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Lifespan trends in sociability: Measurement invariance and mean-level differences in ages 3 to 86 years☆

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ABSTRACT

Although sociability is a fundamental dimension of temperament and personality, few studies have examined it over the lifespan. In this study, sociability was measured across ages 3 to 86 years after assessing for measurement invariance through the multigroup confirmatory factor framework and the more recent alignment method to ensure meaningful differences were assessed between different age groups. Using a repeated cross-sectional design, separate adult (N = 1366, ages 17–86 years) and child/adolescent (N = 543, ages 3–16 years) datasets were created to improve research validity across two different but comparable sociability scales. The findings indicated that there was measurement invariance across adult age groups, but not among child/adolescent age groups. Average levels of sociability followed a significant nonlinear trend (quadratic) across the adult lifespan. Measurement invariance was found across sex for both adult and child/adolescent samples. In adults, females had higher average levels of sociability than males, whereas in children/adolescents, females and males did not differ in mean-levels of sociability. We discuss potential explanations for the quadratic nature of sociability across the adult lifespan, the theoretical implications of these results to understanding personality development, and the methodological issues encountered in studying lifespan differences in sociability from early childhood to senescence.

1. Introduction

Interest in sociability has been scattered throughout the literature and across many domains of research, perhaps most frequently in association with temperament and personality and their relation with individual differences in behavior. Most of the prominent models of temperament and personality have included sociability as a characteristic, trait or facet and its operationalization revolves around the definition of 'a preference for being with others rather than being alone' (Cheek & Buss, 1981). Past research on sociability has provided some understanding of how this construct relates to psychological, interpersonal, and health functioning across different developmental periods (Chen et al., 2018; Cohen, 2004; Poole, Van Lieshout, & Schmidt, 2017). Yet, it is unclear whether the structure of the sociability construct as measured through multi-item surveys in these varied studies was equivalent across age and sex and whether different respondents understood the survey items in the same way as to allow for unbiased comparisons among different groups (Mathiesen & Tambs, 1999; Naerde, Røysamb, & Tambs, 2004; Walker, Ammaturo, & Wright, 2017). Furthermore, it appears average levels of sociability across the life course have been left mostly uncharted despite a lifespan perspective suggesting that average levels vary alongside maturational changes and life transitions (Baltes, Lindenberger, & Staudinger, 2006; Roberts & Nickel, 2017); understanding variance in average levels of sociability is likely a fundamental step to unraveling the relation between sociability and individual differences over the life course. As a first step to fill this gap in the extant literature, our study investigated lifespan trends in sociability between the ages of 3 to 86 years and across sex.

1.1. Theoretical perspectives on sociability across the lifespan

Various theories have been proposed to account for the development of personality traits over the life course, and these have typically followed one of three general theoretical approaches (Roberts, Walton, & Viechtbauer, 2006). The first approach has emphasized that trait development is largely stable by early adulthood and the well-established five factor theory of personality typifies the point of view that traits develop throughout childhood and then remain relatively stable

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across adulthood (McCrae & Costa, 2008). A second approach focused on the role of the environment with respect to personality, and the social cognitive theory of personality exemplifies this viewpoint. Specifically, personality development was perceived as an evolving cognitive and social adaptation to specific contexts at the individual level (Bandura, 1999). And last, a third approach to trait development stressed the importance of a dynamic transactional process occurring between traits and context. The neosocioanalytic theory is representative of this perspective and its complex and comprehensive theoretical framework incorporates the varying influences of continuity (e.g., traits, abilities) and change (e.g., community roles, relationships) that are hypothesized to shape temperament and personality across the lifespan (Roberts & Nickel, 2017).

Although not measuring genetic or environmental effects specifically, the present study may broadly shed some light on which theoretical perspective most closely aligns with the pattern of mean-level differences observed in our data for sociability (we examined only differences, not change, due to the cross-sectional nature of our data); on the one hand, evidence of *no differences* after early adulthood would be consistent with the trait theory that primarily advocates for genetic control over personality traits that are static, on the other hand, evidence for *differences* would align with the transactional theories that promote the idea of a dynamic interplay between genes and context that result in continually developing traits. The contextual theory would not inform on mean-level differences because it only considers the impact of the environment on trait development at the individual level (Roberts et al., 2006).

1.2. Mean-level differences in sociability across the lifespan

1.2.1. Adulthood and adolescence

Within the literature on personality development during adulthood, most research has concentrated on determining mean-levels of the higher order trait extraversion over the lifespan rather than focusing on lower order traits such as sociability. From this work, both cross-sectional and longitudinal studies have shown that mean-levels of extraversion decrease across age, although some variation in this trend has been observed with evidence of increases or even stability at varying developmental periods (Roberts et al., 2006; Specht, 2017). With respect to the facet of sociability, to the best of our knowledge, only two studies have explicitly examined mean-levels across the life course into older age. The first investigation collected online concurrent data that showed sociability had an upward trend across mid adolescence, a downward trend from late adolescence until age 40, and a stable trend up to age 70 (Ashton & Lee, 2016). A second longitudinal study, with only two waves of data, indicated that sociability did not change between the ages of 16 and 66 (Damian, Spengler, Sutu, & Roberts, 2018). Although the former study showed average levels of sociability had diverse developmental trends across age, the latter study was unable to corroborate this interpretation due to the limitation of analyzing trends with only two data points. Other longitudinal research has studied changes in sociability but over relatively narrow young adult age ranges (Klimstra, Noftle, Luyckx, Goossens, & Robins, 2018; Mund & Neyer, 2014).

1.2.2. Childhood and adolescence

In an attempt to partly address the ongoing debate over the conceptual relation between temperament and personality, some research groups have started to investigate mean-levels of personality traits in children and adolescents through the hierarchical trait structure of adult personality (Shiner & DeYoung, 2013; Soto & Tackett, 2015). Within this classification system, sociability in childhood and adolescence also has been positioned under the broad reach of the extraversion trait and understood as approaching people (not objects) and linked to approach motivations that are reinforced through social rewards (Shiner & DeYoung, 2013). Altogether, the evidence has suggested that extraversion steadily declines across childhood and adolescence. Contrary to the research on extraversion, and to the best of our knowledge, the mean-levels of the facet sociability have not been examined across childhood and adolescence. However, some limited work has investigated other facets within the extraversion domain and found that the overall decline in extraversion appeared to be driven by varying facets at different developmental phases (de Haan, De Pauw, van den Akker, Deković, & Prinzie, 2017; Soto, John, Gosling, & Potter, 2011). From these child/adolescent studies and other research in the adult personality domain (Roberts et al., 2006), researchers have concluded that personality research should include analyses at both the trait and facet level to fully capture lifespan age differences.

With respect to the purpose of the present study, examining the mean-levels of sociability as compared to extraversion across childhood and adolescence was hypothesized to capture unique information that would elicit a more finely grained understanding of this construct. Without previous research for guidance, this led us to question whether the mean-level trend of sociability would parallel the overall downward trend of extraversion in childhood and adolescence.

1.3. The issue of measurement invariance: stability of the sociability measurement structure

Studies investigating mean-level comparisons frequently include a measurement invariance (MI) analysis to ensure that the same construct is being measured across different groups (Van De Schoot, Lugtig, & Hox, 2012). Typically, this practice has involved performing a series of nested models with increasing restrictions within a multigroup confirmatory factor analysis (MGCFA) framework to ascertain whether the factor structure (structural invariance), loadings (metric invariance – invariance of loadings), and intercepts/thresholds (scalar invariance – invariance of loadings and item intercepts/thresholds) are equivalent among groups. Nonsignificant model fit changes for nested model comparisons indicate equivalence of the factor structure among groups (Van De Schoot et al., 2012). As of yet, however, MI has not become standard practice despite the likelihood that there may be group differences in interpretation of questionnaire items, which in turn might lead to biased mean comparisons, especially across the lifespan.

With regard to adult personality, few investigations have tested for MI in the extraversion trait across the lifespan (Allemand, Zimprich, & Hendriks, 2008). More commonly, MI has been implicitly assumed (not tested) in studies on extraversion (Milojev & Sibley, 2017; Soto et al., 2011) and sociability (Ashton & Lee, 2016; Damian et al., 2018). Across childhood and adolescence, on the other hand, full (de Haan et al., 2017) or partial (Borghuis et al., 2017; Soto, 2016) MI have been established for extraversion (and some of its facets), but not for sociability. Accordingly, though scalar invariance is regarded as a critical prerequisite for meaningful mean-level comparisons among groups, meeting this assumption has been frequently overlooked or full MI has not always been achieved, particularly when more than a few groups were compared.

Recently, a new method has been developed that relaxes the assumptions required for traditional invariance testing by applying a different set of restrictions to solve the difficulty in obtaining scalar invariance. The alignment method tests for approximate invariance by first estimating *only* a configural model across groups, and then, optimizing the alignment among the groups by minimizing the total amount of noninvariance in the model through a simplicity function. Next, a series of group comparisons (controlling for pairwise comparisons) are performed that eventually establish a stable set of invariant groups from among all the groups for each measurement parameter (Asparouhov & Muthén, 2014). Ultimately, the goal of the alignment method is to balance the requirement of both a good configural model fit and meaningful (unbiased) group comparisons. Thus, in the present study, we followed up any MGCFA (traditional MI) with the alignment method (approximate MI) if scalar invariance was not supported by a nonsignificant change in fit statistics between nested models. Further information regarding the specifics of the alignment method analytic strategy can be found elsewhere (Muthén & Asparouhov, 2013).

1.4. Overview of the present study

At the research level, studying sociability across a large age range is problematic. While sociability has been included in many of the major temperament and personality measures (Ashton & Lee, 2008; Buss & Plomin, 1984; Cattell, 1965; Eysenck, 1967; Goldberg, 1999; McCrae & Costa, 2008; Putnam, Gartstein, & Rothbart, 2006; Thomas, Chess, & Birch, 1970; Zuckerman, 1994), it has come in a variety of guises depending on the core assumptions underlying each temperament or personality model and the developmental age of measurement that would likely modify its expression and assessment. For instance, sociability has been operationalized as: 1) a *lower order trait* under the extraversion/introversion dimension of Eysenck's seminal PEN model of personality for children and adults based primarily on *genetics and physiology* (Eysenck, 1967); 2) a *higher order factor* in the three factor Buss and Plomin (1984) Emotionality Activity Sociability (EAS) Temperament Survey that explicitly assesses early appearing *inherited traits* and *behavioral styles* in children and adults; 3) part of the *affiliation dimension* (independent of the shyness and extraversion dimensions) in the *psychobiologically* based Early Adolescent Behavior Questionnaire (Ellis & Rothbart, 2001); and last, 4) a *facet* under the higher order factor of extraversion in the *psycholexically* based HEXACO Personality Inventory for adolescents and adults (Ashton & Lee, 2008).

While measuring the same trait over such a diverse age range is challenging, we hoped to surmount the obstacle of differing temperament/personality theoretical assumptions by using sociability items from the well-established self-report sociability subscale of the Cheek and Buss Shyness and Sociability Scale – CBSS – (Cheek & Buss, 1981) and the equally well-known parent-report sociability subscale of the Colorado Children's Temperament Inventory – CCTI – (Buss & Plomin, 1984). These two measures in tandem are well suited to studying sociability across the lifespan; the CBSS and CCTI sociability subscales were developed by the same researchers to study sociability from early childhood to older ages with item content that is almost indistinguishable except for some age-related wording (Table S1), are comparable by definition and theoretical underpinnings (Buss & Plomin, 1984), and have been established as reliable and valid indicators of sociability (Mathiesen & Tambs, 1999; Naerde et al., 2004).

Furthermore, to facilitate unbiased mean-level comparisons of sociability, we investigated whether the structure of sociability remained stable across age group and sex through an MGCFA framework. Because scalar invariance is frequently difficult to obtain, we followed up on any failed MGCFA, in which change in global fit statistics among the nested models were found to be significant, with the more recently developed alignment method. This newer methodology relaxes the exact invariance assumption to facilitate detection of good configural model fit while still allowing for meaningful group mean comparisons.

In summary, the overall objective of the present study was to investigate mean-levels of sociability across age groups and sex over the lifespan through theoretically analogous constructs, the adult CBSS and child/adolescence CCTI, while relying on two complementary MI analyses to assure that there were meaningful comparisons of average levels of sociability among the groups. We expected that mean-levels of sociability would differ across age as based on the perspective that dynamic transactional processes occur between traits and developmental context over time, as well as on supporting evidence from previous research studying sociability in late adolescence and young adulthood (Ashton & Lee, 2016; Klimstra et al., 2018; Roberts & Nickel, 2017). Unfortunately, there was insufficient information in the literature to hypothesize any particular pattern of effects for group differences in sociability across our sample range of ages 3 to 86 years. Likewise, sex differences were investigated, but it also was unclear whether mean-level trends would differ between the sexes over the same age range (Mathiesen & Tambs, 1999; Roberts et al., 2006).

2. Method

2.1. Participants and overview

In this study, we used convenience samples derived from 17 archival independent cross-sectional studies conducted within a 20-year span (1997–2017). The total sample included 1909 primarily Caucasian participants that were divided into two samples for analysis, the first contained emerging adults, adults, and older adults ($N = 1366$, $M_{\text{age}} = 31.37$, $SD = 13.61$, age range 17–86 years, 60.1% female) and the second included children/adolescents ($N = 543$, $M_{\text{age}} = 8.05$, $SD = 2.83$, age range 3 to 16 years, 53.0% female). All participants were recruited from the Central West region of Ontario, Canada or on MTurk. Within the one MTurk dataset (55% of the adult sample), the average participant had “completed a college/apprenticeship diploma and/or technical diploma”, and they were from diverse ethnic backgrounds. For the remaining participants, the overall educational and economic background of the participants was rated by the median family income that increased from $50,422 to $87,590 (in Canadian dollars) between the years of 1996 and 2015, respectively (Statistics Canada, 2016, 2017). Missing data were negligible; sex was missing for only two adult participants. University Ethics Board approval was acquired for each study and each participant consented to participate. Parental consent was obtained in the child/adolescent studies.

2.2. Measures

2.2.1. Demographics

Age and sex were assessed for all participants.

2.2.2. Self-report sociability

Sociability was measured with four items (Table S1) from the CBSS (Cheek & Buss, 1981). Likert responses were between 1 = *strongly disagree* to 5 = *strongly agree*, such that higher scores indicated higher levels of sociability. The alpha coefficient ranged between 0.72 and 0.87 across the 11 samples and was 0.82, 95% [CI = 0.80 to 0.84], for the entire sample. The omega coefficient, considered a better indicator of reliability (Dunn, Baguley, & Brunsden, 2014), also was 0.82, 95% [CI = 0.80 to 0.84], for the entire sample

2.2.3. Parent-report sociability

Four items from the parent-report sociability subscale of the Colorado Children's Temperament Inventory – CCTI – were used to measure sociability (Table S1). Responses were recorded on a 5-point Likert scale, ranging from 1 = *not at all like my child* to 5 = *a lot like my child*, with higher scores indicating higher levels of sociability. Cronbach's alpha for the entire sample was 0.75, 95% [CI = 0.70 to 0.78], although the six different samples ranged between 0.70 and 0.77. The omega coefficient was also 0.75, 95% [CI = 0.71 to 0.79], for the entire sample.

2.3. Analytic strategy

Two samples were formed within a repeated cross-sectional design; one arising from 11 merged adult datasets, and the second from 6 merged child/adolescent datasets. The use of the repeated cross-sectional design eliminated the difficulty in maintaining a good sample size and collecting data longitudinally, with the added benefit of avoiding the issue of biased estimates arising from participant attrition (Steel, 2008). In addition, while cohort and selection effects (e.g., older adults may be more sociable) were of concern, our requirement of a lifespan sample necessitated the use of participants from a variety of ages.

Table 1
Adult sociability MGCFA goodness-of-fit indices: group comparisons by age group (N = 1366) and participant sex (N = 1364).

Group comparisons	Model	χ^2	df	p	RMSEA [90% CI]	p	CFI	ΔRMSEA	ΔCFI
By age	Configural	18.971	14	> .050	0.043 [0.000, 0.087]	> .050	0.995	–	–
(7 groups)	Metric	37.521	32	> .050	0.030 [0.000, 0.064]	> .050	0.995	–	–
	Scalar	76.335	50	.010	0.052 [0.038, 0.082]	> .050	0.974	–	–
	Configural vs. metric*	17.692	18	> .050	–	–	–	0.013	0.000
	Metric vs. scalar*	40.936	18	.001	–	–	–	0.022	0.021
By sex	Configural	2.987	4	> .050	0.000 [0.000, 0.051]	> .050	1.00		
(2 groups)	Metric	12.195	7	> .050	0.033 [0.000, 0.063]	> .050	0.995		
	Scalar	15.132	10	> .050	0.027 [0.000, 0.054]	> .050	0.995		
	Configural vs. metric*	12.444	3	.001	–	–	–	0.033	0.005
	Metric vs. scalar*	2.536	3	> .050	–	–	–	0.006	0.000

Note. MGCFA = multiple group confirmatory factor analysis; χ^2 = chi-square, df = degrees of freedom; RMSEA = root mean square error of approximation; CI = 90% confidence intervals for the RMSEA; CFI = comparative fit index. Sex was missing for two participants in groups 1 and 6, respectively, *MLR estimation requires using the Satorra-Bentler scaled statistic for chi-square difference testing.

Using the adult and child/adolescent samples as independent datasets, we followed several analytical steps to compare mean-levels of sociability among the different age groups across the lifespan. First, we formed convenience age groups loosely based on well-known life course theories of development (Arnett, Žukauskienė, & Sugimura, 2014; Erikson, 1966). Next, we performed several nested MI analyses using the MGCFA platform (Van De Schoot et al., 2012). In the first instance, a good configural model fit was investigated across age groups and sex. Traditional cutoff criteria for good model fit included a nonsignificant χ^2 test (this statistic was included due to conventional practice but was likely to be significant as the χ^2 test is sensitive to sample size), a root mean square error of approximation close to RMSEA < 0.08, and a comparative fit index of CFI ≥ 0.95 (Brown, 2015). Next, once configural invariance was established, sequential constraints within the same MGCFA structure were applied to test for 1) metric invariance (constraint of equal loadings across groups) and then 2) scalar invariance (further adding the constraint of equal intercepts across groups). Critical cutoff criteria to determine if there was a nonsignificant change in model fit with added constraints between the configural and metric models, and the metric and scalar models, were a nonsignificant $\triangle\chi^2$ conducted through the Satorra-Bentler scaled chi-square difference test (Satorra & Bentler, 2010), △RMSEA ≤ 0.015 and △CFI ≤ 0.01 (Chen, 2007; Cheung & Rensvold, 2002).

If achieving scalar invariance failed due to significant changes in the χ^2, RMSEA and/or CFI among the nested models, secondary testing for MI was undertaken with the alignment method that could estimate unbiased group means while still allowing for some variance (unlike the traditional MGCFA). This new analysis also required good configural model fit among the groups but metric and scalar invariance restrictions were not a requirement for determining MI. Instead, the means were made comparable by minimizing noninvariance through a different set of restrictions that also quantified noninvariance in the model more precisely (Asparouhov & Muthén, 2014). The alignment method provided detailed information on every parameter (i.e., intercept and loading for all four items) in the model for all groups, which was interpretable through three key statistics including: overall *percent noninvariance* in every parameter across groups, such that 25% or less noninvariance in the overall model supported trustworthy alignment results; R^2 as an indicator of invariance accounted for by every parameter across groups in the factor mean and factor variance, scored on a scale between 0 and 1 such that higher values implied a higher degree of parameter invariance across groups; and last, *fit function*, which indexed the contribution of all parameters to noninvariance across groups, with larger contributions represented by larger fit functions. While the first statistic was indicative of overall noninvariance in the model, the latter two statistics revealed which item parameters contributed the most to noninvariance.

Finally, a quality check of the alignment results was carried out with a Monte Carlo (MC) simulation study (100 repetitions) to test how well the group sociability means were estimated. Asparouhov and Muthén (2014) have recommended that a near-perfect correlation of ≥ 0.980 should exist between the real data and MC generated means to validate the performance of the alignment method. Subsequently, if approximate MI was established, mean-level comparisons were made between the groups. All analyses were undertaken with Mplus 8.2 using maximum likelihood robust estimation (MLR) because it does not assume multivariate normality of continuous data (see Supplementary for sample MI input syntax for the MGCFA and alignment method).

3. Results

Descriptives for adult and child/adolescent variables can be found in Tables S2 and S3, respectively. Seven age groups were formed from the adult sample (late adolescence, early emerging adulthood, middle emerging adulthood, late emerging adulthood, young adulthood, middle adulthood, older adulthood), and three age groups were formed from the child/adolescent sample (early childhood, middle childhood, and late childhood/adolescence). Each of the ten groups had a sample size of approximately 200, except for the oldest adult group and the youngest child/adolescent group. Our sample sizes fell within general statistical guidelines for SEM; we had two simple models (Figs. S1 and S2), no missing data on sociability and normally distributed manifest variables (Wolf, Harrington, Clark, & Miller, 2013).

3.1. Measurement invariance and mean-level comparisons across adult age groups and between the sexes

3.1.1. Adult age groups

The configural model for sociability was found to have good global and local fit, the latter indicating that there were no significant standardized residuals (approximately interpreted as z-scores), and subsequently was used as the baseline model to test for measurement invariance (Table 1). Results from the MGCFA indicated that there was a significant $\triangle\chi^2$, △RMSEA, and △CFI for the comparison between the metric and scalar models, signifying there might be problematic noninvariance in the adult measurement model.

With evidence of failed scalar invariance, we followed up the MGCFA with the alignment method (Table S4). Overall, 0% noninvariance was detected in the eight parameters across the seven groups, which was supportive of approximate MI. R^2 values revealed that there was little noninvariance accounted for by the parameters across groups in the sociability mean and sociability variance. The fit functions by parameter across groups were comparable in size. To check the alignment results, we ran a MC simulation study with starting values from the real data to verify how accurately the sociability group sample means had been estimated. The suggested cutoff criterion of a near perfect correlation of ≥ 0.980 between the real data and MC generated means was met for all group sample sizes (N_{range} = 109–228)

Table 2
Adult sociability standardized factor mean comparison in the alignment metric: group comparisons by age group (N_{age} = 1366) and participant sex (N_{sex} = 1364).

Group comparisons	Ranking	Group #	Mean value	Groups with significantly smaller factor mean (5% significance level)
By age	1	1	0.342	3 7 4 6 5
(7 groups)	2	2	0.339	3 7 4 6 5
	3	3	0.000	4 6 5
	4	7	−0.256	5
	5	4	−0.484	–
	6	6	−0.516	–
	7	5	−0.683	–
By sex	1	2	0.149	1
(2 groups)	2	1	0.000	–

Note. Ranking = represents the number of the group starting from youngest to oldest or male to female; Group # = ordering of groups from highest to lowest standardized mean value of sociability; Mean Value = standardized mean value of sociability in the alignment optimization metric. Sex was missing for two adult participants in groups 1 and 6, respectively.

except for the oldest age group, which had a correlation of 0.972. We concluded that our findings broadly supported approximate MI among our seven age groups, which in turn validated the likelihood of making meaningful group mean comparisons.

Overall, the results provided evidence of significant differences in mean-levels among the adult age groups, which unfolded as a nonlinear trend (quadratic) over the age groups in chronological order (Table 2, Fig. 1). Younger ages between 17 and 22 years (groups 1 and 2) had the highest mean scores of sociability, whereas those aged 30 to 39 (group 5) reported the lowest mean scores of sociability, significantly lower than the oldest age group between 56 and 86 years (group 7). We inferred from these findings that there was a slight upward trend in sociability for the oldest age group.

3.1.2. Adult sex

While our intent was to test for MI in the sociability measurement model across age by sex, our sample size was not sufficient to estimate unbiased means. Instead, we assessed sex differences across the entire sample, as has been done in other studies (Marsh, Nagengast, & Morin, 2013). The global and local fit indexes for the configural model were good, and it was subsequently used as the baseline model for the MGCFA (Table 1). The results from the MGCFA indicated that there was a significant change in model fit between the configural and metric models, signifying that there was some noninvariance in the measurement model for sex.

Accordingly, we continued to assess MI with the alignment method. The test revealed that there was 0% invariance in the eight parameters across the two groups, supportive of approximate MI between the sexes (Table S4). However, it was notable that the R^2 estimates indicated that all four loading parameters accounted for a high degree of noninvariance in the sociability mean and sociability variance. Despite this, the fit function estimates showed that all parameters across groups roughly contributed the same to the optimized fit function. A MC simulation indicated there was a correlation of 0.980 between the sample and MC generated means for both sex groups (sample sizes of N_{male} = 544 and N_{female} = 820), which was above the suggested cutoff criterion. Despite some noninvariance detected in four of the parameters, our findings of approximate MI between the sexes supported an unbiased comparison between female and male mean-levels of sociability across the entire sample. We were able to conclude that females tended to have significantly higher levels of sociability on average than males over the entire sample (Table 2).

3.2. Measurement invariance and mean-level comparisons across child/adolescent age groups and between the sexes

3.2.1. Child/adolescent age groups

The configural model for sociability in child/adolescence showed good global and local fit to the data and was used as the baseline model for the MGCFA (Table 3). However, the test of MI failed as indicated by a significant change in the χ^2, RMSEA, and CFI fit statistics for model comparisons (Table 3); all values were above the critical cutoff points for change in model fit.

We followed the MGCFA with the alignment method to test for approximate invariance. The results showed that there was 0% noninvariance in the sociability model among the aligned parameters for all groups (Table S5). The R^2 values revealed that only the CCTI7 intercept and the CCTI8 loading (two out of eight) accounted for a high degree of noninvariance in the sociability mean and sociability variance. Estimates for the fit function, which minimized the total noninvariance in the model, confirmed that these same two parameters contributed the most to the fit function. Subsequently, an MC simulation was run with starting values from the real data to verify how reliably the sample means had been estimated through the alignment analysis. The correlations (r_{range} = 0.933–0.947) between the real data means and MC generated means for the three different group sizes (N_{range} = 132–207) were below the recommended cutoff criterion of ≥0.980. We concluded that approximate MI was not well supported and a comparison of mean-levels of sociability among our child/adolescent age groups would likely be biased. However, we noted as a point of interest that the late childhood/adolescence group had significantly lower mean-levels of sociability on average than the middle childhood group. In contrast, the early childhood group was not significantly different from either the middle childhood or late childhood/adolescence groups in mean-levels of sociability (Table 4, Fig. 1).

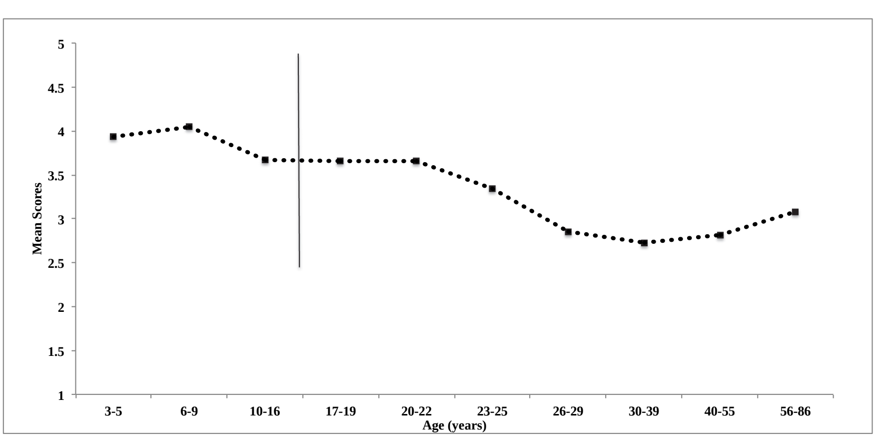

Fig. 1. Mean scores on the sociability across adulthood (after the vertical line) and childhood/adolescence (before the vertical line) by age group. Despite the use of two sociability scales with different informants, both measured on Likert scales between 1 and 5, adult and child/adolescent mean scores were illustrated together to show an overall downward trend in sociability across age followed by an upward trend in older adulthood. Note. MI was not established among the three child/adolescent age groups; dotted line indicates mean-level differences in sociability among age groups, not change in sociability.

Table 3
Child/adolescent sociability MGCFA goodness-of-fit indices: group comparisons by age group and participant sex ($N_{age/sex}$ = 543).

Group comparisons	Model	χ^2	*df*	*p*	RMSEA [90% CI]	*p*	CFI	ΔRMSEA	ΔCFI
By age	Configural	3.078	6	> .050	0.000 [0.000, 0.062]	> .050	1.000	–	–
(3 groups)	Metric	15.917	12	> .050	0.042 [0.000, 0.092]	> .050	0.988	–	–
	Scalar	35.430	18	.008	0.073 [0.036, 0.109]	> .050	0.947	–	–
	Configural vs. metric*	13.618	6	.010	–	–		0.042	0.012
	Scalar vs. metric*	21.181	6	.001	–	–		0.031	0.041
By sex	Configural	2.296	4	> .050	0.000 [0.000, 0.071]	> .050	1.000	–	–
(2 groups)	METRIC	4.205	7	> .050	0.000 [0.000, 0.052]	> .050	1.000	–	–
	SCALAR	5.838	10	> .050	0.000 [0.000, 0.040]	> .050	1.000	–	–
	Configural vs. metric*	1.910	3	> .050	–	–		0.000	0.000
	Metric vs. scalar*	1.597	3	> .050	–	–		0.000	0.000

Note. MGCFA = multi-group confirmatory factor analysis; χ^2 = chi-square, *df* = degrees of freedom; RMSEA = root mean square error of approximation; CI = 90% confidence intervals for the RMSEA; CFI = comparative fit index, *MLR estimation requires using the Satorra-Bentler scaled statistic for chi-square difference testing.

3.2.2. Child/adolescent sex

As in the adult analysis for sex, the child/adolescent sample size was not sufficient to test for MI across age by sex. Instead, a MGCFA was run on the whole sample to test for MI between the sexes using the same baseline model as in the age group analysis. Global and local fit indexes for the sociability configural model across the sexes was found to be excellent (Table 3) and the subsequent MGCFA results indicated that there were no significant changes in the global model fit indexes, including the χ^2, RMSEA, and CFI. With good support for scalar invariance, we assumed that the same sociability construct was being measured across females and males and that no further MI testing was necessary (Marsh et al., 2018). We inferred from the evidence that females and males with the same mean-levels of sociability would likely have the same score on the four sociability items across ages 3 to 16. Comparisons between females and males showed they had equivalent mean-levels of sociability ($p > .05$).

4. Discussion

Using a repeated cross-sectional design, the purpose of this study was to investigate average levels of sociability across ten different age groups between the ages of 3 to 86. To maintain research validity, separate adult and child/adolescent datasets were created despite the two measurement instruments (the self-report CBSS and the parent-report CCTI, respectively) having been developed by the same researchers based on comparable item content and the same theoretical perspective (Buss & Plomin, 1984; Cheek & Buss, 1981). In order to justify mean comparisons among the different age groups and across sex, MI analyses were first run to ascertain that all the groups attributed the same meaning to the items in the scale and that the participants with the same mean score on sociability had the same score on the items used to measure sociability.

We found evidence to support MI among our seven adult age groups and across sex using the newer alignment method with a follow up MC simulation of the real data as a complement to the traditional MGCFA framework. Consequently, we were able to conclude that there were significant differences in sociability among the different adult age groups and between the adult sexes such that these differences took on a nonlinear pattern (quadratic) across age and females had higher average levels of sociability than males across the entire sample (the sample size did not support examining age by sex), respectively. In contrast, the results failed to provide support for MI among the three child/adolescent age groups. We speculate that perhaps assessment by parent-report might not have best capture the sociability construct, especially during a rapidly evolving developmental age range (are parents able to distinguish between a child's key desire to socialize with their parents as opposed to not wishing to socialize with others, most particularly in younger ages). Despite the results for comparisons across age group, good support for MI was found between the sexes; the evidence suggested that child/adolescent females and males were not different in average levels of sociability across the entire sample (the sample size did not support investigating age by sex).

Generally, the highest mean-levels of sociability were found in late adolescence and early emerging adulthood and the lowest mean-levels of sociability in young adulthood, to subsequently become significantly higher again in the older adulthood group. Broadly, these findings were consistent with those of Ashton and Lee (2016), who reported that mean-levels of sociability were highest in later adolescence, followed by a downward trend until age 40, and then remained stable until age 70 (note this latter study was cross-sectional and stability was not tested longitudinally). Yet, our older adulthood group had significantly higher mean-levels of sociability than our young adulthood group, a result that might have stemmed from the item composition of the CBSS scale, items which were not identical to those in Ashton and Lee's HEXACO sociability subscale. Indeed, two of their items (not found in the CBSS) followed substantially different age trends from one another and perhaps this influenced the findings for their oldest age group. In a study by Damian et al. (2018), mean-levels of sociability remained the same across two time points, between the ages of mid 20s and mid 60s. Our results corresponded with their findings; the middle emerging adulthood group (mid 20s) was not significantly different in mean-levels of sociability from our older adulthood group (mid 60s). However, Damian and colleagues' research did not speak to change or trends in sociability over different age periods because they had only two data points in their longitudinal design.

Most importantly, we verified that scores on sociability could be convincingly compared across our adult age groups and sex. To our knowledge, this has not been demonstrated previously. Indeed, this also

Table 4
Child/adolescent sociability standardized factor mean comparison in the alignment metric: group comparisons by age group ($N_{age/sex}$ = 543).

Group comparisons	Ranking	Group #	Mean value	Groups with significantly smaller factor mean (5% significance level)
By age	1	2	0.000	3
(3groups)	2	1	−0.263	–
	3	3	−0.569	–

Note. Ranking = represents the number of the group starting from youngest to oldest ; Group # = ordering of groups from highest to lowest standardized mean value of sociability; Mean Value = standardized mean value of sociability in the alignment optimization metric. MI was not established among the three child/adolescent age group.

may explain why the results for our oldest adult age group may have differed from the results reported by Ashton and Lee (2016), whose research did not include assessing for MI despite the statistical imperative that valid comparisons are best made among groups after MI confirmation analyses have been performed (Van De Schoot et al., 2012). We also suggest that this finding may be of interest to those concerned with the well-being of an aging population whose social interactions are curtailed by increasing health concerns and decreasing productivity, particularly as health care costs and average life expectancy continue to rise. In fact, a closer look at mean-levels of sociability in our older adulthood group by sex (Table S2) revealed that males seemed to have significantly higher average levels of sociability than females, as well as higher levels than males and females aged 26 to 55 years. If our results garner support in future research, perhaps engaging the elderly (particularly women) in diverse social interactions may be of socioemotional benefit.

In addition to addressing concerns with respect to MI, we also added to the literature by supplementing the traditional MCCFA framework with the newly developed alignment method. The key benefits of this new MI analysis were twofold. First, scalar invariance is often difficult to achieve through MGCFA (both the factor loadings and intercepts/thresholds must be invariant), which limits researchers from reporting statistically meaningful group comparisons. As an alternative, the approximate MI alignment method permits researchers another opportunity to investigate this prerequisite for group comparisons without requiring scalar invariance. Second, the alignment method provides compelling noninvariance information that is helpful in determining where in the model fit is jeopardized, data that cannot be easily deduced from a MGCFA. Real world data are often not suited to the constraints imposed by the MGCFA framework and the alternative alignment method provides researchers with an option for studying MI under more realistic conditions.

4.1. Theoretical implications

Overall, our research on trends in sociability between ages 17 to 86 indicated that average levels varied for different age groups, even into older age. These findings were not consistent with the theoretical perspective that personality matures and becomes more stable by early adulthood (i.e., emerging adulthood), as typified by the trait perspective (McCrae & Costa, 2008). Instead, a lifespan perspective of transactional processes involving key life changes and role transitions more closely matched our results (Roberts & Nickel, 2017). In the mid 20th century, Erikson (1966) framed some of these processes in his influential Psychosocial Lifespan Theory. He maintained that the success or failure in achievement of a given age-related task, one within each of eight psychosocial developmental stages, was a turning point in personality development. For instance, adolescents and those in late adolescence/early emerging adulthood were tasked with exploring new personal and committed relationships outside the nuclear family, while at the same time discovering their place in society. In contrast, Erikson proposed that young adults were more likely motivated by building longer-term relationships, for example, within careers and/or families, by directing their attention away from exploring the larger social world and focusing instead on fostering established relationships. Indeed, our result of higher mean-levels of sociability in late adolescence/early emerging adulthood as compared to young adulthood corresponded with this perspective.

Finally, evidence for significantly higher mean-levels of sociability in older adulthood as compared to young adulthood was consistent with a broader perspective on general human ontogeny (Baltes, 1997). Within this framework, the foundational components of biology-genes and culture-socialization were conceived to be interlinking forces behind human development. Psychological processes such as personality development were assumed to be open to both continuity and change throughout the lifespan. As part of this overall model of plasticity, sociability on average would be expected to vary substantially across the lifespan. In fact, we speculate that our result of significantly higher mean-levels of sociability in older adulthood as compared to young adulthood might have reflected an underlying motivation to maintain a desirable social intimacy with others as abilities and friendships declined, an idea based on the evolutionary argument that social interactions are compensatory for declining levels of functioning (Baltes, 1997). In sum, then, it appeared that our evidence of differences between various sequential age groups between the ages of 17 to 86 seemed to correspond with and support prominent transactional lifespan perspectives.

4.2. Strengths and limitations

Several interrelated issues became apparent during our study on sociability trends among different age groups and across the sexes between the ages of 3 to 86 years. The first of these was the difficulty in assessing a fundamental personality construct over such a developmentally diverse sample. In an attempt to address this concern, we used two theoretically related and well-established sociability scales that were comparable in item content and constructed by the same researchers; the adult self-report CBSS (Cheek & Buss, 1981) and the child/adolescent parent-report CCTI (Buss & Plomin, 1984). Furthermore, we assessed whether the same underlying construct or measurement model held across age to ensure that the same sociability construct was being assessed among the different age groups. At the very least, if MI was established, it confirmed that a multi-item scale was stable across groups and that the association between items and the sociability factor did not depend on group membership (i.e., age or sex). Nevertheless, a deeper discussion needs to emerge on the use of multi-item scales of fundamental personality constructs that allow for unbiased mean comparisons from birth to senescence, a discussion that most certainly involves investigating a multi-trait, multi-method approach (Campbell & Fiske, 1959).

A second issue was related to the difficulty in following participants from birth to senescence. Longitudinal data best speaks to change and causal implications but comes with the limitation of substantial participant attrition and cumbersome data collection. The methodological barriers would be considerable if studies followed the same individual over a lifetime; average life spans are eighty years or more in Western cultures. In all likelihood, research approaches, statistical methodology, and generational influences change significantly over time, perhaps making older data redundant or challenging to assimilate in terms of both reliability and validity. Our use of the repeated cross-sectional design provided an innovative way of expeditiously selecting a diverse sample of participants, while still maintaining sample size and eliminating the potential problem of biased estimates arising from participant attrition.

A last issue stems from a foundational concern of whether the phenomenon of sociability looks the same across different developmental ages. While we attempted to address this through the use of theoretically and empirically related measures, one would expect there would be developmental differences in sociability. For example, social motivations at age 3 are facilitated through the initiation and exploration of newly formed interpersonal skills in an expanding social world, whereas at age 86 the manifestations of sociability are likely impeded by the loss of many personal relationships and the difficulty in maintaining social interactions (both emotionally and physically) in a shrinking social world. The question then arises as to how best to structure comparisons across diverse developmental stages based on foundational equivalencies. For instance, would these comparisons be best made through measures rooted in physiology or rather on prevailing behavioral markers that can be reliably captured across the lifespan?

4.3. Conclusions

Given that we are social animals, sociability has long been recognized as an important part of the human condition, which in turn has spurred interest in its development as a temperament characteristic and influence on behavior (Cheek & Buss, 1981; Guilford, 1975; Thurstone, 1951). Remarkably, reports in the literature have indicated that higher levels of sociability have been linked to both adaptive and maladaptive outcomes (Buss, 2012; Cohen, 2004; Emmons & Diener, 1986). In some circumstances, research has focused on sociability in combination with other constructs, particularly shyness, to demonstrate its negative impact on socioemotional functioning (Mounts, Valentiner, Anderson, & Boswell, 2006; Poole et al., 2017) or as a risk factor for maladaptive behavior (Santesso, Schmidt, & Fox, 2004). Altogether, the evidence suggests that the effects of sociability are complex and our finding of variation in normative levels across distinct developmental ages could better inform our understanding of individual differences in sociability.

Indeed, elucidating mean-levels across the life course provides essential information. For instance, if evidence of differences across age in sociability corresponds with developmental (e.g., adolescence, older age) or demographic (e.g., leaving home, moving to a retirement home) trends, then it provides a starting point for investigations into reasons why there are differences. Furthermore, at the individual level, mean-levels provide a benchmark for understanding behavior that no longer follows normative patterns and a springboard for investigating reasons why this behavior might become adaptive or maladaptive. In point of fact, a first step in developing norms for a measure is to understand mean-level age trends of the measure.

Finally, while this study found evidence that indicated sociability on average followed a significant nonlinear trend (quadratic) across adulthood, it also ascertained that sociability was being interpreted in the same way across a large age span. Future research should consider why there is significant variability in mean-levels of sociability across age and whether these differences impact the relation between individual differences in sociability and adaptive or maladaptive outcomes, as well as examine these relations and lifespan trends in sociability across different cultures in order to establish whether the trends reported herein are culturally-specific.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2019.109579.

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