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Personality Stability Is Associated With Better Cognitive Performance in Adulthood: Are the Stable More Able?

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Objectives. Although personality is relatively stable over time, there are individual differences in the patterns and magnitude of change. There is some evidence that personality change in adulthood is related to physical health and longevity. The present study expanded this work to consider whether personality stability or change would be associated with better cognitive functioning, especially in later adulthood.

Method. A total of 4,974 individuals participated in two waves of The Midlife in the United States Study (MIDUS) in 1994–1995 and 2004–2005. Participants completed the MIDUS personality inventory at both times and the Brief Test of Adult Cognition by Telephone cognitive battery at Time 2.

Results. Multiple regression and analysis of covariance analyses showed that, consistent with predictions, individuals remaining stable in openness to experience and neuroticism had faster reaction times and better inductive reasoning than those who changed. Among older adults, those who remained stable or decreased in neuroticism had significantly faster reaction times than those who increased.

Conclusions. As predicted, personality stability on some traits was associated with more adaptive cognitive performance on reasoning and reaction time. Personality is discussed as a possible resource for protecting against or minimizing age-related declines in cognition.

Key Words: Aging—Cognitive performance—Personality change.

Background

Research shows that personality is relatively stable in adulthood, yet there are individual differences in the degree and direction of change (Roberts, Walton, & Viechtbauer, 2006). There is some evidence that personality changes in a socially desirable direction may be adaptive for physical health and longevity (Mroczek & Spiro, 2007; Turiano et al., 2011). Although personality has been well documented as a significant correlate of cognitive performance (Meier, Perrig-Chiello, & Perrig, 2002) across the adult life span (Baker & Bichsel, 2006; Willis & Boron, 2008), few studies have examined whether the patterns and magnitude of personality change or stability are related to cognitive performance. The objectives of the current study were to examine individual differences in the stability and change of personality traits in relation to cognitive performance and to consider whether this relationship varies by age.

Both personality and cognition are core aspects of adult behavior and functioning, and some have considered intellectual abilities to be a subcomponent of personality (Ackerman & Rolfhus, 1999; Cattell, 1943). A number of studies have shown that there are associations between these two major domains, especially using the five-factor model of personality traits and a wide range of cognitive dimensions. A large body of literature has established age-related declines in cognitive abilities including short-term memory, verbal fluency, executive functioning, episodic and working memory, as well as reaction time. Even though, on average, abilities decline, there are individual differences in the magnitude and patterns of change (Salthouse & Ferrer-Caja, 2003). More work is needed to understand individual difference factors such as personality traits that could be related to such variations in cognitive aging. Personality may serve as a protective resource or a source of vulnerability when it comes to changes in cognitive performance (Costa & McCrae, 1997; Costa, Metter, & McCrae, 1994; Kranz Graham & Lachman, 2011).

Personality and Cognition

We first review the major findings linking personality and cognition in adulthood before turning to our main focus on personality stability and change in relation to cognitive functioning. Although much of this work has been correlational and does not allow for clear conclusions about directionality or mechanisms, we present the most promising theoretically derived suggestions about the processes involved in these linkages.

Neuroticism is consistently linked to lower performance across various domains including executive functioning, information processing, pattern analysis, memory, and creativity (Ackerman & Heggestad, 1997; Chamorro-Premuzic,

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Furnham, & Ackerman, 2006; McCrae & Costa, 1987; Moutafi, Furnham, & Crump, 2003; Moutafi, Furnham, & Paltiel, 2005; Schaie, Willis, & Caskie, 2004; Williams, Suchy, & Kraybill, 2010; Willis & Boron, 2008). Possible mechanisms are that individuals high in neuroticism are characteristically more anxious and prone to intrusive thinking and distraction, which likely impedes their ability to focus on a task. Neuroticism is not necessarily linked to intelligence or inherent ability but is associated with an individual's ability to perform in a given situation. Extraversion also is related to cognition but the directional nature of the relationship varies. It has been associated with better creativity, speed, long-term memory, and intelligence, but worse divergent thinking, crystallized intelligence, spatial orientation, reasoning, and verbal ability (Ackerman & Heggestad, 1997; Baker & Bichsel, 2006; Chamorro-Premuzic, Furnham, & Ackerman, 2006; Chamorro-Premuzic, Furnham, & Petrides, 2006; McCrae & Costa, 1987; Moutafi et al., 2005; Willis & Boron, 2008). Extraverted individuals may be less invested in intellectual activities than social ones or are less likely to develop effective study habits or test-taking strategies (Chamorro-Premuzic, Furnham, & Ackerman, 2006). Further, extraverted individuals may be better at performing speed-based tasks but worse at tasks requiring effortful processing because they are less inclined to deliberate over problems for long periods of time but thrive in a setting where completing a task quickly is the goal (Baker & Bichsel, 2006). Openness to experience has been consistently linked to intelligence and cognitive performance, specifically with executive functioning, divergent thinking, creativity, verbal ability, verbal memory, spatial orientation, and inductive reasoning (Ackerman & Rolfhus, 1999; Baker & Bichsel, 2006; Chamorro-Premuzic, Furnham, & Ackerman, 2006; DeYoung, Flanders, & Peterson, 2008; DeYoung, Peterson, & Higgins, 2005; Higgins, Peterson, Pihl, & Lee, 2007; Holland, Dollinger, Holland, & MacDonald, 1995; McCrae & Costa, 1987; Schaie et al., 2004; Sharp, Reynolds, Pedersen, & Gatz, 2010; Williams et al., 2010; Willis & Boron, 2008). Those who are flexible and open minded are more likely to perform well on complex tasks and abstract reasoning than those who are more rigid and narrow minded (Schaie, Dutta, & Willis, 1991). Conscientiousness shows positive associations to reasoning, speed, and academic performance but is negatively related to intelligence, verbal ability, reasoning, and divergent thinking (McCrae & Costa, 1987; Moutafi et al., 2003; Moutafi et al., 2005; Schaie et al., 2004; Willis & Boron, 2008). Individuals who need to work hard to do well on cognitive tasks may develop conscientious characteristics as a means of compensation, such that being more organized, motivated, and deliberate may help him or her perform well. Finally, agreeableness, which is not typically associated with cognitive ability, has been linked in a few studies with worse inductive reasoning, spatial orientation, and general cognition (Schaie et al., 2004; Willis & Boron, 2008). The limited findings for agreeableness may be due, in part, to the fact that it is a trait related to how a person interacts interpersonally which may not affect their cognitive performance. However, the negative association may reflect that those who are agreeable are not highly invested in demonstrating cognitive competence but attain success primarily through their social skills. Further, having higher cognitive abilities may be associated with being less dependent on pleasing others; in turn, being less agreeable may "foster intellectual achievement" (Baker & Bichsel, 2006, p. 869).

Whereas most studies reviewed earlier examined the personality–cognition relationships without consideration of age, some have specifically focused on older adults or compared younger and older adults. Baker and Bichsel (2006) studied the link between cognitive abilities and the "Big Five" in younger and older adults, who were either cognitively comparable or superior to the young adults. They found for young adults, openness is a positive predictor of crystallized intelligence and short-term memory, whereas extraversion is positively related to speed but negatively related to crystallized intelligence. The cognitively comparable old had similar results, with positive links for extraversion and long-term retrieval as well as openness and auditory processing. Finally, the cognitively superior old not only had a similar link to openness and visual spatial ability but also in this group it was also beneficial to be high in conscientiousness for auditory and short-term memory and low in agreeableness for better crystallized intelligence (Baker & Bichsel, 2006). This indicates that individuals who have exceptional cognitive performance, or have been able to maintain good cognitive functioning into old age, may have a unique personality profile. Crowe, Andel, Pedersen, Fratiglioni, & Gatz (2006) examined the relationship between personality and risk of cognitive impairment in older adults. They measured extraversion and neuroticism at one time point and cognition at 25-year intervals and found that those with a combination of high neuroticism and high extraversion showed the greatest risk for cognitive impairment and cognitive decline in adulthood.

A recent study by Sharp and colleagues (2010) examined the role of openness to experience in predicting cognitive change. They found that openness was associated with better cognitive performance but not with maintaining cognitive functioning over time. Individuals high in openness may have a cognitive advantage in later life, suggesting that being more open to experience may serve as a protective factor in older adulthood. These studies show that personality traits are related to cognitive performance in adults, and moreover, this relation may vary across the adult life span. There are wide individual differences in cognitive performance and patterns of change with aging, and personality factors may moderate age differences or changes in cognitive performance.

Personality and Aging

There is a good deal of evidence that personality remains relatively stable across the adult life span (Caspi & Bem,

1990; Costa & McCrae, 1997; Roberts & Del Vecchio, 2000; Weiss et al., 2005). There is some indication that personality is a resource that may be protective against declines in health and may be a contributor to successful aging and other behavioral outcomes (Costa & McCrae, 1980; Costa et al., 1994; Funder & Colvin, 1991). "Traits provide the stable structure of personality within which the aging individual copes, adjusts, defends, compensates, or adjusts" (Costa & McCrae, 1980, p. 97). Nevertheless, not everyone is stable, and there is evidence for both average, mean-level change (Schaie et al., 2004) and correlational, individual differences in change, and the findings on the nature of change are mixed. Longitudinal work has shown increases in extraversion, agreeableness and conscientiousness, and decreases in neuroticism across the adult life span (Cramer, 2003; Roberts et al., 2006). Others have found that extraversion is stable (Mroczek & Spiro, 2003) or declines with age (Mottus, Johnson, & Deary, 2011; Schaie et al., 2004). One possible reason for the discrepant findings is that most studies examine only general trait-level changes, whereas the profile of change in extraversion may differ by specific facets, as reported by Terracciano, Costa, and McCrae (2006).

An extensive body of research has examined individual differences in personality change across the adult life span; yet few, if any, have looked directly at the relation to adult cognition. Recent studies suggest that changes and stability in personality, specifically neuroticism, are related to later life outcomes such as risk of dementia (Duchek, Balota, Storandt, & Larsen, 2007) and mortality (Mroczek & Spiro, 2007). Further, the literature suggests a possible mechanism in that neuroticism change may be associated with mortality because individuals high or increasing in neuroticism may engage in riskier health behaviors (Mroczek, Spiro, & Turiano, 2009). Costa and McCrae (1980) and Costa, McCrae, and Arenberg (1980) suggested that the stable personality is the adaptive norm. Further, the work of Roberts and colleagues (2000) has shown that personality becomes more stable with age and is by and large stabilized by age 50. Personality is less likely to change in later life except in extreme conditions (such as major life events or disease). Given this, it seems reasonable to expect that personality change in later life would not be ideal. Thus, stability in personality, in contrast to change in any direction, may have a significant beneficial impact on later life health outcomes, including cognitive performance.

The Present Study

The overall purpose of this study was to examine the relationship of personality to cognitive performance across the adult life span in a large national sample, with four specific objectives. The first goal was to explore personality, specifically the big five traits (neuroticism, extraversion, conscientiousness, openness, and agreeableness), in relation to cognitive performance across multiple cognitive domains including reasoning, reaction time, speed of processing, working memory, episodic memory, and verbal fluency. The second objective was to examine the magnitude of individual differences in stability and change of personality over the course of 8–10 years. Third, we examined whether individual differences in stability and change of personality were related to cognition, that is, whether cognitive performance varies as a function of the magnitude and direction of change in personality. Finally, we examined whether the relationships between cognition, personality, and change in personality varied by age.

Our first hypothesis was that personality would be related to cognitive performance. Based on patterns in prior work with more age homogenous samples, we expected that neuroticism would be negatively associated with performance and that openness and conscientiousness would be positively associated with performance across all cognitive domains. Furthermore, we expected to find that extraversion would be associated with poorer performance on tasks involving more effortful processing, specifically reasoning and episodic memory, but faster performance on speed of processing and reaction time.

Our second hypothesis was that there would be moderately high correlational stability, with some evidence for individual differences in rank-order change for personality from Time 1 to Time 2. We also expected mean-level changes in personality from Time 1 to Time 2; specifically, that neuroticism would decrease and that openness, conscientiousness, extraversion, and agreeableness would increase as suggested in past studies (Cramer, 2003; Roberts et al., 2006).

Our third hypothesis was that individual differences in personality stability and change would be related to cognitive performance, as has been found with regard to mortality (Mroczek & Spiro, 2007) and dementia (Duchek et al., 2007). Those who were stable in neuroticism, extraversion, openness, agreeableness, and conscientiousness were expected to have higher cognitive performance than those who changed in either direction.

Finally, for our fourth hypothesis, we predicted that the relationship of cognition with personality and personality change would vary by age. We expected that stability of personality would benefit the cognitive performance of older adults more so than younger adults (Costa et al., 1994).

Method

Participants

Participants were community-dwelling adults from the Midlife in the United States Study (MIDUS), which was conducted at two time periods. Time 1 data were collected in 1994–1995 and included a sample of 7,112 adults aged 20–79 years. Time 2 data were collected in 2004–2005 and consisted of 4,974 adults aged 28–84 years, which is approximately 70% of the original sample, adjusted for mortality (Brim, Ryff, & Kessler, 2004). Compared with

those who dropped out, those who completed the study reported lower neuroticism (survivors: $M = 2.23$, $SD = 0.66$; dropouts: $M = 2.27$, $SD = 0.67$); $t(6,260) = 2.43$, $p < .05$, higher conscientiousness (survivors: $M = 3.44$, $SD = 0.44$; dropouts: $M = 3.38$, $SD = 0.46$), $t(6265) = 4.28$, $p < .001$, and higher education level (survivors: $M = 7.03$, $SD = 2.47$; dropouts: $M = 6.18$, $SD = 2.43$), $t(7,085) = 13.45$, $p < .001$. There were no differences in age, level of extraversion, agreeableness, or openness.

Procedures

Personality measures were collected at Time 1 and Time 2 by mail questionnaire, and cognitive data were collected only at Time 2 and by telephone.

Measures

Age.—Age was computed by subtracting the interview date from the participant's reported birthdate, rounded to a whole number. Time 2 age ranges were 32–84 ($M = 55$, SD = 12.4). We computed a five-group age variable, which was broken down by decade for the analysis of covariance (ANCOVA).

Education.—Education was measured categorically on a scale of 1 to 12 and ranged from 1 = *some grade school*, 6 = 1–2 *years college*, *no degree*, 9 = 4-*year college degree to* 12 = *doctoral level degree* ($M = 7.2$, SD = 2.52).

Health.—A health composite was computed, consisting of the number of chronic and acute conditions, and function limitations were reported and recoded so that higher scores reflect better health.

Hearing problems.—Hearing was measured by asking participants to rate their hearing compared with others their age, on a 5-point scale (1 = *excellent*, 5 = *poor*).

Personality.—Personality was measured using the MIDUS survey questionnaire in which the Big Five personality traits were assessed. Participants were asked the degree to which self-descriptive adjectives described them (Lachman & Prenda-Firth, 2004; Lachman & Weaver, 1998). This measure has been validated and significantly correlates with the NEO trait scales (see http://www.brandeis.edu/departments/psych/lachman/instruments/other-instruments.html). Each question was scored on a 1–4 scale, with 1 = *A lot*, 2 = *Some*, 3 = *A little*, and 4 = *Not at all*. The variables were recoded so that high scores reflected higher levels of that particular trait, and means were calculated for each item set. Coefficient alphas are as follows: neuroticism (moody, worrying, nervous, calm—not reverse coded) = .74; extraversion (outgoing, friendly, lively, active, talkative) = .78; openness (creative, imaginative, intelligence, curious, broadminded, sophisticated, adventurous) = .77; conscientiousness (organized, responsible, hardworking, careless—not reverse coded) = .58; and agreeableness (helpful, warm, caring, softhearted, sympathetic) = .80 (Prenda & Lachman, 2001).

Cognitive measures.—All cognitive measures are part of the MIDUS 2 Brief Test of Adult Cognition by Telephone, which was designed to test areas of cognition that are sensitive to age effects (Lachman & Tun, 2008; Tun & Lachman, 2008). The battery takes 20 min or less to complete, with minimal fatigue effects. Interviewers first administered a numbers-repeat task to make sure that participants were able to hear clearly. Hearing problems were negatively correlated with performance on the cognitive measures (Episodic Memory = −.18, $p < .001$; Reasoning = −.09, $p < .001$; Verbal Fluency = −.08, $p < .001$; Working Memory = −.09, $p < .001$) and positively correlated with latencies for reaction time (RT = 0.08, $p < .001$), such that worse hearing was associated with poorer performance, so this was included in all models as a covariate.

Working memory was assessed using the backward digit span from the Wecshler Adult Intelligence Scale-III test (Wechsler, 1997) where participants were asked to repeat strings of numbers in reverse order. Each level has an increased number of digits, and participants have two chances to accurately complete each level. Scores range from 2 to 8 digits and scores represent the largest set size that was correctly completed.

Processing speed was measured using a backward counting task. Participants were given 30 s to count backward from 100 as quickly and accurately as possible. The score is the number of correct numbers reported, subtracting skipped and erroneous numbers.

Reaction time latencies were measured using the Stop and Go Switch task (Tun & Lachman, 2008). Participants completed two single task trials with 20 blocks each, first with a congruent response (to RED, say "STOP," to GREEN, say "GO"), then with an incongruent response (to RED, say "GO," to GREEN, say "STOP"). In the mixed trials, participants were given a cue to switch between congruent and noncongruent responses. The task sequence was randomized, so switch cues were given at random intervals in order to increase sensitivity to age effects (Tun & Lachman, 2008). For the current analysis, the median reaction time score in seconds for the mixed trials in which individuals switched between congruent and incongruent cues was used.

Reasoning was assessed using a number series completion task where participants were given a series of numbers (such as "3 6 9 12 15") and asked to generate the next number in the progression. They received five series, with increasing levels of difficulty. Scores were calculated based on the number of sets correctly completed for each level, for a highest possible score of 5.

Episodic memory, immediate and delayed, was assessed using the Rey Auditory-Verbal Learning Test (Lezak, 1995;

Rey, 1964; Taylor, 1959). Participants were instructed to listen to a list of 15 words read aloud at the rate of one word per second. They were then given 1 min to recall as many words as they could. One point was given for each correct response for a total possible score of 15. Episodic memory delayed was not significantly related to personality, so it is not included in the analyses.

Verbal fluency was measured using the category fluency task (Kozora & Cullum, 1995; Lezak, 1995). Participants were given 1 min to generate as many words within the category "animal" as they could. Scores were based on the number of unique words they could generate within 60 s. The number of repeated words and intrusion errors were omitted from their final score.

Data Analysis

Personality and cognitive performance.—Six regression models were analyzed, one for each cognitive dimension as the dependent variable (reaction time, speed, verbal fluency, reasoning, episodic memory immediate, and working memory). Age, education, sex, health, and hearing were entered as predictors in Step 1, and at Step 2 the five personality traits from Time 2 were added. Interactions between centered age and personality were computed and entered into Step 3, but none were significant so they are not reported below. Further, speed of processing was not significantly predicted by any trait, so this model is not reported below.

Personality stability and change.—Change in personality was computed by subtracting the personality scores at Time 1 from Time 2 scores. The use of change scores is considered acceptable especially with just two measurement occasions (i.e., Rogosa, 1988; Rogosa & Saner, 1995), as multivariate approaches, such as multilevel modeling, require three or more occasions. To examine whether those who were stable differed from those who changed (either increased or decreased), we created categorical change variables and analyzed them using a series of univariate ANCOVA models. Based on the procedure used by Schaie (1984) and Willis and Schaie (2006), three personality change groups were formed, with change scores within 1 *SD* classified as the stable group, scores 1.0 *SD* below the mean were classified as the decrease group, and scores more than 1.0 *SD* above the mean were classified as the increase group. For additional follow-up analyses, the stable group was dichotomized (high and low) via median split at both Time 1 and Time 2, based on the raw score of each trait. Individuals who were high at both Time 1 and Time 2 were labeled as stable high, whereas individuals who were low at both Time 1 and Time 2 were labeled as stable-low.

Personality change, cognitive performance, and age differences.—The categorical change group variables (stable, increase, decrease for each personality trait) were entered together as independent variables, in a univariate ANCOVA to determine the mean differences between these groups on cognitive performance after controlling for health, hearing problems, sex, education, and age. We also examined the interaction between age group and personality change group to determine whether the effects of personality change on cognition varied by age.

Results

Personality and Cognitive Performance

Each analysis included all available cases. For demographic variables, we found that age (−), education (+), health (+), and hearing problems (−) were significantly related to cognition. Also, sex was significantly related, with men showing higher verbal fluency and reasoning and women higher episodic memory and reaction time. The regression analyses showed that, after controlling for age, sex, education, health, and hearing, personality added a significant amount of variance to the models for reasoning ($\Delta R^2 = .02$, $p < .001$), episodic memory ($\Delta R^2 = .01$, $p < .001$), working memory ($\Delta R^2 = .01$,

Table 1. Summary of Regression Models, Personality Time 2 Predicting Cognition at Time 2 (values are standardized betas)

	Episodic memory	Working memory	Verbal fluency	Reasoning	Reaction time
Age	−.26***	−.10***	−.26***	−.19***	.25***
Education	.08***	.10***	.22***	.22***	−.06**
Sex	.21***	.03	−.06**	−.13***	.08***
Health	.06**	.06**	.03	.11***	−.10***
Hearing	−.07***	−.03	−.03	−.06**	.01
Regression model	$F(7, 2292) = 71.01$***	$F(7, 2375) = 13.90$	$F(7, 2385) = 60.58$***	$F(7, 2392) = 66.92$***	$F(7, 2386) = 40.66$***
R^2	.18***	.04***	.15***	.16***	.12***
Extraversion	−.01	−.04	−.05^t	−.10***	.02
Neuroticism	−.04	−.05*	−.02	−.10***	.01
Openness	.06**	.06*	.14***	.07**	−.01
Agreeableness	−.02	.02	−.05*	−.06*	−.05*
Conscientiousness	.03	−.02	−.01	.02	.01
Regression model	$F(122, 292) = 42.88$***	$F(122, 375) = 9.24$***	$F(122, 385) = 39.58$***	$F(12, 2392) = 43.92$***	$F(12, 2386) = 24.23$***
ΔR^2	.01**	.01*	.02***	.02***	.002

Note. $t < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

$p < .001$), and verbal fluency ($\Delta R^2 = .02$, $p < .001$). Neuroticism was negatively related to working memory ($p < .05$) and reasoning ($p < .001$) see Table 1. Extraversion was negatively related to reasoning ($p < .001$) and marginally related to verbal fluency ($p < .10$), indicating that high extraversion is related to lower cognitive performance, which supports our hypothesis that extraversion would be associated to worse performance on tasks requiring effortful processing. Openness was, as expected, positively related to almost all aspects of cognition, including reasoning ($p < .01$), verbal fluency ($p < .001$), working memory ($p < .05$), and episodic memory ($p < .01$). Agreeableness showed a few weak, although significant, negative associations with cognition, including verbal fluency ($p < .05$), reasoning ($p < .05$), and reaction time ($p < .05$). Conscientiousness was not significantly related to any cognitive domain.

Personality Stability and Change

To test the second hypothesis, we first looked at the correlations from Time 1 to Time 2. Correlational stability, that is, the Time 1 to Time 2 correlation (Baltes, Reese, & Nesselroade, 1977), was significant for all traits: agreeableness ($r = .64$, $p < .001$), conscientiousness ($r = .61$, $p < .001$), openness ($r = .69$, $p < .001$), neuroticism ($r = .64$, $p < .001$), and extraversion ($r = .70$, $p < .001$). To analyze whether there was mean-level change in personality, dependent t tests were computed, and results showed there were significant decreases in neuroticism (T1: $M = 2.22$, $SD = .66$; T2: $M = 2.07$, $SD = 0.63$), $t(3,861) = 18.08$, $p < .001$; extraversion (T1: $M = 3.19$, $SD = 0.55$; T2: $M = 3.10$, $SD = 0.57$), $t(3,865) = 13.25$, $p < .001$; agreeableness (T1: $M = 3.48$, $SD = 0.40$; T2: $M = 3.45$, $SD = 0.50$), $t(3,863) = 4.69$, $p < .001$, $t(3,864) = 2.11$, $p < .05$; and openness (T1: $M = 3.01$, $SD = 0.52$; T2: $M = 2.90$, $SD = 0.54$), $t(3,830) = 15.98$, $p < .001$ and no change in conscientiousness (T1: $M = 3.45$, $SD = 0.43$; T2: $M = 3.46$, $SD = 0.43$, $p > .05$). The stability correlations from Time 1 to Time 2 were quite similar for both older and younger adults, ranging from .60 to .71 for all traits and across age groups ($p < .001$). Further examination of the computed change groups (described previously) for all traits showed that 64%–65% of those in the stable group were from the older age group (groups computed via median split), consistent with prior findings showing stability is greater after age 50 (Roberts et al., 2006).

Table 2. Between-Subjects Effects Results From Analysis of Covariance for Brief Test of Adult Cognition by Telephone Cognitive Variables, Personality Change, and Age (controlling for sex, health, hearing, and education)

Source	Dependent variable	*df*	Mean squares	*F*	η_p^2
Age group	Reasoning	4	55.31	28.42***	.04
	Reaction time	4	4.08	30.63***	.03
Neuroticism change	Reasoning	2	11.43	5.87**	.004
	Reaction time	2	1.03	7.69***	.01
Openness change	Reasoning	2	13.58	6.98**	.01
Neuroticism change × age	Reaction time	8	.33	2.44*	.01
Error	Reasoning	2633	1.99		
	Reaction time	2416	.13		

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

Personality Change, Cognitive Performance, and Age Differences

To test the third and fourth hypotheses, we tested the 3 (Personality Change Group) × 5(Age Group) univariate ANCOVA for each of the cognitive domains as the dependent variables, controlling for sex, hearing problems, health, and education. These analyses tested the relationships between personality change and cognition, and whether these relationships varied by age. Table 2 summarizes the significant effects from each model. Results indicate that change in neuroticism was significantly related to reasoning ($p < .01$). Post hoc pairwise comparisons indicated that those stable in neuroticism ($M = 2.33$, $SE = 0.04$) had higher reasoning scores compared with those either increasing ($M = 2.12$, $SE = 0.08$, $p < .01$) or decreasing ($M = 2.13$, $SE = 0.08$, $p < .01$). Moreover, those who remained stable and low ($M = 2.55$, $SE = 0.05$) in neuroticism had better reasoning than those who were stable high ($M = 2.30$, $SE = 0.05$, $p < .01$). Those who increased did not differ from those who were stable and high in neuroticism from Time 1 to Time 2, suggesting that maintaining low neuroticism is best for reasoning performance. Change in neuroticism was also significantly related to reaction time ($p < .001$) with post hoc analyses revealing that those who were stable ($M = 1.28$, $SE = 0.01$, $p < .001$) or decreased ($M = 1.28$, $SE = 0.02$, $p < .01$) in neuroticism had faster reaction times than those who increased ($M = 1.37$, $SE = 0.02$). Change in openness was associated with reasoning ($p < .01$), and post hoc comparisons showed that remaining stable ($M = 2.35$, $SE = 0.04$) was associated with higher reasoning than increasing ($M = 2.09$, $SE = 0.08$, $p < .01$) or decreasing ($M = 2.15$, $SE = 0.08$, $p < .05$) and that being stable and high in openness ($M = 2.47$, $SE = 0.04$) is associated with the best performance ($p < .01$).

Finally, in support of our fourth hypothesis, we found that the relation of reaction time to change in neuroticism varied by age ($p < .05$), such that, for older adults, those who increased in neuroticism ($M = 1.74$, $SE = 0.06$) performed significantly worse (higher latencies) than those who either remained stable ($M = 1.51$, $SE = 0.03$) or decreased ($M = 1.40$, $SE = 0.06$) ($p < .01$), see Figure 1.

Discussion

The current findings show that individual differences in neuroticism, extraversion, openness, and agreeableness are related to cognitive performance across the adult years. As expected, we found that there was relative stability, in terms of cross occasion correlations, from Time 1 to Time 2 (Costa & McCrae, 1997; Schaie et al., 2004), as well as significant

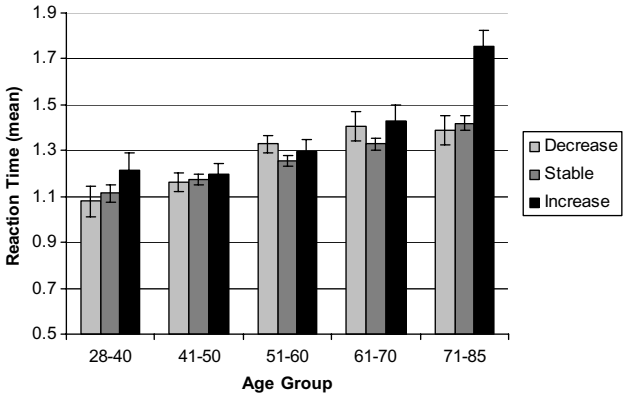

Figure 1. Reaction time scores by change in neuroticism and age group.

mean-level changes in neuroticism, extraversion, openness, agreeableness, and conscientiousness (Roberts et al., 2006). Moreover, the extent of stability versus change in personality also was related to cognition, with some variations by age.

Our findings related to our first hypothesis regarding relationships between personality and cognition were mostly consistent with previous studies. The findings for neuroticism support previous work, suggesting that high neuroticism may interfere with performance, which could be explained by the heightened anxiety and intrusive thoughts associated with neuroticism (Moutafi et al., 2005; Stelmack, Houlihan, & McGarry-Roberts, 1993). For extraversion, our findings were consistent with the studies showing that high extraversion is associated with lower performance on tasks that require effortful processing such as reasoning (e.g., Baker & Bichsel, 2006; Wolf & Ackerman, 2005). High openness and was associated with better cognitive performance, which supports past work, suggesting that individuals high in openness have high intelligence and cognitive ability (Ackerman & Heggestad, 1997) and indicates that individuals who are intellectually engaged, pursue new interests, and think critically may have higher cognition and may possibly maintain this ability as they age (Baker & Bichsel, 2006; Lachman, Agrigoroaei, Murphy, & Tun, 2010). Finally, high agreeableness was associated with lower performance, as supported by limited other work (Baker & Bichsel, 2006). There were no associations between conscientiousness and performance.

Adding to the body of work on personality and cognition, we found that individual differences in stability and change in personality were related to cognitive performance. Whereas past research has focused on concurrent relationships between personality and cognition, the present study expanded the findings by also considering whether individual differences in personality change were related to cognition in adulthood. We found that stability is related to better reasoning performance and faster reaction time, than change in either direction, for neuroticism and openness to experience. This indicates that maintaining a consistent personality is more beneficial than even socially desirable change (such as declining in neuroticism) for some cognitive abilities (with one exception for neuroticism and reaction time, for which decreases were also adaptive). Furthermore, we found that the relation between personality change and cognition varied by age with respect to neuroticism, such that older adults who increased in neuroticism had significantly lower reaction time performance than those who either remained stable or decreased in neuroticism. This suggests that the effects of neuroticism may become more detrimental with age, which is consistent with research showing that increases in neuroticism can have negative consequences for domains other than cognition (e.g., physical health, mortality) in later life (Mroczek & Spiro, 2007; Roberts et al., 2006; Turiano et al., 2011). This pattern also could be indicative of changes in the brain and health, which impact both neuroticism and cognition (e.g., Duchek et al., 2007).

Our findings are consistent with the view that personality stability may serve as a protective resource throughout the aging process (Costa et al., 1980; Costa et al., 1994). The results show that personality stability is associated with better reasoning and reaction time than change in either direction in some cases. In other cases, socially desirable change and stability are both equally effective for cognitive performance. This was the case for neuroticism, in which case decreasing was as beneficial as stability for reaction time. It will be important in future work to consider why stability may be beneficial for cognitive functioning. Theoretical work suggests that personality (Costa et al., 1994) and behavioral consistency are adaptive (Funder & Colvin, 1991). After many years, adults may become comfortable "in their own skin," and this familiarity may breed adaptive functioning especially in the face of changes that could occur in health and cognitive functioning with age. In contrast, those who experience personality change, for whatever reason, may be at a disadvantage as they need to adjust to a different way of approaching the world. Another possibility is that changes to personality could be caused by major life events or diseases such as dementia. In that case, the positive signs of stability for cognition may be a reflection of the absence of major upheavals in one's life (McCrae & Costa, 1994). As Costa and McCrae have stated "the durability of dispositions despite biological, social and cognitive changes, must result from some form of adaptation" (Costa, McCrae, & Arenberg 1980, p. 799), which provides a framework for interpreting our results. Nevertheless, more research is needed to address questions about the mechanisms that allow for maintenance of personality and the effects on cognitive performance. It is possible that maintaining low neuroticism and high openness in later life may help buffer against cognitive declines. Future examination of the underlying mechanisms (e.g., anxiety, social engagement) of these traits is needed to understand more precisely how these processes operate.

One of the limitations of the current study is that we only had cognitive data at one time point. In order to gain further

insights into the directionality and underlying mechanisms of the patterns observed in the current study, future studies should examine change in both cognitive performance and personality. We considered if stability/change in personality is related to individual differences in cognitive performance and whether the relationship differs by age. It would be informative in the future to examine change in both personality and cognitive performance. This would provide additional insight into the nature of the relationship including the directionality. It is possible that changes in cognitive performance, including the onset of mild cognitive impairment or dementia (Duchek et al., 2007), result in changes in personality. We also acknowledge that we found a limited number of, albeit consistent, significant effects. Although we included five personality traits and six cognitive dimensions, we found significant effects for just four of the relationships. Nevertheless, of these significant associations, we found that stability was the most adaptive for cognitive performance in two of these associations, whereas for the other two effects we found that change in the adaptive direction to be associated with better performance. In future work, it will also be important to consider why these results were found for reaction time and reasoning and not for the other cognitive dimensions. Also, in future studies, it will be desirable to include more than two occasions of measurement. Although the change score method we used is acceptable, when only two measurements are available (Rogosa, 1988; Rogosa & Saner, 1995) especially given our large sample, which enhances the reliability, we acknowledge that future studies would benefit from having three or more measurements of personality to adequately model change and test directionality using other methods such as multilevel modeling.

The present results are a first step in demonstrating that personality change is related to cognitive performance and that maintaining a stable personality may be an asset for cognitive functioning, especially in later life. More research is needed to understand the processes involved in linking changes in personality and cognition and to consider how personality dispositions may serve as a protection or vulnerability for cognitive declines. This could allow researchers and clinicians to intervene more effectively into the lives of middle-aged and older adults to moderate declines in cognitive performance and competence. It could provide valuable information for tailoring interventions to individual differences in personality, especially for those who are experiencing personality changes in later life.

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