

Personality Factors in the Long Life Family Study

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Objectives. To evaluate personality profiles of Long Life Family Study participants relative to population norms and offspring of centenarians from the New England Centenarian Study.

Method. Personality domains of agreeableness, conscientiousness, extraversion, neuroticism, and openness were assessed with the NEO Five-Factor Inventory in 4,937 participants from the Long Life Family Study (mean age 70 years). A linear mixed model of age and gender was implemented adjusting for other covariates.

Results. A significant age trend was found in all five personality domains. On average, the offspring generation of long-lived families scored low in neuroticism, high in extraversion, and within average values for the other three domains. Older participants tended to score higher in neuroticism and lower in the other domains compared with younger participants, but the estimated scores generally remained within average population values. No significant differences were found between long-lived family members and their spouses.

Discussion. Personality factors and more specifically low neuroticism and high extraversion may be important for achieving extreme old age. In addition, personality scores of family members were not significantly different from those of their spouses, suggesting that environmental factors may play a significant role in addition to genetic factors.

Key Words: Centenarian—Longevity—NEO—Neuroticism—Personality.

INTRODUCTION

Growing evidence suggests that specific personality traits are conducive to and associated with exceptional longevity. The paradigm commonly used to assess personality is the Five-Factor Theory, which consists of the traits: conscientiousness, agreeableness, neuroticism, openness to experience, and extraversion (McCrae & Costa, 2003). Terracciano, Lockenhoff, Zonderman, Ferrucci, and Costa (2008) followed a group of adults for almost 50 years and found reduced mortality associated with lower neuroticism and higher conscientiousness. Similarly, other studies have found reduced mortality to be associated with low neuroticism (Fry & Debats, 2009; Wilson, Mendes de Leon, Bienias, Evans, & Bennett, 2004), high conscientiousness (Fry & Debats, 2009; Hill, Turiano, Hurd, Mroczek, & Roberts, 2011; Kern & Friedman, 2008; Martin & Friedman, 2000; Wilson et al., 2004), agreeableness (Fry & Debats, 2009; Martin & Friedman, 2000), and extraversion (Fry & Debats, 2009; Mosing et al., 2012; Terracciano et al., 2008; Wilson et al., 2004). Furthermore, these associations remain even after controlling for baseline presence of other well-known determinants of survival including cardiac conditions, smoking and alcohol history, and body mass index (BMI) (Wilson et al., 2005). However, results are not consistent and may vary according to the population that is assessed. For example, Weiss and Costa (2005) assessed personality in a group of older adults requiring

medical care and help in activities of daily living (ADLs) or instrumental activities of daily living (IADLs) and found that high agreeableness, conscientiousness, and, in contrast to many other studies, high neuroticism were all associated with lower mortality over an interval of up to 5 years. Other studies have found no association of neuroticism (Martin & Friedman, 2000; Mosing et al., 2012) or extraversion (Martin & Friedman, 2000) with mortality.

In assessing the relationship between personality and longevity, one can also look at personality factors in those who have already demonstrated exceptional longevity. Among centenarians in the Georgia Centenarian Study, a personality profile of low neuroticism, high competence (a facet of conscientiousness), and high extraversion was found to be the most prevalent (Martin, da Rosa, Siegler, Davey, Macdonald, & Poon, 2006). The Swedish Centenarian Study also found low neuroticism and high conscientiousness among centenarians (Samuelsson et al., 1997). A sex-specific analysis of personality traits in Japanese centenarians found higher openness in men and higher conscientiousness, extraversion, and openness in women compared with younger elderly controls (Masui, Gondo, Inagaki, & Hirose, 2006). Furthermore, informant reports of centenarians' personalities indicated low neuroticism and openness and high extraversion, agreeableness, and conscientiousness (Martin, Baenziger, Macdonald, Siegler, & Poon, 2009). A study of centenarian

offspring found that men and women had low levels of neuroticism and high levels of extraversion with women also scoring high in agreeableness (Givens et al., 2009). Most recently, low neuroticism and high conscientiousness were found in Ashkenazi Jewish centenarians in the Longevity Genes Project (Kato, Zweig, Barzilai, & Atzmon, 2012).

This study analyzed personality scores in participants of the Long Life Family Study (LLFS) using the NEO Five-Factor Inventory (NEO-FFI), a measure of the five domains of personality consisting of neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Because the LLFS is a multigeneration study of families selected for exceptional longevity and includes family members with ages ranging from 28 to 110 years, this analysis allows us to examine differences in personality traits with age, as well as to compare personality traits in participants with established longevity (the proband generation) or familial predisposition to longevity (the offspring generation) relative to normative values. The results are also compared with a cohort of offspring enrolled in the New England Centenarian Study (NECS).

METHOD

Study Participants

LLFS.—The LLFS is a study of 583 families with evidence of longevity and healthy aging living in the United States, Canada, and Denmark. Study eligibility criteria have been described in detail elsewhere (Newman et al., 2011; Sebastiani et al., 2009). In brief, potential probands in the United States were identified between 2006 and 2009 using name and address files generated from the Centers for Medicare and Medicaid Services of people aged 79 or older (increased to age 89 or older after the pilot phase of the LLFS), without end-stage renal disease or on hospice, and living within a 3-hr driving radius of one of the U.S. field centers (Boston University, Columbia University, University of Pittsburgh). Probands were also identified through existing studies of longevity (NECS), media events, study publicity, and mailings generated from voter registry and commercial mailing lists. The University of Southern Denmark identified potential probands, people more than 90 years, through the use of Danish National Register of Persons (Pedersen, Gotzsche, Moller, & Mortensen, 2006) in conjunction with parish registers to identify potential probands with living siblings. Potential probands were screened for evidence of familial longevity using the Family Longevity Selection Score, which scored family longevity using birth-year cohort survival probabilities of the proband and siblings (Sebastiani et al., 2009). In addition to a Family Longevity Selection Score > 7.0, potential probands and their relatives became eligible for the study if the proband had at least one living sibling who was willing

to participate in the study and if the two siblings had one offspring who was willing to participate in the study. In addition, the proband and sibling were required to not have dementia. Eligible probands were then asked to contact all of their living siblings, offspring, and nieces and nephews for participation in the study. Spouses of the offspring generation were recruited as controls. Spouses of the proband generation were recruited only if their biological children were enrolled in the study. Enrollment to the study was closed in 2009, and since 2009, members have been followed annually. We refer to the enrollment phase as Phase 1 and the follow-up phase as Phase 2.

NECS.—The NECS is an ongoing study of exceptional longevity that has recruited since 1995 approximately 1,800 centenarians, 600 offspring, and 150 of their spouses and about 180 control participants who did not have parental longevity and were from the same birth cohort as the offspring generation. In 2008, a sample of 246 unrelated offspring of centenarians was selected to participate in a study of personality traits and exceptional longevity reported in Givens et al. (2009).

NEO-FFI

The NEO-FFI is a brief version of the Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992). The NEO-FFI consists of 60 items, with 12 items for each of the five domains of personality compared with the NEO PI-R that has 48 items per domain for a total of 240 items. Each item is scored using a five-item Likert scale of agreement with each statement. Scores range from 0 to 4 for each item and 0 to 48 for each domain, with higher scores indicating a higher level of the personality trait. Correlations between the NEO PI-R and NEO-FFI domains range from .75 to .92 (Costa & McCrae, 1992). During Phase 1 of the LLFS (2006–2009), only the domains neuroticism and conscientiousness of the NEO-FFI were administered to 4,937 participants at baseline, during either a phone interview or an in-home interview along with other questionnaires and measurements. During Phase 2 (2009–present) of the LLFS, which is ongoing, all five domains of the NEO-FFI were administered by phone or mail with the participant or his/her proxy. The data analyzed in this second phase include responses from 3,032 participants who had completed the NEO-FFI by July 2011. Due to the staggered telephone follow-up windows (the offspring generation only completed the full telephone follow-up, which includes the NEO-FFI in the third year of follow-up) and attrition of the sample due to death, the number of participants who completed the NEO-FFI is smaller than the number that completed the two domain questionnaire at baseline.

The NEO-FFI was administered once by telephone interview to 246 unrelated offspring (age range: 57–95) of the NECS.

Both studies are overseen by the Boston University Medical Campus Institutional Review Board and, in the case of the LLFS, by each study center's respective review board.

Statistical Analyses

Summary statistics are presented as means and standard errors. Only completed questionnaires were included in the primary analysis (agreeableness: $n = 2,784$; conscientiousness: $n = 4,680$; extraversion: $n = 2,785$; neuroticism: $n = 4,864$; openness: $n = 2,766$). The agreement between repeated measures of neuroticism and conscientiousness in Phase 1 and Phase 2 and correlation between repeated measures and age of participants were estimated using Spearman correlation coefficient, and repeated measures were summarized by the average score. Raw scores were transformed into sex-specific standardized T-scores with a mean of 50 and a standard deviation of 10 using the sex-specific means and standard deviations in Table B-4 on page 78 of the NEO PI-R manual (Costa & McCrae, 1992). T-scores between 45 and 55 represent average values, T-scores < 45 represent lower than average, and T-scores > 55 represent higher than average values. Departure of the T-score from normality was tested by using the Kurtosis test. The five personality traits were analyzed using a linear mixed model of age, gender, field center, an indicator variable to denote whether a participant was a spouse or a biologically related family member and a participant random effect to account for relatedness. The random effects were modeled as a multivariate normal distribution, with 0 mean vector and variance-covariance matrix proportional to the kinship matrix (Lange, 1997) in order to fully describe the familial relations. Cubic models of age were fit initially to describe age trend, and the significant polynomial terms were selected by backward elimination of terms with Wald test p value > .05. Gender and field center were forced in the model. Means of ages at repeated measures were used in the regression analysis. Similar regression analyses were conducted in the replication set of 244 NECS offspring after removing outliers in the same manner as with the LLFS data. All analyses were conducted in R.2.9. Family-based linear mixed models were estimated using the kinship package.

RESULTS

Complete NEO-FFI scores for a minimum of 2,766 participants (openness) and a maximum of 4,864 (neuroticism) were analyzed. Age and gender distributions of these participants at enrollment are summarized in Table 1 for the generations of probands/siblings, their offspring, and the spouses. Note that given the older ages of probands and siblings (mean age at enrollment was 91 years), only a small proportion of spouses were alive and enrolled. Participants were enrolled from the four field centers in approximately the same proportions.

Concordance of Repeated Measures

The two domains neuroticism and conscientiousness of the NEO-FFI were completed in both Phase 1 and Phase 2 of the study by 2,759 participants. The correlations between the repeated measures were .66 and .67, respectively, and suggest that the scores are reliable even for participants of older ages. We did not note any significant trend between age at enrollment and difference between neuroticism and conscientiousness scores (correlation .04 and .05 for neuroticism and conscientiousness, respectively).

Age Trends

Figure 1 shows the age trends for the scores in each domain by gender and field center. Fitted means of T-scores by gender at representative ages of 65 and 95 for the proband and offspring generations are shown in Table 2. Age trends were significant for all five domains. Younger participants scored lower than the average range in neuroticism between the ages of 40 and 70, with scores higher but remaining in the low-average range for the oldest old participants. Extraversion showed a linear age trend with offspring tending to score in the high range between 40 and 50 years of age and older participants scoring lower but remaining in the average range up to age 100. We found a significant cubic age trend for openness that remained within the average range but tended to be higher for younger participants than older participants with the very oldest participants, those aged more than 90 years, falling slightly below the average range. The age trend for agreeableness shows that participants scored in the high-average range across all ages, with younger participants scoring higher

Table 1. LLFS Participants' Characteristics at Enrollment, Grouped by Generation and Family Roles

Participants	Total counts (M/F)	Age (Mean \pm SD)	Gender	Age (Mean \pm SD)	Range
Probands/siblings	1,433 (686/747)	91.01 \pm 6.01	M	90.37 \pm 5.48	72–105
			F	91.59 \pm 6.41	72–110
Spouse of probands/siblings	187 (40/147)	83.84 \pm 7.19	M	85.88 \pm 6.57	64–98
			F	83.29 \pm 7.27	55–97
Offspring	2,423 (1,026/1,397)	61.14 \pm 8.28	M	61.06 \pm 8.27	31–86
			F	61.20 \pm 8.29	36–88
Spouse of offspring	796 (420/376)	61.59 \pm 8.71	M	63.82 \pm 8.14	39–89
			F	59.09 \pm 8.65	25–80

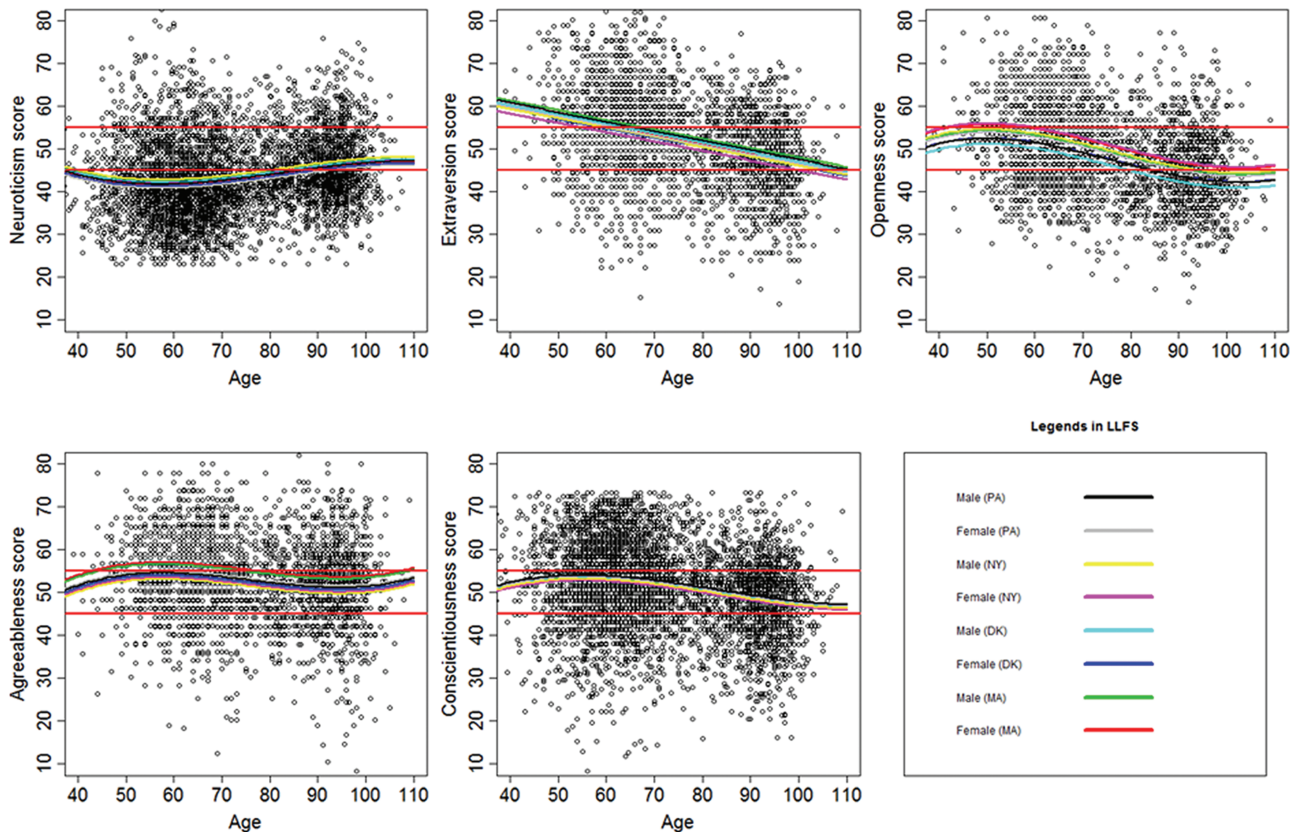


Figure 1. Scatter plots of NEO scores in participants of the LLFS. The y-axes report the T-score for the five domains included in the NEO-FFI. The x-axes report the age at the test. The color lines represent the fitted values by gender and field center as explained in the legend. The area between the two red horizontal lines indicates the normal range for T-score values.

than older participants. We found a significant cubic age trend for conscientiousness such that younger participants scored in the high-average range and older participants scored in the low-average range. The results are essentially unchanged if sex-combined norms are used rather than sex-specific norms. See [supplementary material](#) for details.

Replication Study

The mean ages of the participants of the replication set of centenarian offspring from the NECS as reported by [Givens and colleagues \(2009\)](#) were 75.6 ± 6.5 for men and 74.9 ± 7.6 for women. Mean scores were published in the previous study; however, age trends were generated in this study for comparison of cohorts. [Figure 2](#) shows the plots of the NECS data by gender for each personality domain. Age trends were significant for all personality domains except conscientiousness and agreeableness. Consistent with previously published results, men and women of the NECS cohort scored low in neuroticism for ages 61–85 years and high in extraversion for ages < 80 years. In comparing the NECS and LLFS cohorts, we found similar trends in the overlapping age ranges of 65 to 85 for all domains. The age trend for neuroticism was similar in shape but lower in score across ages in the NECS cohort compared with the LLFS cohort.

DISCUSSION

This study examines personality factors in a novel cohort, the LLFS. Although the proband generation personality domain scores tended to fall in the average range, the offspring generation scored low on neuroticism and high on extraversion for a wide age range. The offspring generation also scored in the high-average range in conscientiousness, and participants scored in the high-average range in agreeableness across all ages. This is in agreement with previous studies that have shown reduced mortality and greater longevity to be associated with low neuroticism and high extraversion, agreeableness, and conscientiousness. Our replication study using the NECS cohort of centenarian offspring showed similar trends to the LLFS cohort for ages 65–85 for each of the five personality domains. In addition, the findings of low neuroticism and high extraversion seen in the offspring generation of the LLFS were replicated in the NECS centenarian offspring.

The Baltimore Longitudinal Study of Aging (BLSA) published mean NEO-PI-R factor scores for a wide range of age groups ([Terracciano, McCrae, Brant, & Costa, 2005](#)). In comparing LLFS fitted mean values at age 65 for the Boston University (BU) site to the BLSA mean values for the 60–70 decade (mean age 65.1), we found that LLFS offspring scored lower in neuroticism (BLSA: 46.8; LLFS

Table 2. Fitted Mean Values of Personality Score and 95% Confidence Intervals by Field Center, Gender, and Mean Ages of the Proband and Siblings, and Offspring, at Enrollment.

Field center	Gender	Agreeableness				Conscientiousness				Extraversion				Neuroticism				Openness			
		65 years		95 years		65 years		95 years		65 years		95 years		65 years		95 years		65 years		95 years	
		Mean	CI	Mean	CI	Mean	CI	Mean	CI	Mean	CI	Mean	CI	Mean	CI	Mean	CI	Mean	CI	Mean	CI
BU	M	56.23	(55.3;57.16)	53.19	(52.23;54.16)	52.84	(52.10;53.57)	47.99	(47.14;48.84)	55.78	(54.84;56.73)	49.14	(48.13;50.16)	43.07	(42.42;43.72)	47.19	(46.44;47.94)	52.35	(51.39;53.31)	44.70	(43.70;45.70)
		56.66	(55.77;57.55)	53.63	(52.69;54.57)	52.46	(51.74;53.19)	47.62	(46.78;48.46)	54.75	(53.84;55.66)	48.11	(47.11;49.11)	42.11	(41.48;42.75)	46.23	(45.50;46.97)	53.75	(52.82;54.68)	46.10	(45.12;47.08)
	53.27	(52.33;54.21)	50.24	(49.13;51.35)	52.67	(51.93;53.42)	47.83	(46.91;48.75)	54.85	(53.85;55.84)	48.2	(47.04;49.37)	42.55	(41.90;43.20)	46.67	(45.87;47.48)	49.13	(48.14;50.13)	41.48	(40.32;42.65)	
DK	F	53.70	(52.79;54.61)	50.67	(49.57;51.77)	52.30	(51.56;53.04)	47.46	(46.55;48.37)	53.81	(52.85;54.77)	47.17	(46.01;48.33)	41.59	(40.95;42.24)	45.71	(44.92;46.51)	50.54	(49.56;51.51)	42.89	(41.73;44.05)
		52.77	(51.72;53.82)	49.74	(48.78;50.70)	52.56	(51.58;53.04)	47.78	(46.93;48.62)	53.92	(52.86;54.98)	47.28	(46.26;48.3)	43.21	(42.50;43.91)	47.33	(46.59;48.07)	52.62	(51.55;53.69)	44.97	(43.97;45.97)
	53.2	(52.19;54.22)	50.17	(49.23;51.11)	52.25	(51.47;53.04)	47.41	(46.58;48.23)	52.88	(51.86;53.9)	46.24	(45.24;47.25)	42.25	(41.56;42.94)	46.37	(45.64;47.10)	54.03	(52.98;55.07)	46.38	(45.40;47.35)	
PT	M	54.22	(53.25;55.19)	51.19	(50.24;52.14)	53.49	(52.72;54.25)	48.64	(47.79;49.50)	55.33	(54.35;56.32)	48.69	(47.68;49.70)	42.20	(41.53;42.87)	46.32	(45.57;47.07)	50.47	(49.46;51.48)	42.82	(41.83;43.81)
		54.65	(53.73;55.58)	51.62	(50.71;52.53)	53.11	(52.38;53.85)	48.27	(47.44;49.10)	54.30	(53.37;55.23)	47.65	(46.67;48.64)	41.24	(40.59;41.88)	45.36	(44.64;46.09)	51.87	(50.90;52.84)	44.22	(43.26;45.18)
	54.65	(53.73;55.58)	51.62	(50.71;52.53)	53.11	(52.38;53.85)	48.27	(47.44;49.10)	54.30	(53.37;55.23)	47.65	(46.67;48.64)	41.24	(40.59;41.88)	45.36	(44.64;46.09)	51.87	(50.90;52.84)	44.22	(43.26;45.18)	

Note. Entries in bold faces are higher or lower than normal values.

men: 43.1; LLFS women: 42.1) and higher in extraversion (BLSA: 48.8; LLFS men: 55.8; LLFS women: 54.8), agreeableness (BLSA: 50.4; LLFS men: 56.2; LLFS women: 56.7), and conscientiousness (BLSA: 50.8; LLFS men: 52.8; LLFS women: 52.5). We compared the LLFS proband generation fitted mean at age 95 for the BU site to the BLSA mean scores for ages 80–100 (mean age 84.1) and found that LLFS proband generation participants scored lower in neuroticism (BLSA: 48.1; LLFS men: 47.2; LLFS women: 46.2) and openness (BLSA: 50.4; LLFS men: 44.7; LLFS women: 46.1) and higher in extraversion (BLSA: 44.7; LLFS men: 49.1; LLFS women: 48.1). In comparison to the cross-sectional study by McCrae, Martin, and Costa (2005), our age-related trends follow the same shape across the ages of 40 to 70 for all five domains, but the scores are notably lower in the LLFS cohort in the case of neuroticism and higher for extraversion. Similarly, LLFS age trends matched those from the BLSA study (Terracciano et al., 2005) for all domains except agreeableness across the age range of 40–90, with the LLFS cohort scoring lower across the age range on neuroticism and higher in extraversion.

A personality profile of low neuroticism and high extraversion, conscientiousness, and agreeableness has additional implications beyond reaching extreme old age. Personality factors have also been associated with many health outcomes. Lower levels of conscientiousness predicted worse self-rated physical health, self-reported blood pressure, and more work limitations after almost a decade long follow-up, whereas lower levels of neuroticism predicted better health outcomes (Turiano et al., 2012). Lower levels of conscientiousness and higher neuroticism and also higher extraversion have been associated with higher BMI (Sutin, Ferrucci, Zonderman, & Terracciano, 2011). Furthermore, those with higher neuroticism or lower conscientiousness showed greater weight change over follow-up, and lower agreeableness was associated with greater increases in BMI. Those with low conscientiousness or high levels of a facet of neuroticism were found to have a less favorable lipid profile (Sutin, Terracciano, et al., 2010). Disease risk is also associated with personality factors. Higher neuroticism and lower agreeableness and conscientiousness have been associated with a greater chance of metabolic syndrome (Sutin, Costa, et al. 2010). Studies have also shown that the risk of developing Alzheimer’s disease was increased for those who were lower in conscientiousness and openness and higher in neuroticism (Duberstein et al., 2011) and, in particular, for the facets of anxiety and vulnerability within the neuroticism domain (Wilson, Begeny, Boyle, Schneider, & Bennett, 2011). Physical function has also been shown to be associated with personality factors. Suchy, Williams, Kraybill, Franchow, and Butner (2010) found that higher neuroticism was associated with self-reported IADL difficulties and lower agreeableness was associated with performance-based IADL difficulties. Lower conscientiousness has been associated with slower

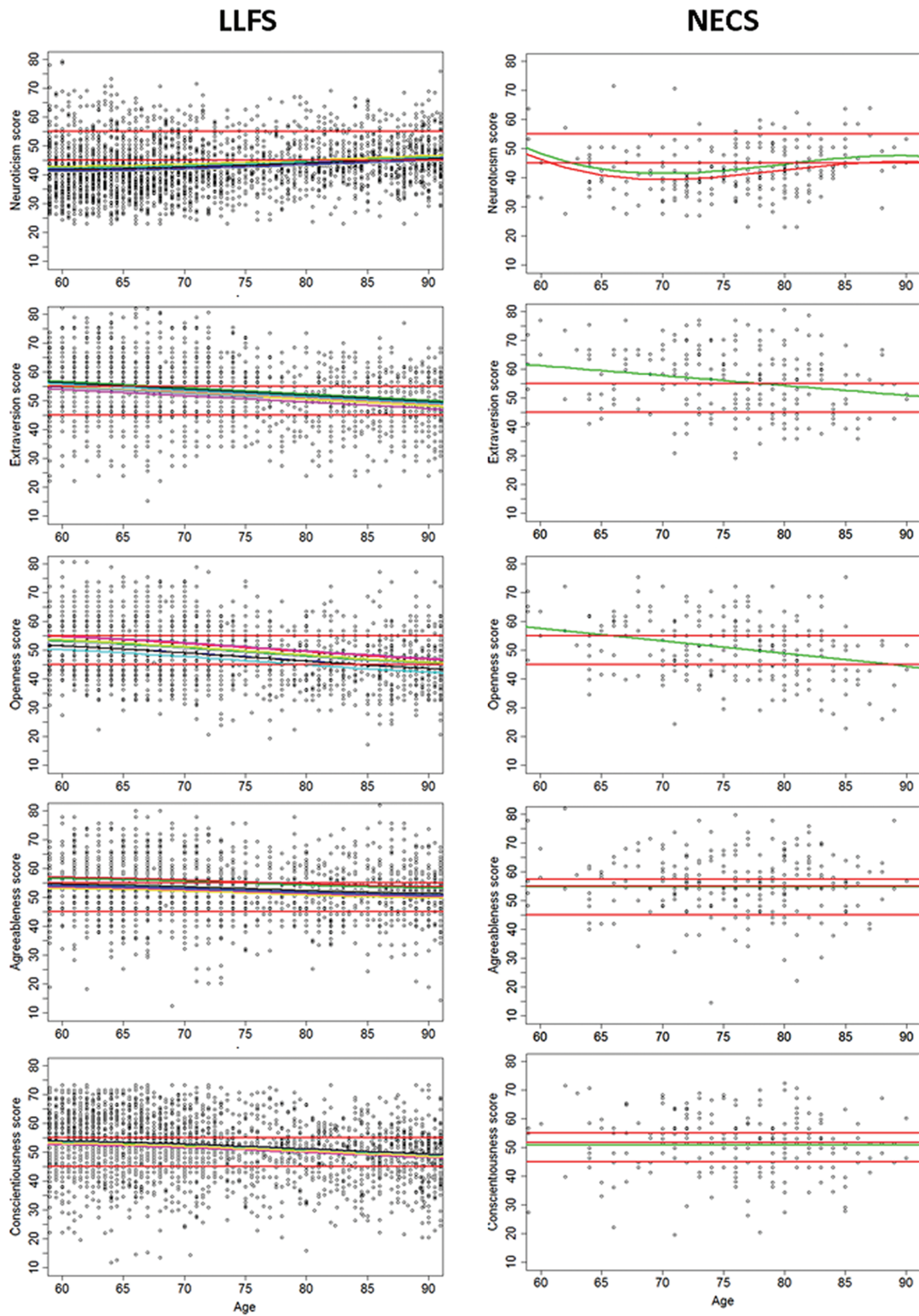


Figure 2. Scatter plots of NEO scores (T-score on the y-axis) for the five domains included in the NEO-FFI versus age (x-axis) in participants of the LLFS with ages between 60 and 90 years (left panel) and offspring of the NECS in the same age range (right panel). Coding for the colored lines in the left panel is as in Figure 1. The colored lines in the right panel represent the fitted values by gender in NECS offspring (red = women, green = men). In all plots, the area between the red horizontal lines at 45 and 55 indicates the normal range for T-score values.

walking speed and a greater decline in walking speed over a 3-year follow-up period (Tolea, Costa, et al., 2012), and lower openness scores have been associated with the development of walking limitations due to health or physical impairment (Tolea, Ferrucci, et al., 2012). Studies of cognitive and mental health have shown associations with personality. Graham and Lachman (2012) found that higher neuroticism, extraversion, and agreeableness were related to poorer cognitive function, whereas higher openness was related to better cognitive function. Higher neuroticism has been shown to be associated with lower emotional well-being and greater negative affect (Ready, Akerstedt, & Mroczek, 2011). However, the association between personality and mortality and other health outcomes may be mediated through the effect of personality on daily health and social habits. Traits indicating higher conscientiousness were associated with lower rates of unhealthy habits such as drug and alcohol use, risky driving, and unhealthy eating (Bogg & Roberts, 2004) and more health maintaining habits such as healthy eating and engaging in physical activity (Lodi-Smith et al., 2009). Lower levels of neuroticism and higher levels of extraversion have been found to be associated with higher levels of physical, social, and cognitive activity (Wilson et al., 2005). A study by Jerant, Chapman, Duberstein, Robbins, and Franks (2011) found that neuroticism was negatively correlated with medication adherence among older adults. However, controlling for education and health habits reduces but does not completely eliminate the association between conscientiousness and health (Lodi-Smith et al., 2009). Other studies have also found that adjusting for health habits does not eliminate the association between personality traits and mortality (Fry & Debats, 2009; Terracciano et al., 2008).

Spouses of Long-Lived Family Members

This study found no statistical differences in the five personality domain scores of long-lived family members compared with the spouses (see [Supplementary Figure 1](#)). In the proband generation, the spouses are also long lived so it is not surprising that they may share many of the same personality characteristics as the long-lived family members. Those spouses who did not have personality traits conducive to longevity may not have been available for the study due to mortality. In contrast, the spouses of the offspring generation are not subjected to this selection bias, yet they shared similar personality profiles with the LLFS offspring. One possibility for this finding is that people marry others with similar personalities as suggested by McCrae and colleagues (2008).

Age Trends

Although personality was initially believed to be stable across the life span, there has been evidence that changes in personality across age cohorts and longitudinal follow-ups

do exist. A 12-year longitudinal study of men found significant between-person and within-person changes on measures of extraversion and neuroticism, indicating that personality profiles do change over time (Mroczek & Spiro, 2003). Furthermore, rates of personality change varied across age groups. A large study of participants aged 17–84 found decreasing stability of personality after the age range of 60–70, indicating that older age groups show greater personality change over time (Lucas & Donnellan, 2011). However, another study found that the majority of participants with stable personality traits were more likely to be from older age groups (Graham & Lachman, 2012). Similarly, a meta-analysis of longitudinal studies found that stability is highest after the fifth decade of life (Roberts & DelVecchio, 2000). Interestingly, the BLSA found that rank-order consistency was not associated with age (Terracciano, Costa, & McCrae, 2006). However, it is conceivable that nonagenarians and centenarians may have different personality profiles than when they were younger regardless of evidence of increasing stability in older adulthood. Our results of significant age trends across all five domains show that personality varies by age even among the oldest old adults, but this study does not allow us to address change within individuals as they age.

A meta-analysis of longitudinal studies of personality traits found that agreeableness, conscientiousness, and emotional stability (the inverse of neuroticism) increase with age across the adult life span and openness to experience decreases in older age (Roberts, Walton, & Viechtbauer, 2006a). However, these studies consisted of adults younger than the average age of the proband generation of the LLFS. Studies comparing personality at different ages among older adults have found that extraversion, openness, and conscientiousness are lower in the oldest adult age groups compared with younger adult age groups, whereas mixed results are seen for neuroticism/emotional stability and agreeableness (Lucas & Donnellan, 2011; Specht, Egloff, & Schmukle, 2011; Terracciano et al., 2005). Consistent with previous studies and extending the age trends up to age 110, we found evidence of lower extraversion, openness, and conscientiousness in the oldest old LLFS participants compared with the offspring generation. In agreement with age trends up to 90 years presented by Terracciano and colleagues (2005) but in contrast to the age trends up to 80 years presented by Specht and colleagues (2011) and age cohorts up to 85 years presented by Lucas and Donnellan (2011), we found that neuroticism was higher at the oldest ages compared with younger adults. In the domain of agreeableness, we found that the oldest adults scored lower than the younger adult age group as did Specht and colleagues (2011), whereas Terracciano and colleagues (2005) and Lucas and Donnellan (2011) found the reverse.

Personality change in old age is not unexpected. Lifestyle changes, differences in outlook, the onset of physical limitations, the loss of friends and family members, changes

in cognitive function, and changing social and work roles can precipitate personality change. A study of personality change in response to major life events found that those who got married showed a decline in extraversion and openness following the marriage, whereas those who separated became more agreeable and those who divorced became more conscientious (Specht et al., 2011). A study of men found that those who had recently married or remarried had faster declines in neuroticism over the following 10 years, whereas those whose spouse died had higher neuroticism and a faster decline in neuroticism than those who did not lose a spouse (Mroczek & Spiro, 2003). Additionally, changing work roles, as indicated by retirement, have been associated with a decrease in conscientiousness (Specht et al., 2011). However, research has also shown that baseline personality features have an effect on one's environment. Specht and colleagues (2011) found that those with lower neuroticism had fewer negative life events and those with higher extraversion had more positive life events over the next 4 years. Therefore, personality traits may be shaped by one's life events, but in turn those with preferable personality traits may also experience fewer negative events.

We must also consider that differences in personality scores across ages may not simply reflect a change in personality with increasing age. Cohort effects also likely play a role as changes in social norms and culture occur over time. Meta-analyses of studies of personality have found cohort effects for the domains of neuroticism, extraversion, agreeableness and conscientiousness such that people born in different cohorts and, therefore, subjected to different environmental and social conditions had differing personality profiles (Roberts et al., 2006a; Twenge, 2000, 2001). Additionally, a longitudinal study of men found cohort effects in the domains of extraversion and neuroticism (Mroczek & Spiro, 2003), and a study by Smits, Dolan, Vorst, Wicherts, and Timmerman (2011) found cohort effects among college freshmen spanning 25 years in the domains of agreeableness, conscientiousness, and neuroticism. The latter study also noted that the personality questionnaire items with the greatest cohort effects were those that may have been affected by changes in social conventions.

The meta-analysis by Twenge (2000) found that neuroticism was higher in later cohorts of college students, indicating that neuroticism is increasing in successive generations. In contrast, a study of aging found that later cohorts scored lower in neuroticism and higher in conscientiousness (Terracciano et al., 2005). In line with these findings, our results show lower neuroticism and higher conscientiousness among the offspring generation in comparison to older participants. In the domain of extraversion, Twenge (2001) found higher extraversion in later college-age cohorts. This trend is in agreement with the results across increasing ages in the LLFS and NECS cohorts. Therefore, we cannot rule

out that some of the differences in neuroticism, conscientiousness, and extraversion scores between the younger and older adults may be due to cohort effects. Furthermore, due to the cross-sectional nature of this study, we cannot parse out the contribution of cohort effects on the age trends that are reported.

Education level might also explain some of the differences in personality scores across ages. In our sample, the offspring generation had more years of education on average than the proband generation. Higher education has been associated with higher scores in openness (Costa & McCrae, 1992). In addition, Rammstedt, Goldberg, and Borg (2010) found different response patterns on personality measures in individuals with low educational attainment versus those with higher education.

Reliability of the NEO-FFI in the Oldest Old

This study demonstrated high test-retest reliability of the NEO-FFI in the oldest age groups as indicated by the high correlation between repeated measures. At baseline, we tested only two domains (neuroticism and conscientiousness) of the NEO-FFI to reduce participant burden. However, as our results indicate significant age trends across all five domains in conjunction with evidence that this questionnaire is reliable in older adults, we suggest that a full assessment of personality is warranted in studies of longevity and the oldest old.

Limitations

This study has several limitations. Most notably, as this is a cross-sectional study, associations between long-lived family members and personality profiles cannot be taken to denote causality. A personality profile of low neuroticism and high extraversion in the offspring generation cannot be inferred to predict longevity. Prospective studies are needed to explore causality.

Secondly, differences in findings from other studies may be related to differences in personality measures. A meta-analysis of studies investigating conscientiousness and longevity found that studies using the NEO-FFI demonstrated a stronger effect than studies using other personality measures (Kern & Friedman, 2008). Personality measures from different tests, no doubt, have different levels of specificity for various traits.

Along the same lines, the use of the shorter NEO-FFI rather than the full personality assessment of the NEO PI-R may be a limitation. Individual facets of each personality domain, which can only be assessed with the NEO PI-R, may show differences across ages that the domains cannot detect. One study found that although the domain of extraversion showed no longitudinal trend across a follow-up period, two individual traits within the domain of extraversion showed opposite trends such that gregariousness

decreased and assertiveness increased over time (Soto & John, 2012). Similarly, Roberts and colleagues (2006a) found that two components of extraversion, social vitality and social dominance, had different patterns of change across age groups. However, McCrae and colleagues (2005) and Terracciano and colleagues (2005) found that age trends for facets generally followed the domain age trends with some notable exceptions in the domains of openness and extraversion.

Another limitation of this study may be that statistical differences among cohorts may not relate to clinical differences. It is unknown how much of an increase or decrease in a particular personality domain relates to a clinical change, and in fact, what constitutes significant change in personality has been debated (Costa & McCrae, 2006; Roberts et al., 2006a; Roberts, Walton, & Viechtbauer, 2006b). In this study, we chose to use T-scores to better interpret differences in personality across ages and for ease in comparison with normal-range scores. However, the normative data used to generate the normal-range scores may not be valid for the proband generation participants who have an average age of 91 as the cohorts used to generate normative data were much younger. Normative data for personality scores of the oldest old would facilitate interpretation of personality in unique cohorts such as the LLFS.

Future Directions

Based on our results of lower neuroticism and higher extraversion in the offspring generation of this cohort compared with normative data, it is suggested that a future study of personality in the LLFS should explore genetic underpinnings of personality domains. Additionally, an analysis of personality profiles rather than individual analyses of each personality domain may reveal stronger associations. For example, Friedman, Kern, and Reynolds (2010) looked at interactions between personality domains and found that women with high conscientiousness and low neuroticism had the lowest probability of death after 70 years of follow-up. Perhaps a key to achieving exceptional survival is related to a favorable personality profile. Finally, the offspring generation of the LLFS affords the opportunity for longitudinally following these individuals over time to assess the stability or change in personality with increasing age in a cohort that is predisposed for exceptional longevity.

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SUPPLEMENTARY MATERIAL

Supplementary material can be found at: <http://psychogerontology.oxfordjournals.org/>

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