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Neuroticism, Extraversion, and Motor Function in Community-Dwelling Older Persons

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Abstract

Objective—Personality traits are associated with adverse health outcomes in old age, but their association with motor function is unclear. We tested the hypothesis that neuroticism and extraversion are associated motor decline in older persons.

Design—Prospective, observational cohort study.

Setting—Retirement communities across metropolitan Chicago.

Participants—983 older persons without dementia.

Measurements—At baseline, neuroticism and extraversion were assessed and annual assessment of 18 motor measures were summarized in a composite measure.

Results—Average follow-up was 5 years. Separate linear mixed-effects models controlling for age, sex and education showed that baseline levels of neuroticism and extraversion were associated with the rate of motor decline. For each 7- point (~1SD) higher neuroticism score at baseline, the average annual rate of motor decline was more than 20% faster. This amount of motor decline was associated with a 10% increased risk of death as compared to a participant with an average neuroticism score. Each 6- point (~1SD) lower extraversion score at baseline was associated with an 8% faster rate of motor decline. This amount of motor decline was associated with about 9% increased risk of death as compared to a participant with an average extraversion score. Neuroticism and extraversion were relatively independently associated with motor decline. These associations were unchanged when controlling for depressive symptoms and current health status, but were partially attenuated when controlling for late-life cognitive and social activities.

Conclusions—Higher levels of neuroticism and lower levels of extraversion are associated with more rapid motor decline in old age.

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Keywords

Personality; Neuroticism; Extraversion; Aging; Motor Decline

INTRODUCTION

A growing body of evidence suggests that psychosocial factors are important determinants of healthy aging. Prior studies have reported that personality traits are associated with the risk of death,[1-3] incident disability,[4] cognitive decline and risk of Alzheimer's disease.[5-7] Declining motor function such as reduced strength or slower walking is a common concomitant of aging and is increasingly recognized as an important barrier to the maintenance of independence and well-being in old age.[8-10] Yet, the relationship between personality traits and physical or motor function has received little focus, although some cross-sectional studies have reported that personality traits such as neuroticism and extraversion are related to levels of physical activity and walking speed.[11, 12] However, little is known about the association of neuroticism and extraversion with objective motor performance measures or the extent to which these personality traits are associated with longitudinal changes in motor function in advanced age.

We used data from 983 non-demented older participants in the Rush Memory and Aging Project, a community-based longitudinal study of chronic conditions of aging, to test the hypothesis that neuroticism and extraversion are related to the annual rate of change in motor function in old age.[13] Participants completed standard self-report questionnaires on neuroticism and extraversion at baseline and underwent annual detailed motor examinations for up to 12 years.[14, 15] We examined the associations of neuroticism and extraversion with the annual rate of change in motor function via a series of linear mixed-effect models adjusted for age, sex, and education. Next, we examined whether depressive symptoms, current health status or patterns of participation in late-life cognitive, social and physical activities might affect these associations.

METHODS

Participants

Participants were recruited from about 40 retirement facilities and subsidized housing facilities, as well as from church groups and social service agencies in northeastern Illinois. All participants signed an informed consent agreeing to annual clinical evaluation. In addition, all participants signed an anatomical gift act donating their entire brain and spinal cord, as well as selected nerves and muscles, to Rush investigators at the time of death. The study was in accordance with the latest version of the Declaration of Helsinki and was approved by the Rush University Medical Center institutional review board.[13]

At the time of these analyses, 1288 participants had enrolled and completed a baseline evaluation. Eligibility for these analyses required: 1) the absence of clinical dementia, at the baseline evaluation; 2) a valid assessment of neuroticism and extraversion at baseline; and 3) a baseline motor evaluation and at least one follow-up evaluation in order to assess change in motor function. We excluded 260 participants which included 72 persons who met criteria for dementia at baseline; 87 who had incomplete motor, cognitive or personality data at baseline and 101 persons who had completed a baseline evaluation but did not have a second evaluation either because they died before their first follow-up examination or because they had not been in the study long enough for follow-up evaluation. Of the 1028 with complete baseline data and therefore eligible for these analyses, 45 (4.4%) had missing follow-up data leaving 983 for these analyses. Mean follow-up for these participants was 5.1 years (SD, 2.45; range 0.4, 12 years). Overall, participants included in these analyses (N=983) were younger, more likely to be female, had better global cognitive and motor function, and had fewer depressive symptoms as compared to participants excluded from these analyses (N=305). The groups did not differ with respect to education, BMI, vascular risk factors and diseases (results not shown).

Clinical Diagnoses

Clinical diagnoses were made using a multi-step process, as previously described.[13] Cognitive function testing included 19 performance tests were summarized into a composite measure of global cognition as described previously.[13] Participants were then evaluated in person by an experienced physician who diagnosed dementia,[16] stroke,[17] or Parkinson's disease[18] or other neurological and psychiatric disorders based on published criteria.

Assessment of Neuroticism and Extraversion

Two measures of personality were available at the baseline interview. Six items (item numbers 1, 6, 26, 91, 136, 221; e.g., I often feel inferior to others) from the neuroticism scale of the NEO Personality Inventory-Revised were administered at baseline and used as a measure of proneness to psychological distress.[19] Extraversion, the tendency to be sociable, active, and optimistic, was assessed with six items (items 37, 67, 122, 177, 227 and 237; e.g., I like to have a lot of people around me) from the extraversion scale of the same inventory. The participant rated each item on a five-point scale (0 to 4), with higher scores indicating a higher level of the trait. The total score was computed by adding the item scores and then multiplying the sum by two to make the score comparable to standard 12-item versions of these scales. [19] Cronbach's coefficient alpha was 0.74 for the neuroticism measure and 0.67 for the extraversion measure; indicating adequate internal consistency. In 1055 participants without dementia in the Rush Religious Orders Study, the correlations of the standard 12–item measures for neuroticism and extraversion with the 6-item subsets used in the current study were 0.90 [df=1053] ($p<0.001$) for neuroticism and 0.91[df=1051] ($p<0.001$) for extraversion, supporting the validity of the 6-item scales used in the current study.[5, 7]

Assessment of Motor Function

Strength measures for the following muscle groups including grip, pinch, arm abduction, arm flexion, arm extension, hip flexion, knee extension, plantar flexion, and ankle dorsiflexion were collected bilaterally as previously described.[15] Time and number of steps to walk 8 feet and turn 360° were measured. Time to stand on each leg and then on toes for 10 seconds was recorded. We counted the number of steps off line when walking an 8 foot line in a heel to toe manner. We also measured the number of pegs that could be placed (Purdue pegboard) in 30 seconds and the rate of index finger tapping for 10 seconds (Western Psychological Services, Los Angeles, CA) bilaterally. A composite measure of global motor function was constructed by converting the raw score from each measure to z scores and averaging z scores of all 18 motor tests together as previously described.[15] The composite motor measure and its components used in these analyses have been shown to be related to a number of adverse health outcomes including death, disability, dementia and cognitive decline.[15, 20, 21]

Assessment of Other Covariates

Sex was recorded at the baseline interview. Age in years was computed from self-reported date of birth, and date of the baseline clinical examination was that at which the strength measures were first collected. Education (reported highest grade or years of education) was obtained at the time of the baseline cognitive testing. Depressive symptoms over the prior week were assessed with a 10-item version of the Center for Epidemiologic Studies Depression (CES-D) scale.[22] Weight and height were measured and recorded at each visit and BMI was calculated as weight in kilograms divided by height in meters squared. As previously described,[23] the number of 3 self-reported vascular risk factors (i.e. hypertension, diabetes mellitus, and smoking), and the number of 4 self-reported vascular diseases (i.e., myocardial infarction, congestive heart failure, claudication and stroke) were used in these analyses.[23] Frequency of participation in cognitively stimulating activities was quantified with a scale, wherein people rated how often they had participated in each of 7 cognitive activities (e.g., reading a newspaper) over the past year. [24] Frequency of participation in social activity was based on 6 items about activities involving social interaction over the past year. [15] Physical activity was assessed using questions adapted from the 1985 National Health Interview Survey. Minutes spent engaged in each activity were summed and expressed as hours of activity/week. [25]

Statistical Analyses

We first examined the bivariate associations of personality traits and global motor with several other covariates. We next used separate mixed-effect models[26] to assess the relation of neuroticism and then of extraversion with the baseline level of global motor and its annual rate of change. The core model for neuroticism included terms for time in years since baseline, as well as terms, for neuroticism at baseline and a term for its interaction with time since baseline. An initial model included quadratic terms for non-linear change in global motor scores which were not significant and therefore not retained in subsequent analyses. The term for Time indicates the average annual rate of change in global motor score for a typical participant with a mean neuroticism score of 15; the term for neuroticism indicates the average difference in motor function at baseline associated with a 1- point difference in neuroticism score; and the interaction of neuroticism with time indicates the effect of a 1-point difference in neuroticism score on the annual rate of change in global motor scores. To control for demographic variables, all models included terms for age, sex, and education and their interactions with time. In subsequent models, we added interaction terms to determine if the association of neuroticism and global motor scores varies by age, sex, and education. Similar models were employed using extraversion. Then we examined whether depressive symptoms, several measures of current health status including BMI, vascular risk factors and diseases as well as levels of self-reported participation in cognitive, social and physical activities, affected the association of personality traits and motor decline. Finally, to determine the clinical significance of the amount of change in motor decline related to personality, we constructed Cox proportional hazards models examining the rate of motor decline and risk of death estimating the hazard ratios associated with a given unit of change. These models controlled for age, sex, education, and baseline global motor function. For these analyses we used ordinary least squares regression to estimate the annual rate of change in global motor function for each person. Models were examined graphically and analytically and assumptions were judged to be adequately met. *A priori* level of statistical significance was 0.05. Programming was done in SAS version 9.2 (SAS Institute Inc, Cary, NC).[27]

RESULTS

Descriptive Properties of Personality Measures

The characteristics of the cohort at baseline are included in Table 1. Baseline neuroticism scores ranged from 0 to 44 with higher values indicating higher level of this trait. The neuroticism scores were approximately normally distributed (mean, 15.17; SD, 7.09). Neuroticism was higher in women (mean 15.8; SD, 7.12) versus men (mean 13.2; SD,6.66) [t (981)= -5.02, p<0.001]. Neuroticism was associated with education (Rho -0.25 [df_{981}], p<0.001) and depressive symptoms (Rho 0.44 [df_{981}], p<0.001) but not with age, BMI, vascular risk factors or diseases (results not shown).

Baseline extraversion scores ranged from 10 to 48 with higher values indicating more extraversion. The extraversion scores were approximately normally distributed (mean, 31.62; SD, 6.08). Extraversion did not vary by sex [t (981) = 0.96, p=0.340]. Extraversion was associated with age (Rho -0.10 [df_{981}], p<0.001), depressive symptoms (Rho -0.19 [df_{981}], p<0.001) and BMI (Rho -0.10 [df_{961}], p<0.05), but not with education, vascular risk factors or diseases (results not shown).

Neuroticism and Change in Motor Function

Baseline global motor scores ranged from -2.11 to 1.99 (mean -0.05; SD, 0.57). Men had higher global motor scores (mean 0.25; SD, 0.57) versus women (-0.02; SD, 0.56) [t (981) = -6.33, p<0.001]. We used a linear mixed - effects model controlled for age, sex, and education to test the hypothesis that the baseline level of neuroticism was associated with the rate of motor decline. On average, annual global motor scores declined (Time, Table 2, Model A). Baseline neuroticism was associated with the level of global motor scores (Neuroticism, Table 2) as well as the annual rate of motor decline (Neuroticism × Time, Table 2, Model A). Thus, for each 7- point (1 SD) higher neuroticism score at baseline, the average rate of decline in global motor score was more than 20% faster. Additional analyses showed that the association of neuroticism with motor decline (Neuroticism × Time) did not vary by age, sex or education (results not shown).

Extraversion and Change in Motor Function

Using similar models, extraversion at baseline was associated with the rate of motor decline (Table 2, Model B). For each 6 point (1 SD) lower extraversion score at baseline, the average rate of decline in global motor was nearly 8% faster. Additional analyses showed that the association of extraversion with motor decline (Extraversion × Time) did not vary by age, sex or education (results not shown).

Neuroticism and Extraversion Together and Change in Motor Function

We first examined whether neuroticism and extraversion were associated with motor decline when both were included in a single model. Results indicated that both neuroticism and extraversion were relatively independently associated with motor decline because the terms for both neuroticism and extraversion showed statistically significant coefficients for both predictors, although the magnitude and significance of the slope coefficients are slightly reduced in the combined model C relative to the single trait models A and B (Table 2).

Next, we examined whether extraversion might modify the association of neuroticism and motor decline by adding an interaction term to the previous model. The association between neuroticism and motor decline did not vary by extraversion (Time × Neuroticism × Extraversion, Coefficient= <0.0001 (S.E.= <0.001, Wald x^2 0.01 [df=1], p=0.563).

Personality, Current Health Status and Change in Motor Function

Based on the association between depressive symptoms and personality traits, we examined whether depressive symptoms might affect the associations of personality and motor decline. The association of neuroticism with motor decline was not affected when we added terms for depressive symptoms (Neuroticism × Time, Coefficient=-0.0015 (S.E.= 0.001, Wald x^2 0.04 [df=1], p=0.007). Similarly, the association of extraversion with motor decline remained when we added terms for depressive symptoms (Extraversion × Time, Coefficient= 0.0016 (S.E., 0.001, Wald x^2 0.04 [df=1], p = 0.004).

In further analyses, we examined whether the association of personality with motor decline was affected by current health measures. We repeated the core model (Table 2, Model A), adding terms for BMI and BMI squared (because both very low and very high body mass affect health) as well as for vascular risk factors including smoking and vascular diseases first in separate analyses and then together in a single model. Adding these measures of current health status did not change the association of neuroticism and motor decline (Neuroticism × Time, Coefficient= -.0014 [S.E.= 0.001, p=0.005]). A similar model showed that the association of extraversion with motor decline was not affected when we included terms for current health measures (Extraversion × Time, Estimate, -.0019 [S.E. = 0.001, p<0.001]).

Personality, Late-Life Activities and Change in Motor Function

In prior work in this cohort, we have shown that higher levels of late-life activities are associated with a slower rate of motor decline.[15, 25] Personality traits may influence health outcomes like motor function through lifestyle choices and participation patterns in a range of late-life activities. We examined whether of the levels of late-life cognitive, social, and physical activities might mediate the association of personality traits and the rate of motor decline. We repeated the core model for neuroticism (Table 2, Model A) but added additional terms for the levels of cognitive, social, and physical activities and their interaction with Time in separate models. As shown in Table 3, higher levels of each of these activities were associated with a slower rate of motor decline (Table 3, Late-Life Activity × Time). Thus, the association of neuroticism with rate of change in motor function was reduced by 31% after adjusting for cognitive activity (Table 3, Model B), by 38% after adjusting for social activity (Table 3, Model A) and by 8% after adjusting for physical activity (Table 3, Model C). We repeated this series of analyses for the measure of extraversion with similar results (Table 4); the association of extraversion and the rate of change in motor function was reduced by 15% after adjusting for cognitive activity (Table 4, Model B) by 46% after adjusting for social activity (Table 4, Model A) and by 8% after adjusting for physical activity (Table 4, Model C).

In further analyses, we examined whether the level of late-life activities might modify the associations of personality and motor decline by adding an interaction term to each of the models in Table 3 & 4. We found that the association of personality traits and the rate of change in global motor score did not vary with the frequency of participation in cognitive, social or physical activities (results not shown).

Clinical Significance of the Loss of Motor Function Associated with Personality

To determine the clinical significance of the increased rate of decline of global motor scores associated with a 7-point (about 1 SD) increased neuroticism score at baseline (Neuroticism * Time, Model A, Table 2), we constructed Cox proportional hazards models examining the association of change in motor function with death and subsequently estimated the hazard ratios associated with increased annual motor decline, (i.e., the amount of change in global motor scores associated with a 7-point higher baseline neuroticism score [~1 SD)). From these models (data not shown), we calculated that a 7-point increased neuroticism score at baseline was associated with about 10% increased risk of death as compared to a participant with an average neuroticism score (Hazard Ratio: 1.094; 95% CI: 1.081,1.101). A similar analysis was used to examine the association of extraversion and motor decline. A 6 point lower baseline extraversion score [~1 SD)) was associated with a 9% increased risk of death.

DISCUSSION

We examined the relation of neuroticism and extraversion to the rate of change in motor function during an average follow-up of 5 years in almost 1000 community-dwelling older persons without dementia. These two personality traits were independently associated with the rate of change in motor function, such that a higher level of neuroticism and a lower level of extraversion were associated with more rapid motor decline. These associations persisted even after adjustment for depressive symptoms and measures of current health status, but, were reduced when we controlled for levels of participation in late-life cognitive and social activities. Together these data suggest that personality is associated with the level and rate of motor decline in community-dwelling older persons. In addition, patterns of participation in late-life activities may partially account for the association of personality with motor function in older persons.

Decline in motor function is a familiar concomitant of aging and is associated with loss of independence and adverse health consequences.[20, 28, 29] Thus, in our aging population, motor decline poses a rapidly growing public health challenge. Although risk factors for common diseases known to cause motor dysfunction such as cerebrovascular disease are recognized, little is known about risk factors for motor decline which could be translated into potential public health or clinical interventions.[25] Previous research on the relation of neuroticism and extraversion with motor function in older persons has been sparse and limited to cross-sectional studies. Some but not all cross-sectional studies have reported associations between the personality traits, neuroticism or extraversion with physical activity, a well-known risk factor for motor decline[11, 30] Further, one recent study reported an association between extraversion and walking speed.[12] The current study extends previous reports in several important ways. First, we provide evidence that neuroticism and extraversion are associated with the rate of change in motor function over time in older persons tested annually for up to 12 years. Second, the motor measure used in the current study was based on annual structured assessment of a broad range of objective motor performances which have previously been demonstrated to be associated with a number of adverse health outcomes.[15, 20] Third, we show that when neuroticism and extraversion are considered together in the same model, both traits contribute to the prediction of motor decline. Fourth, the association between both personality traits and motor decline persisted even after controlling for depressive symptoms and current health status, but were partially attenuated when controlling for the frequency of participation in several late-life activities. These results have important translational implications as they suggest that personality traits need to be considered for our understanding of individual differences in motor decline as well as for the design and testing of strategies to decrease the burden of motor impairment in our rapidly aging population.

The basis of the association between personality and motor decline is uncertain and likely complex. Controlling for depression and health status did not affect the associations between neuroticism and extraversion and motor decline, suggesting that other factors account for these associations. Recent work has suggested that psychological factors can be associated with motor performance (i.e., higher concern about falls is associated with slower gait speeds).[31] Furthermore, high levels of neuroticism and low levels of extraversion may lead to physiologic changes similar to those described for depression which may damage brain-related motor regions decreasing the brain's capacity to tolerate ongoing neurodegeneration.[32-35] A novel finding of this study is that controlling for the frequency of participation in late-life activities especially cognitive, and social activities reduced the associations of both neuroticism and extraversion with the rate of change in motor function. These findings might suggest that personality traits may be partially linked with motor function by lifestyle choices which affect patterns of late-life activities; thus these activities (rather than personality traits per se) may ultimately impact the level and rate of change in motor function. Recent brain imaging studies in older persons suggest a structural link between personality traits and motor function.[36-38] Both personality traits and motor function in older persons are preferentially associated with changes of the volume and cortical thickness of frontal lobe structures.[36-38] Furthermore, recent studies suggest that personality traits and motor function may also be linked at the biologic level. The beneficial brain effects of physical activity in older persons on motor function are thought to be mediated in part by increased neuronal plasticity through neurotrophins like BDNF.[39] Similarly, recent studies suggest that both neuroticism and extraversion are linked to genes and pathways which may regulate BDNF.[40, 41] Finally, a third unmeasured variable might affect both personality traits as well as motor function in old age and account for the associations observed in the current study. Further work is needed to clarify the biology underlying the association between personality traits and motor decline in older persons as well as the degree to which other psychological factors may be associated with motor decline in the elderly.

Our study has some limitations. Most importantly, inferences regarding causality must be drawn with great caution from observational studies. Furthermore, since personality was only measured at baseline, we cannot rule out correlated decline in both personality and motor function. Further, while some studies have suggested that personality traits are stable even in old age, others suggest personality changes somewhat with age but there are few studies which have focused on individuals older than 80 years.[42-46] Thus, while the findings were robust to potential confounding variables, the potential for reverse causality cannot be excluded. Other psychological symptoms such as anxiety were not measured and might confound our findings. Further, it is possible that a third unmeasured variable is related to both personality traits and motor decline. A precondition for participation in the current study is consent to annual exam and organ donation at death, so given the selected nature of the cohort, our findings will need replication in other cohorts.

However, several factors increase confidence in our findings. Perhaps most importantly, the study enjoys high follow-up participation reducing bias due to attrition. In addition, personality traits were assessed among persons without dementia and motor function was evaluated as part of a uniform clinical evaluation which incorporated many widely accepted and reliable strength and motor performance measures. Furthermore, strength and motor performance testing was done in all four extremities. In addition, a relatively large number of older persons representative of the general population was studied, so that there was adequate statistical power to identify the associations of interest while controlling for several potentially confounding demographic variables.

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Table 1

Demographics of the Cohort at Baseline (N=983)*

Variable	Mean (SD)
Age (years)	79.67 (7.36)
Sex (% male)	N=245 (24.87%)
Education (years)	14.42 (3.14)
Depressive Symptoms Score	1.33 (1.78)
BMI (kg/m2)	27.35 (5.25)
Vascular Risk Factors (sum)	1.15 (0.80)
Smoking	N= 395 (40.14%)
Diabetes	N= 132 13.40%
Hypertension	N= 603 (61.22%)
Vascular Diseases (sum)	0.35 (0.63)
Myocardial Infarction	N= 112 (11.38%)
Congestive Heart Failure	N= 41 (4.73%)
Claudication	N= 75 (7.61%)
Stroke	N= 82 (8.3%)
Cognitive Activity	3.15 (0.69)
Social Activity	2.61 (0.58)
Physical Activity	3.17 (3.71)

*Depressive Symptoms**: Modified 10 item CESD scale, a higher score indicates greater depressive symptomatology. **BMI**: Body mass index: weight in kilograms divided by height in meters squared. **Vascular Risk Factors**: sum of smoking, diabetes, and hypertension self-reported. **Vascular Diseases**: sum of myocardial infarction, congestive heart failure, claudication and stroke self-reported. **Cognitive Activity**: Self reported frequency of participation in 7 cognitive activities, a higher score indicates more frequent participation. **Social Activity**: Self-reported frequency of participation in 6 items about activities involving social interaction, a higher score indicates more frequent participation. **Physical Activity**: Self-reported frequency of participation in 5 physical activities (hours/week), a higher score indicates more frequent participation.

Table 2

Neuroticism, Extraversion and Change in Motor Function*

Terms	Model A Coefficient (S.E., p)	Model B Coefficient (S.E., p)	Model C Coefficient (S.E., p),
Time	-0.050 (0.009, p<0.001)	-0.130 (0.018, p<0.001)	-0.097 (0.023, p<0.001)
Age	-0.032 (0.002, p<0.001)	-0.032 (0.002, p<0.001)	-0.032 (0.002, p<0.001)
Age*Time	-0.004 (0.001, p<0.001)	-0.004 (0.001, p<0.001)	-0.004 (0.001, p<0.001)
Sex	0.243 (0.036, p<0.001)	0.266 (0.036, p<0.001)	0.250 (0.036, p<0.001)
Sex *Time	-0.061 (0.008, p<0.001)	-0.057 (0.008, p<0.001)	-0.059 (0.008,p<0.001)
Education	0.025 (0.005, p<0.001)	0.029 (0.005, p<0.001)	0.025 (0.005, p<0.001)
Education*Time	0.000 (0.001, p=0.969)	0.001 (0.001, p=0.599)	0.0001 (0.001,p=0.949)
Neuroticism	-0.009 (0.002, p<0.001)		-0.007 (0.002, p=0.003)
Neuroticism *Time	-0.0016 (0.001, p=0.002)		-0.0012 (0.001, p=0.028)
Extraversion		0.010 (0.003, p<0.001)	0.007 (0.003, p=0.007)
Extraversion*Time		0.0017 (0.001, p=0.002)	0.0013 (0.001, p=0.030)

Model A is based on a linear mixed-effect model which shows the annual rate of change in the global motor score (Time); the increase in average motor function with a 1-point higher score on the Neuroticism scale (Neuroticism) as well as the increase in the rate of change in motor function (Neuroticism * Time) and terms to control for age, sex and education and their interactions with Time. Significance was based on a t-statistic from the mixed-effect model. The degrees of freedom for the slope terms including the annual rate of change in Global Motor (Time) and the interaction of neuroticism with the annual rate of change in global motor (Global motor × Time) have 4451 degrees of freedom and the main effect terms each have 978 degree of freedom. Units of comparison: Time in years since baseline, age and education in years. *Model B* shows analogous results for extraversion and motor decline (4451 degrees of freedom for the interaction term and 978 degrees of freedom for the main effect terms). *Model C* includes terms for both neuroticism, extraversion and their interactions with Time (4450 degrees of freedom for the interaction term and 977 degrees of freedom for the main effect terms).

Table 3

Relation of Neuroticism, Late-Life Activities and Change in Motor Function*

Terms	Model A Coefficient (S.E., p)	Model B Coefficient (S.E., p)	Model C Coefficient (S.E., p)
Time	-0.117 (0.020, <0.001)	-0.113 (0.025, <0.001)	-0.058 (0.009, <0.001)
Neuroticism	-0.007 (0.002, <0.001)	-0.008 (0.002, 0.002)	-0.009 (0.002, <0.001)
Neuroticism *Time	-0.0013 (0.001, 0.010)	-0.0013 (0.001, 0.025)	-0.0015 (0.001, 0.003)
Social Activity	0.191 (0.027, <0.001)		
Social Activity *Time	0.024 (0.006, <0.001)		
Cognitive Activity		0.189 (0.027, <0.001)	
Cognitive *Time		0.018 (0.007, 0.010)	
Physical Activity			0.019 (0.004, <0.001)
Physical Activity *Time			0.002 (0.001, 0.025)

*Based on linear mixed-effect models which shows the annual rate of change in the global motor score (Time); the increase in average motor function with a 1-point higher score on the Neuroticism scale (Neuroticism) as well as the average increase in the rate of change in motor function (Neuroticism * Time) and with terms to control for social activity, age, sex, education and their interactions with Time. Significance was based on a t-statistic from the mixed-effect model. The degrees of freedom for the slope terms including the annual rate of change in Global Motor (Time) and the interaction of neuroticism with the annual rate of change in global motor (Global motor × Time) have 4450 degrees of freedom and the main effect terms each have 977 degrees of freedom. Units of comparison: Time in years since baseline, age and education in years. *Model B* shows analogous results with terms to control for cognitive activity and its interaction with Time (3486 degrees of freedom for the interaction terms and the main effect terms each have 866 degrees of freedom). *Model C* shows analogous results with terms to control for physical activity and its interaction with Time (4450 degrees of freedom for the interaction terms and the main effect terms each have 977 degrees of freedom).

Table 4

Relation of Extraversion, Late-Life Activities and Change in Motor Function*

Terms	Model A Coefficient (S.E., p)	Model B Coefficient (S.E., p)	Model C Coefficient (S.E., p)
Time	-0.169 (0.022, <0.001)	-0.187 (0.028, <0.001)	-0.131(0.018,<0.001)
Extraversion	0.005 (0.003, 0.054)	0.006 (0.003, 0.020)	0.008 (0.003,0.0010)
Extraversion *Time	0.0011 (0.001, 0.051)	0.0018 (0.001, 0.007)	0.0016 (0.001,0.005)
Social Activity	0.187 (0.028, <0.001)		
Social Activity *Time	0.022 (0.007, <0.001)		
Cognitive Activity		0.017 (0.004, <0.001)	
Cognitive *Time		0.002 (0.0010, 0.048)	
Physical Activity			0.017 (0.004, <0.001)
Physical Activity *Time			0.002 (0.001, 0.048)

*Based on linear mixed-effect models which shows the annual rate of change in the global motor score (Time); the increase in average motor function for a 1-point higher score on the Extraversion scale (Extraversion) as well as the average increase in the rate of change in motor function (Extraversion * Time) and controls for social activity, age, sex, education and their interactions with Time. Significance was based on a t-statistic from the mixed-effect model. The degrees of freedom for the slope terms including the annual rate of change in Global Motor (Time) and the interaction of neuroticism with the annual rate of change in global motor (Global motor × Time) have 4450 degrees of freedom and the main effect terms each have 977 degrees of freedom. Units of comparison: Time in years since baseline, age and education in years. *Model B* shows analogous results with terms to control for cognitive activity and its interaction with Time (3486 degrees of freedom for the interaction terms and the main effect terms each have 866 degrees of freedom); *Model C* shows analogous results with terms to control for physical activity and its interaction with Time (4450 degrees of freedom for the interaction terms and the main effect terms each have 977 degrees of freedom).