disliked me	Disliked
19.	People were unfriendly	Unfriendly

[1] *Note*: Key words are used in the text, tables, and figure of the manuscript to indicate a particular item of the CES-D.

Figure

Figure Captions

Figure 1. Baseline Factor Structure of the CES-D


Blues
Depressed
Failure
Fearful
Lonely
Crying
Sad
Depressive Affect
Good
Hopeful
Happy
Enjoyed
Well Being
Bothered
Appetite
Mind
Effort
Sleep
Talked
Get Going
Somatic Symptoms
Unfriendly
Disliked
Interperson Relations
Depression