Turiano, N.A., Pitzer, L., Armour, C., Karlamangla, A., Ryff, C.D., & Mroczek, D.K. (2012). Personality trait level and change as predictors of health outcomes: findings from a national study of americans (midus). *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 67(1)*, 4–12, doi:10.1093/geronb/gbr072. Advance Access published on July 15, 2011

Personality Trait Level and Change as Predictors of Health Outcomes: Findings From a National Study of Americans (MIDUS)

Nicholas A. Turiano,[1] Lindsay Pitzer,[2] Cherie Armour,[3] Arun Karlamangla,[4] Carol D. Ryff,[5] and Daniel K. Mroczek[1]

[1]Department of Human Development & Family Studies, Center on Aging and the Life Course, Purdue University, West Lafayette, Indiana.
[2]Department of Psychology, University of Notre Dame, Indiana.
[3]National Centre of Psychotraumatology, University of Southern Denmark, Odense, Denmark.
[4]Division of Geriatrics, Department of Medicine, University of California, Los Angeles.
[5]Institute on Aging and Department of Psychology, University of Wisconsin, Madison.

Objectives. Personality traits predict numerous health outcomes, but previous studies have rarely used personality change to predict health.

Methods. The current investigation utilized a large national sample of 3,990 participants from the Midlife in the U.S. study (MIDUS) to examine if both personality trait level and personality change longitudinally predict 3 different health outcomes (i.e., self-rated physical health, self-reported blood pressure, and number of days limited at work or home due to physical health reasons) over a 10-year span.

Results. Each of the Big Five traits, except openness, predicted self-rated health. Change in agreeableness, conscientiousness, and extraversion also predicted self-rated health. Trait levels of conscientiousness and neuroticism level predicted self-reported blood pressure. All trait levels except agreeableness predicted number of work days limited. Only change in conscientiousness predicted the number of work days limited.

Discussion. Findings demonstrate that a full understanding of the link between personality and health requires consideration of trait change as well as trait level.

Key Words: Health—Longitudinal change—Personality.

PERSONALITY traits have emerged in recent years as predictors of important health outcomes (Hampson & Friedman, 2008). For example, high neuroticism and low conscientiousness are each associated with earlier mortality (Friedman et al., 1993; Wilson, Mendes de Leon, Bienas, Evans, & Bennett, 2004). However, a small number of recent studies demonstrated that not only does personality level predict key health outcomes but so does personality change (Roberts & Mroczek, 2008). Prior studies highlight the importance of considering both trait level and change to predict outcomes as diverse as substance abuse (Hampson, Tildesley, Andrews, Luckyx, & Mroczek, 2010), obesity (Siegler et al., 2003), and mortality (Mroczek & Spiro, 2007). No study, however, has used a large national sample with a wide age range to examine whether both personality level and change predict health outcomes. In the present study, we extend the findings of these prior investigations using the Midlife in the U.S. (MIDUS) survey, a large national longitudinal sample of adult Americans to determine whether personality trait level and change independently predict three distinct self-reported health outcomes.

Background

Personality Trait Level and Physical Health

A burgeoning literature documents a link between personality trait level and health (Hampson & Friedman, 2008; Smith, 2006), and this association is strongest for conscientiousness and neuroticism. For instance, there is evidence that low conscientiousness (e.g., persons who tend to be disorganized, irresponsible, and undisciplined) is related to negative health behaviors (e.g., smoking, drinking, poor diet, and lack of exercise; Friedman et al., 1993; Hampson, Goldberg, Vogt, & Dubanoski, 2007; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007) and negative health outcomes (e.g., diabetes, hypertension, urinary problems, stroke, a variety of mental illnesses, and earlier mortality; Bogg & Roberts, 2004). Neuroticism, or negative emotionality, also has clear associations with both health behaviors and health outcomes. Neuroticism is related to the exposure people have to stressors but also in their reaction (or overreaction) to stress (Bolger & Schilling, 1991; Kling, Ryff, Love, & Essex, 2003; Mroczek & Almeida, 2004). One such reaction is smoking, which accounts for about 25% of

Received August 13, 2010; Accepted May 11, 2011
Decision Editor: Rosemary Blieszner, PhD

the association between neuroticism and mortality, at least among older adults (Mroczek, Spiro, & Turiano, 2009). People high in neuroticism also have a higher risk of developing hypertension (Spiro, Aldwin, Ward, & Mroczek, 1995) as well as obesity and metabolic syndrome (Hampson & Friedman, 2008).

The personality–health link is less established for the other Big Five traits, but the body of evidence is growing. Earlier investigations of the Type A behavior pattern and hostility facet of agreeableness clearly demonstrated an association with risk of coronary heart disease (Myrtek, 2001; Rosenman et al., 1964) as well as poor health behaviors (Brummett et al., 2006). More recent investigations of general trait agreeableness also suggest that lower levels are associated with increased mortality risk (Weiss & Costa, 2005). A small number of studies found that low levels of extraversion predicted earlier mortality (e.g., Wilson et al., 2004). Additionally, people high in extraversion tend to experience greater amounts of positive affect and optimism, both of which are also associated with health and longevity (Danner, Snowdon, & Friesen, 2001). Openness has the fewest documented links to health. Yet, recent studies have found higher levels of openness to be protective against earlier mortality (Hampson & Friedman, 2008).

The Effect of Trait Change on Physical Health

Most models of personality and health exclusively conceptualize traits as static fixed predictors in the explanatory chain that proceeds from traits to disease and ultimately mortality. However, there are now studies documenting that personality traits do change in adulthood (Jones & Meredith, 1996; Mroczek & Spiro, 2003; Roberts, Walton, & Viechtbauer, 2006; Small, Hertzog, Hultsch, & Dixon, 2003), although they tend to change slowly over a number of years and they do not change for everyone; some individuals do remain stable. Furthermore, it is quite rare that predictors of health, whether psychosocial or biomedical, do not possess some dynamic element that changes over time. Thus, our theoretical model goes further by hypothesizing that personality trait change is likely to be, along with initial trait level, important in predicting health outcomes.

The theoretical position that trait change, along with trait level, is both important for health outcomes is supported by a small number of recent studies. Mroczek and Spiro (2007) documented both level and rate of change in neuroticism predicted mortality over 18 years. Hampson and colleagues (2010) demonstrated that change in agreeableness and sociability predicts substance use. Siegler and colleagues (2003) found that decreases in agreeableness predicted a wide range of physical health risk factors, including obesity, avoidance of exercise, a high-fat diet, and self-reports that one's physical health had changed for the worse. Although personality traits are often assumed static risk factors for illness or health, akin to the way that sex or race is conceived as unchanging predictors, these more recent findings confirm that personality change has implications for the association between personality and health. That is, if someone is at a given trait level (e.g., the 5th percentile on conscientiousness), their risk of developing a health problem is elevated. However, their risk may be reduced if the person changes in the positive direction (e.g., rises to the 50th percentile on conscientiousness).

Present Study

In the current study, we examined the predictive effect of both level and change among the Big Five personality traits on three very different health outcomes assessed over a decade after initial personality trait measurements: (a) self-rated physical health, (b) self-reported blood pressure, and (c) number of days limited at work or home due to physical health reasons.

Hypotheses

With respect to trait level, we expected that higher levels of agreeableness, conscientiousness, extraversion, and openness would predict better health profiles, whereas higher levels of neuroticism would be associated with worse overall physical health. Moreover, we expected that people decreasing on agreeableness, conscientiousness, extraversion, and openness (from MIDUS 1 to MIDUS 2) would predict worse health, whereas increases should be associated with better physical health. For neuroticism, we expected a decrease to be associated with better physical health, whereas increases predicting worse health. Finally, for all the above, we tested whether level and change can combine in multiplicative ways to predict health outcomes. Although exploratory, previous work by Mroczek and Spiro (2007) demonstrates the utility in uncovering level by change effects.

Method

Sample and Longitudinal Design

The first wave of the MIDUS study (MIDUS 1) collected survey data from 7,108 noninstitutionalized English-speaking adults in the coterminous United States, aged 25–74 years. Data were collected in 1995–1996. A longitudinal follow-up of the original MIDUS study was conducted in 2004–2006 (MIDUS 2). Every attempt was made to contact all the original respondents and invite them to participate in a second wave of data collection. The average longitudinal follow-up interval was approximately nine years (7.8–10.4 years). Of the 7,108 participants in MIDUS 1, 4,963 (75% response rated, adjusted for mortality) were successfully contacted to participate in another phone interview of approximately 30 min in length. Those who completed both the self-administered questionnaires (SAQ) and the phone interviews at MIDUS 1 and MIDUS 2 numbered 3,990.

Approximately 70% of participants were retained from MIDUS 1 to MIDUS 2 (6% deceased, 12% refusal, 3% unable to interview, and 9% no working phone number). Analysis of attrition revealed that respondents lost to follow-up differed from those who participated in the longitudinal panel on certain variables. The longitudinal sample was significantly higher on conscientiousness, $t(6265) = 6.87$, $p < .001$, and significantly lower on neuroticism, $t(6262) = 2.34$, $p < .001$, and agreeableness, $t(6264) = 2.53$, $p < .001$. The longitudinal sample also had significantly higher self-rated physical health, $t(7095) = 10.97$, $p < .001$, lower blood pressure, $t(7020) = 3.61$, $p < .001$, and fewer work limitations, $t(7037) = 4.83$, $p < .001$. A more complete discussion of selective attrition among the MIDUS longitudinal sample is available elsewhere (Radler & Ryff, 2010).

Measures

Control variables.—All models were adjusted for age, sex, and education. Age ranged from 32 to 84 ($M = 55$) at MIDUS 2, and the sex distribution of participants was 47% male (coded as 0) and 53% female (coded as 1). Participants reported the highest level of education completed, which ranged from 1 (*some grade school/high school)* to 4 (*college graduate to professional degree*). Approximately 39% had a high-school degree or graduate equivalence degree, whereas 30% had graduated college or obtained a professional degree.

Health outcomes.—The health outcomes considered were assessed via the phone interview portion of the MIDUS 2. First, self-rated physical health was assessed by the following question: "In general, would you say your physical health is excellent, very good, good, fair or poor?" Scores ranged from 1 (*poor*) to 5 (*excellent*). This straightforward evaluation of health is a valuable outcome because there is strong empirical support that subjective evaluations of health predict mortality above and beyond objective health status measures and other known risk factors (DeSalvo, Bioser, Reynolds, He, & Muntner, 2005; Idler & Benyamini, 1997; Miller & Wolinsky, 2007).

Self-reported blood pressure evaluated if personality level and change predicted a more direct physiological measure of health. Participants responded if their blood pressure at their last physician visit was low, about normal, slightly raised, or high. Scores ranged from 1 (*low*) to 4 (*high*). Self-reported blood pressure is a quick and an effective means of assessing the physiologic aspect of general health. In fact, estimates show that a sizable proportion of global premature deaths and disability each year is attributed to high blood pressure (Lawes, Vander Hoorn, & Rodgers, 2008).

The third outcome, work limitations, was assessed by asking how many of the past thirty days respondents were limited in their work or normal household work activities because of physical health. Respondents were required to give the actual number of days out of 30, with 0 meaning that no work limitations occurred. This outcome provides a more functional day-to-day evaluation of how health limits individuals from working or completing normative daily tasks (Keyes & Grzywacz, 2005). In essence, it measures the degree of impairment experienced on a daily level specifically because of physical functioning.

Utilizing these distinct yet related outcomes allows for a more comprehensive understanding of how personality and personality change influences various proxies of health. They provide a broad array of general, physiologic, and functional indices of health. As displayed in Supplementary Table 1, the correlations between the outcomes demonstrate the interconnectedness of such physical health proxies. Specifically, the correlations between self-rated health and both blood pressure and work days limited were negative, and those reporting better overall physical health also report lower blood pressure and fewer days limited in work.

Personality traits.—The key predictor variables (personality trait level and trait change) were assessed via the self-administered adjectival measures of the Big Five assessed in both MIDUS 1 and 2 (Prenda & Lachman, 2001). Respondents were asked how much each of 25 adjectives described themselves on a scale ranging from 1 (*not at all*) to 4 (*a lot*). The adjectives were moody, worrying, nervous, and calm (*neuroticism*); outgoing, friendly, lively, active, and talkative (*extraversion*); creative, imaginative, intelligent, curious, broad minded, sophisticated, and adventurous (*openness*); organized, responsible, hardworking, and careless, (*conscientiousness*); and helpful, warm, caring, soft-hearted, and sympathetic (*agreeableness*). The mean was calculated from the adjectives for each trait after reverse scoring the appropriate items.

The MIDUS Big Five scale was developed from a combination of existing personality trait lists and inventories (Lachman & Weaver, 1997). From these lists, the most consistently used adjectives were selected and used in a pilot study of 1,000 men and women (ages 30–70 years) to identify the adjectives with the highest item to total correlations and factor loadings. This scale has good construct validity (Mroczek & Kolarz, 1998) and significantly correlates with the NEO trait scales (Prenda & Lachman, 2001). Examination of the correlation matrix also provides evidence of construct validity for this scale (Supplementary Table 1). There was a significant and positive correlation between agreeableness, conscientiousness, extraversion, and openness, whereas there was a significant and negative correlation between neuroticism and the other four personality traits. Furthermore, the longitudinal trait correlations from MIDUS 1 to MIDUS 2 were .64 for agreeableness, .62 for conscientiousness, .69 for extraversion, .64 for neuroticism, and .70 for openness. Reliability alphas for the personality traits are as follows: agreeableness = .80, conscientiousness = .58, extraversion = .76, neuroticism = .74, and openness = .77.

Table 1. Mean Big Five Scores for MIDUS 1 and MIDUS 2 With Paired *t* Tests

Trait	MIDUS 1	MIDUS 2	Mean change score (*SD*)	Change score range	*t* (*df*)
Agreeableness	3.48	3.45	−0.03 (0.42)	−2.40 to 2.33	4.71 (3866)***
Conscientiousness	3.42	3.39	−0.03 (0.39)	−1.55 to 1.80	9.66 (3892)***
Extraversion	3.20	3.10	−0.10 (0.44)	−2.20 to 2.40	13.23 (3869)***
Neuroticism	2.24	2.07	−0.17 (0.55)	−2.25 to 2.50	18.09 (3865)***
Openness	3.02	2.90	−0.12 (0.42)	−1.72 to 2.14	15.98 (3833)***

Note. ***$p < .001$.

Paired *t* tests using a Bonferroni adjustment documented if each of the Big Five mean trait scores was significantly different from MIDUS 1 to MIDUS 2 (Table 1). These analyses indicated that each of the Big Five trait mean scores decreased over the 9- to 10-year interval, and all the five mean differences were statistically significant, thus indicating mean-level personality change (Table 1).

Personality change scores.—Ideally, a study of change contains at least three occasions of measurement along with modeling that is specialized for estimating change (e.g., multilevel modeling). However, many long-term longitudinal studies, such as the MIDUS, do not yet have three waves of data. The use of change scores in such studies have reemerged in recent years as an acceptable and a transparent way of assessing change if one is limited by two measurement occasions (Mroczek & Spiro, 2007; Mroczek, Almeida, Spiro, & Pafford, 2006; Rogosa, 1995; Spiro, 2007; Taris, 2000). In the current study, trait scores from the MIDUS 1 were subtracted from MIDUS 2 scores for each of the Big Five. This yielded a difference score, or change score, for each of the five traits for each person. Persons with positive change scores were those for whom an MIDUS 2 trait score was higher than their MIDUS 1 score. These were individuals who increased on a given trait. Conversely, persons with negative change scores were those for whom a MIDUS 2 trait score was lower than their MIDUS 1 trait score. A change score of zero implied stability over the 9- to 10-year interval between the two measurement occasions. The range and standard deviations for all trait change scores are displayed in Table 1.

Note, the negative means for trait change reflect the findings from the *t* tests analyses showing that scores on each of the Big Five went down over the decade-long longitudinal interval (Table 1). Note also that neuroticism has the largest mean change score in terms of magnitude (−.17) and also the highest standard deviation of the five, indicating greater individual differences in amount of change compared with the other four traits. Note that change scores were as large as 2 in some individuals (Table 1).

One limitation of change scores is that they may represent regression to the mean and not represent real change. Examination of the variance in change scores explained by baseline (MIDUS 1) score suggested that the changes represented more than just regression to the mean: *R*-squared values were .16 (agreeableness), .14 (conscientiousness), .12 (extraversion), .22 (neuroticism), and .12 (openness).

Statistical Analysis

Each of the three health outcomes from MIDUS 2 were regressed on the estimates of trait level and trait change for each of the Big Five, controlling for age, sex, education, and sample. Because all Big Five traits (trait level and change) were included in one parsimonious model, the effects control for one another. The mean of MIDUS 1 and MIDUS 2 personality scores represented trait level and the difference scores represented trait change. The former indicated whether absolute amount of a given trait predicted health. We chose to use the mean of MIDUS 1 and MIDUS 2 personality scores instead of the MIDUS 1 score by itself to represent trait level because adjustment for baseline scores when analyzing change is known to lead to spurious results in the presence of measurement error (Cain, Kronmal, & Kosinski, 1992; Glymour, Weave, Berkman, Kawachi, & Robins, 2005). The underlying problem is that when adjusted for a noisy baseline measurement, the change score carries information about both level and change. Use of the mean of MIDUS 1 and MIDUS 2 measurements as trait level avoids this issue but in the process underestimates the true effect of change (Cain et al., 1992). Lastly, a small number of participants gave responses of *don't know* or did not give answers to some questions. This reduced the number of respondents in the current study depending on the outcome variable (see Table 2).

Results

Age and education were significant covariates for all three health outcomes. Increasing age and lower levels of education were associated with poorer evaluations of health, higher blood pressure ratings, and more reported days limited in work. Sex was a significant predictor for self-rated health and blood pressure but not for days limited in work. Women reported better physical health and lower blood pressure.

Table 2 displays the regression models for all three outcomes investigated. For self-rated physical health, higher levels of conscientiousness and extraversion predicted better self-rated physical health at MIDUS 2. Higher levels of neuroticism and agreeableness were associated with worse self-rated physical health in the MIDUS 2. With respect to

Table 2. Personality Trait and Change Predicting Self-Reported Health Outcomes

	Self-rated health		Blood pressure		Work reductions	
Predictors	*B* (*SE B*)	β	*B* (*SE B*)	β	*B* (*SE B*)	β
Controls						
Age	−0.32 (0.03)	−0.16***	0.09 (0.02)	0.08***	0.92 (0.14)	0.11***
Sex	0.07 (0.03)	0.03*	−0.07 (0.02)	−0.06***	0.21 (0.15)	0.03
Education	0.26 (0.02)	0.24***	−0.04 (0.02)	−0.07***	−0.28 (0.08)	−0.07***
Personality level[a]						
Agreeableness	−0.07 (0.02)	−0.07***	0.01 (0.01)	0.01	0.04 (0.09)	0.01
Conscientiousness	0.17 (0.02)	0.16***	−0.03 (0.01)	−0.04*	−0.21 (0.08)	−0.05**
Extraversion	0.16 (0.02)	0.16***	−0.02 (0.01)	−0.03	−0.29 (0.09)	−0.07***
Neuroticism	−0.17 (0.02)	−0.15***	0.03 (0.01)	0.05**	0.14 (0.07)	0.03*
Openness	−0.03 (0.02)	−0.03	−0.01 (0.01)	−0.01	0.19 (0.09)	0.04*
Personality change						
Agreeableness	−0.04 (0.02)	−0.04*	0.02 (0.01)	0.03	0.07 (0.08)	0.02
Conscientiousness	0.03 (0.02)	0.03*	0.01 (0.01)	0.01	−0.19 (0.07)	−0.04**
Extraversion	0.09 (0.02)	0.09***	0.01 (0.01)	0.01	−0.13(0.08)	−0.03
Neuroticism	−0.02 (0.02)	−0.02	0.01 (0.01)	0.01	−0.01 (0.07)	−0.01
Openness	−0.01 (0.02)	−0.01	−0.01 (0.01)	−0.01	0.04 (0.08)	0.01
R^2	.19		.03		.03	
N	3,455		3,437		3,451	

Notes. All variables expressed in standard deviation units. Males are the referent group.
[a]Personality level = mean of MIDUS 1 and MIDUS 2 personality.
*$p < .05$; **$p < .01$; ***$p < .001$.

trait change, increases in conscientiousness and extraversion predicted better self-rated physical health at MIDUS 2. Conversely, increases in agreeableness predicted worse self-rated physical health in MIDUS 2.

Personality levels of conscientiousness and neuroticism were significant predictors of self-reported blood pressure. Higher levels of conscientiousness predicted lower reported blood pressure, whereas higher levels of neuroticism predicted higher blood pressure at MIDUS 2. None of the five trait change variables predicted blood pressure at MIDUS 2.

Personality level was a significant predictor of the number of days limited at work for all traits except agreeableness. Higher levels of conscientiousness and extraversion predicted fewer limited days in MIDUS 2. Conversely, higher levels of neuroticism and openness were associated with more limited workdays. Only conscientiousness change predicted work limitations. Increases in conscientiousness predicted fewer work limitations in MIDUS 2. Lastly, none of the interactions between trait level and change were significant predictors of the three health outcomes.

Because the MIDUS study includes a subsample of twins (30%) and siblings (15%), we conducted a post hoc sensitivity analysis to ensure independence of observations. Specifically, one twin/sibling from each pair was randomly dropped, and all analyses were conducted with this reduced sample. The statistical significance of each main effect was not affected, even in a substantially reduced sample size.

Discussion

This study builds on previous investigations documenting that the level of personality traits predicts health outcomes (Bogg & Roberts, 2004; Hampson & Friedman, 2008; Roberts et al., 2007; Smith, 2006; Wilson, Bienas, Mendes de Leon, Evans, & Bennett, 2003) and extends those findings to a national sample of Americans. Across all three health variables, higher levels of conscientiousness predicted better health outcomes, whereas higher levels of neuroticism reflected poorer outcomes. Higher levels of extraversion predicted better self-rated health and fewer health-related work reductions, whereas higher levels of openness predicted fewer work reductions. Lastly, higher levels of agreeableness predicted poorer health outcomes. As noted in the "Introduction," considerable prior work has documented the impact of neuroticism and conscientiousness on health, but few studies prior to this investigation have shown evidence that higher levels of agreeableness, extraversion, and openness are also significant predictors of health.

Most importantly, this study provides evidence that long-term change in the Big Five is related to various indices of physical health, thereby extending similar findings from smaller and less representative samples (Hampson et al., 2010; Mroczek & Spiro, 2007; Siegler et al., 2003). The findings were strongest for self-rated physical health, where as predicted, increments on the more positive traits (conscientiousness and extraversion) predicted better health, whereas decrements predicted poorer health. Counter to hypotheses and previous literature, being more agreeable and increases in this trait predicted poorer self-rated health. For blood pressure, none of the change scores were significant predictors. However, increases in conscientiousness significantly predicted fewer health-related work reductions.

Overall, such results underscore the importance of cross-time dynamics in personality traits as independent influences on health. The fact that both trait level and change predicted self-rated health, an outcome that clearly predicts mortality (Idler & Benyamini, 1997), constitutes an important extension of prior literature that personality traits are not static risk factors but dynamic predictors of health (Mroczek & Spiro, 2007). In fact, the percentages of explained variance specifically by personality (trait and change net of controls) were highest for self-rated health (R^2 = .09) but much smaller for blood pressure (R^2 = .01), and work reductions (R^2 = .01). Future work is clearly needed to document the scope of effects of personality and change on multiple indices of physical health.

Future Directions

Mechanisms linking personality and health.—As evidence accumulates linking personality (level and change) and health outcomes, research will necessarily need to shift in the direction of accounting for these effects, that is, explicating the pathways through which core individual difference variables are consequential for multiple aspects of health, including disability, morbidity, and mortality. From an epidemiological framework, personality traits are distal predictors of health, meaning personality operates through a series of interconnected mechanisms. Thus, future inquiries would benefit from simultaneously attending to behavioral and psychosocial mechanisms (e.g., Friedman, 2000; Hampson & Friedman, 2008; Roberts et al., 2007) as well as related physiological processes (neuroendocrine, cardiovascular, and inflammatory; e.g., B. Singer & Ryff, 2001; Uchino, 2006).

Putting all the above together to understand how personality traits set in motion a panoply of influences (behavioral, psychosocial, and situational), many of which invoke multifaceted biological substrates, is a tall agenda. In managing the attendant complexities, there is merit in invoking the idea of a pathway through which these multiple influences converge, albeit via different combinations of factors for different subgroups of individuals. Previous work illustrates how to implement this kind of integrative approach with novel (at least for psychologists) analytic tools, such as recursive partitioning (Gruenewald, Mroczek, Ryff, & Singer, 2008), which allow for multiway interactions as well as nonlinear relations among variables on the way to particular health outcomes.

Finally, to the extent that such integrative analyses interest investigators toiling in the above fields, such inquiries should not be disproportionately focused on negative pathways (i.e., how high neuroticism or low conscientiousness activate an array of dysfunctional processes that culminate in early morbidity or mortality). Extensive attention is also needed to understand the positive/preventive pathways (i.e., how high extraversion, agreeableness, and openness contribute to a multitude of salutogenic processes that help keep people healthy as they move across the decades of adulthood and later life), which illuminate how positive health is achieved and sustained (Ryff & Singer, 1998).

Prevention and intervention.—In light of the inherent complexities connecting personality to health, the fact remains that personality is a set of malleable traits. A more recent framework for personality development is the idea of interindividual differences in personality change throughout adulthood (Mroczek & Spiro, 2007; Roberts & Mroczek, 2008; Roberts et al., 2006; Small et al., 2003). Some individuals remain stable on personality traits, whereas some increase and others decrease. Moreover, Mroczek and Spiro (2007) show that this change has important consequences on health—namely mortality.

The main issue that remains is how to facilitate personality change that benefits health over the life course. First, epidemiologic research would stress targeting upstream factors or preventative measures earlier in life to impede trajectories of damaging health behavior and physiological functioning (Moffitt et al., 2011). Second, it is not entirely clear to what extent personality would need to change to affect deleterious downstream processes. Current research shows that personality change occurs over long time spans (i.e., decades; Roberts et al., 2006), and the effect sizes are modest, so any brief personality intervention will likely falter. However, when examining personality during longer durations such as from young adulthood to old age, traits such as conscientiousness have shown increases up to a full standard deviation (Roberts et al. 2006). Third, it is unlikely that *one size would fit all* because some individuals as well as certain traits are more amenable to personality change than others (Caspi, Roberts, & Shiner, 2005) in certain environments (Caspi & Moffitt, 1993), and there is evidence for individual differences in who remains stable, who changes, and the rate of change (Mroczek & Spiro, 2003).

Potential interventions aimed at single or multiple aspects of personality could include changing the underlying cognitive or psychological processes associated with particular traits (i.e., creativity, responsibility), the physiological responses to stress (i.e., dampening stress reactivity of the hypothalamic–pituitary–adrenal axis), or the health behaviors associated with particular traits (i.e., substance use behaviors). For example, targeting specific aspects of personality for individuals scoring higher in neuroticism that are predisposed to experience negative affect and adverse physiologic arousal would involve implementing more effective ways to deal with stress (e.g., relaxation techniques, refraining from smoking) or increasing self-control (Moffitt et al., 2011). These techniques are not necessarily changing a person's level of neuroticism but the negative health behaviors and physiological

reactions underlying this trait. At this point, it may be presumptuous to suggest specific personality-related interventions, but some have laid out a framework for doing so (Moffitt et al., 2011), and preliminary intervention research provides promise (Baumeister, Gailliot, DeWall, & Oaten, 2006; Conrod, Stewart, Comeau, & Maclean, 2006; Jackson, Hill, Payne, Roberts, & Stine-Morrow, Under review).

Limitations

The main limitation of the current study is the availability of only two measurement occasions of personality. With only two measurement occasions, advanced statistical techniques such as "MLM" are not appropriate (J. D. Singer & Willett, 2003). Utilizing change scores is often criticized with respect to regression to the mean. However, after using the mean of MIDUS 1 and MIDUS 2 personality scores to represent level, we are confident that the analysis estimated true trait change and not simply a statistical artifact caused by regression to the mean. In fact, this technique actually leads to an underestimate of the change score effect (Cain et al., 1992; Glymour et al., 2005). As Spiro (2007) has argued, the concerns regarding change scores are more perceived than real. A second limitation of having only two measurements of personality is the inability to estimate rate of change or any parameter that informs us about the process of change (Raudenbush & Bryk, 2002; Rogosa, 1995; J. D. Singer & Willett, 2003). Using statistical techniques such as "MLM" when at least three time points are available will permit the best estimation growth curves that are characterized by relatively accurate intercepts and slopes in any psychosocial variable (Raudenbush & Bryk, 2002; J. D. Singer & Willett, 2003).

Addressing a final issue of change, trait change itself is predicted by such variables as role change (Roberts, 1997; Roberts & Chapman, 2001), major life events (divorce and death of spouse; Mroczek & Spiro, 2003), and health itself (Mroczek & Spiro, 2007). Moreover, the two points of measurement in the MIDUS does not establish cause–effect relationships among personality, change, and health, which must be considered when interpreting the findings of the current study. It would be interesting to examine the complex pathways and feedback loops between role change, health, or life events with personality and trait change.

A second caveat of the current study is the interconnectedness of personality and self-reported health outcomes. For example, individuals scoring higher in neuroticism tend to report more negative health symptoms and perceive themselves in poorer health (Chapman, Duberstein, Sorensen, & Lyness, 2006; Costa & McCrae, 1987; Watson & Pennebaker, 1989). Thus, self-reported health outcomes by neurotics may not reflect poorer health but their perception of their health. There are apparent difficulties in disentangling perceived versus actual health, but as stated earlier, it is this perception of one's own health that is a better predictor of mortality than more objective measures. Likewise, it is not a coincidence that the higher levels of the other Big Five traits are associated with better self-reported health (Goodwin, & Engstrom, 2002). Individuals high in these traits are likely to report better health simply because they are the ones in better health, which can be supported empirically (Hampson & Friedman, 2008). Moreover, the selective attrition from MIDUS 1 to MIDUS 2 leaves unanswered questions about the role of personality change among those already in poor health. Drop out among those lower in conscientiousness and higher in neuroticism could bias the findings but are also likely to underestimate the effect of personality and change on the health outcomes investigated. The significant main effects for both personality level and change in the current study exist despite range restrictions due to selective drop out based on personality as well as those already rating their health as poor.

Lastly, future investigations would benefit from more descriptive (i.e., both systolic and diastolic) and objective measures of blood pressure from trained personnel. Although physicians actually measured blood pressure at a previous medical visit, participants were still required to retrospectively report whether their doctor told them that they had low, normal, or high blood pressure. Obviously, this may influence the validity of this outcome. It would be more useful to have exact readings of systolic and diastolic blood pressure that provide an opportunity to examine pulse pressure (systolic minus diastolic), which may be the best predictor of subsequent cardiovascular function (Haider, Larson, Franklin, & Levy, 2003).

Conclusions

Despite the noted limitations, the current study adds to the burgeoning literature that personality traits predict important health outcomes. Moreover, this study is among the first documenting that both personality trait level and trait change predict various health outcomes. The findings are also strengthened by longitudinal period (approximately 10 years) and the national representativeness of this sample. Uncovering personality level and change combinations that lead to poor or positive health outcomes over time should become a priority for personality–health research. Indeed, trait change may occur slowly and for many people may not occur at all. Yet for others, trait change becomes a salient factor influencing physical health outcomes across the life course.

Funding

This research was supported by grants from the National Institute on Aging (T32-AG025671) and National Institute on Aging (P01-AG020166) to conduct a longitudinal follow-up of the MIDUS (Midlife in the United States) investigation. The original study was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development. D. K. Mroczek is also supported by the National Institute on Aging (R01-AG1843).

Supplementary Material

Supplementary material can be found at: http://psychsocgerontology.oxfordjournals.org/

Correspondence

Correspondence should be addressed to Nicholas Turiano, MS, Department of Human Development & Family Studies, Center on Aging & the Life Course, Purdue University, 1200 W. State Street G-025, West Lafayette, IN 47907-2055. E-mail: nturiano@purdue.edu.

References

Baumeister, R. F., Gailliot, M., DeWall, C. N., & Oaten, M. (2006). Self-regulation and personality: How interventions increase regulatory success, and how depletion moderates the effects of traits on behavior. *Journal of Personality*, *74*, 1773–1802. doi:10.1111/j.1467-6494.2006.00428.x

Bogg, T., & Roberts, B. W. (2004). Conscientiousness and health behaviors: A meta analysis of the leading behavioral contributors to mortality. *Psychological Bulletin*, *130*, 887–919. doi:10.1037/0033-2909.130.6.887

Bolger, N., & Schilling, E. A. (1991). Personality and problems of everyday life: The role of neuroticism in exposure and reactivity to daily stressors. *Journal of Personality*, *59*, 356–386. doi:10.1111/j.1467-6494.1991.tb00253.x

Brummett, B. H., Babyak, M. A., Williams, R. B., Barefoot, J. C., Costa, P. T., & Siegler, I. C. (2006). NEO personality domains and gender predict levels and trends in body mass index over 14 years during midlife. *Journal of Research in Personality*, *40*, 222–236. doi:10.1016/j.jrp.2004.12.002

Cain, K. C., Kronmal, R. A., & Kosinski, A. S. (1992). Analysing the relationship between change in a risk factor and risk of disease. *Statistics in Medicine*, *11*, 783–797.

Caspi, A., & Moffitt, T. E. (1993). When do individual differences matter? A paradoxical theory of personality coherence. *Psychological Inquiry*, *4*, 247–271.

Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology*, *56*, 453–484.

Chapman, B. P., Duberstein, P. R., Sorensen, S., & Lyness, J. M. (2006). Personality and perceived health in older adults: The five factor model in primary care. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *61*, 362–365.

Conrod, J. P., Stewart, S. H., Comeau, N., & Maclean, A. M. (2006). Efficacy of cognitive–behavioral interventions targeting personality risk factors for youth alcohol misuse. *Journal of Clinical Child and Adolescent Psychology*, *35*, 550–563. doi:10.1207/s15374424jccp3504_6

Costa, P. T., & McCrae, R. R. (1987). Neuroticism, somatic complaints, and disease: Is the bark worse than the bite? *Journal of Personality*, *55*, 299–316. doi:10.1111/j.1467-6494.1987.tb00438.x

Danner, D. D., Snowdon, D. A., & Friesen, W. V. (2001). Positive emotions in early life and longevity: Findings from the nun study. *Journal of Personality and Social Psychology*, *80*, 804–813.

DeSalvo, K. B., Bioser, N., Reynolds, K., He, J., & Muntner, P. (2005). Mortality prediction with a single general self-rated health question: A meta-analysis. *Journal of General Internal Medicine*, *20*, 267–275. doi:10.1111/j.1525-1497.2005.0291.x

Friedman, H. S. (2000). Long-term relations of personality and health: Dynamisms, mechanisms, tropisms. *Journal of Personality*, *68*, 1089–1108. doi:10.1111/1467-6494.00127

Friedman, H. S., Tucker, J. S., Tomlinson-Keasey, C., Schwartz, J. E., Wingard, D. L., & Criqui, M. H. (1993). Does childhood personality predict longevity? *Journal of Personality and Social Psychology*, *65*, 176–185.

Glymour, M. M., Weave, J., Berkman, L. F., Kawachi, I., & Robins, J. M. (2005). When is baseline adjustment useful in the analysis of change? An example with education and cognitive change. *American Journal of Epidemiology*, *162*, 267–278. doi:10.1093/aje/kwi187

Goodwin, R., & Engstrom, G. (2002). Personality and the perception of health in the general population. *Psychological Medicine*, *32*, 325–332. doi:10.1017/S0033291701005104

Gruenewald, T. L., Mroczek, D. K., Ryff, C. D., & Singer, B. H. (2008). Diverse pathways to positive and negative affect in adulthood and later life: An integrative approach using recursive partitioning. *Developmental Psychology*, *44*, 330–343. doi:10.1037/0012-1649.44.2.330

Haider, A. W., Larson, M. G., Franklin, S. S., & Levy, D. (2003). Systolic blood pressure, diastolic blood pressure, and pulse pressure as predictors of risk for congestive heart failure in the Framingham Heart Study. *Annals of Internal Medicine*, *138*, 10–16.

Hampson, S. E., & Friedman, H. S. (2008). Personality and health: A life span perspective. In O. P. John, R. Robins & L. Pervin (Eds.), *The handbook of personality* (3rd ed.). New York: Guilford Press.

Hampson, S. E., Goldberg, L. R., Vogt, T. M., & Dubanoski, J. P. (2006). Forty years on: Teachers' assessments of children's personality traits predict self-reported health behaviours and outcomes at midlife. *Health Psychology*, *25*, 57–64. doi:10.1037/02786133.25.1.57

Hampson, S. E., Goldberg, L. R., Vogt, T. M., & Dubanoski, J. P. (2007). Mechanisms by which childhood personality traits influence adult health status: Educational attainment, healthy eating habits, and smoking. *Health Psychology*, *26*, 121–125. doi:10.1037/0278-6133.26.1.121

Hampson, S. E., Tildesley, E., Andrews, J. A., Luckyx, K., & Mroczek, D. K. (2010). The relation of change in hostility and sociability during childhood to substance use in mid adolescence. *Journal of Research in Personality*, *44*, 103–114. doi:10.1016/j.jrp.2009.12.006

Idler, E. L., & Benyamini, Y. (1997). Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior*, *38*, 21–37.

Jackson, J. J., Hill, P. L., Payne, B., Roberts, B. W., & Stine-Morrow, E. A. L. (Under review). Can an old dog learn (and want to experience) new tricks? Cognitive training increases openness to experience in older adults.

Jones, C. J., & Meredith, W. (1996). Patterns of personality change across the life span. *Psychology and Aging*, *11*, 57–65. doi:10.1037/0033-2909.132.1.1

Keyes, C. L. M., & Grzywacz, J. G. (2005). Health as a complete state: The added value in work performance and healthcare costs. *Journal of Occupational and Environmental Medicine*, *47*, 523–532.

Kling, K. C., Ryff, C. D., Love, G., & Essex, M. (2003). Exploring the influence of personality on depressive symptoms and self-esteem across a significant life transition. *Journal of Personality & Social Psychology*, *85*, 922–932. doi:10.1037/0022-3514.85.5.922

Lachman, M., & Weaver, S. L. (1997). *The Midlife Development Inventory (MIDI) personality scales: Scale construction and scoring (Tech. Rep. No.1)*. Waltham, MA: Brandeis University, Department of Psychology.

Lawes, C. M. M., Vander Hoorn, S., & Rodgers, A. (2008). Global burden of blood-pressure-related disease, 2001. *The Lancet*, *371*, 1513–1518. doi:10.1016/S0140-6736(08)60655-8

Miller, T. R., & Wolinsky, F. D. (2007). Self-rated health trajectories and mortality among older adults. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *62*, 22–27.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R., Harrington, H., . . . Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences of the United States of America Early Edition*, *108*, 1–6.

Mroczek, D. K., & Almeida, D. M. (2004). The effects of daily stress, age, and personality on daily negative affect. *Journal of Personality*, *72*, 354–378. doi:10.1111/j.0022-3506.2004.00265.x

Mroczek, D. K., Almeida, D. M., Spiro, A., III, & Pafford, C. (2006). Modeling intraindividual stability and change in personality. In D. K. Mroczek & T. D. Little (Eds.), *Handbook of personality development* (pp. 163–180). Mahwah, NJ: Lawrence Erlbaum Associates.

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology*, *75*, 1333–1349.

Mroczek, D. K., & Spiro, A., III (2003). Modeling intraindividual change in personality traits: Findings from the Normative Aging Study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *58*, 153–165. doi:10.1093/geronb/58.3.P153

Mroczek, D. K., & Spiro, A., III (2007). Personality change influences mortality in older men. *Psychological Science*, *18*, 371–376. doi:10.1111/j.1467-9280.2007.01907.x

Mroczek, D. K., Spiro, A., & Turiano, N. (2009). Do health behaviors explain the effect of neuroticism on mortality? Longitudinal findings from the VA Normative Aging Study. *Journal of Research in Personality*, *43*, 653–659. doi:10.1016/j.jrp.2009.03.016

Myrtek, M. (2001). Meta-analyses of prospective studies on coronary heart disease, type A personality, and hostility. *International Journal of Cardiology*, *79*, 245–251.

Prenda, K., & Lachman, M. E. (2001). Planning for the future: A life management strategy for increasing control and life satisfaction in adulthood. *Psychology and Aging*, *16*, 206–216. doi:10.1037//0882-7974.16.2.206

Radler, B. T., & Ryff, C. D. (2010). Who participates? Accounting for longitudinal retention in the MIDUS national study of health and well-being. *Journal of Aging and Health*, *22*, 307–331. doi:10.1177/0898264309358617

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Roberts, B. W. (1997). Plaster or plasticity: Are adult work experiences associated with personality change in women? *Journal of Personality*, *65*, 205–232. doi:10.1111/j.1467-6494.1997.tb00953.x

Roberts, B. W., & Chapman, C. N. (2001). Change in dispositional well-being and its relations to role quality: A 30-year longitudinal study. *Journal of Research in Personality*, *34*, 26–41. doi:10.1006/jrpe.1999.2259

Roberts, B. W., Kuncel, N. R., Shiner, R., Caspi, A., & Goldberg, L. R. (2007). The power of personality: The comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. *Perspectives on Psychological Science*, *2*, 313–345. doi:10.1111/j.1745-6916.2007.00047.x

Roberts, B. W., & Mroczek, D. K. (2008). Personality trait change in adulthood. *Current Directions in Psychological Science*, *17*, 31–35. doi:10.1111/j.1467-8721.2008.00543.x

Roberts, B. W., Walton, K., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin*, *132*, 1–25. doi:10.1037/0033-2909.132.1.1

Rogosa, D. (1995). Myths and methods: "Myths about longitudinal research" with supplemental questions. In J. M. Gottman (Ed.), *The analysis of change* (pp. 3–66). Hillsdale, NJ: Lawrence Erlbaum Associates.

Rosenman, R. H., Friedman, M., Straus, R., Wurm, M., Kositcheck, R., Hahn, W., . . . Werthessen, N. T. (1964). A predictive study of coronary disease. The Western Collaborative Group Study. *Journal of the American Medical Association*, *189*, 103–110.

Ryff, C. D., & Singer, B. (1998). The contours of positive human health. *Psychological Inquiry*, *9*, 1–28.

Siegler, I. C., Costa, P. T., Brummett, B. H., Helms, M. J., Barefoot, J. C., Williams, R. B., . . . Rimer, B.K. (2003). Patterns of personality change in hostility from college to midlife in the UNC Heart Study predict high risk status. *Psychosomatic Medicine*, *65*, 738–745. doi:10.1097/01.PSY.0000088583.25140.9C

Singer, B., & Ryff, C. D. (2001). *New horizons in health: An integrative approach*. Washington, DC: National Academy Press.

Singer, J. D., & Willett, J. B. (2003). Survival analysis. In J. A. Schinka & W. F. Velicer (Eds.), *Handbook of psychology: Research methods in psychology* (pp. 555–580). Hoboken, NJ: John Wiley & Sons.

Small, B. J., Hertzog, C., Hultsch, D. F., & Dixon, R. A. (2003). Stability and change in adult personality over 6 years: Findings from the Victoria Longitudinal Study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *58*, 166–176. doi:10.1093/geronb/58.3.P166

Smith, T. W. (2006). Personality as risk and resilience in physical health. *Current Directions in Psychological Science*, *15*, 227–231. doi:10.1111/j.1467-8721.2006.00441.x

Spiro, A., III (2007). The relevance of a lifespan developmental approach to health. In C. M. Aldwin, C. L. Park & A. Spiro III (Eds.), *Handbook of health psychology and aging*. New York: Guilford Press.

Spiro, A., III, Aldwin, C. M., Ward, K., & Mroczek, D. K. (1995). Personality and the incidence of hypertension among older men: Longitudinal findings from the Normative Aging Study. *Health Psychology*, *14*, 563–569. doi:10.1037/0278-6133.14.6.563

Taris, T. W. (2000). Quality of mother-child interaction and the intergenerational transmission of sexual values: A panel study. *Journal of Genetic Psychology*, *161*, 169–181. doi:10.1080/00221320009596704

Uchino, B. N. (2006). Social support and health: A review of physiological processes potentially underlying links to disease outcomes. *Journal of Behavioral Medicine*, *29*, 377–387. doi:10.1007/s10865-006-9056-5

Watson, D., & Pennebaker, J. W. (1989). Health complaints, stress, and distress: Exploring the central role of negative affectivity. *Psychological Review*, *96*, 234–254.

Weiss, A., & Costa, P. T., Jr. (2005). Domain and facet personality predictors of all-cause mortality among Medicare patients aged 65 to 100. *Psychosomatic Medicine*, *67*, 724–733. doi:0033-3174/05/6705-0724

Wilson, R. S., Bienas, J. L., Mendes de Leon, C. F., Evans, D. A., & Bennett, D. A. (2003). Negative affect and mortality in older persons. *American Journal of Epidemiology*, *158*, 827–835. doi:10.1093/aje/kwg224

Wilson, R. S., Mendes de Leon, C. F., Bienas, J. L., Evans, D. A., & Bennett, D. A. (2004). Personality and mortality in old age. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *59*, 110–116. doi:10.1093/geronb/59.3.P110