Journal of Personality and Social Psychology

Owner of a Lonely Heart: The Stability of Loneliness Across the Life Span

Marcus Mund, Oliver Lüdtke, and Franz J. Neyer

Online First Publication, September 26, 2019. http://dx.doi.org/10.1037/pspp0000262

AMERICAN PSYCHOLOGICAL ASSOCIATION

Journal of Personality and Social Psychology:
Personality Processes and Individual Differences

ISSN: 0022-3514

http://dx.doi.org/10.1037/pspp0000262

Owner of a Lonely Heart: The Stability of Loneliness Across the Life Span

Marcus Mund
Friedrich Schiller University Jena

Oliver Lüdtke
Leibniz Institute for Science and Mathematics Education, Kiel, Germany, and Centre for International Student Assessment, Munich, Germany

Franz J. Neyer
Friedrich Schiller University Jena

Individuals feel lonely when they perceive a discrepancy between their aspired and their actually experienced amount of closeness and intimacy in social relationships. In the present study, we disentangled developmental constancy factors, time-varying factors such as person-environment transactions, and stochastic mechanisms as sources of interindividual differences in loneliness by applying STARTS models in nationally representative samples from Germany ($n = 13{,}397$), Switzerland ($n = 6{,}599$), Australia ($n = 30{,}496$), and The Netherlands ($n = 12{,}810$). Across the 4 studies, we found trait-like sources reflecting developmental constancy factors and the influence of time-varying factors to account for 19–43% and 23–30% of interindividual differences in loneliness, respectively. Depending on the type of measurement instrument, state-like stochastic mechanisms accounted for 30% to 55% of interindividual differences, whereby multi-item measures were less affected by stochastic mechanisms. We found gradual sex differences but considerable differences between age groups regarding the amount of interindividual differences in loneliness accounted for by the three sources. Taken together, the results demonstrate that interindividual differences in loneliness are to a large degree trait-like. Based on these findings, we discuss implications for theory and measurement.

Keywords: loneliness, interindividual differences, state-trait, STARTS, integrative data analysis

Supplemental materials: http://dx.doi.org/10.1037/pspp0000262.supp

Individuals have an innate need to belong and to be socially included (Axelrod & Hamilton, 1981; Baumeister & Leary, 1995). Being embedded in a network of social relationships helps individuals to maintain health and well-being (Cohen, 2004; House, Landis, & Umberson, 1988) and social relationships provide important contexts for personality development (Mund & Neyer, 2014; Reis, Collins, & Berscheid, 2000; Reitz, Zimmermann, Hutteman, Specht, & Neyer, 2014). Despite these well-established findings, individuals also experience being alone, both voluntarily and involuntarily.

Solitude, that is, being alone by will, occurs when individuals withdraw from others by choice. Reasons for solitude might be societal changes (Putnam, 2000) or expression of individual needs and preferences (Danneel, Maes, Vanhalst, Bijttebier, & Goossens, 2018; Hagemeyer, Schönbrodt, Neyer, Neberich, & Asendorpf, 2015; Lay, Pauly, Graf, Biesanz, & Hoppmann, 2019). In some contexts, such as romantic relationships, solitude can have beneficial effects for relationship satisfaction and stability (Hagemeyer et al., 2015).

In contrast to solitude, which is typically accompanied by positive affect (Danneel et al., 2018; Lay et al., 2019), loneliness—the subjective perception of one's social relationships as deficient in terms of quality or quantity (de Jong Gierveld, 1998; Ernst & Cacioppo, 1999; Hawkley & Cacioppo, 2010; Perlman & Peplau, 1981)—is predominantly characterized by negative affect. Loneliness has been consistently found to relate to depressive mood (J. T. Cacioppo, Hawkley, & Thisted, 2010; J. T. Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Qualter, Brown, Munn, & Rotenberg, 2010; Vanhalst et al., 2012), behavioral (e.g., smoking, physical inactivity) as well as objective health risk factors (e.g., elevated blood pressure, increased number of inflammatory markers; Hawkley, Burleson, Berntson, & Cacioppo, 2003;

Marcus Mund, Department of Personality Psychology and Psychological Assessment, Institute of Psychology, Friedrich Schiller University Jena; Oliver Lüdtke, Department of Educational Measurement, Leibniz Institute for Science and Mathematics Education, Kiel, Germany, and Centre for International Student Assessment, Munich, Germany; Franz J. Neyer, Department of Personality Psychology and Psychological Assessment, Institute of Psychology, Friedrich Schiller University Jena.

Complete model syntax and all model outputs are available at https://osf.io/zdf6w/.

We thank Antonia Gutzeit and Jakob Naton for their help with finding suitable datasets.

Preparation of this article was supported by Grants DRM/2017-06 (Friedrich-Schiller-Universität Jena) and MU 4338/1-1 (German Research Foundation) awarded to Marcus Mund.

Correspondence concerning this article should be addressed to Marcus Mund, Institut für Psychologie, Friedrich-Schiller-Universität Jena, Humboldtstraße 11, D-07743 Jena. E-mail: marcus.mund@gmail.com

Hawkley, Thisted, & Cacioppo, 2009; Hawkley, Thisted, Masi, & Cacioppo, 2010; Shankar, McMunn, Banks, & Steptoe, 2011; Shankar, McMunn, Demakakos, Hamer, & Steptoe, 2017), and less favorable personality development across young adulthood (Mund & Neyer, 2016, 2019).

Loneliness has to be further distinguished from social isolation. Whereas social isolation describes the *objective* absence of close relationships (Caspi, Harrington, Moffitt, Milne, & Poulton, 2006; de Jong Gierveld, van Tilburg, & Dykstra, 2006), loneliness refers to the *subjectively* sensed lack of close and meaningful relationships. Loneliness can, thus, also occur for individuals who have large support networks. Socially isolated individuals, in contrast, are objectively excluded from social interactions and report very small to no support networks (Caspi et al., 2006; de Jong Gierveld et al., 2006; Hawkley & Cacioppo, 2010).

Being distinct from rather state-like solitude and objective social isolation, loneliness can be thought of as encompassing a variety of trait-like features that have been fleshed out in a large body of research. Loneliness has been found to be (a) as heritable as other personality characteristics (for reviews, see Goossens et al., 2015; Spithoven, Cacioppo, Goossens, & Cacioppo, 2019), (b) connected to basic biological systems (Goossens et al., 2015; J. T. Cacioppo, Cacioppo, Capitanio, & Cole, 2015; J. T. Cacioppo, Capitanio, & Cacioppo, 2014), and (c) predictive of a wide variety of outcomes from different domains (Cacioppo et al., 2006; Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Mund & Neyer, 2016; Shankar et al., 2011, 2017; Vanhalst et al., 2012). Furthermore, a recent meta-analysis found interindividual differences in loneliness across various age groups over the life span to be as stable as interindividual differences in the Big Five and other personality characteristics (Mund, Freuding, Möbius, Horn, & Neyer, 2019). The latter finding indicates that there are some individuals experiencing more loneliness than others, irrespective of their current situation and environment.

In the present study, we teased apart the sources underlying interindividual differences in loneliness, thereby employing the theoretical framework for investigating patterns of consistency and change formulated by Fraley and Roberts (2005). To achieve this goal, we applied latent state-trait models (Kenny & Zautra, 1995, 2001) to data from four nationally representative samples from Germany, Switzerland, Australia, and The Netherlands. In this way, we were able to separate a completely stable factor underlying the observed correlations of loneliness from a factor that captures systematic changes over time and from a factor capturing a blend of occasion-specific fluctuation and random error. In addition to disentangling these sources of interindividual stability in loneliness, we further examined whether these sources differed between women and men and between different age groups covering the time from adolescence to old age. In this way, we addressed questions that are crucial for the understanding of the stability and change of loneliness across the life span.

Patterns of Consistency in Psychological Constructs

When examining the stability of interindividual differences for a given characteristic, a specific pattern can be observed (Fraley & Roberts, 2005; Roberts & DelVecchio, 2000). First, the stability of interindividual differences decreases as the interval between measurement occasions increases. Second, interindividual differences stabilize as individuals grow older. Third, in contrast to prior assumptions (Conley, 1984), the stability of interindividual differences never declines to zero, but instead approaches a nonzero asymptote, even over very long time periods (Fraley & Roberts, 2005). This empirical pattern was proposed to be due to three factors underlying interindividual differences: developmental constancy factors, person–environment transactions, and stochastic processes (Fraley & Roberts, 2005).

Developmental constancy factors are thought of as completely stable sources of interindividual differences that define the asymptote that the stability of interindividual differences approaches over time. As such, developmental constancy factors function to preserve interindividual differences even over very long time periods. Stable sources of interindividual differences that might constitute developmental constancy factors include genetic and environmental influences. Regarding the former, it has to be noted that genetic influences on individual characteristics vary over the life span, despite stability of the genotype (Briley & Tucker-Drob, 2014; Kandler & Papendick, 2017). Thus, only genetic influences that operate in a completely stable fashion across the life span are part of developmental constancy factors. Similarly, as environments are never perfectly stable at any point in the life span (Briley & Tucker-Drob, 2014; Kandler, 2012), it is only their stable, long-lasting influence that can operate as a developmental constancy factor. This is the case, for example, for environments that individuals have experienced earlier in their development and which exert a stable influence across the life span (e.g., Fraley, Roisman, & Haltigan, 2013). Passive genotype–environment transactions (Plomin, DeFries, & Loehlin, 1977; Scarr & McCartney, 1983) might also constitute developmental constancy factors, as they contribute to establish such environments with stable influences on the individual.

Person–environment transactions as defined by Fraley and Roberts (2005) describe how individuals interact with their environment, social and nonsocial alike. This includes shaping the environment according to one's personality and being influenced by that so-formed environment. Across the life span, differences between individuals might become more stable because individuals progressively succeed in shaping environments according to their needs and preferences (Buss, 1987; Neyer, Mund, Zimmermann, & Wrzus, 2014; Plomin et al., 1977; Wrzus, Wagner, & Riediger, 2016). At the same time, person–environment transactions affect a part of personality that is malleable and susceptible to changes over time.

Finally, stochastic mechanisms mainly contribute to decreases in the stability of interindividual differences over time. Specifically, interindividual differences might be blurred over time by short-term intraindividual variability, random, unpredictable life events, an indeed more state-like nature of a given construct, or measurement error (Fraley & Roberts, 2005).

Approaches to Examine Patterns and Sources of Interindividual Differences

Three different approaches have been used to examine the patterns and sources of interindividual differences: behavior genetic analyses (Bleidorn, Kandler, & Caspi, 2014; Kandler, Zimmermann, & McAdams, 2014), studies on the long-term stability of interindividual differences (i.e., rank-order stability; Conley, 1984; Ferguson, 2010; Roberts & DelVecchio, 2000; Trzesniewski, Donnellan, & Robins, 2003), and latent state-trait modeling (Anusic & Schimmack, 2016; Donnellan, Kenny, Trzesniewski, Lucas, & Conger, 2012; Kuster & Orth, 2013; Lucas & Donnellan, 2007; Wagner, Lüdtke, & Trautwein, 2016).

Behavior genetic studies examine to what extent genetic influences, shared environments, and nonshared environments account for interindividual differences in a given characteristic (Bleidorn et al., 2014; Kandler & Papendick, 2017; Kandler et al., 2014). For the Big Five personality traits, for example, genetic influences have been found to account for approximately 50% of interindividual differences (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009; Kandler & Papendick, 2017; Kandler et al., 2014); this proportion is somewhat lower for other personality characteristics such as self-esteem, goals, and interests (for a review, see Kandler et al., 2014). With respect to loneliness, 20% to 40% of interindividual variation has been found to be attributable to differences in genetic influences (Goossens et al., 2015; Spithoven et al., 2019). In addition to disentangling genetic and environmental sources of interindividual differences, behavior genetic studies have been concerned with unraveling the interplay between genetic and environmental influences on individuals' personality and life experiences (Bleidorn et al., 2009; Kandler, Bleidorn, Riemann, Angleitner, & Spinath, 2012; Kandler, Waaktaar, Mõttus, Riemann, & Torgersen, 2019; Scarr & McCartney, 1983).

The second approach to examine the stability of interindividual differences uses test-retest correlations to evaluate the stability of the rank-order of individuals over time (Conley, 1984; Ferguson, 2010; Roberts & DelVecchio, 2000; Trzesniewski et al., 2003). Concerning loneliness, a meta-analysis has shown that the rank-order stability of loneliness across the life span is very similar to that of the Big Five traits (Mund et al., 2019). Although appealing, test-retest correlations have limitations. For instance, no single construct is perfectly stable (Conley, 1984; Roberts & DelVecchio, 2000) and even over very short time periods, the rank-order of individuals is to some degree volatile (Anusic, Lucas, & Donnellan, 2012; Chmielewski & Watson, 2009). Thus, it is unclear what benchmark empirically determined stability estimates should be compared to (Fraley & Roberts, 2005). Furthermore, observed correlations are influenced by developmental constancy factors, person–environment transactions, and stochastic mechanisms (Fraley & Roberts, 2005). To disentangle these sources to examine their relative contribution to the observed patterns, it has been suggested to apply latent state-trait models (Kenny & Zautra, 1995).

Several statistical models have been discussed in the literature for partitioning interindividual differences of psychological constructs across time (for an overview, see Cole, 2012). One very general framework is provided by the STARTS (stable trait, autoregressive trait, and state) model (Kenny & Zautra, 1995, 2001), in which individual differences across time are decomposed into three sources of variation: first, a time-invariant stable trait (ST) component; second, a time-varying, partly stable autoregressive trait (ART) component; and third, a state (S) component that is composed of occasion-specific transient factors (e.g., current mood or time-specific stress during an exam period) and random error. The path diagram of a STARTS model is presented in Figure 1.

The STARTS Model

The ST component captures the portion of variance that is completely stable across time and does not naturally change at all. It can, thus, be conceived of as reflecting the influence of developmental constancy factors on interindividual differences. As such, the ST component also determines the asymptote of stability, that is, the amount of interindividual differences that will be preserved even over very long time periods (Lüdtke, Robitzsch, & Wagner, 2018).

The ART component reflects the malleable part of loneliness that changes over time. These changes can be brought about by internal or external time-varying factors. As internal factors, change might be induced as a concomitant of changes in other, related characteristics (i.e., correlated changes; Allemand & Martin, 2016; Klimstra, Bleidorn, Asendorpf, van Aken, & Denissen,

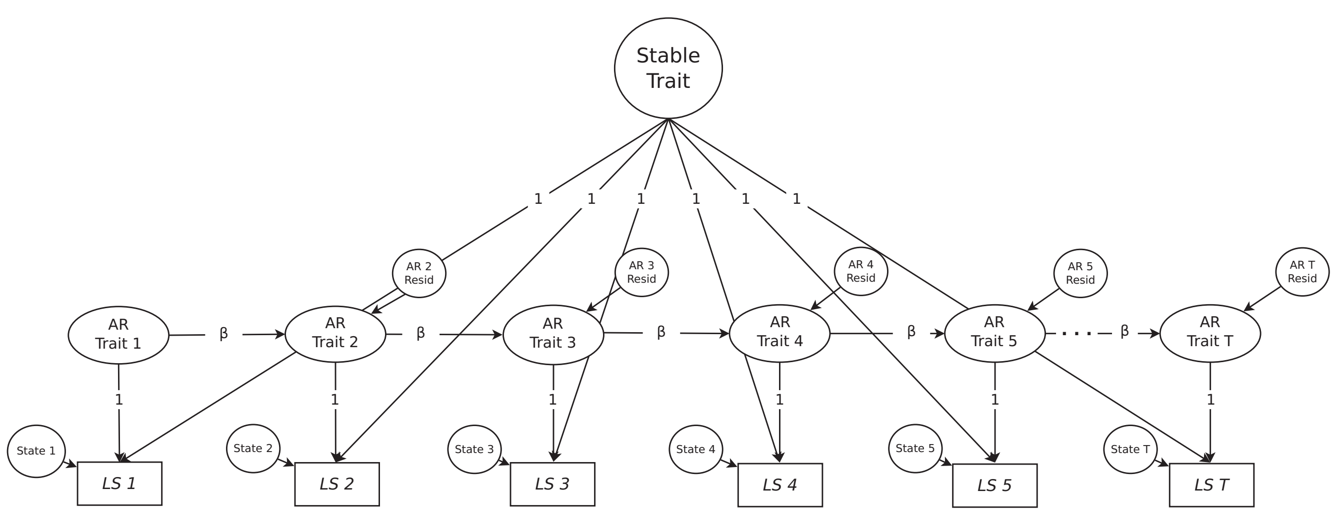

Figure 1. Generic STARTS model for loneliness. The variance in loneliness (LS) is decomposed into variance accounted for by a stable trait factor, autoregressive (AR) trait factors, and state factors.

2013) such as social motives in the case of loneliness. Changing genetic influences are also part of the ART component as they might contribute to predictable, but not perfectly stable patterns of how individuals approach the world (Briley & Tucker-Drob, 2014; Kandler, 2012; Scarr & McCartney, 1983). Regarding external factors, changes might be a response to environmental influences such as life events (e.g., Lüdtke, Roberts, Trautwein, & Nagy, 2011; Luhmann, Hofmann, Eid, & Lucas, 2012) or enduring relationship experiences (Hsieh & Hawkley, 2018; Stokes, 2017). Internal and external factors might further influence each other and constitute, for example, person–environment transactions in a broader sense (e.g., Deventer, Wagner, Lüdtke, & Trautwein, 2019; Kandler et al., 2012; Mund & Neyer, 2014; Neyer et al., 2014; Neyer & Asendorpf, 2001; Scarr & McCartney, 1983; Wrzus et al., 2016). In this regard, behavior genetic models of genotype–environment interplay are particularly informative. First, genotype–environment transactions reflect that individuals with certain genotypes for a given trait are more likely to experience particular environments. Second, genotype–environment interactions imply that the effects of specific environments on a given trait differ across genotypes (Kandler et al., 2012; Plomin et al., 1977; Scarr & McCartney, 1983). In all, independent internal and external factors as well as their interplay are determinants of the malleability of a personality characteristic.

The sustainability of these time-varying factors is indicated by the β-coefficient (Lüdtke et al., 2018; Wagner, Lüdtke, & Robitzsch, 2019). For instance, if the ART component would account for 30% of the overall variance in loneliness, this proportion of interindividual differences in loneliness can be thought of as being influenced by time-varying factors (e.g., correlated changes, relationship experiences, person–environment transactions). A β-coefficient of .80 would then indicate that these time-varying factors are relatively stable for loneliness over 1 year, for instance. In addition, the β-coefficient contains information on the rate of decay of interindividual differences. Put differently, a small β signals that interindividual differences approach the asymptote defined by the ST component rapidly, whereas a large β would indicate a slow decay of interindividual differences. To the best of our knowledge, the ART component along with the β-coefficient provides the most accurate approximation of the part of interindividual differences in a personality characteristic that is accounted for by person–environment transactions as proposed by Fraley and Roberts (2005).

Finally, the S component of the STARTS model captures two aspects. On the one hand, it captures occasion-specific, yet reliable variance; on the other hand, it also captures random error (Lucas & Donnellan, 2012). In case of multi-item instruments, the proportion of random error can be expected to be smaller than in applications with single-item measures. This is due to random error being canceled out by averaging multiple items. However, even with single-item measures, the S component contains not only random error, but still a certain amount of reliable occasion-specific variance (Lucas & Donnellan, 2012). In this way, the S component closely reflects stochastic mechanisms in interindividual differences as discussed by Fraley and Roberts (2005).

In previous work, STARTS models have been applied to self-esteem (Anusic & Schimmack, 2016; Donnellan et al., 2012; J. Wagner et al., 2016; Kuster & Orth, 2013) and life satisfaction (Anusic & Schimmack, 2016; Lucas & Donnellan, 2007). With regard to self-esteem, previous studies have found the ST component to account for 28% to 44% of interindividual differences. The ART component has been shown to account for an amount between 42% and 49% of overall variation in self-esteem. Finally, the S component reflecting stochastic mechanisms accounted for 14% to 29% of interindividual differences in self-esteem (Donnellan et al., 2012; J. Wagner et al., 2016; Kuster & Orth, 2013). Concerning life satisfaction, Lucas and Donnellan (2007) found 34%, 33%, and 33% of interindividual differences in this characteristic to be accounted for by the ST, the ART, and the S component, respectively.

To the best of our knowledge, only one study so far has applied STARTS models to loneliness (Zhong, Chen, Tu, & Conwell, 2016). In this study, STARTS models were used to determine the lower bound of reliability of a single-item measure of loneliness in a large sample of older adults from China. The results indicated that 59.5% of the overall variance in loneliness was accounted for by a blend of completely stable (i.e., ST) and malleable (i.e., ART) factors. However, no study so far has used STARTS models to properly disentangle all three sources of interindividual differences in loneliness in large age-heterogeneous samples and with regard to different measures of loneliness.

Sex and Age as Moderators of Interindividual Differences in Loneliness

In addition to disentangling the sources of interindividual differences in loneliness, we will also examine whether the relative contribution of these sources differs between women and men and between different age groups across the life span. Although interindividual differences in loneliness have been shown to be similar for women and men across the life span (Mund et al., 2019), these empirical correlations might be due to different constellations of the components of the STARTS model. Women and men might differ because women have been shown to have a stronger affiliation motive than men (Drescher & Schultheiss, 2016). Furthermore, in the context of partner relationships, women have been shown to experience a greater discrepancy than men between their relationship standards and how often they are fulfilled (Vangelisti & Daly, 1997). This means that men might be prone to feel lonely in specific situations (e.g., after a severe conflict), whereas women might more often experience loneliness, which would translate into greater state-like variability for men and greater proportions of loneliness being accounted for by the ST and the ART components in women.

Concerning age, meta-analyses on loneliness (Mund et al., 2019), personality traits (Ferguson, 2010; Roberts & DelVecchio, 2000), and self-esteem (Trzesniewski et al., 2003) have found the stability of interindividual differences to change from adolescence to old age. In the present study, we examine how these changes are reflected in the components of the STARTS model and if interindividual differences in various age groups differ concerning the contribution of their underlying sources. It should be noted that we did not formulate specific hypotheses regarding the age-differential contributions of the STARTS components; this part of the analysis should, hence, be considered exploratory.

To examine the moderating role of sex and age on the distribution of the STARTS components, we ran all STARTS models for specific subsets of the full samples (i.e., separate models for women and men as well as one model for each age group; Lucas & Donnellan, 2007; J. Wagner et al., 2016). We separated the age groups based on classifications used in developmental psychology. Specifically, we examined the sources of interindividual differences in loneliness in adolescence (i.e., younger than 18 years), emerging adulthood (i.e., between ages 18 and 25; Arnett, 2000), young adulthood (i.e., between ages 25 and 40 years; Helson, Soto, & Cate, 2006), midlife (i.e., between ages 40 and 60 years; Helson et al., 2006; Lachman, 2004), and old age (i.e., older than 60 years).

The Present Study

The aim of the present study was to disentangle the sources of interindividual differences in loneliness by decomposing the observed retest-correlations into different variance components. Specifically, we applied STARTS models to four nationally representative samples from Germany, Switzerland, Australia, and The Netherlands. In a first step, we applied the STARTS models to the full samples. Subsequently, we incorporated sex and age as moderators to investigate whether interindividual differences in loneliness are differently affected by the STARTS components in women and men and across age groups, respectively. By using the same analysis strategy in four independent data sets, our analytic approach entails features of an integrative data analysis (Hofer & Piccinin, 2009), which is particularly valuable in terms of robustness and replicability of the results (Duncan, Engel, Claessens, & Dowsett, 2014). Furthermore, we integrated the results of the separate analyses to parallel a meta-analytic approach, which helps to gain a more general picture of the results beyond the specifics of the separate samples. It should be noted, however, that, with only four studies, the meta-analytic aggregation particularly serves an illustrative purpose.

Method

In the following, we will give a brief overview over the four samples and the measures employed. Table 1 provides a comparison between the four samples regarding their key aspects.

As can be seen in Table 1, three of the four studies used single items. Although single-item measures have been criticized for various reasons (e.g., Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012), such measures have been proven valid in loneliness research. First, the results of studies using single-item measures of loneliness converge very well with studies using multiple items. For instance, the results of a study by Shiovitz-Ezra and Ayalon (2010) using a single-item measure of loneliness to predict mortality in a sample of 7,638 individuals from the United States are consistent with the results reported by Holt-Lunstad, Smith, Baker, Harris, and Stephenson (2015) in a comprehensive meta-analysis incorporating a wide variety of loneliness measures. In a similar vein, Mund and Neyer (2019) found considerable convergence between a single-item measure of loneliness and an 11-item version of the de Jong Gierveld Loneliness Scale in predicting later levels of the Big Five.

Second, there is substantial overlap between the nomological networks of single- and multi-item measures of loneliness. For example, von Soest, Luhmann, Hansen, and Gerstorf (2018) reported virtually identical correlations with demographic and health-related variables for a single-item measure of loneliness and a 3-item version of the de Jong Gierveld Loneliness Scale.

Third, the associations of single-item and ultrashort measures of loneliness with a wide variety of external variables seem to be largely independent of age. For example, a study by Luhmann and Hawkley (2016) using a large German sample has shown consistent correlations across age between a three-item version of the UCLA Loneliness Scale and a wide variety of external variables. Similar findings have been reported by Lasgaard, Friis, and Shevlin (2016) for a large Danish sample. In a study using a single-item measure, Mund and Neyer (2019) have shown that the effects of loneliness on personality are invariant across three age groups (adolescents, young adults middle-aged adults). In light of these findings, we conclude that single-item measures of loneliness demonstrate a considerable amount of measurement invariance across age groups and convergent validity with multi-item measures.

German Socioeconomic Panel

Sample. The German Socioeconomic Panel Study (SOEP; Schupp et al., 2015; Wagner, Frick, & Schupp, 2007) started in 1984 and is a still ongoing study tracking the development of a variety of individual economic (e.g., income), sociological (e.g., family structure), and psychological (e.g., satisfaction, personality) variables in a sample representative for the German population (for details, see Wagner et al., 2007). The selected participants are

Table 1
Basic Features of the Four Samples

Dataset	*n*	% women	Age	Duration	Loneliness	Instrument
SOEP (D)	13,397	51.59	42.90	17	6	Single item
SHP (CH)	6,599	55.54	43.48	16	5	Single item
HILDA (AU)	30,496	52.51	43.35	16	16	Single item
LISS (NL)	12,810	53.79	43.69	9	8[a]	6 items (de Jong Gierveld & van Tilburg, 2006)

Note. Age = mean age of the sample at the first measurement occasion; Duration = duration of the study (in years) from the first measurement of loneliness to the (currently) last; Loneliness = number of measurement occasions assessing loneliness; SOEP (D) = Socioeconomic Panel (Germany); SHP (CH) = Swiss Household Panel (Switzerland); HILDA (AU) = Household, Income, and Labor Dynamics in Australia (Australia); LISS (NL) = Longitudinal Internet Study for the Social Sciences (The Netherlands).
[a] One measurement occasion in LISS was excluded from the analysis due to a temporary shift in the coding scheme.

interviewed each year at their homes (see https://www.diw.de/en/soep for information on study protocol, methods, and information on accessing data). Data collection was approved by the research ethics officer from the German Institute for Economic Research. A complete list of all publications using SOEP data can be obtained from https://www.diw.de/en/diw_02.c.221182.en/publications_with_soep_data.html.

For the present study, we used Version 30 of the SOEP (Schupp et al., 2015), which contained all data from 1984 to 2013. For the present analyses, we used data of 13,397 (51.59% women) individuals who provided data on loneliness. The age of the present sample at the first relevant measurement occasion (i.e., 1992, see below) ranged from 16 to 97 years with a mean of 42.90 (SD = 16.86) years.

Measures. Loneliness was assessed in 1992, 1993, 1995, 1996, 1997, and 2008 using a single item ("I feel lonely") answered on a 4-point Likert-type scale ranging from 1 (*applies fully*) to 4 (*fully not apply*). The item was recoded for the present study so that higher values reflect greater loneliness.

Based on the sex of the participants, we took subsets of men and women, respectively for the sex-specific analyses. These analyses were run with 6,903 women and 6,494 men.

Based on the information provided on age, we applied the STARTS models separately for five age groups: adolescence (younger than 18; n = 444), emerging adulthood (18–25, n = 1,859), young adulthood (26–40, n = 4,284), midlife (41–60, n = 4,536), and old age (older than 60, n = 2,274).

Swiss Household Panel

Sample. The Swiss Household Panel (SHP; Tillmann et al., 2016) is a household-based survey that started in 1999 and is still ongoing. Data collection was approved by the research ethics officer of FORS (see https://forscenter.ch/projects/swiss-household-panel/ for information on study protocol, methods, and information on accessing data). A complete list of publications using data from the SHP can be obtained from https://forscenter.ch/publications/scientific-publications/. The SHP comprises three samples whose participants entered the study at different time points; in the present study, we only used data of SHP I. SHP II and SHP III were not included because there were not enough measurement occasions to apply the STARTS models. SHP I, the original study, started in 1999 and sampled 7,799 individuals. In 2001, when loneliness was measured for the first time, 6,601 individuals still participated. From these 6,601 persons, we excluded two individuals who never provided data on loneliness. Thus, the final sample size used for the present analysis was 6,599. At the first measurement occasion used here, 55.54% of the participants were women and the mean age of the sample was 43.48 (SD = 16.93) years ranging from 13 to 90 years.

Measures. Loneliness was assessed in 2001, 2002, 2003, 2013, and 2016 using a single item ("How lonely do you feel in your life?") answered on an 11-point Likert-type scale ranging from 0 (*not at all*) to 10 (*an extreme amount*).

Based on the sex of the participants at the first measurement occasion relevant for the present study, we took subsets of men and women, respectively for the sex-specific analyses. These analyses included data from 3,665 women and 2,934 men.

Based on the information provided on age at the first measurement occasion relevant for the present analysis, we ran the STARTS models separately for five age groups: adolescence (younger than 18; n = 544), emerging adulthood (18–25, n = 551), young adulthood (26–40, n = 1,910), midlife (41–60, n = 2,456), and old age (older than 60, n = 1,138).

Household, Income, and Labor Dynamics in Australia

Sample. The Household, Income, and Labor Dynamics in Australia (HILDA; Melbourne Institute of Applied Economic & Social Research, 2017; Summerfield et al., 2017) survey started in 2001 and is an ongoing study with participants representative for Australia (see https://melbourneinstitute.unimelb.edu.au/hilda for information on study protocol, methods, and information on accessing data). For the present analysis, we used Release 16 including data from 2001 to 2016 (Melbourne Institute of Applied Economic & Social Research, 2017; Summerfield et al., 2017). Data collection was approved by the University of Melbourne's research ethics committee. A complete list of publications using HILDA data can be obtained from https://melbourneinstitute.unimelb.edu.au/hilda/publications. Overall, we used data of 30,496 individuals (52.51% women). At the first measurement occasion, the mean sample age was 43.35 (SD = 17.7) years ranging from 14 to 99 years.

Measures. Loneliness was assessed at each wave using a single item ("I often feel very lonely") answered on a 7-point Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).[1]

Based on the sex of the participants at the first measurement occasion, we took subsets of men and women, respectively for the sex-specific analyses. These analyses were run with 7,335 women and 6,634 men.[2]

Based on the information provided on age at the first measurement occasion, we ran the STARTS models separately for five age groups: adolescence (younger than 18; n = 1,010), emerging adulthood (18–25, n = 1,483), young adulthood (26–40, n = 4,203), midlife (41–60, n = 4,677), and old age (older than 60, n = 2,596).

Longitudinal Internet Study for the Social Sciences

Sample. The Longitudinal Internet Study for the Social Sciences (LISS; Scherpenzeel & Das, 2010) is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a probability sample of households drawn from the population register. Households that could not otherwise

[1] The item on loneliness was part of a larger catalogue of questions on social support in the HILDA questionnaire. As detailed in Section 1 of the online supplemental material, we tried to construct a multi-item measure of loneliness from this catalogue but found the single item to be more valid and more closely related to an established multi-item loneliness measure (de Jong Gierveld & van Tilburg, 2006) than a four-item scale derived from the larger catalogue of questions.

[2] Given the many measurement occasions, we also included participants in the full sample who entered the study at a later point in time when they were old enough to participate in the survey. For the sex- and age-specific analyses, we split the sample based on data provided at the first relevant measurement occasion.

participate were provided with a computer and Internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains including work, education, income, housing, political views, values, and personality (see https://www.lissdata.nl/ for information on study protocol, methods, and information on accessing data). The LISS panel data were collected by CentERdata (Tilburg University, The Netherlands) through its MESS project funded by the Netherlands Organization for Scientific Research. For questionnaire research, no ethics approval is necessary in The Netherlands. A complete list of studies using data from LISS can be obtained from https://dataarchive.lissdata.nl/publications. LISS started in 2008 and provided complete data for nine yearly measurement waves at the time the present analyses were conducted. In the present article, we used data of 12,810 individuals who provided data on loneliness. At the first measurement occasion in 2008, mean age of the sample was 43.69 (SD = 17.41) years ranging from 12 to 95; 53.79% of the participants were women.

Measures. Loneliness was assessed at each wave using the short version of the de Jong Gierveld Loneliness Scale (de Jong Gierveld & van Tilburg, 2006). The scale contains six items that avoid the terms *loneliness* or *lonely* (e.g., "I know a lot of people that I can fully rely on," reverse coded; "I have a sense of emptiness around me"). The items were rated on a 3-point scale including the response options *yes*, *more or less*, and *no*. Items were recoded if necessary so that higher scores reflect greater loneliness. At the fifth measurement occasion, the coding scheme changed temporarily and was not comparable to the coding scheme of the other years. Thus, we decided to exclude this measurement occasion from the analyses. By examining the measurement invariance of the scale, we could establish strong invariance (i.e., equal loadings and intercepts) across, time, gender, and age groups (see Supplemental Table S1 in the online supplemental material).

Based on the sex of the participants at the first measurement occasion, we took subsets of men and women, respectively for the sex-specific analyses. These analyses were run with 6,891 women and 5,919 men.

Based on the information provided on age at the first measurement occasion, we ran the STARTS models separately for five age groups: adolescence (younger than 18; n = 1,025), emerging adulthood (18–25, n = 1,194), young adulthood (26–40, n = 3,213), midlife (41–60, n = 4,559), and old age (older than 60, n = 2,417).

Overall Analytic Procedure

One major obstacle to applying the STARTS model in previous research was that the traditional maximum likelihood approach often showed serious estimation problems such as nonconvergence or inadmissible estimates (e.g., negative variance). In the present study, we used a recently introduced Bayesian approach to estimating the STARTS model (Lüdtke et al., 2018). If appropriate prior distributions are specified for the STARTS model parameters, the Bayesian approach guarantees that the parameter estimates fall within the admissible range and estimation problems are usually avoided. For the Bayesian estimation, we used Version 0.4–24 of the STARTS package (Robitzsch & Lüdtke, 2018) for R (R Core Team, 2018). In accordance with Lüdtke et al. (2018), we chose weakly informative prior distributions for all four STARTS model parameters. Weakly information prior distributions provide some direction for the estimation of the model parameters but still allow the inferences to be driven by the data (Chung, Rabe-Hesketh, Dorie, Gelman, & Liu, 2013; for a detailed discussion of the specification of prior distributions in the context of the STARTS model, see Lüdtke et al., 2018). To ensure convergence of the Bayesian approach, we inspected two criteria: (a) the potential scale reduction factor (Muthén & Asparouhov, 2012) was smaller than 1.01 for each parameter and (b) the effective sample size was larger than 400 (Hoff, 2009). Missing data were treated using a model-based approach in which all model parameters are estimated by using all available information assuming that data are missing at random (Enders, 2010). The mode of the posterior distributions was used as the point estimate, and the 2.5th and the 97.5th percentiles of the posterior distribution were used to construct a Bayesian version of the confidence interval.

As the time intervals between the measurement occasions differed across the studies and sometimes also from wave to wave within studies, we coded time to reflect a uniform metric (one year from t to $t + 1$) across studies so that differences in the stability parameter β could be compared. Thus, the stability parameter indicates the stability of the ART component across one year (i.e., lag-1). The complete model syntax as well as all model outputs are available at https://osf.io/zdf6w/.

The STARTS model parameters can also be used to calculate model-implied correlations for different time lags. These model-implied correlations can be compared with the observed correlations or can be used to predict correlations for specific time lags. In the present study, we scaled the stability parameter β in the STARTS model to reflect the stability of the ART factors of loneliness across 1 year. Thus, the lag-1 correlation reflects the stability of loneliness over one year and is calculated as $Var(\text{ST}) + \beta * Var(\text{ART})$, where Var(ST) and Var(ART) denote the variance of the ST and the ART component, respectively.[3] For larger time intervals, higher-order terms of β need to be used (e.g., β^2 for 2-year correlation, β^{10} for 10-year correlation). In addition, the asymptote toward interindividual differences in loneliness are predicted to converge to over time is given by the variance of the ST component relative to the overall variance (i.e., $\frac{Var(ST)}{Var(ST) + Var(ART) + Var(S)}$).

To examine the moderating role of sex and age on the distribution of the STARTS components, we ran all STARTS models for subsets of the samples. Specifically, we ran separate models for women and men and one model for each age of the five age groups considered (i.e., adolescence, emerging adulthood, young adulthood, midlife, old age; Lucas & Donnellan, 2007; Wagner et al., 2016).

We used the posterior distribution of each model parameter to test whether the components of the STARTS model differed between women and men or age groups (see Lüdtke, et al., 2018). More specifically, we applied a multivariate Wald test to examine whether the components of the STARTS model could be constrained to be equal across groups. The Wald test is based on the posterior distribution (obtained from the MCMC output) and approximates maximum likelihood inference for large sample sizes

[3] This formula applies to standardized variables. In case of unstandardized variables, the entire term has to be divided by the total variance.

(Gelman et al., 2014; Hildebrandt, Lüdtke, Robitzsch, Sommer, & Wilhelm, 2016). If this overall test signaled significant differences between the groups, we further explored these differences via pairwise comparisons. For these pairwise comparisons, the posterior distribution obtained for men, for instance, was subtracted from the women's posterior distribution. In this way, we obtained a new distribution that represented the posterior distribution of the difference between men and women. If the Bayesian version of the 95% confidence interval (CI) of this new distribution did not include zero, the component under scrutiny differed between women and men with $p < .05$. We draw these comparisons only for the sex- and age-specific subgroups within each dataset.

To summarize the results of the individual models across all four data sets, we conducted a meta-analytic aggregation of the results separately for the full models, the sex-specific, and the age-specific models. To this end, we used an unweighted average of the posterior distributions of each STARTS model parameter.

Results

Full Models

The empirically observed correlations for each dataset are presented in Supplemental Tables S2–S5 in the online supplemental material. Table 2 displays the results of the STARTS model for the full samples. Across all four data sets, all variance components of the STARTS model were substantial. Between one fifth and a quarter of the total between-person variance in loneliness was accounted for by the ST component in SOEP (22.7%, confidence interval [CI] [20.7–24.5%]), SHP (19.2%, CI [5.8–29.9%]), and HILDA (28.9%, CI [26.9–30.6%]), the three data sets in which single-item measures of loneliness have been used. For LISS, in which an indirect multi-item instrument has been used to assess loneliness, this figure amounted to 41.4% (CI [30.4–48.3%]). Despite these differences, these findings suggest that interindividual differences in loneliness have a substantial trait-like core that does not naturally change over time and, thus, preserves interindividual differences.

The ART component captures the part of loneliness that changes systematically over time. Across all four studies, this component accounted for approximately a quarter to a third of the total observed variance in loneliness. The β-coefficient was lowest for SOEP (0.734, CI [0.667–0.781]) and highest for SHP (0.930, CI [0.858–0.966]). The implied correlation over one year, which combines the ST and ART component as well as β was highest for LISS (.680) and lowest for SOEP (.390). The implied correlations for SHP (.467) and HILDA (.491) were close to each other. Overall, the model-implied correlations closely resembled the empirical correlations (see Figure 2), which indicates that the STARTS model provides an accurate description of the observed pattern of retest-correlations.

Finally, for SOEP, SHP, and HILDA, approximately half the variation in loneliness was accounted for by the S component, which captures both reliable occasion-specific variance and random error (SOEP: 54.6%, CI [52.4–56.4%]; SHP: 52.5%, CI [50.4–54.3%]; HILDA: 47.6%, CI [46.9–48.2%]). This proportion was markedly smaller, however, in LISS (27.6%, CI [26.3–28.7%]). The lower proportion of the S component in LISS might partly be due to a reduction in random error as a result of multiple items being averaged (and hence random error being canceled out).

In an additional analysis, we ran a latent (i.e., multiple-indicator) STARTS model for the LISS dataset to separate random error from reliable occasion-specific variance in the S component (Donnellan et al., 2012; Wagner et al., 2016). The results of this latent STARTS model, which we had to estimate using maximum likelihood instead of the Bayesian approach used in the other analyses, converged well with the manifest STARTS model. The ST component was estimated to account for 48.3% of the overall variance in loneliness (+6.8% compared to the manifest model), the ART component accounted for 33.9% of the overall variance (+2.8%) and β amounted to 0.800 (−0.050). The implied 1-year stability amounted to .754, which is slightly higher (+.072) than the 1-year stability derived from the manifest model (.680; see Table 2). As expected, the largest difference to the manifest model occurred for the S component. In the latent model, the share of variance explained by this component dropped by 10.4% compared to the manifest model. However, the S component still accounted for 17.7% of the overall variance in loneliness. Thus, even after separating random error, the S component remained substantial, supporting the notion that this component contains occasion-specific, yet reliable variance (Lucas & Donnellan, 2012).

Sex Differences

Table 3 displays the results of the STARTS models for women and men in each dataset. We will discuss the findings separate for each dataset.

SOEP. In the SOEP, the multivariate Wald test indicated significant differences in the components of the STARTS models

Table 2
Results of STARTS Models for the Full Samples

Dataset	Stable trait		Autoregressive trait		State		β		Implied 1-year correlation
	%	95% CI	%	95% CI	%	95% CI	β	95% CI	
SOEP (D)	22.7	[20.7, 24.5]	22.8	[20.8, 24.9]	54.5	[52.4, 56.4]	.728	[.667, .781]	.396
SHP (CH)	19.2	[5.8, 29.9]	28.4	[18.3, 41.4]	52.5	[50.4, 54.3]	.930	[.858, .966]	.467
HILDA (AU)	28.9	[26.9, 30.6]	23.6	[22.1, 25.3]	47.6	[46.9, 48.2]	.850	[.829, .870]	.491
LISS (NL)	41.4	[30.4, 48.3]	31.1	[25.0, 41.6]	27.6	[26.3, 28.7]	.852	[.792, .906]	.680

Note. SOEP (D) = Socioeconomic Panel (Germany); SHP (CH) = Swiss Household Panel (Switzerland); HILDA (AU) = Household, Income, and Labor Dynamics in Australia (Australia); LISS (NL) = Longitudinal Internet Study for the Social Sciences (The Netherlands); CI = confidence interval of the parameter estimate. Values for the variance components (stable trait, autoregressive trait, state) represent the percentage of between-person variance in loneliness accounted for by each component. β is scaled for one year.

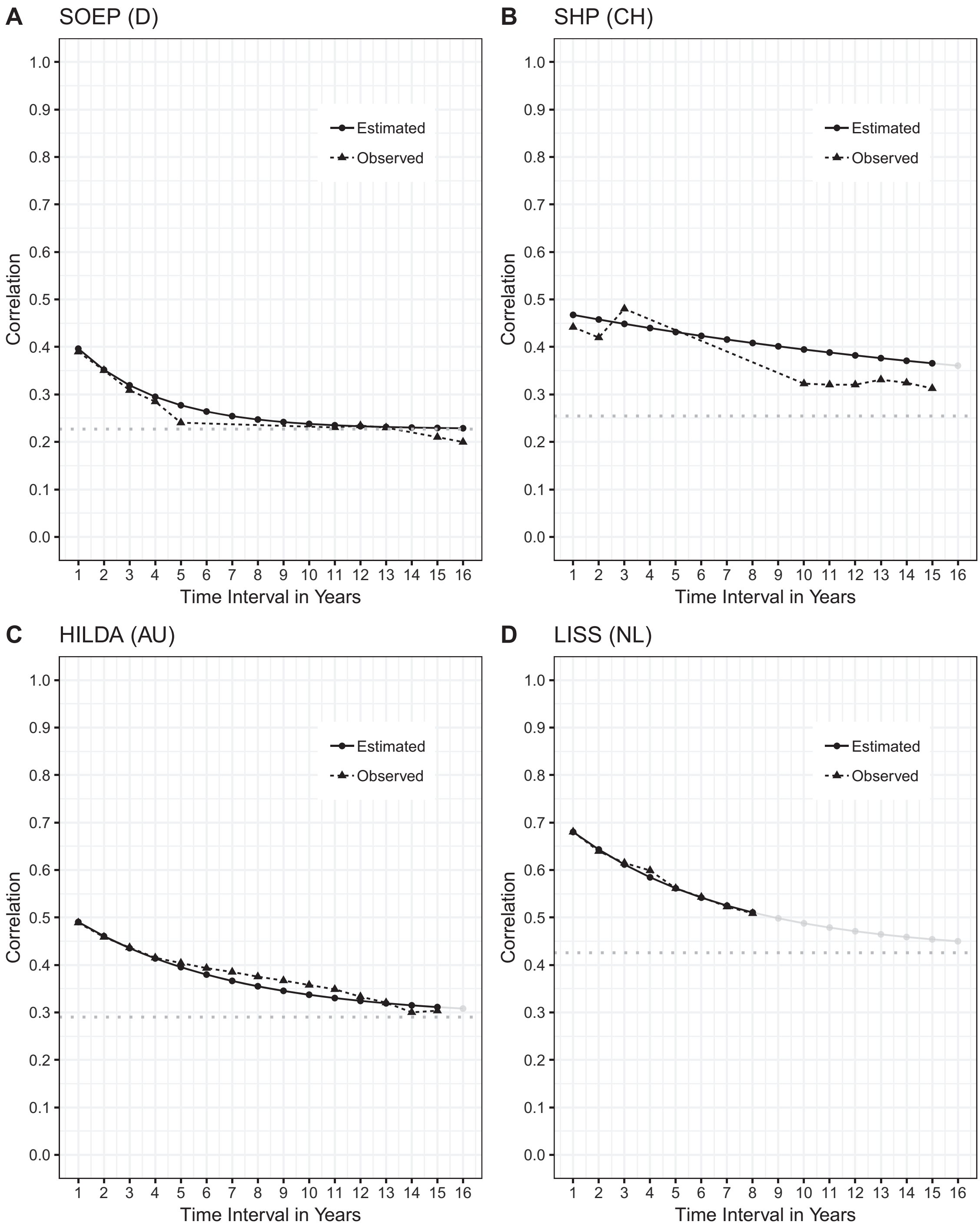

Figure 2. Autocorrelation plot for the STARTS models in the full samples. The triangles connected by the dashed line represent the empirical correlations as calculated from the data. The dots connected by the solid line indicate the implied correlation pattern derived from the results of the STARTS models. The dotted gray line denotes the variance of the stable trait component, that is, the asymptote toward which the correlation converges over time. Solid gray lines depicted for SHP, HILDA, and LISS indicate an extrapolation of the estimated correlation beyond the actual study period. SOEP (D) = Socioeconomic Panel (Germany); SHP (CH) = Swiss Household Panel (Switzerland); HILDA (AU) = Household, Income, and Labor Dynamics in Australia (Australia); LISS (NL) = Longitudinal Internet Study for the Social Sciences (the Netherlands).

Table 3
Results of STARTS Models by Sex

Group	Stable trait %	Stable trait 95% CI	Autoregressive trait %	Autoregressive trait 95% CI	State %	State 95% CI	β	β 95% CI	Implied 1-year correlation
SOEP (D)									
Women	24.3	[21.6, 26.8]	23.9	[21.0, 26.8]	51.8	[48.8, 54.4]	.710	[.632, .776]	.411
Men	18.7	[15.3, 21.5]	22.2	[19.1, 25.3]	59.1	[55.8, 62.0]	.740	[.647, .821]	.353
SHP (CH)									
Women	22.6	[6.7, 33.3]	25.2	[15.1, 40.6]	52.2	[49.6, 54.6]	.924	[.830, .970]	.470
Men	22.8	[9.0, 30.3]	25.5	[18.4, 38.2]	51.8	[47.5, 55.2]	.867	[.734, .952]	.460
HILDA (AU)									
Women	28.7	[25.4, 31.3]	23.3	[21.2, 26.1]	48.0	[46.9, 49.2]	.860	[.831, .889]	.487
Men	28.1	[23.1, 31.7]	23.4	[20.3, 27.8]	48.5	[47.3, 49.7]	.883	[.851, .915]	.487
LISS (NL)									
Women	32.1	[18.4, 43.6]	39.7	[28.8, 53.0]	28.2	[26.9, 29.4]	.898	[.844, .934]	.681
Men	49.0	[42.3, 53.5]	25.0	[21.5, 30.5]	26.0	[23.8, 28.0]	.761	[.670, .843]	.683

Note. SOEP (D) = Socioeconomic Panel (Germany); SHP (CH) = Swiss Household Panel (Switzerland); HILDA (AU) = Household, Income, and Labor Dynamics in Australia (Australia); LISS (NL) = Longitudinal Internet Study for the Social Sciences (The Netherlands); CI = confidence interval of the parameter estimate. Values for the variance components (stable trait, autoregressive trait, state) represent the percentage of between-person variance in loneliness accounted for by each component. β is scaled for 1 year.

between women and men ($\chi^2(3) = 36.938$, $p < .001$).[4] Pairwise comparisons between the components of the STARTS model indicated that the ST component accounted for a higher proportion of variance in loneliness in women (24.2%, CI [21.6–26.8%]) than it did in men (18.4%, CI [15.3–21.5%]; $p < .05$). There were no differences between men and women regarding the ART component and β. The implied 1-year stability was higher for women (.411) than for men (.353) Finally, a larger amount ($p < .05$) of interindividual differences in loneliness was accounted for by occasion-specific variance and random error (i.e., S component) in men (59.2%, CI [55.8–62.0%]) than in women (51.9%, CI [48.8–54.4%]; see Table 3).

SHP. In the SHP, no substantial sex differences emerged, Wald $\chi^2(3) = 0.734$, $p = .865$ (see Table 3). As a consequence, the implied 1-year correlations were nearly identical for women (.470) and men (.460).

HILDA. The results for HILDA yielded no sex differences, Wald $\chi^2(3) = 5.517$, $p = .138$. The models for women and men converged on virtually identical parameter estimates regarding all three variance components, β, and the model-implied stability of loneliness over one year (see Table 3).

LISS. In the LISS dataset, we found differences between men and women, Wald $\chi^2(3) = 8.409$, $p = .038$. Specifically, differences occurred with regard to the ST and ART component as well as β. Whereas half of the variance (49.0%, CI [42.3–53.5%]) of loneliness in men was accounted for by the ST component, this component accounted for only one third (32.1%, CI [18.4–43.6%]) of the variance in women ($p < .05$). However, for women, the ART component was stronger (39.7%, CI [28.8–53.0%]) than for men (25.0%, CI [21.5–30.5%]; $p < .05$). The β-coefficient of the ART component was very high for women (0.898, CI [0.844–0.934]) and considerably lower ($p < .05$) for men (0.761, CI [0.670–0.843]; see Table 3). With regard to the model-implied correlation over one year, however, there were no differences between women (.681) and men (.683). These findings illustrate how the same observed correlations in two groups can differ with respect to their sources.

To summarize, we found no consistent evidence for sex differences regarding the sources of interindividual differences in loneliness. In two of the four studies (SHP, HILDA), the results were nearly identical between men and women. In the two other (i.e., SOEP and LISS), the observed sex differences were inconsistent in that they pertained to different aspects of the employed analysis models across the data sets.

Differences Between Age Groups

The results of the STARTS models separate for each age group in each dataset are displayed in Table 4. As before, we will discuss the results separately for each of the four data sets.

SOEP. The multivariate Wald test indicated differences between age groups regarding the components of the STARTS model, $\chi^2(12) = 136.424$, $p < .001$. As displayed in Table 4, there were no differences regarding the proportions of variance accounted for by the ST and the ART component. There were age differences, however, regarding β. Specifically, although β amounted to 0.318 (CI [0.121–0.640]) in adolescence, it increased across age groups up to 0.832 (CI [0.734–0.909]) in old age. The β-coefficient was significantly lower ($p < .05$) in adolescence than in both midlife and old age. Furthermore, the β-path for individuals in midlife and old age was significantly higher than in emerging adulthood. Finally, β was lower in young adulthood than in old age ($p < .05$). The implied correlations increased from adolescence (.319) to emerging adulthood (.391), remained at a similar level during young adulthood (.361) and midlife (.367) and increased again in old age (.488; see also Supplemental Figure S1 in the online supplemental material).

[4] As we examined whether the proportion of total variance accounted for by the ST, ART, and S component, respectively, differed between groups, we had a set of dependent hypotheses. Specifically, as the variance proportions sum up to 1, there were only two degrees of freedom for the variance components and another degree of freedom for the β-coefficient.

Table 4
Results of STARTS Models by Age Group

Group	Stable trait %	Stable trait 95% CI	Autoregressive trait %	Autoregressive trait 95% CI	State %	State 95% CI	β	β 95% CI	Implied 1-year correlation
SOEP (D)									
Adolescence	22.8	[16.4, 28.6]	38.8	[15.9, 63.1]	38.4	[13.8, 61.4]	.312	[.121, .640]	.319
Emerging adulthood	22.3	[18.1, 26.1]	31.0	[22.4, 45.8]	46.7	[30.1, 56.1]	.532	[.310, .706]	.391
Young adulthood	22.5	[19.7, 25.0]	22.0	[18.1, 26.8]	55.5	[49.6, 59.6]	.625	[.480, .738]	.361
Midlife	19.5	[15.8, 22.7]	22.0	[18.4, 25.6]	58.4	[55.1, 61.4]	.757	[.659, .841]	.367
Old age	24.1	[13.5, 31.9]	29.5	[22.1, 39.3]	46.4	[42.8, 49.7]	.832	[.734, .909]	.488
SHP (CH)									
Adolescence	19.7	[9.3, 27.8]	17.5	[6.0, 48.3]	62.8	[29.5, 73.5]	.636	[.114, .944]	.303
Emerging adulthood	37.4	[23.0, 45.0]	11.7	[3.4, 40.1]	50.9	[20.4, 60.7]	.502	[.029, .974]	.394
Young adulthood	29.7	[18.4, 35.2]	23.3	[17.2, 32.1]	47.0	[40.0, 52.2]	.793	[.612, .936]	.485
Midlife	20.8	[6.2, 33.2]	27.7	[15.6, 42.4]	51.6	[48.8, 54.2]	.938	[.864, .972]	.482
Old age	28.6	[22.8, 34.0]	44.1	[28.4, 62.7]	27.3	[8.1, 43.6]	.500	[.305, .703]	.491
HILDA (AU)									
Adolescence	22.6	[13.5, 29.0]	33.9	[28.2, 41.7]	43.6	[40.4, 46.7]	.830	[.760, .892]	.513
Emerging adulthood	34.8	[30.2, 38.7]	26.9	[23.9, 30.3]	38.3	[35.1, 41.2]	.749	[.673, .822]	.552
Young adulthood	33.1	[30.1, 35.6]	24.1	[22.1, 26.4]	42.9	[41.4, 44.4]	.815	[.779, .850]	.525
Midlife	26.7	[17.3, 32.5]	24.2	[18.9, 33.0]	49.1	[47.7, 50.4]	.914	[.876, .947]	.496
Old age	17.1	[6.5, 25.8]	24.4	[16.5, 34.9]	58.4	[56.5, 60.4]	.915	[.853, .954]	.400
LISS (NL)									
Adolescence	38.5	[21.5, 48.1]	24.9	[15.7, 37.5]	36.5	[21.8, 45.2]	.619	[.236, .912]	.584
Emerging adulthood	36.3	[20.6, 48.2]	34.6	[24.5, 48.0]	29.1	[21.4, 34.6]	.729	[.496, .875]	.639
Young adulthood	41.1	[26.9, 49.6]	32.4	[25.3, 45.2]	26.5	[23.6, 29.2]	.793	[.678, .890]	.675
Midlife	42.7	[28.0, 51.8]	32.6	[24.3, 46.7]	24.7	[23.1, 26.2]	.864	[.793, .922]	.711
Old age	37.3	[20.6, 51.3]	36.0	[23.0, 52.5]	26.7	[24.8, 28.6]	.900	[.821, .945]	.699

Note. SOEP (D) = Socioeconomic Panel (Germany); SHP (CH) = Swiss Household Panel (Switzerland); HILDA (AU) = Household, Income, and Labor Dynamics in Australia (Australia); LISS (NL) = Longitudinal Internet Study for the Social Sciences (The Netherlands); CI = confidence interval of the parameter estimate. Values for the variance components (stable trait, autoregressive trait, state) represent the percentage of between-person variance in loneliness accounted for by each component. β is scaled for one year.

Differences between age groups were also evident regarding the S component, which captures both reliable occasion-specific variance and random error (see Table 4). The S component accounted for the largest proportion of overall variance in loneliness in young adulthood and midlife. In young adulthood, the S component accounted for a significantly larger proportion of variance than in old age. Moreover, in midlife, the S component accounted for significantly more variance than in emerging adulthood and in old age (all *p*s $< .05$).

SHP. The STARTS models for the age groups in the SHP yielded several age differences, Wald $\chi^2(12) = 93.956$, $p < .001$ (see Table 4). Whereas the proportion of interindividual differences accounted for by the ST component ranged between 20% and 37% across all age groups, the ART component accounted for increasingly large shares of the total variance in loneliness. Specifically, although only 18% and 12% of the variance in loneliness were due to the ART component in adolescence and emerging adulthood, respectively, this proportion increased to 23% and 28% in young adulthood and midlife, respectively, and up to 44% in old age. However, only the difference between adolescence and emerging adulthood reached statistical significance ($p < .05$).

The age groups also differed with regard to the ART component and β. Specifically, the ART component accounted for a significantly larger share of overall variance in old age than in both emerging and young adulthood. The β-coefficient in old age, however, was significantly lower than in both young adulthood and midlife (all *p*s $< .05$). Taking all these results into account, the implied correlation showed an increasing trend across the age groups. It was lowest in adolescence (.303), increased in emerging adulthood (.394), further increased to young adulthood (.485), and remained at this level in midlife (.482) and old age (.491; see also Supplemental Figure S2 and in the online supplemental material).

Regarding the S component, the highest estimate resulted for adolescence (62.8%, CI [29.5–73.5%]) and the lowest for old age (27.3%, CI [8.1–43.6%]). In adolescence, emerging adulthood, young adulthood, and midlife, approximately 50% of the overall variance in loneliness was accounted for by this component. The differences between old age and adolescence, young adulthood, and midlife reached statistical significance (all *p*s $< .05$).

HILDA. The results obtained with the Australian HILDA data set yielded several differences across age groups, Wald $\chi^2(12) = 233.066$, $p \leq .001$ (see Table 4). With regard to the ST component, we found the highest estimates in emerging (34.8%, CI [30.2–38.7%]) and young adulthood (33.1%, CI [30.1–35.6%]). The lowest estimate occurred for old age (17.1%, CI [6.5–25.8%]). In adolescence and midlife, the ST component accounted for approximately 25% of the overall variance in loneliness. The differences regarding the ST component between adolescence and both emerging and young adulthood, emerging adulthood and both midlife and old age, as well as young adulthood and old age were statistically significant (all *p*s $< .05$).

With regard to the ART component, we found the highest estimate in adolescence (33.9%, CI [28.2–41.7%]). This proportion was significantly higher than in emerging (26.9%, CI [23.9–30.3%]) and young adulthood (24.1%, CI [22.1–26.4%]; all *p*s $< .05$). The β-coefficient was generally high. However, in midlife, β was significantly higher than in adolescence, emerging adulthood, and young adulthood. Furthermore, β was also higher in old age than in both emerging and young adulthood (all ps $<$ .05). The implied correlations over 1 year, taking into account the ST component, the ART component, and β, yielded a picture different from that obtained in the other data sets. Specifically, the implied correlations tended to decrease across age groups from .513 in adolescence to .400 in old age (see Table 4 and Supplemental Figure S3 in the online supplemental material).

Most differences between the age groups emerged for the S component. Specifically, the differences in explained variance were significant in all comparisons (all ps $<$ .05) except one: In adolescence (43.6%, CI [40.4–46.7%]) and young adulthood (42.9%, CI [41.4–44.4%]), the factors captured by the S component (i.e., occasion-specific variance and random error) accounted for a similar share of the overall variance in loneliness.

LISS. The STARTS models for LISS yielded differences across age groups (Wald $\chi^2(12) = 40.432$, $p < .001$; see Table 4). The ST component accounted for approximately 40% of interindividual differences in loneliness across all age groups with estimates ranging from 36.3% (CI [21.5–48.1%]) in emerging adulthood to 42.7% (CI [28.0–51.8%]) in midlife. All confidence intervals of the differences between age groups included zero and were, thus, not statistically significant.

A similar picture emerged for the ART component. Across all age groups considered, the ART component accounted for a proportion of approximately 30% of interindividual differences in loneliness. As before, there were no significant differences between age groups. The only difference between the age groups in LISS occurred regarding β. As displayed in Table 4, β was highest in old age (0.900, CI [0.821–0.945]) and midlife (0.864, CI [0.793–0.922]) and lowest in adolescence (0.619, CI [0.236–0.912]) and emerging adulthood (0.729, CI [0.496–0.875]). The difference between emerging adulthood and old age was the only one that reached statistical significance ($p < .05$). The implied 1-year correlations increased from adolescence (.584) to emerging adulthood (.639), and young adulthood (.675), and peaked in midlife (.711) and old age (.699).

The S component accounted for approximately 30% of overall variance in loneliness, with the exception of adolescence. In this age period, occasion-specific influences and random error, as captured by the S component, were estimated to account for 36.5% (CI [21.8–45.2%]) of interindividual differences. The estimates in the other age groups were close to each other and all confidence intervals of the pairwise comparisons included zero.

Meta-Analytic Aggregation

The results of the meta-analytic aggregation of all data sets are displayed in Table 5. Across all four data sets, the ST component accounted for 28% (CI [9.3–46.4%]) of the total variance in loneliness. A further 26.5% (CI [20.2–39.6%]) of variance was accounted for by the ART component. On average, β was high (0.840, CI [0.692–0.961]), implying a slow decay of interindividual differences in loneliness toward the asymptote defined by the ST component (see Figure 3). The implied correlation of loneliness over 1 year was estimated to amount to .453. The S component accounted for the remaining 45.5% of variance in loneliness.

To examine the robustness of the meta-analytic results, we applied two alternative aggregation procedures. First, we weighted the single studies based on sample size; as shown in Supplemental Table S7 in the online supplemental material, the point estimates were identical to the unweighted averages presented in Table 5; the confidence intervals, however, tended to be smaller with the weighted aggregation. In a second alternative estimation, we excluded the LISS data set from the meta-analysis to create a set of more similar studies and with similar constituents of the S component (i.e., a similar amount of random error and occasion-specific variance). As shown in Supplemental Table S8 in the online supplemental material, the pattern of results remained unchanged. As already observed in the primary studies, the S component (51.5%, CI [47.0–56.1%]) was stronger at the expense of the ST component (23.6%, CI [8.2–30.3%]) when using only the single-item studies for the meta-analytic aggregation. The implied stability over 1 year amounted to .448 when using only the SOEP, SHP, and HILDA in the meta-analysis. This estimate is only slightly smaller than the 1-year stability obtained for both the unweighted and the weighted aggregation of all data sets (i.e., including LISS), which amounted to .453.

Table 5
Results of the Meta-Analytic Aggregation of STARTS Models Across All Datasets

Group	Stable trait		Autoregressive trait		State		β		Implied 1-year correlation
	%	95% CI	%	95% CI	%	95% CI	β	95% CI	
Full sample									
Overall	28.0	[9.3, 46.4]	26.5	[20.2, 39.6]	45.5	[26.7, 55.9]	.840	[.692, .961]	.453
Sex-specific									
Women	26.9	[11.5, 40.4]	28.0	[17.0, 48.7]	45.0	[27.2, 53.8]	.848	[.660, .964]	.459
Men	29.7	[13.6, 52.3]	24.0	[19.5, 33.5]	46.3	[24.4, 61.2]	.813	[.671, .938]	.447
Age-specific									
Adolescence	26.0	[12.5, 46.0]	28.8	[8.4, 57.7]	45.3	[18.6, 56.8]	.598	[.147, .915]	.364
Emerging adulthood	32.7	[19.2, 45.5]	26.1	[4.8, 45.0]	41.2	[23.9, 54.3]	.628	[.084, .928]	.472
Young adulthood	31.6	[20.4, 47.6]	25.5	[18.4, 39.5]	42.9	[24.4, 58.7]	.757	[.539, .901]	.484
Midlife	27.5	[9.4, 49.5]	26.6	[17.7, 42.1]	45.9	[23.6, 60.7]	.868	[.698, .967]	.457
Old age	26.8	[9.5, 47.6]	33.5	[18.4, 57.3]	39.7	[25.3, 59.9]	.788	[.359, .948]	.523

Note. CI = confidence interval of the parameter estimate. Values for the variance components (stable trait, autoregressive trait, state) represent the percentage of between-person variance in loneliness accounted for by each component. β is scaled for one year. The values represent unweighted average values that were obtained by aggregating the values from the posterior distributions of each STARTS model parameter across the four datasets.

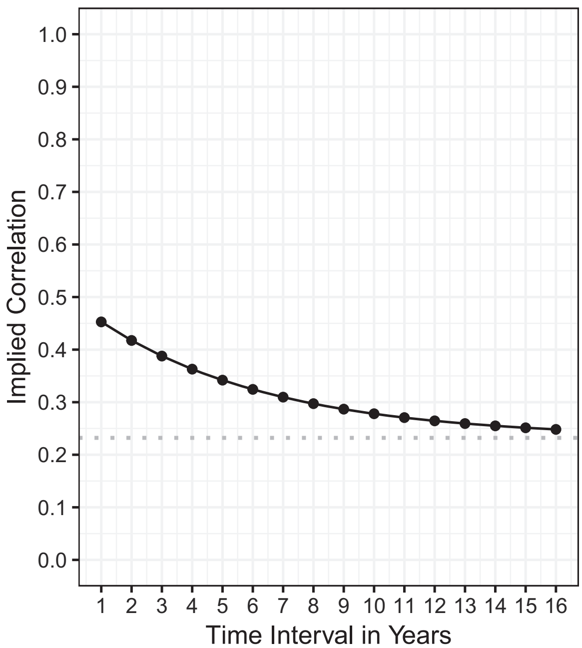

Figure 3. Autocorrelation plot for the meta-analytic aggregation of all full-sample STARTS models. The dots denote the implied correlation pattern based on the results of the STARTS models. The dotted gray line denotes the variance of the Stable Trait component, that is, the asymptote toward which the correlation converges over time.

Sex differences. Overall, there was no evidence for sex differences regarding the sources of interindividual differences in loneliness (see Table 5). The ST component accounted for 2.8% more variance in men, and the ART component accounted for 4% more variance in women. The β-coefficient was slightly larger for women. The share of total variance accounted for by the S component was 1.2% higher in men than in women. Consequently, the implied 1-year correlations were virtually identical for women (.459) and men (.447).

As for the meta-analysis on the full samples, the two alternative meta-analytic procedures (see Supplemental Tables S7 and S8 in the online supplemental material) yielded results very similar to those presented in Table 5; the implied 1-year stabilities were identical to (weighted aggregation) or only slightly smaller (aggregation of studies using single items) than those obtained for the unweighted aggregation of all four studies.

Age differences. Although there were substantial differences between age groups in the components of the STARTS model, no clear pattern of these age differences emerged in the meta-analytic aggregation of all four data sets (see Table 5). Specifically, across all age groups in the four samples, the ST component accounted for a share between one fourth (adolescence, midlife, old age) and one third (emerging adulthood, young adulthood) of the total variance. The only significant difference between age groups based on the posterior distributions was found between adolescence and emerging adulthood ($p < .05$).

Approximately 25% of the variance in loneliness was accounted for by the ART component; in old age, the share of variance explained by this component was higher and amounted to 33.5%. This proportion was significantly higher than in young adulthood ($p < .05$); no other differences between age groups regarding the ART component reached statistical significance. Most differences between age groups occurred with respect to the β-coefficient. Specifically, the differences between β in midlife and all other age groups were statistically significant, indicating that the decay of interindividual differences was slowest in this age period (see also Supplemental Figure S5 in the online supplemental material). The difference in β between old age and adolescence also reached statistical significance. The implied correlations indicated increases from adolescence (.364) to emerging adulthood (.472). During young adulthood (.484) and midlife (.457), the implied 1-year stability remained relatively stable before it increased again in old age (.523; see also Table 5 and Supplemental Figure S5 in the online supplemental material).

Finally, the S component, capturing occasion-specific variance and random error, accounted for approximately 40% of the overall variance in all age groups. The specific figures ranged from 39.7% (CI [25.3–59.9%]) in old age to 45.9% (CI [23.6–60.7%]) in midlife. The S component explained significantly more variance in midlife than in emerging adulthood, young adulthood, and old age, as indicated by the differences calculated based on the posterior distributions.

Paralleling our line of action for the full samples and the sex-specific models, we also ran alternative meta-analytic models for the age groups (see Supplemental Tables S7 and S8 in the online supplemental material). As before, the results of these alternative approaches dovetailed well with the results presented in Table 5.

Discussion

Loneliness occurs when individuals perceive qualitative and/or quantitative aspects of their social relationships as deficient (Ernst & Cacioppo, 1999; Perlman & Peplau, 1981; de Jong Gierveld, 1998). A recent meta-analysis (Mund et al., 2019) has shown that interindividual differences in loneliness across the life span are as stable as interindividual differences in personality characteristics such as the Big Five and self-esteem (Roberts & DelVecchio, 2000; Trzesniewski et al., 2003). In the present study, we examined the sources of interindividual differences in loneliness in four independent nationally representative samples.

Sources of Interindividual Differences in Loneliness

Across all analyses, all components of the STARTS models substantially contributed to the explanation of interindividual differences in loneliness. In the following, we will discuss the findings separately for each of these components.

Stable trait. In three of the four samples, we found between 20% and 30% of interindividual differences in loneliness to be accounted for by the ST component. In the fourth sample (LISS), this proportion amounted to 40%. Meta-analytically, this component accounted for 28% of the observed variance in loneliness across all four samples. The ST component as estimated in the STARTS model closely corresponds to developmental constancy factors as described by Fraley and Roberts (2005). Specifically, as the ST component, developmental constancy factors reflect sources of interindividual differences that do not naturally change over time. In this way, they define a lower bound of interindividual differences in loneliness. This means that even after very long time periods, interindividual differences in loneliness will still be detectable. Such developmental constancy factors primarily include stable genetic influences on loneliness and the stable effects of environments that individuals were exposed to in the past (Fraley & Roberts, 2005; Fraley et al., 2013).

It should be noted that it is difficult to pinpoint specific developmental constancy factors. To do so, it would be necessary to observe individuals across their entire life span to flesh out which specific genetic and environmental aspects exert constant effects on interindividual differences in loneliness. Apart from loneliness, Fraley et al. (2013) have shown that early caregiving experiences have enduring effects on individual outcomes even after several years. This finding persisted after controlling for potential confounders, the stability of the environment, and possible transactional processes (Fraley et al., 2013). These findings, thus, imply that some key experiences individuals make early in their lives affect them almost disattenuatedly across their life span.

Autoregressive trait. The ART component pertains to the part of loneliness that changes over time. These changes can occur due to time-varying factors that are either internal (e.g., correlated changes with other psychological constructs, changing genetic influences), external (e.g., environmental influences, relationship experiences), or result from the interplay between internal and external factors (e.g., person–environment transactions, genotype–environment transactions, genotype–environment interactions; Deventer et al., 2019; Kandler et al., 2012; Mund & Neyer, 2014; Neyer & Asendorpf, 2001; Neyer et al., 2014; Plomin et al., 1977; Scarr & McCartney, 1983; Wrzus, et al., 2016). The β-coefficient indicates how strongly these time-varying factors contribute to maintaining interindividual differences in loneliness and, hence, how quickly interindividual differences decay toward the asymptote (ST). In the present analysis, we found between 20% and 30% (meta-analytic aggregation: 26.5%) of the overall variance in loneliness to be accounted for by the ART component.

It is important to bear in mind that neither internal nor external time-varying factors influence loneliness only unidirectionally. Although not modeled in the STARTS framework, such time-varying factors affecting interindividual differences in loneliness are likely to be reciprocally influenced by loneliness. For example, loneliness has been shown to increase in partner relationships when the relationship is perceived as conflictual and of low quality (Hsieh & Hawkley, 2018; Stokes, 2017). When individuals feel more lonely, they might react, for instance, by withdrawing from the partner with the goal to protect themselves from being rejected (J. T. Cacioppo & Hawkley, 2009). This behavior might, in turn, lead to further decreases in relationship quality (for reviews, see J. T. Cacioppo & Hawkley, 2009; Qualter et al., 2015; Spithoven, Bijttebier, & Goossens, 2017).

More generally, it will be important for future research to take into account genotype–environment effects (Buss, 1987; Plomin et al., 1977; Scarr & McCartney, 1983). With regard to the stability of interindividual differences in loneliness, active and reactive genotype–environment transactions are primarily relevant. Active genotype–environment transactions refer to processes through which individuals directly select and shape their environments according to their needs and preferences. Reactive genotype–environment transactions describe processes through which individuals evoke certain reactions from their environment. These genotype–environment transactions might help to understand which factors contribute to maintaining interindividual differences in loneliness across time.

The results of the STARTS models further suggested that time-varying factors have relatively stable influences on loneliness. With regard to self-esteem, J. Wagner et al. (2016) and Donnellan et al. (2012) reported β-coefficients ranging between 0.85 and 0.89, respectively. These values closely correspond to the β amounting to 0.840 that we have found in the present study. This finding reflects that loneliness is upheld by a wide variety of internal (e.g., attributional styles, self-evaluations) and external (e.g., life events) factors as well as their dynamic interactions (for reviews, see J. T. Cacioppo & Hawkley, 2009; Spithoven et al., 2017).

State. In the model proposed by Fraley and Roberts (2005), stochastic mechanisms mainly contribute to the instability of interindividual differences, as they reflect random fluctuations and unsystematic influences. In the STARTS model, these mechanisms are partly captured by the S component. However, the S component also contains a certain amount of occasion-specific, yet reliable variance (Lucas & Donnellan, 2012). In three of the four data sets in the present analysis, the S component accounted for approximately 50% of interindividual differences in loneliness. In the fourth dataset (LISS), this proportion amounted to 28% (meta-analytic aggregation: 45.5%).

One example of a stochastic mechanism affecting the stability of interindividual differences in loneliness is random error. Instruments with lower reliability might not be able to capture finer-grained differences between individuals but instead capture noise manifesting as weaker interindividual differences. In the present study, the least amount of overall variation in loneliness accounted for by the S component was found in LISS. In this study, loneliness was measured using a six-item instrument for which the higher aggregation probably led to a reduction of random error, at least to some extent.

The moderating role of sex and age. A recent meta-analysis has shown that gender does not affect the stability of interindividual differences in loneliness (Mund et al., 2019). In the present study, we examined whether the virtually identical phenotypic rank-order coefficients for women and men might differ with respect to their sources. We hypothesized that the ST and ART component might be stronger in women than in men due to their, on average, higher social motivation (Drescher & Schultheiss, 2016) and relationship standards (Vangelisti & Daly, 1997). However, this assumption was not supported. In fact, there were no consistent substantial differences between men and women in either component of the STARTS model. This finding suggests that interindividual differences in loneliness between women and men are not only similar in their phenotype but also with regard to their sources.

With respect to age, no clear pattern emerged across the four data sets concerning the age-differential contributions of the STARTS components to the stability of interindividual differences in loneliness. The most marked differences between the age groups emerged for the β-coefficient. This coefficient indicates the sustainability of the time-varying factors captured by the ART component (e.g., correlated changes, person–environment transactions). The finding that the β-coefficient is strongest in midlife might reflect the results of previous studies suggesting that, in general, environmental continuity is relatively high in this period of life compared to other periods of life (Briley & Tucker-Drob, 2014; Kandler, 2012; Rindfuss, 1991; for reviews, see Helson et al., 2006; Lachman, 2004). This environmental continuity, in turn, might be a consequence of individuals becoming more successful in shaping their environments in a way that corresponds to their individual characteristics (Wrzus et al., 2016). Such processes of active genotype–environment transactions (Plomin et al., 1977; Scarr & McCartney, 1983) closely correspond to factors captured by the ART component.

Comparison With Other Constructs

STARTS models have already been applied to other constructs than loneliness, which allows us to compare the results of these prior studies to those obtained in the current study to further determine the standing of loneliness on the state-trait continuum. Previous work found interindividual differences in self-esteem to be primarily accounted for by both the ST (35–44%) and the ART (42–49%) component. Accordingly, only 14% to 16% of the overall variation in self-esteem were found to be accounted for by the S component (Donnellan et al., 2012; J. Wagner et al., 2016). Concerning satisfaction with life, Lucas and Donnellan (2007) found interindividual differences to be accounted for by each component to an equal share.

In three of the four samples of the present study, we found considerably higher estimates for the S component (around 50%) and, consequently, interindividual differences in loneliness to be less strongly accounted for by the stable components. It should be noted, though, that multi-item measures have been used in the studies investigating the sources of interindividual differences in self-esteem. These multi-item measures can be expected to be less affected by random error than the single-item measures used for loneliness in SOEP, SHP, and HILDA. Indeed, in the LISS sample, in which a multi-item measure for loneliness was used, we obtained estimates for the components of the STARTS model that fell within the range previously reported for self-esteem. In comparison to satisfaction with life—which was likewise measured with a single item (Lucas & Donnellan, 2007)—interindividual differences in loneliness seem to be preserved by person–environment transactions (as captured by the ART component) to a larger extent.

Finally, in the only other study we are aware of in which a STARTS model was applied to loneliness (Zhong et al., 2016), 40.5% of interindividual differences in loneliness as assessed with a single item were found to be accounted for by the S component. The study by Zhong et al. (2016) was conducted with a sample of Chinese aged 65 and older and we, thus, compare their findings with our findings for the age group 60 years and older (old age). Based on the confidence intervals obtained for the S component in this age group, we found the estimate reported by Zhong et al. (2016) to be closely approached in SOEP, covered in SHP, exceeded in HILDA, and remarkably lower in LISS. The meta-analytic aggregation of the results across all four data sets yielded an average contribution of 39.7% of the S component for this age group, which is almost identical to the estimate obtained by Zhong et al. (2016). We cannot conduct similar comparisons for the other components of the STARTS model as Zhong et al. (2016) only report findings for the sum of the ST and ART component and provide no information on the β-coefficient.

Implications for Theory and Measurement

The findings of the present study have several implications for the theory and measurement of loneliness. A strong theoretical implication of the present study is that interindividual differences in loneliness have a stable core and a nonzero asymptote. To further understand the nature of loneliness, future research might particularly focus on the time-varying factors loneliness reciprocally interacts with.

Research on dynamic transactions between loneliness and both internal and external variables is still scarce. Until now, research has been mainly concerned with the consequences of loneliness for health (e.g., J. T. Cacioppo et al., 2006; Hawkley, Masi, Berry, & Cacioppo, 2006; Holt-Lunstad et al., 2015; Shankar et al., 2011, 2017) and individual development (Mund & Neyer, 2016, 2019), or with the predictors, antecedents, and concomitants of loneliness (Bosma, Jansen, Schefman, Hajema, & Feron, 2015; Hsieh & Hawkley, 2018; Luhmann & Hawkley, 2016; Savikko, Routasalo, Tilvis, Strandberg, & Pitkälä, 2005). Studies adopting a dynamic-transactional perspective (Magnusson, 1990; Neyer et al., 2014) on loneliness by taking into account mutual influences between loneliness and other domains are still scarce (for example, see Böger & Huxhold, 2018; McHugh Power, Steptoe, Kee, & Lawlor, 2019). We deem such an approach particularly promising for understanding loneliness, as it allows investigating intra- and interpersonal antecedents, consequences, and processes underlying such dynamic transactions. Thus, a dynamic-transactional perspective provides a comprehensive view on loneliness (for reviews proposing such a perspective on loneliness, see J. T. Cacioppo & Hawkley, 2009; Spithoven et al., 2017).

With regard to measurement, the present study shows that single-item measures also tap into (relatively) stable aspects of loneliness. This finding adds to the research showing that single-item measures of loneliness are valid and useful instruments. Beyond the mere length of the scales, the measures used in the four data sets differ from each other regarding a second aspect. The single-item measures used in SOEP, SHP, and HILDA fall in the category of direct measures of loneliness, that is, measures that directly refer to loneliness in their wording (Marangoni & Ickes, 1989). Indirect measures such as the de Jong Gierveld Loneliness scale, in contrast, avoid the terms *lonely* and *loneliness* in their items. Previous research has already demonstrated indirect and direct measures to differ regarding their correlations with demographic characteristics (Borys & Perlman, 1985; Shiovitz-Ezra & Ayalon, 2012; Victor, Grenade, & Boldy, 2005). In the present study, we have shown that these measurement approaches also differ with regard to the sources of interindividual differences by which they are affected. Specifically, the direct single-item measures were mostly affected by the S component, whereas the single most powerful source of interindividual differences in the indirect measure was the ST component. Surprisingly, the dominance of the S component in the direct measures came at the expense of the ST component. This suggests that single-item direct measures of loneliness might underestimate the influence of developmental constancy factors and tap more into occasion-specific aspects of loneliness. This line of reasoning is supported by the results of the analysis of the latent STARTS model in the LISS data set, which enabled us to separate random error from occasion-specific variance in the S component (Donnellan et al., 2012; Wagner et al., 2016). Indeed, the ST and ART component of the STARTS model remained largely unaffected by this approach, whereas the S component was reduced, but remained significant. Based on these results, if we could account for random error in the single-item measures, we would expect large shifts in the S component but no or only small shifts in the ST and ART components. Following this assumption, the occasion-specific part of the S component of the direct measure would still account for more variance in interindividual differences in loneliness than the indirect measure.

The differences regarding the measurement instruments also imply that it partly depends on the assessment method whether loneliness should be considered more a state or a trait (see also Marangoni & Ickes, 1989). If measured with an indirect multi-item instrument, loneliness leans more toward the trait-end of the state-trait continuum, closely approaching the properties of self-esteem. It should be noted, though, that we cannot determine whether it is the nature of the measurement instrument (indirect vs. direct) or the mere length of the scale that led to these differences. To disentangle these factors, either a direct multi-item measure or an indirect single-item measure would have been necessary in at least one of the studies.

Limitations

Despite a number of strengths such as employing large samples from four different countries, the integrative data analysis approach (Hofer & Piccinin, 2009), internal replications and extensive robustness checks (Duncan et al., 2014), and the time span covered by the included studies, the present work also has limitations that need to be considered when interpreting the results.

First, similar to behavior genetic studies (Bleidorn et al., 2014), the models applied in the present study provide estimates of indirect influences on interindividual differences (Anusic & Schimmack, 2016; J. Wagner et al., 2019). That is, although we obtained estimates of the extent to which interindividual differences in loneliness are accounted for by developmental constancy factors, for example, we do not know which particular factors contribute to the actual occurrence of stable interindividual differences. Neither do we know which stochastic mechanisms destabilize interindividual differences in loneliness or which time-varying factors operate to preserve them. To arrive at more detailed conclusions about the specifics of each source of interindividual differences, it is necessary to conduct studies specifically tailored to this goal.

Second, three of the four samples analyzed in this study used single-item measures of loneliness. Thus, the S component reflects a blend of occasion-specific influences on interindividual differences in loneliness and random error. Hence, it is difficult to determine whether these measurement instruments are indeed more sensitive to stochastic mechanisms or more biased by measurement error at the expense of actually stable sources of interindividual differences in loneliness. However, the results of the latent STARTS model conducted for the LISS data set provides some support for the former notion.

Third, when investigating the moderating role of age, we separated the sample into different age groups. Although these age groups resemble important developmental periods (Arnett, 2000; Helson et al., 2006), it would be desirable to analyze the effects of age in a continuous fashion (J. Wagner et al., 2019), for instance by applying local structural equation modeling (LSEM; Hildebrandt et al., 2016; Hildebrandt, Wilhelm, & Robitzsch, 2009). It might be worthwhile for future research to identify and resolve the many methodological challenges that would arise from combining STARTS and LSEM (e.g., convergence problems and inadmissible parameter estimates with small samples; Kenny & Zautra, 2001; Lüdtke et al., 2018).

Fourth, we have conducted an extensive search for eligible data sets from all around the world to draw a picture as nuanced and at the same time as generalizable as possible. Despite these efforts, three of the four samples analyzed in this study are from Europe and the fourth from Australia. These countries are likely to share similar values and attitudes toward social relationships and might, thus, be too similar to generalize the results beyond Western cultures. Despite our efforts, however, we could not find eligible studies from Asia, South America, Africa, or North America. This was possibly due to the strict requirements possible studies had to meet both concerning methodological (i.e., at least four waves of loneliness required) and other criteria (i.e., household-based panel with broad age range). As a consequence, the meta-analytic aggregation of the results mainly serves illustrative purposes.

Conclusion

The findings of the present study contribute to the understanding of the development of loneliness across the life span. Specifically, the results of our analyses show that loneliness has a stable kernel that preserves the stability of interindividual differences over many years so that it will never drop to zero. At the same time, we also found time-varying factors such as correlated changes, environmental influences, or person–environment transactions in a broad sense to affect the stability of interindividual differences in loneliness. Occasion-specific influences also substantially influenced the empirically observed interindividual differences in loneliness. Taken together, these findings suggest that loneliness is a complex characteristic. This complexity needs to be further integrated into theoretical conceptions of loneliness in order to further advance the understanding of its intra- and interpersonal antecedents, concomitants, and consequences across the life span.

References

Allemand, M., & Martin, M. (2016). On correlated change in personality. *European Psychologist, 21,* 237–253. http://dx.doi.org/10.1027/1016-9040/a000256

Anusic, I., Lucas, R. E., & Donnellan, M. B. (2012). Dependability of personality, life satisfaction, and affect in short-term longitudinal data. *Journal of Personality, 80,* 33–58. http://dx.doi.org/10.1111/j.1467-6494.2011.00714.x

Anusic, I., & Schimmack, U. (2016). Stability and change of personality traits, self-esteem, and well-being: Introducing the meta-analytic stability and change model of retest correlations. *Journal of Personality and Social Psychology, 110,* 766–781. http://dx.doi.org/10.1037/pspp0000066

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist, 55,* 469–480. http://dx.doi.org/10.1037//0003-066X.55.5.469

Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211,* 1390–1396.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachment as a fundamental human motivation. *Psychological Bulletin, 117,* 497–529. http://dx.doi.org/10.1037/0033-2909.117.3.497

Bleidorn, W., Kandler, C., & Caspi, A. (2014). The behavioural genetics of personality development in adulthood. *European Journal of Personality, 28,* 244–255. http://dx.doi.org/10.1002/per.1957

Bleidorn, W., Kandler, C., Riemann, R., Angleitner, A., & Spinath, F. M. (2009). Patterns and sources of adult personality development. *Journal of Personality and Social Psychology, 97,* 142–155. http://dx.doi.org/10.1037/a0015434

Böger, A., & Huxhold, O. (2018). Do the antecedents and consequences of loneliness change from middle adulthood into old age? *Developmental Psychology, 54,* 181–197. http://dx.doi.org/10.1037/dev0000453

Borys, S., & Perlman, D. (1985). Gender differences in loneliness. *Personality and Social Psychology Bulletin, 11,* 63–74. http://dx.doi.org/10.1177/0146167285111006

Bosma, H., Jansen, M., Schefman, S., Hajema, K. J., & Feron, F. (2015). Lonely at the bottom: A cross-sectional study on being ill, poor, and lonely. *Public Health, 129,* 185–187. http://dx.doi.org/10.1016/j.puhe.2014.11.016

Briley, D. A., & Tucker-Drob, E. M. (2014). Genetic and environmental continuity in personality development: A meta-analysis. *Psychological Bulletin, 140,* 1303–1331. http://dx.doi.org/10.1037/a0037091

Buss, D. M. (1987). Selection, evocation, and manipulation. *Journal of Personality and Social Psychology, 53,* 1214–1221. http://dx.doi.org/10.1037/0022-3514.53.6.1214

Cacioppo, J. T., Cacioppo, S., Capitanio, J. P., & Cole, S. W. (2015). The neuroendocrinology of social isolation. *Annual Review of Psychology, 66,* 733–767. http://dx.doi.org/10.1146/annurev-psych-010814-015240

Cacioppo, J. T., & Hawkley, L. C. (2009). Perceived social isolation and cognition. *Trends in Cognitive Sciences, 13,* 447–454. http://dx.doi.org/10.1016/j.tics.2009.06.005

Cacioppo, J. T., Hawkley, L. C., & Thisted, R. A. (2010). Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. *Psychology and Aging, 25,* 453–463. http://dx.doi.org/10.1037/a0017216

Cacioppo, J. T., Hughes, M. E., Waite, L. J., Hawkley, L. C., & Thisted, R. A. (2006). Loneliness as a specific risk factor for depressive symptoms: Cross-sectional and longitudinal analyses. *Psychology and Aging, 21,* 140–151. http://dx.doi.org/10.1037/0882-7974.21.1.140

Cacioppo, S., Capitanio, J. P., & Cacioppo, J. T. (2014). Toward a neurology of loneliness. *Psychological Bulletin, 140,* 1464–1504. http://dx.doi.org/10.1037/a0037618

Caspi, A., Harrington, H., Moffitt, T. E., Milne, B. J., & Poulton, R. (2006). Socially isolated children 20 years later: Risk of cardiovascular disease. *Archives of Pediatric and Adolescent Medicine, 160,* 805–811. http://dx.doi.org/10.1001/archpedi.160.8.805

Chmielewski, M., & Watson, D. (2009). What is being assessed and why it matters: The impact of transient error on trait research. *Journal of Personality and Social Psychology, 97,* 186–202. http://dx.doi.org/10.1037/a0015618

Chung, Y., Rabe-Hesketh, S., Dorie, V., Gelman, A., & Liu, J. (2013). A nondegenerate penalized likelihood estimator for variance parameters in multilevel models. *Psychometrika, 78,* 685–709. http://dx.doi.org/10.1007/s11336-013-9328-2

Cohen, S. (2004). Social relationships and health. *American Psychologist, 59,* 676–684. http://dx.doi.org/10.1037/0003-066X.59.8.676

Cole, D. A. (2012). Latent state-trait models. In R. H. Hoyle (Ed.), *Handbook for structural equation modeling* (pp. 585–600). New York, NY: Guilford Press.

Conley, J. J. (1984). The hierarchy of consistency: A review and model of longitudinal findings on adult individual differences in intelligence, personality and self-opinion. *Personality and Individual Differences, 5,* 11–25. http://dx.doi.org/10.1016/0191-8869(84)90133-8

Danneel, S., Maes, M., Vanhalst, J., Bijttebier, P., & Goossens, L. (2018). Developmental change in loneliness and attitudes toward aloneness in adolescence. *Journal of Youth and Adolescence, 47,* 148–161. http://dx.doi.org/10.1007/s10964-017-0685-5

de Jong Gierveld, J. (1998). A review of loneliness: Concept and definitions, determinants and consequences. *Reviews in Clinical Gerontology, 8,* 73–80. http://dx.doi.org/10.1017/S0959259898008090

de Jong Gierveld, J., & van Tilburg, T. (2006). A 6-item scale for overall, emotional, and social loneliness: Confirmatory tests on survey data. *Research on Aging, 28,* 582–598. http://dx.doi.org/10.1177/0164027506289723

de Jong Gierveld, J., van Tilburg, T., & Dykstra, P. A. (2006). Loneliness and social isolation. In A. L. Vangelisti & D. Perlman (Eds.), *The Cambridge handbook of personal relationships* (pp. 485–500). Cambridge, UK: Cambridge University Press.

Deventer, J., Wagner, J., Lüdtke, O., & Trautwein, U. (2019). Are personality traits and relationship characteristics reciprocally related in emerging adulthood? Longitudinal analyses of codevelopment in the transition out of school and beyond. *Journal of Personality and Social Psychology, 116,* 331–347. http://dx.doi.org/10.1037/pspp0000191

Diamantopoulos, A., Sarstedt, M., Fuchs, C., Wilczynski, P., & Kaiser, S. (2012). Guidelines for choosing between multi-item and single-item scales for construct measurement: A predictive validity perspective. *Journal of the Academy of Marketing Science, 40,* 434–449. http://dx.doi.org/10.1007/s11747-011-0300-3

Donnellan, M. B., Kenny, D. A., Trzesniewski, K. H., Lucas, R. E., & Conger, R. D. (2012). Using trait-state models to evaluate the longitudinal consistency of global self-esteem from adolescence to adulthood. *Journal of Research in Personality, 46,* 634–645. http://dx.doi.org/10.1016/j.jrp.2012.07.005

Drescher, A., & Schultheiss, O. C. (2016). Meta-analytic evidence for higher implicit affiliation and intimacy motivation scores in women compared to men. *Journal of Research in Personality, 64,* 1–10. http://dx.doi.org/10.1016/j.jrp.2016.06.019

Duncan, G. J., Engel, M., Claessens, A., & Dowsett, C. J. (2014). Replication and robustness in developmental research. *Developmental Psychology, 50,* 2417–2425. http://dx.doi.org/10.1037/a0037996

Enders, C. K. (2010). *Applied missing data analysis*. New York, NY: Guilford Press.

Ernst, J. M., & Cacioppo, J. T. (1999). Lonely hearts: Psychological perspectives on loneliness. *Applied and Preventive Psychology, 8,* 1–22. http://dx.doi.org/10.1016/S0962-1849(99)80008-0

Ferguson, C. J. (2010). A meta-analysis of normal and disordered personality across the life span. *Journal of Personality and Social Psychology, 98,* 659–667. http://dx.doi.org/10.1037/a0018770

Fraley, R. C., & Roberts, B. W. (2005). Patterns of continuity: A dynamic model for conceptualizing the stability of individual differences in psychological constructs across the life course. *Psychological Review, 112,* 60–74. http://dx.doi.org/10.1037/0033-295X.112.1.60

Fraley, R. C., Roisman, G. I., & Haltigan, J. D. (2013). The legacy of early experiences in development: Formalizing alternative models of how early experiences are carried forward over time. *Developmental Psychology, 49,* 109–126. http://dx.doi.org/10.1037/a0027852

Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2014). *Bayesian data analysis* (3rd ed.). New York, NY: Chapman and Hall/CRC.

Goossens, L., van Roekel, E., Verhagen, M., Cacioppo, J. T., Cacioppo, S., Maes, M., & Boomsma, D. I. (2015). The genetics of loneliness: Linking evolutionary theory to genome-wide genetics, epigenetics, and social science. *Perspectives on Psychological Science, 10,* 213–226. http://dx.doi.org/10.1177/1745691614564878

Hagemeyer, B., Schönbrodt, F. D., Neyer, F. J., Neberich, W., & Asendorpf, J. B. (2015). When "together" means "too close": Agency motives and relationship functioning in coresident and living-apart-together couples. *Journal of Personality and Social Psychology, 109,* 813–835. http://dx.doi.org/10.1037/pspi0000031

Hawkley, L. C., Burleson, M. H., Berntson, G. G., & Cacioppo, J. T. (2003). Loneliness in everyday life: Cardiovascular activity, psychosocial context, and health behaviors. *Journal of Personality and Social Psychology, 85,* 105–120. http://dx.doi.org/10.1037/0022-3514.85.1.105

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine, 40,* 218–227. http://dx.doi.org/10.1007/s12160-010-9210-8

Hawkley, L. C., Masi, C. M., Berry, J. D., & Cacioppo, J. T. (2006). Loneliness is a unique predictor of age-related differences in systolic blood pressure. *Psychology and Aging, 21,* 152–164. http://dx.doi.org/10.1037/0882-7974.21.1.152

Hawkley, L. C., Thisted, R. A., & Cacioppo, J. T. (2009). Loneliness predicts reduced physical activity: Cross-sectional & Longitudinal analyses. *Health Psychology, 28,* 354–363. http://dx.doi.org/10.1037/a0014400

Hawkley, L. C., Thisted, R. A., Masi, C. M., & Cacioppo, J. T. (2010). Loneliness predicts increased blood pressure: 5-year cross-lagged analyses in middle-aged and older adults. *Psychology and Aging, 25,* 132–141. http://dx.doi.org/10.1037/a0017805

Helson, R., Soto, C. J., & Cate, R. A. (2006). From young adulthood through the middle ages. In D. K. Mroczek & T. D. Little (Eds.), *Handbook of personality development* (pp. 337–352). Mahwah, NJ: Erlbaum.

Hildebrandt, A., Lüdtke, O., Robitzsch, A., Sommer, C., & Wilhelm, O. (2016). Exploring factor model parameters across continuous variables with local structural equation models. *Multivariate Behavioral Research, 51,* 257–278. http://dx.doi.org/10.1080/00273171.2016.1142856

Hildebrandt, A., Wilhelm, O., & Robitzsch, A. (2009). Complementary and competing factor analytic approaches for the investigation of measurement invariance. *Review of Psychology, 16,* 87–102.

Hofer, S. M., & Piccinin, A. M. (2009). Integrative data analysis through coordination of measurement and analysis protocol across independent longitudinal studies. *Psychological Methods, 14,* 150–164. http://dx.doi.org/10.1037/a0015566

Hoff, P. D. (2009). *A first course in Bayesian statistical methods*. New York, NY: Springer. http://dx.doi.org/10.1007/978-0-387-92407-6

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and social isolation as risk factors for mortality: A meta-analytic review. *Perspectives on Psychological Science, 10,* 227–237. http://dx.doi.org/10.1177/1745691614568352

House, J. S., Landis, K. R., & Umberson, D. (1988). Social relationships and health. *Science, 241,* 540–545. Retrieved from http://www.jstor.org/stable/1701736

Hsieh, N., & Hawkley, L. C. (2018). Loneliness in the older adult marriage. *Journal of Social and Personal Relationships, 35,* 1319–1339. http://dx.doi.org/10.1177/0265407517712480

Kandler, C. (2012). Nature and nurture in personality development: The Case of Neuroticism and Extraversion. *Current Directions in Psychological Science, 21,* 290–296. http://dx.doi.org/10.1177/0963721412452557

Kandler, C., Bleidorn, W., Riemann, R., Angleitner, A., & Spinath, F. M. (2012). Life events as environmental states and genetic traits and the role of personality: A longitudinal twin study. *Behavior Genetics, 42,* 57–72. http://dx.doi.org/10.1007/s10519-011-9491-0

Kandler, C., & Papendick, M. (2017). Behavior genetics and personality development: A methodological and meta-analytic review. In J. Specht (Ed.), *Personality development across the life span* (pp. 473–495). San Diego, CA: Elsevier. http://dx.doi.org/10.1016/B978-0-12-804674-6.00029-6

Kandler, C., Waaktaar, T., Mottus, R., Riemann, R., & Torgersen, S. (2019). Unraveling the interplay between genetic and environmental contributions in the unfolding of personality differences from early adolescence to young adulthood. *European Journal of Personality*. http://dx.doi.org/10.1002/per.2189

Kandler, C., Zimmermann, J., & McAdams, D. P. (2014). Core and surface characteristics for the description and theory of personality differences and development. *European Journal of Personality, 28,* 231–243. http://dx.doi.org/10.1002/per.1952

Kenny, D. A., & Zautra, A. (1995). The trait-state-error model for multiwave data. *Journal of Consulting and Clinical Psychology, 63,* 52–59. http://dx.doi.org/10.1037/0022-006X.63.1.52

Kenny, D. A., & Zautra, A. (2001). Trait-state models for longitudinal data. In L. M. Collins & A. G. Sayer (Eds.), *New methods for the analysis of change* (pp. 243–263). Washington, DC: American Psychological Association.

Klimstra, T. A., Bleidorn, W., Asendorpf, J. B., van Aken, M. A. G., & Denissen, J. J. A. (2013). Correlated change of Big Five personality traits across the life span: A search for determinants. *Journal of Research in Personality, 47,* 768–777. http://dx.doi.org/10.1016/j.jrp.2013.08.004

Kuster, F., & Orth, U. (2013). The long-term stability of self-esteem: Its time-dependent decay and nonzero asymptote. *Personality and Social Psychology Bulletin, 39,* 677–690. http://dx.doi.org/10.1177/0146167213480189

Lachman, M. E. (2004). Development in midlife. *Annual Review of Psychology, 55,* 305–331. http://dx.doi.org/10.1146/annurev.psych.55.090902.141521

Lasgaard, M., Friis, K., & Shevlin, M. (2016). "Where are all the lonely people?" A population-based study of high-risk groups across the life span. *Social Psychiatry and Psychiatric Epidemiology, 51,* 1373–1384. http://dx.doi.org/10.1007/s00127-016-1279-3

Lay, J. C., Pauly, T., Graf, P., Biesanz, J. C., & Hoppmann, C. A. (2019). By myself and liking it? Predictors of distinct types of solitude experiences in daily life. *Journal of Personality*. http://dx.doi.org/10.1111/jopy.12421

Lucas, R. E., & Donnellan, M. B. (2007). How stable is happiness? Using the STARTS model to estimate the stability of life satisfaction. *Journal of Research in Personality, 41,* 1091–1098. http://dx.doi.org/10.1016/j.jrp.2006.11.005

Lucas, R. E., & Donnellan, M. B. (2012). Estimating the reliability of single-item life satisfaction measures: Results from four national panel studies. *Social Indicators Research, 105,* 323–331. http://dx.doi.org/10.1007/s11205-011-9783-z

Lüdtke, O., Roberts, B. W., Trautwein, U., & Nagy, G. (2011). A random walk down university avenue: Life paths, life events, and personality trait change at the transition to university life. *Journal of Personality and Social Psychology, 101,* 620–637. http://dx.doi.org/10.1037/a0023743

Lüdtke, O., Robitzsch, A., & Wagner, J. (2018). More stable estimation of the STARTS model: A Bayesian approach using Markov Chain Monte Carlo techniques. *Psychological Methods, 23,* 570–593. http://dx.doi.org/10.1037/met0000155

Luhmann, M., & Hawkley, L. C. (2016). Age differences in loneliness from late adolescence to oldest old age. *Developmental Psychology, 52,* 943–959. http://dx.doi.org/10.1037/dev0000117

Luhmann, M., Hofmann, W., Eid, M., & Lucas, R. E. (2012). Subjective well-being and adaptation to life events: A meta-analysis. *Journal of Personality and Social Psychology, 102,* 592–615. http://dx.doi.org/10.1037/a0025948

Magnusson, D. (1990). Personality development from an interactional perspective. In L. Pervin (Ed.), *Handbook of personality: Theory and research* (pp. 193–222). New York, NY: Guilford Press.

Marangoni, C., & Ickes, W. (1989). Loneliness: A theoretical review with implications for measurement. *Journal of Social and Personal Relationships, 6,* 93–128. http://dx.doi.org/10.1177/026540758900600107

McHugh Power, J. E., Steptoe, A., Kee, F., & Lawlor, B. A. (2019). Loneliness and social engagement in older adults: A bivariate dual change score analysis. *Psychology and Aging, 34,* 152–162. http://dx.doi.org/10.1037/pag0000287

Melbourne Institute of Applied Economic and Social Research. (2017). *The Household, Income and Labour Dynamics in Australia (HILDA) Survey: General release 16 (Waves 1–16)*. Melbourne, Australia: Department of Social Services, Melbourne Institute of Applied Economic and Social Research. http://dx.doi.org/10.4225/87/VHRTR5

Mund, M., Freuding, M. M., Möbius, K., Horn, N., & Neyer, F. J. (2019). The stability and change of loneliness across the life span: A meta-analysis of longitudinal studies. *Personality and Social Psychology Review*. http://dx.doi.org/10.1177/1088868319850738

Mund, M., & Neyer, F. J. (2014). Treating personality-relationship transactions with respect: Narrow facets, advanced models, and extended time frames. *Journal of Personality and Social Psychology, 107,* 352–368. http://dx.doi.org/10.1037/a0036719

Mund, M., & Neyer, F. J. (2016). The winding paths of the lonesome cowboy: Evidence for mutual influences between personality, subjective health, and loneliness. *Journal of Personality, 84,* 646–657. http://dx.doi.org/10.1111/jopy.12188

Mund, M., & Neyer, F. J. (2019). Loneliness effects on personality. *International Journal of Behavioral Development, 43,* 136–146. http://dx.doi.org/10.1177/0165025418800224

Muthén, B., & Asparouhov, T. (2012). Bayesian structural equation modeling: A more flexible representation of substantive theory. *Psychological Methods, 17,* 313–335. http://dx.doi.org/10.1037/a0026802

Neyer, F. J., & Asendorpf, J. B. (2001). Personality-relationship transaction in young adulthood. *Journal of Personality and Social Psychology, 81,* 1190–1204. http://dx.doi.org/10.1037//0022-3514.81.6.1190

Neyer, F. J., Mund, M., Zimmermann, J., & Wrzus, C. (2014). Personality-relationship transactions revisited. *Journal of Personality, 82,* 539–550. http://dx.doi.org/10.1111/jopy.12063

Perlman, D., & Peplau, L. A. (1981). Toward a social psychology of loneliness. In N. Duck & R. Gilmour (Eds.), *Personal relationships in disorder* (pp. 31–56). London, U.K.: Academic Press.

Plomin, R., DeFries, J. C., & Loehlin, J. C. (1977). Genotype–environment interaction and correlation in the analysis of human behavior. *Psychological Bulletin, 84,* 309–322. http://dx.doi.org/10.1037/0033-2909.84.2.309

Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York, NY: Simon & Schuster.

Qualter, P., Brown, S. L., Munn, P., & Rotenberg, K. J. (2010). Childhood loneliness as a predictor of adolescent depressive symptoms: An 8-year longitudinal study. *European Child and Adolescent Psychiatry, 19,* 493–501. http://dx.doi.org/10.1007/s00787-009-0059-y

Qualter, P., Vanhalst, J., Harris, R., van Roekel, E., Lodder, G., Bangee, M., . . . Verhagen, M. (2015). Loneliness across the life span. *Perspectives on Psychological Science, 10,* 250–264. http://dx.doi.org/10.1177/1745691615568999

R Core Team. (2018). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from http://www.r-project.org

Reis, H. T., Collins, W. A., & Berscheid, E. (2000). The relationship context of human behavior and development. *Psychological Bulletin, 126,* 844–872. http://dx.doi.org/10.1037//0033-2909.126.6.844

Reitz, A., Zimmermann, J., Hutteman, R., Specht, J., & Neyer, F. J. (2014). How peers make a difference: The role of peer groups and peer relationships in personality development. *European Journal of Personality, 28,* 279–288. http://dx.doi.org/10.1002/per.1965

Rindfuss, R. R. (1991). The young adult years: Diversity, structural change, and fertility. *Demography, 28,* 493–512. Retrieved from http://www.jstor.org/stable/2061419?origin=JSTOR-pdf

Roberts, B. W., & DelVecchio, W. F. (2000). The rank-order consistency of personality traits from childhood to old age: A quantitative review of longitudinal studies. *Psychological Bulletin, 126,* 3–25. http://dx.doi.org/10.1037/0033-2909.126.1.3

Robitzsch, A., & Lüdtke, O. (2018). *STARTS: Functions for the STARTS model* (R package version 0.4–24). Retrieved from https://CRAN.R-project.org/package=STARTS

Savikko, N., Routasalo, P., Tilvis, R. S., Strandberg, T. E., & Pitkälä, K. H. (2005). Predictor and subjective causes of loneliness in an aged population. *Archives of Gerontology and Geriatrics, 41,* 223–233. http://dx.doi.org/10.1016/j.archger.2005.03.002

Scarr, S., & McCartney, K. (1983). How people make their own environments: A theory of genotype → environment effects. *Child Development, 54,* 424–435. http://dx.doi.org/10.2307/1129703

Scherpenzeel, A., & Das, M. (2010). "True" longitudinal and probability-based internet panels: Evidence from the Netherlands. In M. Das, P. Ester, & L. Kaczmirek (Eds.), *Social and behavioral research and the internet: Advances in applied methods and research strategies* (pp. 77–104). Boca Raton, FL: Taylor & Francis.

Schupp, J., Kroh, M., Goebel, J., Schröder, C., Bügelmayer, E., Giesselmann, M., . . . Wenzig, K. (2015). *German Socio-Economic Panel (SOEP): Data of the years 1984–2013*. Berlin, Germany: DIW Berlin. http://dx.doi.org/10.5684/soep.v30

Shankar, A., McMunn, A., Banks, J., & Steptoe, A. (2011). Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychology, 30,* 377–385. http://dx.doi.org/10.1037/a0022826

Shankar, A., McMunn, A., Demakakos, P., Hamer, M., & Steptoe, A. (2017). Social isolation and loneliness: Prospective association with functional status in older adults. *Health Psychology, 36,* 179–187. http://dx.doi.org/10.1037/hea0000437

Shiovitz-Ezra, S., & Ayalon, L. (2010). Situational versus chronic loneliness as risk factors for all-cause mortality. *International Psychogeriatrics, 22,* 455–462. http://dx.doi.org/10.1017/S1041610209991426

Shiovitz-Ezra, S., & Ayalon, L. (2012). Use of direct versus indirect approaches to measure loneliness in later life. *Research on Aging, 34,* 572–591. http://dx.doi.org/10.1177/0164027511423258

Spithoven, A. W. M., Bijttebier, P., & Goossens, L. (2017). It is all in their mind: A review on information processing bias in lonely individuals. *Clinical Psychology Review, 58,* 97–114. http://dx.doi.org/10.1016/j.cpr.2017.10.003

Spithoven, A. W. M., Cacioppo, S., Goossens, L., & Cacioppo, J. T. (2019). Genetic contributions to loneliness and their relevance to the evolutionary theory of loneliness. *Perspectives on Psychological Science*. http://dx.doi.org/10.1177/1745691618812684

Stokes, J. E. (2017). Marital quality and loneliness in later life: A dyadic analysis of older married couples in Ireland. *Journal of Social and Personal Relationships, 34,* 114–135. http://dx.doi.org/10.1177/0265407515626309

Summerfield, M., Bevitt, A., Freidin, S., Hahn, M., La, N., Macalalad, N., . . . Wooden, M. (2017). *HILDA user manual: Release 16*. Melbourne, Australia: Melbourne Institute of Applied Economic and Social Research, University of Melbourne.

Tillmann, R., Voorpostel, M., Antal, E., Kuhn, U., Lebert, F., Ryser, V.-A., & Wernli, B. (2016). The Swiss Household Panel study: Observing social change since 1999. *Longitudinal and Life Course Studies, 7,* 64–78. http://dx.doi.org/10.14301/llcs.v7i1.360

Trzesniewski, K. H., Donnellan, M. B., & Robins, R. W. (2003). Stability of self-esteem across the life span. *Journal of Personality and Social Psychology, 84,* 205–220. http://dx.doi.org/10.1037/0022-3514.84.1.205

Vangelisti, A. L., & Daly, J. A. (1997). Gender differences in standards for romantic relationships. *Personal Relationships, 4,* 203–219. http://dx.doi.org/10.1111/j.1475-6811.1997.tb00140.x

Vanhalst, J., Klimstra, T. A., Luyckx, K., Scholte, R. H. J., Engels, R. C. M. E., & Goossens, L. (2012). The interplay of loneliness and depressive symptoms across adolescence: Exploring the role of personality traits. *Journal of Youth and Adolescence, 41,* 776–787. http://dx.doi.org/10.1007/s10964-011-9726-7

Victor, C. R., Grenade, L., & Boldy, D. (2005). Measuring loneliness in later life: A comparison of differing measures. *Reviews in Clinical Gerontology, 15,* 63–70. http://dx.doi.org/10.1017/S0959259805001723

von Soest, T., Luhmann, M., Hansen, T., & Gerstorf, D. (2018). Development of loneliness in midlife and old age: Its nature and correlates. *Journal of Personality and Social Psychology*. Advance online publication http://dx.doi.org/10.1037/pspp0000219

Wagner, G. G., Frick, J. R., & Schupp, J. (2007). The German Socio-economic Panel Study (SOEP): Scope, evolution and enhancements. *Journal of Applied Social Science Studies, 127,* 139–169.

Wagner, J., Lüdtke, O., & Robitzsch, A. (2019). Does personality become more stable with age? Disentangling state and trait effects for the big five across the life span using local structural equation modeling. *Journal of Personality and Social Psychology, 116,* 666–680. http://dx.doi.org/10.1037/pspp0000203

Wagner, J., Lüdtke, O., & Trautwein, U. (2016). Self-esteem is mostly stable across young adulthood: Evidence from latent STARTS models. *Journal of Personality, 84,* 523–535. http://dx.doi.org/10.1111/jopy.12178

Wrzus, C., Wagner, G. G., & Riediger, M. (2016). Personality–situation transactions from adolescence to old age. *Journal of Personality and Social Psychology, 110,* 782–799. http://dx.doi.org/10.1037/pspp0000054

Zhong, B.-L., Chen, S.-L., Tu, X., & Conwell, Y. (2016). Loneliness and cognitive function in older adults: Findings from the Chinese Longitudinal Healthy Longevity Survey. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 72,* 120–128. http://dx.doi.org/10.1093/geronb/gbw037

Received November 28, 2018
Revision received July 24, 2019
Accepted August 10, 2019 ■