



Age-Related Differences in the Factor Structure of Multiple Wellbeing Indicators in a Large Multinational European Survey

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Abstract

There is increasing evidence that uni-dimensional wellbeing models often report comparable and sometimes better fit to multi-dimensional and hierarchical models. Recent proliferation in Bi-Factor modelling supports a general factor reflecting substantial commonality in wellbeing indicators. The current study examines age-related differences in the factor structure of wellbeing across the lifespan. Participants ($n=42,038$) were from the European Social Survey (ESS), a large multi-national study who completed the ESS wellbeing module. Confirmatory Factor (CFA) and Bi-factor analyses revealed a uni-dimensional model reported best fit. Age differences in the magnitude and rank order of factor loadings was supported by a formal invariance test of the factor loadings although these differences did not substantially impact on factor scores. In line with a growing body of CFA and Bi-Factor findings, ESS wellbeing indicators reflect one general wellbeing factor. Despite age differences in the factor loadings, these differences had little adverse impact on overall wellbeing score. Overall, a uni-dimensional factor structure was consistent over the lifespan.

Keywords Wellbeing · Confirmatory factor analysis · Bi-factor models

1 Introduction

It is well established that different wellbeing indicators reflect related theoretical frameworks or approaches to the measurement of well-being. Psychological Wellbeing (PWB) focuses on eudaimonic indicators of personal functioning, Subjective Wellbeing (SWB) focuses on hedonic indicators of personal feeling and appraisal and Social Wellbeing (SoWB) focuses on dimensions of social trust, belongingness and support (Deci and Ryan 2000; Huppert et al. 2009; Keyes et al. 2002). There is a considerable literature base that identifies unique drivers and outcomes for these wellbeing domains and differences in these drivers within wellbeing domains (e.g. SWB indicators of satisfaction or positive

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affect) (Huppert and Whittington 2003; Ryan and Deci 2001). For example, in line with a tripartite model of depression and anxiety, high negative affect is a risk factor for both depression and anxiety, whilst low positive affect is a vulnerability for depression (Burns et al. 2011; Clark et al. 1994). Similarly, one meta-analysis identified that different life events had different impacts on affective and cognitive well-being outcomes (Luhmann et al. 2012). And in terms of personality, wellbeing is frequently associated with Big 5 personality constructs (Burns and Machin 2010; DeNeve and Cooper 1998; Keyes et al. 2002; Kling et al. 2003; Schmutte and Ryff 1997; Steel et al. 2008). Further how individuals orient themselves to achieving happiness through meaning, pleasure and engagement has a significant influence over their life satisfaction (Park et al. 2009; Peterson et al. 2005). There is therefore a strong basis for examining multiple indicators of wellbeing.

1.1 The Multi-Dimensional and Hierarchical Structure of Wellbeing

Owing to the differentiation of wellbeing indicators both within and between wellbeing domains, a hierarchical and multi-dimensional wellbeing structure, in which PWB, SWB and SoWB indicators fall into their respective domains, is frequently ascribed to and supported by a number of factor analytical studies. One early but important report (Compton et al. 1996) factor analysed 18 separate indicators of well-being and mental health from which two factors were derived. Compton et al. (1996) concluded that whilst one factor reflected aspects of SWB, the second factor reflected Eudaimonic components with a moderate correlation between the two factors. Factor analysis of PWB and SWB items frequently identifies two higher order PWB and SWB factors (Burns and Machin 2009; Hervás and Vázquez 2013; Linley et al. 2009). More recent extensions to this two factor hierarchical structure have incorporated dimensions of social and inter-personal wellbeing dimensions. For example, Gallagher et al. (2009) used Confirmatory Factor Analysis to compare a unidimensional wellbeing higher-order factor with a 2 (reflecting hedonic and eudaimonic wellbeing) and 3-factor model (reflecting hedonic, eudaimonic and social wellbeing). Whilst model fit for all three models was acceptable, comparatively better fit was reported for the correlated three factor model. Subsequently, much of the literature has argued for a multi-variate higher-order factor structure.

However, there are a number of findings which raise questions regarding the ubiquity of such a multi-dimensional model. Despite emphasising the comparative better fit for a 3-factor model, Gallagher et al. (2009) found that a uni-dimensional model still reported acceptable fit. In contrast, there are a number of studies have actually identified that a model which incorporated a single second-order wellbeing factor was a better fitting model than a model with correlated first-order latent factors only (Kim et al. 2016; Van Horn et al. 2004). Similarly, in their development and validation of the Pemberton Happiness Index, Hervás and Vázquez (2013) identified a single global wellbeing was a better fitting model in contrast to a hypothesised 3 factor model comprising subjective, psychological and social wellbeing.

1.2 Bi-Factor Models

Perhaps of increasing interest is the methodology employed in a number of recent studies that have utilised Bi-Factor modelling techniques to examine the factor structure of wellbeing (Chen et al. 2013; de Bruin and du Plessis 2015; Gatt et al. 2014; Hides et al. 2016; Jovanović 2015; Longo et al. 2017). These studies have tended to support

the notion that multiple wellbeing indicators may best be reflected by a single general wellbeing factor. In contrast to multi-dimensional hierarchical models, Bi-Factor modelling estimates a general factor that captures the commonality between all manifest indicators. Subsequently, remaining variance not accounted for by the general factor is accounted for by either specific factors or residual/measurement error. For example, in an analysis of subjective wellbeing indicators only (positive and negative affect, and life satisfaction), Jovanović (2015) found that a bi-factor model was a superior fit to all traditional hierarchical wellbeing models including a correlated 3-factor SWB model. This suggests that most SWB indicators are reflecting a single SWB factor rather than the commonly held notion that SWB items reflect three first-order factors—positive affect, negative affect and life satisfaction, with a super-ordinate factor which reflects the totality of these separate lower-order factors. Using data from two studies Chen et al. (2013) undertook a bi-factor analysis of items that reflected both subjective and psychological wellbeing. Similar to Jovanović (2015), Chen et al. (2013) found a bi-factor model, in which a general factor captured all shared variance amongst items, with the unique or unexplained variance captured by specific factors or residuals, was a better fitting model than a hierarchical multi-dimensional model. Similar findings are increasingly reported in the wellbeing literature (de Bruin and du Plessis 2015; Gatt et al. 2014; Hides et al. 2016; Longo et al. 2017). However, given the reliance on small convenience samples in many of these studies, further examination of the hierarchical or bi-factor structure of multiple wellbeing components is needed, particularly in large multi-national studies which allow us to estimate the ubiquity of the model between national populations.

1.3 Age Differences in the Factor Structure of Wellbeing

There appears to be no discernible clear pattern in relation to the age-related changes in wellbeing dimensions. For example, there is evidence for stability, decline and gain in both SWB and PWB with age and changes are also inconsistent between different indicators within the SWB or PWB frameworks (Charles et al. 2001; Keyes et al. 2002; Ryff 1989, 2014). In a 23 year longitudinal study, (Charles et al. 2001) identified that negative affect declined with age, whilst positive affect was stable for young and middle aged adults, only declining slightly for older adults. In contrast, one very large ($n > 39,000$) national survey of mid and older adults found that older adults were more likely to report low-arousal positive affect specifically, and less likely to report both high and low-arousal negative affect (Windsor et al. 2013). However, there has been some caution raised about interpreting implied age-related differences in wellbeing components owing to the extent of within-person variation over time. In terms of PWB indicators, Ryff and Singer (2008) emphasised substantial age declines in Personal Growth and Purpose In Life, whilst Autonomy increased and other PWB indicators remained stable. However findings from one longitudinal study suggest that there is far greater variability within age cohorts than between age cohorts (Springer et al. 2011). Springer et al. (2011) concluded that less than 1% of the variance in PWB indicators was accounted for by age. It is important to confirm differences in the wellbeing factor structure and the relative importance of different wellbeing indicators over the lifespan.

1.4 The Current Study

This study first undertook a series of factor analyses to examine the structure of wellbeing in a large multi-national survey. Whilst a multi-dimensional hierarchical model is frequently reported there is increasing evidence that perhaps wellbeing indicators are reflecting a single super-ordinate or general wellbeing factor (Gallagher et al. 2009; Kim et al. 2016; Van Horn et al. 2004). Therefore, using wellbeing indicators that capture a range of SWB, PWB and Social wellbeing dimensions, comparisons were made between a uni-dimensional and a 3-factor correlated factors model, and a series of Bi-Factor models. Examination of the factor structure and the factor loadings across the whole adult lifespan were then undertaken to determine the extent to which the factor structure and loadings were consistent across the lifespan. Specifically, the study formally examined the extent to which the wellbeing factor structure is invariant across the lifespan. By using a large representative multi-national survey of adults across the life course, the findings of the study provide substantial evidence for the purported differences in the relative importance of different wellbeing indicators across the life course.

2 Methods

2.1 Participants

Participant were from the European Social Survey (ESS). Data was obtained from the online ESS website (www.europeansocialsurvey.org). Substantial background and detail about the ESS have been described (Jowell 2007) but to summarise here, the ESS is a large international survey of European social attitudes that has been funded by the European Commission, the European Science and National Science Foundations. The first wave of data collection was undertaken in 2002/3 in 22 countries. The data for the current study was from the third wave of data collection in 2006 (European Social Survey Round 3 Data 2006) and comprised 43,000 participants from 23 countries that include Austria, Belgium, Bulgaria, Switzerland, Cyprus, Germany, Denmark, Estonia, Spain, Finland, France, Great Britain, Hungary, Ireland, Netherlands, Norway, Poland, Portugal, Russia, Sweden, Slovenia, Slovakia and Ukraine. Participants in this study ($n=42,038$) were on average 47.7 years of age ($SD=18.6$ years; range = 14–101); 54.5% were female and provided data on wellbeing. A range of socio-demographic characteristics are provided in Table 1.

2.2 Measures

2.2.1 Wellbeing Outcomes

The ESS Wellbeing Module was used to measure wellbeing and has been fully described elsewhere (Huppert et al. 2009). The ESS module comprises a multi-dimensional wellbeing scale that includes 54 items reflecting multiple dimensions of wellbeing. There were between 2 and 6 items per dimension. A previous study reported an exploratory factor analysis of the ESS wellbeing items and revealed that the items reflected one higher order factor (AUTHORS ref). A comparison with other commonly reported

Table 1 Socio-demographic characteristics of the sample

| | |
|---|---------------|
| Male | 19,530 (45.5) |
| <i>Age</i> | |
| 14–19 | 2523 (5.9) |
| 20–29 | 5995 (14.0) |
| 30–39 | 7040 (16.5) |
| 40–49 | 7641 (17.9) |
| 50–59 | 7137 (16.7) |
| 60–69 | 6106 (14.3) |
| 70–79 | 4335 (10.2) |
| 80+ | 1921 (4.5) |
| <i>Marital status</i> | |
| Partnered | 22,804 (53.4) |
| Separated/divorced | 4193 (9.8) |
| Widowed | 4414 (10.3) |
| Never partnered | 11,278 (26.4) |
| Paid Employment (at least 20 h for the last 3 months) | 37,058 (86.2) |
| <i>Highest level of education</i> | |
| < Lower secondary | 5757 (13.4) |
| Lower secondary | 7983 (18.6) |
| Upper secondary | 16,316 (37.9) |
| Post-secondary | 1128 (2.6) |
| Tertiary | 11,608 (27.0) |

factor structures has not yet been reported. More detail about the development of the ESS wellbeing module is provided by Huppert et al. (2009).

But as a summary for the current paper, Psychological feeling was assessed with items that captured Positive Emotion (e.g. “How much of the time during the past week have you enjoyed life”), Negative Emotions (e.g. “How much of the time during the past week have you felt sad”), Vitality (e.g. “How much of the time during the past week have you had a lot of energy?”), Self-Esteem (e.g. “In general I feel very positive about myself”), Satisfaction (e.g. “All things considered, how satisfied are you with life as a whole nowadays?”) and Optimism (e.g. “I am always optimistic about my future”). Psychological functioning was captured by items reflecting Competence (e.g. “Most days I feel a sense of accomplishment from what I do”), Autonomy (e.g. “I feel I am free to decide how to live my life”), Engagement (e.g. “How much of the time during the past week have you been absorbed in what you were doing”), Purpose (e.g. “I generally feel that what I do in my life is valuable and worthwhile”), and Resilience (e.g. “When things go wrong in my life it takes a long time to get back to normal”). The social wellbeing dimensions were defined by items reflecting Social Support (e.g. “There are people in my life who really care about me”), Social Trust and Belongingness (e.g. “To what extent do you feel that people in your local area help one another?”).

2.3 Statistical Analyses

A series of Confirmatory Factor Analyses (CFA) were undertaken and tested a series of measurement models. Following the literature base, the first model comprised a single

overall wellbeing factor (Model 1) whilst a second model (Model 2) estimated three correlated factors that reflected subjective, psychological and social wellbeing (Burns and Machin 2009; Compton et al. 1996; Gallagher et al. 2009; Hervás and Vázquez 2013; Kim et al. 2016; Linley et al. 2009; Van Horn et al. 2004). Finally, a series of exploratory Bi-Factor models (Models 3 through 9) whereby one general factor and increasing numbers of independent specific wellbeing domain factors were estimated. Bi-factor models are increasingly informing the wellbeing literature (Chen et al. 2013; de Bruin and du Plessis 2015; Gatt et al. 2014; Hides et al. 2016; Jovanović 2015; Longo et al. 2017).

In order to compare age differences in the factor structure, examination of the factor loadings in the best fitting model were compared between age groups with a formal test of invariance. Using a multi-groups framework, a Configural model was first estimated in which factor loadings were freely estimated within each age group. The model fit of this Configural model was then compared with a Metric model in which the factor loadings for each age group were constrained to be equivalent across the lifespan. The model fit for the CFA and measurement invariance models were assessed with several Goodness of Fit Indicators (GFI) following several guidelines (Bentler 1990; Browne and Cudeck 1989; Hu and Bentler 1999; Yang 2006) including the Bayesian Information Criteria (BIC; optimal value = model with the lowest value), Root Mean Square of Approximation (RMSEA; optimal value < .06), Confirmatory Fit Index (CFI; optimal value > .95), Tucker Lewis Index (TLI; optimal value > .95) and Standardized Root Mean Square Residual (SRMR; optimal value < .08).

3 Results

Confirmatory Factor Analyses of the ESS wellbeing items were undertaken to confirm whether manifest items reflect their lower wellbeing factor (e.g. how well do items of negative emotions reflect a single latent Negative Emotion factor?). Overall, the model fit for each wellbeing indicator was appropriate [e.g. from Vitality (CFI=0.92; RMSEA = .07 (95% CI: .07; .07); SRMR = .04) to Positive Emotions [CFI=1.00; RMSEA = .00 (95% CI .00; .01); SRMR = .00]. This supports the examination of the face, content and construct validity of the item content themselves. That is, in a series of factor analyses, items reflect the same lower order wellbeing factors they are assumed to measure. However, there is debate to which these different wellbeing indicators do reflect hedonic or eudaimonic domains. For example, vitality has been purported to be both a hedonic (Keyes 2007) and eudaimonic indicator (Fayad et al. 2013), whilst in the ESS wellbeing module resilience was conceptualised as a functioning/eudaimonic indicator (Huppert et al. 2009) although some factor analyses have suggested it loads onto an affective wellbeing dimension (Huppert and So 2013). Often these differences can be attributed to researchers who posit a theoretical argument versus researchers who use data-driven approaches (e.g. Factor Analysis) to make these determinations. Therefore a series of factor analyses were undertaken to confirm the purported factor loading of the manifest items on their respective wellbeing indicators within their respective domains. Results are presented in Table 2. Given possible issues with determining whether particular indicators are best described as hedonic or eudaimonic, specifically the wellbeing indicators of vitality, resilience and self-esteem, Models 1 and 2 were re-estimated without these indicators. Overall there was no substantial change in model fit between those models which included or excluded these indicators. This may suggest that these indicators reflect both hedonic and eudaimonic dimension, or

Table 2 Confirmatory factor analysis of the manifest indicators within wellbeing domain

| | Model 1 | CFI | RMSEA | SRMR |
|----------|---|-----|----------------|------|
| Model 1a | Correlated PWB with vitality + resilience + self-esteem | .98 | .04 (.03; .04) | .017 |
| Model 1b | Correlated PWB | .99 | .03 (.02; .03) | .012 |
| Model 2a | Correlated SWB with vitality + resilience + self-esteem | .93 | .06 (.06; .06) | .046 |
| Model 2b | Correlated SWB | .93 | .05 (.05; .06) | .048 |
| Model 3 | Correlated SocialWB | .94 | .04 (.04; .05) | .029 |

perhaps an overall general wellbeing factor which will be examined later. The fit of the Social Wellbeing indicators (Model 3) was also a well-fitting model.

As face, content and construct validity and the results of these factor analyses support the position that the items reflect the wellbeing indicators they purport to measure, further factor analyses of the PWB, SWB and Social wellbeing factors were undertaken using the scale scores as the manifest indicators. This would also help improve the estimation process. Factor analysis of the separate wellbeing dimensions with indicators computed using the a priori scales replicated the earlier findings. The separate wellbeing indicators reflected the feeling [CFI=0.97; RMSEA=0.04 (95% CI 0.04; 0.04); SRMR=0.03], functioning [CFI=0.99; RMSEA=0.03 (95% CI 0.02; 0.03); SRMR=0.01] and social [CFI=0.94; RMSEA=0.04 (95% CI 0.04; 0.05); SRMR=0.03] wellbeing dimensions very well. Consequently, further estimation of factor analyses in this paper use the a priori scale scores for the separate wellbeing indicators.

3.1 The Structure of Wellbeing Across the Lifespan

Confirmatory Factor Analyses compared the model fit of several measurement models (Table 3). Model 4 comprised a single overall wellbeing factor and was a far-better fitting model than Model 5 in which three correlated factors, reflecting subjective, psychological and social wellbeing, were estimated and Model 6 which comprised the higher order wellbeing factor. Models 7 through 13 comprised a series of Bi-Factor models in which one general factor and increasing numbers of independent specific wellbeing domain factors were estimated. For the Bi-Factor analyses, up to 8 factors reflecting 1 overall general factor and 7 specific factors were estimated. Analysis that sought to extract more specific factors would not converge. Most of the Bi-Factor analyses reported comparably worse fit than Models 4 and 5. Models 4 and 13 reported the better fitting models and their loadings are reported in Table 4. In Model 13, all items loaded substantially onto the general factor. The specific factors were reflected primarily by only single indicators, with very low loadings for the other indicators, except for factor 4, reflected by Self-Esteem and Optimism, and factor 6, reflected by Purpose in Life and Trust and Belonging. However, these and the loadings of indicators from factors 4 through 7 were very low and much lower in comparison with their corresponding loadings on the general factor. It was decided to focus further analysis on Model 4 which incorporated a single wellbeing factor. Model 4 reported better Goodness of Fit with lower BIC and RMSEA values than those reported in Model 13 and it is a more parsimonious model.

Table 3 Goodness of fit statistics for several competing models

| Model | BIC | RMSEA (95% CI) | CFI | TLI | SRMR |
|-------|-----------|----------------|------|------|------|
| 4 | 3,672,449 | .00 (.00; .01) | 1.00 | 1.00 | .001 |
| 5 | 3,678,431 | .06 (.06; .06) | .97 | .94 | .026 |
| 6 | 3,688,650 | .07 (.07; .08) | .91 | .89 | .039 |
| 7 | 3,684,772 | .07 (.07; .08) | .93 | .90 | .032 |
| 8 | 3,681,251 | .07 (.07; .07) | .95 | .91 | .024 |
| 9 | 3,675,700 | .05 (.05; .05) | .98 | .96 | .016 |
| 10 | 3,673,873 | .04 (.04; .04) | .99 | .97 | .011 |
| 11 | 3,673,170 | .03 (.03; .04) | 1.00 | .98 | .007 |
| 12 | 3,672,665 | .02 (.02; .03) | 1.00 | .99 | .004 |
| 13 | 3,672,517 | .01 (.01; .02) | 1.00 | 1.00 | .001 |

BIC Sample-Size Adjusted Bayesian Information Criteria (BIC), *RMSEA* root mean square error of approximation, *CFI* confirmatory fit index, *TLI* Tucker Lewis Index; *SRMR* standardized root mean square residual

Model 4: 1-factor model; Model 5: correlated 3-factor model; Model 6: 1-higher order wellbeing factor with 3-lower order (PWB, SWB, SocialWB) factors; Model 7: bi-factor model with 1 general factor and 1 specific factor; Model 8: bi-factor model with 1 general factor and 2 specific factors; Model 9: bi-factor model with 1 general factor and 3 specific factors; Model 10: bi-factor model with 1 general factor and 4 specific factors; Model 11: bi-factor model with 1 general factor and 5 specific factors; Model 12: bi-factor model with 1 general factor and 6 specific factors; Model 13: bi-factor model with 1 general factor and 7 specific factors; extracting more specific factors would not converge

Table 4 Factor loadings for Model 4 and Model 13

| | Model 4 | | Model 13 | | | | | | | |
|---------------------|---------------|---------------|----------------|------------------|------------|------------|------------|------------|---------------|--|
| | | | General factor | Specific factors | | | | | | |
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Positive emotions | .80 | .80 | <.01 | <.01 | -.01 | <.01 | -.04 | -.13 | .03 | |
| Negative emotions | -. .65 | -. .65 | -.01 | -.13 | <.01 | <.01 | -.11 | .15 | .11 | |
| Life satisfaction | .77 | .84 | -.01 | -.04 | -.02 | -.05 | -.02 | <.01 | .26 | |
| Vitality | .70 | .68 | <.01 | .99 | <.01 | <.01 | <.01 | <.01 | .00 | |
| Self esteem | .57 | .52 | -.01 | -.01 | -.01 | .49 | .04 | <.01 | -.06 | |
| Optimism | .56 | .52 | <.01 | .01 | <.01 | <.01 | -.03 | <.01 | .08 | |
| Resilience | .46 | .43 | .01 | -.01 | <.01 | <.01 | .45 | <.01 | .01 | |
| Competence | .57 | .54 | <.01 | <.01 | .98 | -.01 | <.01 | <.01 | <.01 | |
| Autonomy | .46 | .42 | -.01 | .01 | .08 | .06 | .10 | .10 | .07 | |
| Engagement | .62 | .55 | .99 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | |
| Purpose in life | .56 | .54 | .03 | .02 | .07 | .09 | -.04 | .32 | .01 | |
| Social support | .57 | .63 | -.01 | -.04 | -.01 | -.02 | -.03 | .04 | -. .33 | |
| Trust and belonging | .41 | .49 | -.01 | -.01 | -.04 | -.05 | .01 | .47 | -.02 | |

Bold indicates $p < .001$

3.2 Contribution of Different Wellbeing Indicators to Overall Wellbeing Across the Lifespan

Having established that a single factor was the best fitting model, multi-groups analysis was undertaken to derive factor loadings by age group. These are reported in Table 5. Comparison of these factor loadings indicated a number of significant age trends. In terms of Subjective Wellbeing, the factor loadings of most wellbeing indicators reported significant changes in terms of magnitude of the loadings over the lifespan. Positive Emotions, Negative Emotions, Life Satisfaction, Vitality and Optimism reported linear increases with increasing age suggesting that the extent to which these components reflect the higher order latent wellbeing factor increases with age. Significant negative quadratic age trends in the factor loadings for Positive Emotions, Life Satisfaction and Vitality indicates an attenuation of the linear increase, whilst the positive quadratic trend for Negative Emotions reflects an increase in the linear trend for the oldest age-groups. Self-Esteem reported no linear trend although a positive significant quadratic effect suggests an increase in the magnitude of the factor loading was reported for the oldest participants. In terms of Psychological Wellbeing, only Engagement reported a positive linear trend with increasing age. Otherwise all other Psychological Wellbeing and all Social Wellbeing indicators did not change in their magnitude of loading over the lifespan suggesting their relative contribution to the latent factor is consistent over the lifespan.

Whilst these analyses reflect a comparison of the magnitude of the factor loadings for each wellbeing indicator. An alternative way to view the contribution of different wellbeing indicators to the latent factor is a review of the rank order stability of the indicators. Table 6 lists the wellbeing indicators in order of highest factor loading by each age group. Across age groups, it is clear that the Subjective Wellbeing indicators Positive Emotions, Life Satisfaction, Vitality and Negative Emotion were the indicators that consistently contributed most to the latent wellbeing factor. Self-Esteem was consistently a middle-ranked contributing factor to wellbeing except for those aged 80+ for whom Self-Esteem was more highly ranked than other age groups. Optimism was a relatively lowly ranked contributor to wellbeing for the younger age groups although there was evidence of an increase in rank order with age, but declining again for the oldest participants. Most Psychological Wellbeing indicators were moderately ranked indicators of wellbeing across all age groups. Exceptions included Competence which contributed more highly to the wellbeing factor in the youngest age group but declined with increasing age to be a moderately ranked indicator for those aged 60+. Also, Autonomy and Resilience consistently comprised the lowest ranked indicators to contribute to the wellbeing factor. The Social Wellbeing indicator Social Support was consistently a moderately ranked indicator in terms of rank order contribution to the latent wellbeing factor. Trust and Belonging was also a moderately ranked indicator for most age groups although it was among the lowest ranked indicators for those aged in their 60s and 70s.

As several indicators appeared to change both their relative magnitude and in terms of the rank order of their importance in contributing to the wellbeing factor, a formal test of measurement invariance was undertaken to examine the extent of these age-related differences in the factor loadings. Measurement invariance is a more stringent analysis of the difference in the factor loadings across age groups. As the focus is on the contribution of each indicator to the factor score, measurement invariance analyses focused on the factor loadings only. Consequently a Configural model ($\chi^2 = 20,345.38$ (520) $p < .001$) in which all parameters were freely estimated for each age group was compared with a Metric Model

Table 5 Individual factor loadings for each wellbeing indicator by age group

| | Age groups | | | | | | | | | | Linear slope | | Quadratic slope | |
|---------------------|------------|-------|-------|-------|-------|-------|-------|------|--------------|--------------|--------------|--------------|-----------------|--|
| | 14–19 | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 | 70–79 | 80+ | β (SE) | β (SE) | β (SE) | β (SE) | | |
| | | | | | | | | | | | | | | |
| Positive emotions | 0.71 | 0.74 | 0.75 | 0.77 | 0.77 | 0.79 | 0.79 | 0.70 | .04 (.01)* | -.01 (.00)* | | | | |
| Negative emotions | 0.59 | 0.64 | 0.65 | 0.69 | 0.69 | 0.73 | 0.72 | 0.69 | .05 (.01)*** | -.01 (.00)** | | | | |
| Life satisfaction | 0.70 | 0.74 | 0.74 | 0.77 | 0.78 | 0.79 | 0.79 | 0.77 | .03 (.00)** | -.01 (.00)** | | | | |
| Vitality | 0.62 | 0.65 | 0.71 | 0.72 | 0.74 | 0.77 | 0.74 | 0.77 | .05 (.01)** | -.01 (.00)* | | | | |
| Self-esteem | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.56 | 0.59 | 0.75 | -.05 (.02) | .01 (.00)* | | | | |
| Optimism | 0.48 | 0.51 | 0.53 | 0.55 | 0.57 | 0.60 | 0.63 | 0.64 | .02 (.00)*** | .00 (.00) | | | | |
| Resilience | 0.44 | 0.46 | 0.46 | 0.45 | 0.46 | 0.47 | 0.40 | 0.54 | -.01 (.02) | .00 (.00) | | | | |
| Competence | 0.59 | 0.59 | 0.62 | 0.61 | 0.60 | 0.56 | 0.56 | 0.65 | -.01 (.02) | .00 (.00) | | | | |
| Autonomy | 0.47 | 0.46 | 0.48 | 0.46 | 0.48 | 0.48 | 0.53 | 0.48 | .00 (.01) | .00 (.00) | | | | |
| Engagement | 0.53 | 0.53 | 0.55 | 0.60 | 0.60 | 0.64 | 0.61 | 0.56 | .04 (.01)* | -.00 (.00) | | | | |
| Purpose in life | 0.56 | 0.59 | 0.59 | 0.59 | 0.55 | 0.58 | 0.59 | 0.67 | -.02 (.02) | .00 (.00) | | | | |
| Social support | 0.56 | 0.58 | 0.58 | 0.59 | 0.60 | 0.59 | 0.59 | 0.65 | -.00 (.01) | .00 (.00) | | | | |
| Trust and belonging | 0.49 | 0.53 | 0.52 | 0.50 | 0.49 | 0.45 | 0.48 | 0.62 | -.03 (.03) | .01 (.00) | | | | |

*** $p < .001$; ** $p < .01$; * $p < .05$

Table 6 Rank order of wellbeing indicators by age group

| Age Groups | | | | | | | |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 14-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80+ |
| Positive Emotions | Life Satisfaction | Positive Emotions | Life Satisfaction | Life Satisfaction | Positive Emotions | Life Satisfaction | Vitality |
| Life Satisfaction | Positive Emotions | Life Satisfaction | Positive Emotions | Positive Emotions | Life Satisfaction | Positive Emotions | Life Satisfaction |
| Vitality | Vitality | Vitality | Vitality | Vitality | Vitality | Vitality | Self-Esteem |
| Competence | Negative Emotions | Negative Emotions | Negative Emotions | Negative Emotions | Negative Emotions | Negative Emotions | Positive Emotions |
| Negative Emotions | Purpose In Life | Competence | Competence | Engagement | Engagement | Optimism | Negative Emotions |
| Self-Esteem | Competence | Purpose In Life | Engagement | Social Support | Optimism | Engagement | Purpose In Life |
| Purpose In Life | Social Support | Social Support | Purpose In Life | Competence | Social Support | Self-Esteem | Social Support |
| Social Support | Self-Esteem | Self-Esteem | Social Support | Optimism | Purpose In Life | Social Support | Competence |
| Engagement | Engagement | Engagement | Self-Esteem | Self-Esteem | Competence | Purpose In Life | Optimism |
| Trust & Belonging | Trust & Belonging | Optimism | Optimism | Purpose In Life | Self-Esteem | Competence | Trust & Belonging |
| Optimism | Optimism | Trust & Belonging | Trust & Belonging | Trust & Belonging | Autonomy | Autonomy | Engagement |
| Autonomy | Autonomy | Autonomy | Autonomy | Autonomy | Resilience | Trust & Belonging | Resilience |
| Resilience | Resilience | Resilience | Resilience | Resilience | Trust & Belonging | Resilience | Autonomy |

Dark grey boxes reflect the social wellbeing indicators. Light grey boxes reflect subjective wellbeing indicators; black boxes reflect the psychological wellbeing indicators

($\chi^2 = 2,021,498.55$ (604) $p < .001$) in which the factor loadings were constrained to be equal between age groups. A Chi square difference test indicated that the Metric Model reported significantly worse fit than the Configural model ($\chi^2 = 1153.18$ (84) $p < .001$) suggesting that there are significant age differences in the indicator loadings on the higher order wellbeing factor. However, recognising that Chi square is adversely affected by sample size, it should be noted that other Goodness of Fit Indicators were comparable between the Configural [CFI = .89; TLI = .87; RMSEA = .09 (95% CI .08; .09); SRMR = .044] and Metric Models [CFI = .89; TLI = .88; RMSEA = .08 (95% CI .08; .08); SRMR = .070] suggesting that the differences between the models may not be that substantive. Indeed, despite the decline in model fit in the metric model in which equality constraints were made on the factor loadings, the substantive impact of this difference was examined by extracting and comparing factor scores from the Configural and Metric models. In this way the factor scores are derived from the population averaged factor loadings (Metric Model) and the age-group specific factor loading (Configural Model). Despite the decrement of fit reported for the metric model in the invariance analysis, comparison of the two factor scores within each age groups were highly correlated ($r > .9991$ for all age groups). This indicates that the age differences in the magnitude of factor loadings does not adversely impact participants' overall rank order on the wellbeing factor if the age differences on the factor loadings are ignored. Simply, assuming the factor loadings are invariant over the lifespan does not adversely impact on participants' derived wellbeing factor score.

4 Discussion

This study utilised data from over 40,000 European adults to examine the factor structure of the ESS wellbeing module across the lifespan. Comparison of a uni-dimensional model, a correlated 3-factor model and a series of bi-factor analyses, showed greater support for a uni-dimensional model. Clearly, the superior fit of a uni-dimensional wellbeing factor is at odds with the findings from other factor analytical studies (Burns and Machin 2009; Compton et al. 1996; Gallagher et al. 2009; Hervás and Vázquez 2013; Linley et al. 2009).

However, as described in the introduction, there are exceptions to this position (Hervás and Vázquez 2013; Kim et al. 2016; Van Horn et al. 2004) and consequently the findings of the current paper are not necessarily unexpected. For instance, Van Horn et al. (2004) identified that a model with a single second-order wellbeing factor was a superior fitting model to a correlated first-order latent factor model. And similar to the findings in this paper, Kim et al. (2016) identified that indicators of hedonic and eudaimonic indicators were best reflected by a single factor rather than the hypothesised correlated two factor structure. To reiterate, there is an increasing bi-factor literature base which supports a general wellbeing hypothesis, although the extent to which specific factors are derived is not consistent (Chen et al. 2013; de Bruin and du Plessis 2015; Gatt et al. 2014; Hides et al. 2016; Jovanović 2015; Longo et al. 2017). As with this study, bi-factor models reported acceptable and to some extent comparable fit with the uni-dimensional model. This point needs to be emphasised. It should be noted that whilst other measurement models report comparatively poorer fit in respect to the uni-dimensional model, the other models still reported acceptable fit across most GFI. This is a pattern that has been reported in other validation studies (Gallagher et al. 2009) and may explain why in some studies a multi-dimensional model is preferred and in others a uni-dimensional model. Comparative judgements need to be balanced by the overall fit of rejected models, which may still report adequate fit.

As a second focus of this paper, comparison of the factor loadings of the uni-dimensional model across age indicated that there were changes in both the magnitude (i.e. the size of factor loadings) and the relative rank of each wellbeing indicator by age group. SWB indicators in particular reported substantial increases in the magnitude of their factor loadings with increasing age and in comparison with the social and PWB indicators, consistently reported the highest loadings. Whilst most PWB indicators were of moderate importance in terms of the magnitude of their factor loadings, the autonomy and resilience indicators consistently reported the lowest comparative factor loading. A more stringent form of comparison of the factor loadings was undertaken and compared the measurement invariance of the factor loadings between a Configural Model, in which factor loadings within each age group were freely estimated, and a Metric model, in which factor loadings were constrained to be equal between age groups. Despite a significant Chi square difference score, comparison of other GFI indicated the Configural and Metric models reported comparative fit. Indeed, the correlation in factor scores derived from the Configural and Metric models were so high such that the factor scores from the two models could be considered equivalent. It can therefore be concluded that the factor structure and relative weight of each wellbeing indicator on the wellbeing factor are consistent across the adult lifespan. The implications of this is that age-related differences in wellbeing are not simply because different wellbeing components are valued differently or at least reflect a latent wellbeing factor differently. A strength of this finding is that the current study comprises such a large number of adults across the lifespan.

Despite the overwhelming evidence that there are no differences in the extent to which different wellbeing indicators are endorsed over the lifespan, and despite the substantial benefit of such a large and representative sample, a number of limitations need to be considered. Although the multi-national component of the ESS is a strength in that the findings can be said to describe European adults across the lifespan, it must be recognised that there may exist response bias between-nations. Further analyses need to consider the extent to which cultural differences may adversely impact response bias. Whilst differential item functioning between-nations has been shown to account for between-nation differences, owing to social desirability or national response norms (Bonsang and van Soest 2012), other studies have identified that between-nation effects do exist when controlling for

cultural differences in response patterns (Vittersø et al. 2005). A further limitation is the examination of age-related differences in wellbeing with a cross-sectional survey design. It is well established that a significant proportion of wellbeing variance is captured within individuals over time (Burns and Ma 2015; Mroczek and Spiro 2005; Mroczek et al. 2003) and given ESS's cross-sectional design it is not possible to estimate the extent to which age-related patterns reflect age, birth-cohort or individual differences. Simply, in order to fully explore age-related differences in the factor structure of wellbeing, we need to be able to follow how individuals change within themselves over substantial periods of time. Unfortunately, much of the wellbeing literature is awash with single or 2-wave designs which preclude examination of intra-individual variation; exceptions are few. And where substantive longitudinal national survey data is available they are often focused on narrow definitions of wellbeing (Butterworth and Crosier 2004; Headey et al. 2010; Thomas et al. 2005) and fail to capture as broad a set of wellbeing measures as captured by the ESS wellbeing module.

Finally, there is a need for examination of wellbeing differences across the lifespan to consider impact of ageing contexts. Studies typically control for physical health which can substantially impact on wellbeing (Charles et al. 2001) and there is increasing evidence that age-related changes in wellbeing are less related to chronological aging, but are related to aging-contexts, primarily age-related declines in health. For example, (Kunzmann et al. 2000) identified that poor functional health and not age was a primary driver of positive emotions in old age. Similarly, (Windsor et al. 2013) identified that unadjusted declines were in old age adults were fully attenuated when controlling for physical functioning such that older adults reported higher positive emotions than adults in mid-life. Similarly, (Burns et al. 2014) identified that the commonly held terminal-decline hypothesis, whereby older adults report substantial declines in cognitive function and wellbeing in the years prior to death, was wholly driven by changes in physical health and functioning. They concluded that older adults were at no increased risk of poor mental health or wellbeing in old age or in the years prior to death if there was no corresponding decline in physical health of functioning.

In conclusion, the findings of the current study support a growing body of research which suggests that despite an intuitively appealing multi-dimensional and hierarchical wellbeing structure, multiple wellbeing indicators are indeed reflecting one higher-order wellbeing factor. Model fit for comparative models, including the hierarchical and bi-factor models supported, were not necessarily 'bad', but in comparison, there appears strong evidence that ultimately, lower order wellbeing indicators are reflecting the same higher order construct. As another particular focus on the current study, although there appeared some age-related differences in the extent of the magnitude of the factor loadings of individual wellbeing indicators on this higher-order factor, the rank order of these multiple indicators is relatively stable. Any statistically significant difference is most likely an outcome of statistical power owing to the very large size. Indeed, comparison of the model fit between two models in which the higher order wellbeing factors were estimated with loadings that were either constrained or freely estimated revealed the two factors to be equivalent.

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