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ORIGINAL PAPER

Factor Structure and Measurement Invariance of a Multidimensional Loneliness Scale: Comparisons Across Gender and Age

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Abstract This study focuses on the factor structure of a multidimensional loneliness measure, that is, the Loneliness and Aloneness Scale for Children and Adolescents (LACA). Confirmatory factor analyses were conducted on a large sample of children and adolescents ($N = 9{,}676$) in Belgium. Results indicated that the supposed four-factor structure of the instrument showed a superior fit when compared to alternative, more parsimonious models. Measurement invariance was established across gender and across all age groups in the intended age range (i.e., elementary school to freshman year in college). Age comparisons indicated that parent-related loneliness and positive attitudes to aloneness increased throughout adolescence. In sum, the present study offers strong support based on strict tests for the factor structure of a particular multidimensional loneliness measure (LACA). Future research should extend such analyses to other multidimensional measures of loneliness.

Keywords Loneliness · Aloneness · Adolescence · Confirmatory factor analysis · Measurement invariance

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Introduction

Loneliness is the unpleasant feeling that occurs when people perceive their network of social relations to be deficient in a quantitative or qualitative way (Perlman and Peplau 1981). It is a universal phenomenon that is experienced by everyone at some point in life. Transient feelings of loneliness may represent normative experiences, but more persistent feelings of loneliness do not. Research on children and adolescents has found relations between loneliness and several psychosocial, mental health, and physical problems, such as peer rejection, delinquency, alcohol abuse, sleep disturbances, low self-esteem, anxiety, depression, and suicidal ideation (Heinrich and Gullone 2006).

Two Approaches to Measuring Loneliness

In research on loneliness, two conceptual approaches have been adopted (Russell 1982). Researchers adhering to the *unidimensional* approach conceptualize loneliness as a unitary phenomenon and focus on commonalities in loneliness experiences across contexts. The UCLA Loneliness Scale (Russell et al. 1980) is a well-known example of a measure inspired by the unidimensional approach. In contrast, researchers adhering to the *multidimensional* approach do not believe that loneliness can be captured by a single global measure and attempt to differentiate among various hypothesized manifestations of loneliness. Within the latter approach, one line of research aims to differentiate loneliness experiences in different relationships, such as family and peer relationships. People may feel very satisfied with their relationship with their parents, but they may at the same time feel very lonely in their contacts with their friends. The Loneliness and Aloneness Scale for

Children and Adolescents (LACA; Marcoen et al. 1987) is among the most commonly used measures inspired by the multidimensional approach.

The LACA distinguishes between two relation-specific types of loneliness, that is, loneliness in relation with parents and peers, and between two types of attitudes towards aloneness, that is, negative and positive attitudes. A person's attitude towards aloneness refers to one's general reaction towards social isolation. Including a person's attitude towards aloneness increases our understanding of that person's reported level of loneliness (Goossens et al. 2009; Marcoen and Goossens 1993). For example, individuals who score relatively high on aversion to aloneness may more easily feel lonely when being alone.

Growing Evidence for the Multidimensionality of Adolescent Loneliness

Even though the unidimensional UCLA Loneliness Scale (Russell et al. 1980) is still the most commonly used loneliness measure, evidence for a multidimensional conceptualization of loneliness is accumulating. Such evidence can be gathered at both the scale level and item level.

At the scale level, two types of evidence can be distinguished, First, exploratory factor analysis (EFA) indicated that scales from different loneliness measures loaded on multiple factors rather than a single one (Cramer and Barry 1999; Goossens and Beyers 2002). Confirmatory factor analysis (CFA) on a set of loneliness scales found a superior fit for a four-factor model as compared to one-, two-, and three-factor models (Goossens et al. 2009). Second, within a given multidimensional measure, research has found that the different relation-specific types of loneliness are differentially related to adolescents' well-being. For example, peer-, but not family-related loneliness was related with social phobia, whereas family-, but not peer-related loneliness was related to deliberate self-harm and eating disorders (Lasgaard et al. 2011). In a similar vein, peer attachment and social skills were more strongly associated with social loneliness (which is similar to peer-related loneliness), whereas parent attachment and relationship quality with parents were more strongly associated with family-related loneliness (DiTommaso et al. 2004).

At the item level, EFA revealed the proposed four-factor structure for the LACA (i.e., parent-related loneliness, peer-related loneliness, aversion to aloneness, and affinity for aloneness; Marcoen et al. 1987). Similar evidence based on CFA was found in a study on the Italian version of the LACA (Melotti et al. 2006). However, these studies did not test the four-factor model against alternative, simpler models. CFA on a similar instrument, the Perth Adolescent Loneness Scale (PALS), did show a superior fit of a four-factor model (i.e., isolation, lack of friendship, aversion to aloneness, and affinity with aloneness) as compared to alternative, simpler models (Houghton et al. 2013).

Gender and Age Differences

A particular strength of multidimensional measures is that they could provide a more differentiated view on loneliness than unidimensional scales do. For instance, gender differences may take on a different form depending on the specific type of loneliness that is examined. Contradictory predictions concerning these differences can be found in the literature. Regarding parent-related loneliness, it could be argued that girls live in a more protected family environment, which leads them to perceive a higher family support and experience lower parent-related loneliness (Musetti et al. 2012). However, it could then also be argued that girls have higher expectations than boys regarding their relationships with their parents, making them more vulnerable for experiences of loneliness when these expectations are not met. Regarding peer-related loneliness, it could be argued that girls invest more in and expect more from their peers than boys, leading them to experience more peer-related loneliness (Musetti et al. 2012). However, it could also be argued that higher investment in peers leads girls to perceive higher peer support, which results in lower peer-related loneliness. In sum, theoretical notions about gender differences in loneliness are inconclusive and clear explanations about why the difference between desired and actual levels of relationships (i.e., loneliness) is different between boys and girls are still missing.

Empirical evidence on gender differences in parent- and peer-related loneliness also points into different directions with studies finding no gender differences (Bossaert et al. 2012; Corsano et al. 2006), higher scores for girls (Corsano et al. 2006; Melotti et al. 2006), and higher scores for boys (Scharf et al. 2011; Musetti et al. 2012). Research on gender differences in attitudes towards aloneness is less common, but results seem to be inconsistent as well (e.g., Corsano et al. 2006; Houghton et al. 2013; Scharf et al. 2011).

Age differences could also take on a different form for the various types of loneliness. From early adolescence onwards, greater interpersonal distance is observed towards parents, while at the same time closer and more intimate bonds are formed with peers (Houghton et al. 2013). These opposing trends might lead to increases in parent-related loneliness and decreases in peer-related loneliness, respectively. Some cross-sectional studies with elementary and high school students confirmed these hypotheses, as they effectively found an increase in parent-related loneliness, accompanied by a decrease in peer-related

loneliness from early adolescence onward (Marcoen and Goossens 1993; Marcoen et al. 1987). Longitudinal work, which is still scarce, corroborated the observed trend for peer-related loneliness (e.g., Van Roekel et al. 2010). Attitudes towards being alone also change throughout adolescence. Whereas children rarely wish to spend time alone, solitude tends to emerge as a constructive experience in adolescence (Larson 1997). Being alone becomes less negative and is even valued by adolescents, perhaps because it provides them opportunities for self-reflection, emotional self-renewal, and identity work (Goossens and Marcoen 1999). Findings from cross-sectional research are in line with this proposition, as they show an increase in positive attitudes towards aloneness throughout adolescence, accompanied by a decrease in negative attitudes (Marcoen and Goossens 1993; Marcoen et al. 1987).

Measurement Equivalence Across Gender and Age

Before researchers engage in gender and age comparisons, however, they have to substantiate that the items, as well as the underlying factors, of the measure included are interpreted in the same way by the gender and age groups. Several requirements have to be met (Chen 2007; Van de Schoot et al. 2012). First, researchers should examine whether the constructs are conceptualized in the same way (i.e., whether the number of factors and the pattern of factor loadings is roughly equivalent across groups; a condition called *configural invariance*). Second, to meaningfully compare associations between variables across groups, researchers should examine whether for all groups of respondents the same meaning can be attributed to the latent construct under investigation (i.e., whether the factor loadings are equal across groups; *metric invariance*). Third, to meaningfully compare means, researchers should examine whether across groups, the constant (intercept) and weights (factor loadings) are equal when items are written as a linear combination of the latent factors (i.e., *scalar invariance*). Unfortunately, these requirements have not yet been tested for the LACA or other multidimensional measures that aim to assess loneliness in different relationships.

The Present Study

The present study addressed various gaps in the extant literature on the LACA and, therefore, had three main objectives. First, we examined the multidimensionality of the LACA by testing the presumed factor structure against alternative, more parsimonious models. We expected the proposed four-factor model to show a superior fit to other, simpler models. Second, we checked whether comparisons across gender and age could be validly interpreted by examining measurement invariance across gender and the intended age range (i.e., students from elementary school, junior high school, senior high school, and college). Third, if the presumed factor structure was confirmed and measurement invariance was established, we proceeded to compare the gender and age groups on peer- and parent-related loneliness and negative and positive attitudes towards aloneness. As theoretical foundations were scarce and earlier results were largely inconsistent, we did not have strong expectations regarding gender differences in loneliness. Regarding age differences, we expected an increase in parent-related loneliness and positive attitudes towards aloneness, and a decrease in peer-related loneliness and negative attitudes towards aloneness.

Method

Participants

Analyses were based on the combined norm groups of the loneliness instrument, that is, 29 independent samples of children and adolescents, for a total of $N = 9{,}676$ participants. Data were collected between 1993 and 2006 in all five provinces of the Dutch-speaking part of Belgium. In preliminary analyses, cohort effects were examined and found to be unsystematic and small (i.e., Cohen's $d < .20$; Goossens 2013). As regards gender, there were 5,332 girls (55 %) and 4,344 boys (45 %). Regarding age, there were 14 samples from the upper grades in elementary school (i.e., Grades 5 and 6; $N = 4{,}014$), 2 samples from junior high school (i.e., Grades 7 through 9; $N = 1{,}298$), 10 samples from senior high school (i.e., Grades 10 through 12, $N = 3{,}256$), and three samples of college students (i.e., from the freshman year in the psychology program; $N = 1{,}108$). The sample was geographically diverse, as all five provinces of the Dutch-speaking part of Belgium were well-represented. All of the high school students were in the academic track, which tend to attract mainly students from Caucasian middle class families.

Gender and age were significantly related, $\chi^2(3) = 273.80$, $p < .001$, with fewer girls than expected by chance in the two youngest age groups and more girls in the two oldest age groups. Only 0.25 % of the data was missing. Little's MCAR Test (Little 1988) revealed a normed χ^2 of 1.27, which according to guidelines by Bollen (1989) indicates that the data were missing completely at random. Therefore, we imputed missing values by means of the Expectation–Maximization procedure in SPSS 22.0.

Procedure

Information letters were sent to the schools, after which the principals of the schools were contacted. The LACA was

administered to all participants in class during regular school hours. A research assistant was present to introduce the study and to answer questions. This assistant emphasized that participation was anonymous and voluntary. The adolescents were informed that they could discontinue their participation in the study at any time, but none of them opted to do so.

Measure

The LACA (Marcoen et al. 1987) is a 48-item measure that comprises four subscales of 12 items each. These subscales tap into (a) parent-related loneliness (e.g., "I feel left out by my parents") (b) peer-related loneliness (e.g., "I think I have fewer friends than others") (c) aversion to being alone (e.g., "When I am alone, I feel bad"), and (d) affinity for being alone (e.g., "I want to be alone"). Each item can be answered on a 4-point scale ranging from (1) *never* to (4) *often*. The measure was originally developed for use with Dutch-speaking children and adolescents and was subsequently translated into English following the procedures outlined by the International Test Commission (Hambleton 1994). This translated version has been used with English-speaking children in Great-Britain (Qualter et al. 2010), Ireland (De Roiste 2000), Canada (McNamara et al. 2005; Terrell-Deutsch 1999), and the United States (Hartmann 1991).

Plan of Analysis

First, we examined whether the four-factor model would be empirically supported and would provide a superior fit to alternative, simpler models. To examine the dimensionality of the LACA, we started with the simplest model comprising just a single factor. Next, we tested whether we could distinguish between loneliness and attitudes towards aloneness by examining a two-factor model. We then tested two models to examine whether we could distinguish between parent- and peer-related loneliness, on the one hand, and between positive and negative attitudes towards aloneness, on the other hand. Finally, we tested the proposed four-factor model comprising parent- and peer-related loneliness, and positive and negative attitudes towards aloneness. The different models are described in greater detail in the "Results" section. We ran several Confirmatory Factor Analyses (CFAs) in Mplus 6.0 (Muthén and Muthén 2007), using maximum likelihood robust (MLR) estimation as MLR has been shown to be the most accurate estimator when the distribution of scores only slightly deviates from a normal distribution (Satorra and Bentler 1994), which happened to be the case with the scores on the subscales.

Second, we examined configural, metric, and scalar invariance. To test for configural invariance, we examined whether the best fitting latent structure of the previous step yielded an adequate fit in the two gender and four age groups. Next, we tested for metric invariance by comparing the fit of a multigroup CFA model without constraints (cf. configural invariance) to a multigroup CFA model in which the factor loadings were constrained to be equal across groups. We tested invariance for the two gender groups and for the four age groups. In addition, because gender and age were related, we tested for invariance of gender separately in the four age groups and for invariance of age separately in the two gender groups. Finally, we tested scalar invariance by comparing the fit of a multigroup CFA model with only the factor loadings constrained to be equal across group (cf. metric invariance) to a multigroup CFA model in which both factor loadings and item intercepts were constrained to be equal across groups.

To evaluate model fit, the use of multiple criteria has been advocated by Vandenberg and Lance (2000), as different criteria can provide information on different sources of model misspecification. Because the χ^2-statistic is well known to be overly sensitive to sample size and model complexity (e.g., Cheung and Rensvold 2002), we relied on three other commonly used fit indices (Chen et al. 2007), that is, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean squared residual (SRMR). In addition, for the fit comparisons of the alternative models, we relied on the Bayesian information criterion (BIC) and the Akaike information criterion (AIC). The Chi square value should be as low as possible and preferably non-significant. As regards CFI .90 represents acceptable fit and .95 good fit. RMSEA should not exceed .06 in well-fitting models and SRMR should not be larger than .08 in such models (Hu and Bentler 1999). BIC and AIC should be as low as possible. Following the guidelines of Chen (2007), we regarded metric invariance as established if the difference in CFI (ΔCFI) between models with group-specific or common factor loadings was smaller than .010, ΔRMSEA was smaller than .015 and ΔSRMR was smaller than .030. We regarded scalar invariance as established if ΔCFI, ΔRMSEA and ΔSRMR between models with group-specific or common intercepts was smaller than .010, .015 and .010 respectively.

For CFAs, using individual items as indicators of latent factors can lead to overly complex models with a large number of parameters to be estimated. In addition, it has been argued that the optimal number of indicators for latent factors is three as it leads to a just-identified model, whereas fewer indicators lead to an under-identified model and more indicators would yield an over-identified model (Little et al. 2002). It has, therefore, been recommended to use parcels consisting of multiple items instead of using

individual items (e.g., Marsh and Hau 1999) to arrive at the optimal number of three indicators per latent factor. We used the well-established item-to-construct balance parceling method (Little et al. 2002) to create three four-item parcels for each LACA subscale resulting in a total of 12 parcels.

Finally, if both the proposed LACA factor structure and measurement invariance were established, a 2 (gender) × 4 (age) multivariate analysis of variance (MANOVA) was conducted to compare the gender and age groups on parent- and peer-related loneliness and negative and positive attitudes towards aloneness.

Results

In support of the supposed four-factor structure, low correlations were found among the four subscales of the LACA (Median $r = .16$). Moreover, high levels of internal consistency were obtained (Table 1).

Comparing Alternative Models

In the first step, we tested five models of which the first was an unlikely model in which all 12 parcels define a common factor. The second was a two-factor model in which the 6 parcels for the parent- and peer-related loneliness subscales define a loneliness factor and the six parcels for the aversion to being alone and affinity for being alone subscales define an attitude towards aloneness factor. The third model comprises a loneliness factor (6 parcels), an aversion to being alone factor (3 parcels), and an affinity for being alone factor (3 parcels). The fourth model comprises an attitude towards aloneness factor (6 parcels), a parent-related loneliness factor (3 parcels), and a peer-related loneliness factor (3 parcels). The fifth model, finally, defines each of the LACA subscales as separate factors (indicated by 3 parcels each).

Fit indices for the various models are presented in Table 2. As expected, the Chi square values for all the models in this table are very high because of the large sample size ($N = 9{,}676$) and the complexity of the models involved. Model 5 (i.e., the four-factor model) was the only model that provided good fit in terms of the remaining indices, that is, CFI, RMSEA, and SRMR. Furthermore, as compared to the other models, BIC and AIC were lowest for Model 5. The four-factor model was therefore selected as the best fitting model.

Measurement Invariance Across Gender and Age

In the next step, we checked whether the factor structure of the optimal fitting model (i.e., the four-factor model) held for boys and girls and across the age groups (i.e., upper elementary school, junior high, senior high, and college). Model fit was good for each gender and age group (Table 3), so configural invariance was established.

Metric and scalar invariance were tested separately for gender and age by running multigroup CFA. Fit statistics were good for all tested models (Table 4). For gender, results revealed both metric ($\Delta CFI < .001$, $\Delta RMSEA = .001$, and $\Delta SRMR < .001$) and scalar invariance ($\Delta CFI = .001$, $\Delta RMSEA < .001$, and $\Delta SRMR = .001$). For age, results also revealed both metric ($\Delta CFI = .002$, $\Delta RMSEA = .001$, and $\Delta SRMR = .004$) and scalar invariance ($\Delta CFI = .013$, but $\Delta RMSEA = .008$, and $\Delta SRMR = .004$). Because of the dependency of gender and age in our sample, we further examined measurement invariance across gender in each age

Table 1 Descriptive statistics, intercorrelations, and internal consistency (Cronbach's alpha) for the four subscales

Subscale	*M*	*SD*	2	3	4	Alpha
1. Parent-related loneliness	19.36	6.27	.18	.04	.17	.89
2. Peer-related loneliness	22.25	6.99	–	.15	.32	.88
3. Aversion to being alone	32.17	5.91		–	−.05	.79
4. Affinity with being alone	31.86	6.08			–	.83

$N = 9{,}676$. All correlations were significant ($p < .001$)

Table 2 Fit indices for various factor models

Model	Number of factors	Description	χ^2	*df*	*CFI*	*RMSEA*	*SRMR*	*BIC*	*AIC*
1	1	No distinctive subscales	34,722.28	54	.31	.26	.19	190,481.73	190,223.35
2	2	Parent + peer/negative + positive	28,682.36	53	.52	.22	.18	179,316.39	179,050.82
3	3	Parent + peer/negative/positive	15,319.11	51	.70	.18	.15	170,059.24	169,779.32
4	3	Parent/peer/negative + positive	10,078.55	51	.80	.14	.12	164,287.38	164,007.46
5	4	Four distinctive subscales	1,173.86	48	.98	.05	.04	154,692.16	154,390.71

All Chi squares were significant ($p < .001$)

CFI comparative fit index, *RMSEA* root mean square error of approximation, *SRMR* standardized root mean squared residual, *BIC* Bayesian information criterion, *AIC* Akaike information criterion, *parent* parent-related loneliness, *peer* peer-related loneliness, *negative* aversion to being alone; *positive* affinity for being alone

Table 3 Configural invariance across gender and age groups

Model	*N*	χ^2	*df*	*CFI*	*RMSEA*	*SRMR*
Gender						
Girls	5,332	612.32	48	.98	.05	.03
Boys	4,344	614.43	48	.97	.05	.04
Age						
Elementary school	3,952	350.21	48	.98	.04	.03
Junior high school	1,413	232.51	48	.98	.05	.04
Senior high school	3,203	564.55	48	.97	.06	.04
College students	1,108	261.22	48	.97	.06	.04
Gender by age						
Elementary school girls	2,019	214.48	48	.98	.04	.03
Junior high school girls	612	115.50	48	.98	.05	.04
Senior high school girls	1,888	287.22	48	.98	.05	.04
College students girls	813	186.08	48	.98	.06	.04
Elementary school boys	1,933	182.24	48	.98	.04	.03
Junior high school boys	801	166.19	48	.97	.06	.04
Senior high school boys	1,315	316.74	48	.96	.07	.05
College students boys	295	112.18	48	.97	.07	.05

All Chi squares were significant ($p < .001$)

CFI comparative fit index, *RMSEA* root mean square error of approximation, *SRMR* standardized root mean squared residual

group separately, and measurement invariance across age in each gender group separately. For each of these models, results revealed both metric and scalar invariance (Table 4).

Gender and Age Differences

Because scalar invariance was established, we proceeded to examine gender and age differences on the four subscales of the LACA. The MANOVA showed significant gender differences on these subscales ($F(4, 9665) = 25.90$, $p < .001$, $\eta_p^2 = .01$). Subsequent univariate ANOVAs revealed significant gender differences for parent-related loneliness and negative attitudes towards aloneness (Table 5). On average, boys scored higher than girls on parent-related loneliness, whereas girls scored higher on negative attitudes towards being alone. Effect sizes, however, were very small (η_p^2s in Table 5). No significant gender differences were found for peer-related loneliness and positive attitudes towards aloneness.

Regarding age, the MANOVA showed significant group differences on the LACA ($F(12, 25571.48) = 142.07$, $p < .001$, $\eta_p^2 = .06$). Subsequent univariate ANOVAs revealed significant age differences for all four subscales. Post-hoc comparisons based on Tukey HSD Tests revealed an increase in scores for parent-related loneliness from elementary to junior high school and further from junior high school to senior high school. A drop in parent-related loneliness was found for college students compared to senior high school students. For peer-related loneliness, after a decrease in junior high school, scores increased for

Table 4 Metric and scalar invariance across gender and age groups

Model	χ^2	*df*	*CFI*	*RMSEA*	*SRMR*
Gender					
Unconstrained	1,226.74	96	0.98	0.05	0.04
Metric invariance	1,242.51	104	0.98	0.05	0.04
Scalar invariance	1,336.80	112	0.98	0.05	0.04
Age					
Unconstrained	1,406.86	192	0.98	0.05	0.04
Metric invariance	1,502.60	216	0.97	0.05	0.04
Scalar invariance	2,182.88	240	0.96	0.06	0.05
Gender invariance elementary school					
Unconstrained	396.70	96	0.98	0.04	0.03
Metric invariance	412.24	104	0.98	0.04	0.03
Scalar invariance	451.37	112	0.98	0.04	0.03
Gender invariance junior high school					
Unconstrained	280.90	96	0.98	0.05	0.04
Metric invariance	288.07	104	0.98	0.05	0.04
Scalar invariance	319.04	112	0.98	0.05	0.05
Gender invariance senior high school					
Unconstrained	604.23	96	0.97	0.06	0.04
Metric invariance	630.53	104	0.97	0.06	0.05
Scalar invariance	683.85	112	0.97	0.06	0.05
Gender invariance college students					
Unconstrained	299.51	96	0.97	0.06	0.05
Metric Invariance	306.20	104	0.97	0.06	0.05
Scalar invariance	343.28	112	0.97	0.06	0.05
Age invariance girls					
Unconstrained	800.46	192	0.98	0.05	0.04
Metric invariance	847.74	216	0.98	0.05	0.04
Scalar invariance	1,278.11	240	0.96	0.06	0.04
Age invariance boys					
Unconstrained	780.61	192	0.97	0.05	0.04
Metric invariance	866.45	216	0.97	0.05	0.05
Scalar invariance	1,186.64	240	0.96	0.06	0.05

All Chi squares were significant ($p < .001$)

CFI comparative fit index, *RMSEA* root mean square error of approximation, *SRMR* standardized root mean squared residual

Table 5 Univariate ANOVAs and post hoc group comparisons based on Tukey HSD tests

Subscale	Girls *Mean (SD)*	Boys *Mean (SD)*	F^1	η_p^2	Elementary *Mean (SD)*	Junior high *Mean (SD)*	Senior high *Mean (SD)*	College *Mean (SD)*	F^2	η_p^2
Parent	19.29 (6.34)	19.44 (6.18)	22.22***	.00	17.52^{a} (4.77)	19.02^{b} (6.57)	21.32^{d} (6.75)	20.70^{c} (7.07)	271.03***	.08
Peer	22.45 (7.08)	22.00 (6.88)	2.98	.00	22.97^{c} (7.08)	20.74^{a} (7.35)	21.58^{b} (6.69)	23.51^{c} (6.54)	53.72***	.02
Negative	32.59 (5.81)	31.65 (6.00)	74.57***	.01	32.20^{b} (5.90)	31.54^{a} (5.99)	$31.96^{a,b}$ (5.89)	32.17^{c} (5.91)	8.48***	.00
Positive	32.18 (6.02)	31.47 (6.12)	0.23	.00	30.92^{b} (5.92)	29.69^{a} (6.45)	32.84^{c} (5.73)	35.15^{d} (5.19)	222.94***	.07

For age, means are significantly different from one another if they have different superscripts

Parent parent-related loneliness, *peer* peer-related loneliness; *negative* aversion to being alone, *positive* affinity for being alone

[a] $df = 1, 9668$

[b] $df = 3, 9{,}668$

*** $p < .001$

senior high school and college students. Scores on negative and positive attitudes towards aloneness followed this same pattern (i.e., an initial decrease followed by an increase). Effect sizes were again relatively small, especially regarding peer-related loneliness and negative attitudes towards aloneness.

Finally, the MANOVA showed a significant interaction effect between gender and age ($F(12, 25571.48) = 9.04$, $p < .001$, $\eta_p^2 = .00$). The interaction effect sizes of the MANOVA and subsequent ANOVAs were very small (i.e., all $\eta_p^2 < .01$). We therefore believe that, although interaction effects were significant due to the large sample size, they have no practical relevance. Hence, we will not present gender comparisons within each age group separately.

Discussion

The present study confirmed the proposed multidimensional structure of the Loneliness and Aloneness Scale for Children and Adolescents (LACA) and established measurement invariance across gender and age groups. Moreover, gender and age group differences, although small, were found regarding parent- and peer-related loneliness and negative and positive attitudes towards aloneness.

Confirmatory factor analyses revealed that the four-factor model that guided the construction of the LACA fitted the data well and showed superior fit to alternative, more parsimonious models. Moreover, intercorrelations among the four subscales were low and internal consistency was high for all subscales. Using (multigroup) confirmatory factor analyses, we further established configural, metric, and scalar invariance across the gender and age groups. These findings imply that the items, as well as the underlying latent factors, are interpreted similarly by boys and girls and by all participants in the intended age range, that is, from elementary school students to college students. LACA scores can thus be meaningfully compared, not only across gender, but also across this large age range.

Results indicated gender and age differences on the LACA subscales. Regarding gender differences, we found that boys scored higher on parent-related loneliness, which confirms an earlier finding for family-related loneliness (Schmitt and Kurdek 1985). Girls scored higher than boys on aversion to aloneness, a finding reported only occasionally in the literature (Marcoen and Goossens 1993). Because the difference we have found is rather small, it might be that previous studies have not detected it due to low statistical power. Finally, we found no significant gender differences for peer-related loneliness and affinity for aloneness which differs from other studies that found higher peer-related loneliness in boys or girls and higher affinity for alones for girls (Corsano et al. 2006; Houghton et al. 2013; Scharf et al. 2011).

However, all effects sizes were small and the differences between boys and girls were <1 point on a 48-point scale in our large sample. These very small effect sizes and the inconsistency of results in previous studies could imply that, on average, there are no or only minimal gender differences in loneliness and attitudes towards aloneness. The differences that have been found may be due to random variation or to specific samples or conditions in which gender differences are more prominent. To arrive at a definitive conclusion regarding gender differences in loneliness, a meta-analysis across the available literature is clearly needed.

Regarding age differences, the results for two of the subscales are in line with prior cross-sectional research in elementary and high school students (Marcoen and Goossens 1993; Marcoen et al. 1987). Parent-related loneliness seems to increase from early adolescence onward. In addition, we found that loneliness in relation to parents was slightly lower for college students as compared to senior high school students. This is in line with prior research that found lower levels of perceived parental conflict in college

students than in high school students (Furman and Buhrmester 1992). College students tend to live away from home, which might lead to lower perceptions of conflict and in turn to less feelings of parent-related loneliness. Positive attitudes towards aloneness tend to drop after elementary school and to increase thereafter. This trend is in line with research showing that it is only during adolescence that positive attitudes towards aloneness emerge and that time alone is used deliberately, for example, for identity formation (Larson 1997).

For the other two subscales, the observed trends were not clearly in line with earlier findings, that is, a decrease in peer-related loneliness and negative attitudes towards aloneness until senior high school. For peer-related loneliness, scores tend to drop after elementary school and then increase again for the senior high school and college students. The same pattern was found for negative attitudes towards aloneness. However, the effect sizes and actual group differences are rather small for both peer-related loneliness and negative attitudes towards aloneness.

Several limitations of the present study need to be mentioned and provide suggestion for further research. First, the study was conducted with children and adolescents from the Dutch-speaking part of Belgium, with a majority of participants representing Caucasian middle class families. Caution is therefore warranted when generalizing our findings to children and adolescents with different cultural and socio-economic backgrounds. Second, longitudinal studies are needed to confirm and extend the present findings. Our results suggest certain age trends, but cross-sectional designs are less suited to infer developmental trends. Third, the present study established measurement invariance across age and gender groups for a specific instrument that focuses on relation-specific types of loneliness. However, other such instruments have been developed as well (e.g., the Social and Emotional Loneliness Scale for Adults, SELSA; DiTommaso and Spinner 1993), for which measurement invariance still needs to be established.

Pending further research, the present study is an important contribution to the literature on psychometric characteristics of multidimensional loneliness measures. Confirmatory factor analysis indicates that the LACA is an excellent option for researchers who wish to examine relation-specific types of loneliness and attitudes towards aloneness across childhood and adolescence. So far, the LACA is the only multidimensional loneliness measure for which it is established that one can legitimately compare gender and age groups on both associations with external variables and mean scores. As the age range examined is considerable, the age differences obtained both confirm and expand upon earlier studies. In line with earlier research, parent-related loneliness increased throughout adolescence, but decreased somewhat in college. Positive attitudes to being alone also increased throughout adolescence and this trend extended into college. Gender differences in loneliness and attitudes to aloneness, however, still await further clarification.

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