

Personality Change Across Four Years in World Trade Center Responders



European Journal of Personality
2025, Vol. 39(3) 323–335
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DOI: 10.1177/08902070241255397
journals.sagepub.com/home/ejop
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Abstract

The present study investigated personality change over the course of a four-year longitudinal study in $N = 452$ older adults who responded to the 9/11 attacks on the World Trade Center ($M_{\text{age}} = 55$ years, $SD = 0.41$). This sample provides the rare opportunity to compare normative findings of personality change with change in a unique group with a common trauma. Participants completed the Faceted Inventory of the Five-Factor Model and the Big Five Inventory-2 across four years. Latent growth modeling showed significant mean-level decreases in Openness and Extraversion. At the facet-level, significant decreases were found for Aesthetic Sensitivity, Creative Imagination, Intellectual Curiosity, Anxiety, Anger Proneness, Positive Temperament, Venturesomeness, Ascendence, Empathy, and Achievement Striving. Further, responders showed variability in change—in particular, for Neuroticism and its facets. Regressions from exposure level and age on personality change were also examined. Results highlight the importance of facet-level analysis, as significant change was found only for certain facets within domains—sometimes when the domains showed no change. Differences between responders and normative comparisons were examined. Responders share unique trauma and personality findings may allow clinically useful information on the mental-health problems that responders experience.

Plain language summary

This study examined how personality traits have changed in older adults who responded to the 9/11 attacks on the World Trade Center (WTC) in 2001. By studying this group, normal personality change could be compared to personality change in people who have experienced the same traumatic event. The average age of the participants was 55. Participants completed personality questionnaires over four years. The results showed that there were decreases in two broad personality traits: openness (i.e., interest in new experiences) and extraversion (i.e., outgoingness). Further analysis showed specific changes within these two traits. For example, people showed decreases in traits represented by an appreciation for art, creativity, curiosity, anger, anxiety, positive emotions, adventurousness, leadership, empathy, and striving for achievement. However, there were differences among individuals, especially in traits related to neuroticism (i.e., emotional instability). These results are important because they show that change in personality can occur in specific aspects of personality, even if broader traits do not change. The study also examined how age, sex, and the amount of exposure to 9/11 affected these personality changes. Understanding these changes can help provide better mental health support for people who have experienced similar traumas.

Keywords

Personality change, world-trade-center, big five, longitudinal, responders

Received 7 January 2022; Revised 9 March 2024; accepted 27 April 2024

Introduction

Personality traits influence important life outcomes including mental health, mortality, relationships, occupation, and financial status (Ozer & Benet-Martinez, 2006). The Five-Factor Model (FFM) of personality, consisting of the broad trait domains of openness, conscientiousness, agreeableness, neuroticism, and extraversion, has emerged as a useful and comprehensive model of personality (John et al., 2008). Traits from the FFM change across time (Roberts & Mroczek, 2008), and these changes themselves have been shown to influence important outcomes (Human et al., 2013; Turiano et al., 2012). The purpose of this study

is to examine how personality traits have changed over time in responders to the World Trade Center (WTC) attacks. Findings may shed important and clinically useful light on

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the long-term consequences of trauma for personality trajectories.

Personality Development Across Time

Personality was previously considered to be stable; however, personality is now seen as continuing to develop and change from childhood, to adolescence, and into old age (Bleidorn et al., 2022). Meta-analysis at the domain level shows agreeableness and emotional stability increase in older age, conscientiousness increases up to age 80, and extraversion and openness decrease through adulthood to old age (Bleidorn et al., 2022). Past findings at the facet level include increases in self-confidence, warmth, self-control, and emotional stability at the mean-level (Roberts & Mroczek, 2008). Meta-analytic findings show that traits such as dominance and assertiveness increase in young adults, while positive temperament and sociability increase in adolescence and towards the end-of-life they decline (Roberts & Mroczek, 2008). Agreeableness increases in transition from middle to old age; however, conscientiousness remains stable (Roberts & Mroczek, 2008). Emotional stability steadily increases throughout middle age, and openness increases in adolescence and then declines into older age (Bleidorn et al., 2022). One study of older adulthood found mean level decreases in self-reports of extraversion and openness (Oltmanns et al., 2020). According to Costello et al. (2017), individuals typically increase in conscientiousness and agreeableness and decrease in neuroticism while aging. In terms of rank-order stability, synthesized results tend to show moderate stabilization in early adulthood that increases with age (Costello et al., 2017).

A more recent meta-analytic study from Bleidorn et al. (2022) found that personality development in young adulthood and middle adulthood are characterized by increases in both trait stability and mean-level changes (e.g., in Emotional Stability and Extraversion). These findings highlight that both rank-order and mean-level coincide with similar directions of trait maturity (e.g., more stability and increases in “good” traits) (Bleidorn et al., 2022). However, this meta-analysis was only at the domain level, few studies focus on later middle age, and no studies have examined personality change in WTC responders.

Importance of the Facet-Level

There are differences when examining personality at the domain level versus at the lower order facet-level. Although the specific facets within higher-order domains vary across measures, making comparison across studies difficult (Costa et al., 2019), facets do provide a more nuanced understanding of personality (Oltmanns et al., 2023; Waszczuk et al., 2018). For example, personality facets within neuroticism such as depressiveness, anxiousness, and anger proneness can each have different relationships with important health outcomes (Oltmanns et al., 2023). Facet-level analysis is necessary because domains can differ from their facets, and facets can differ from one another within the domain (Soto & John, 2012;

Terracciano et al., 2005). Relevant to the current study, findings of facet-level change in middle age include longitudinal increases in Deliberation and increases in Competence and Self-Discipline until middle age, followed by later declines (Terracciano et al., 2005). Importantly, Terracciano et al. (2005) found variation for facets within respective domains. For example, Impulsiveness showed a linear decline across the lifespan; however, other Neuroticism facets showed curvilinear effects (e.g., decreases into middle age and then increases in old age). Similarly, analyses of mean-level age trends indicate longitudinal decreases for the Rumination and Depression facets (Soto & John, 2012). Within conscientiousness, Jackson et al. (2009) found the *transition* into late adulthood is characterized by increases in the Impulse Control, Reliability, and Conventionality facets.

Costello et al. (2017) was able to replicate findings that are consistent with the “maturity principle” (Caspi et al., 2005) in a sample of 858 participants for three Big Five domains (i.e., Emotional Stability, Consciousness, and Agreeableness). Despite the large amount of evidence for the maturity principle at the domain level, there is little suggesting that facets also follow this trend. Specifically, Schwaba et al. (2022) recently found that openness to feelings, activity, and social potency (i.e., three healthy facets) significantly declined across adulthood in a sample of 30–70-year-old adults—therefore going against the maturity principle. Moreover, 15 facets failed to mature in conjunction with their domain, and post-hoc analysis suggested these traits may have already stabilized and matured by the time the participant was 30 years. Facet-level changes can also be influenced by genetics and environmental factors, according to Bleidorn et al. (2009), who examined this over the course of a large ten-year twin study, indicating that changes may be different in WTC responders due to their shared trauma. Despite the importance of studying facet-level measures when examining personality change, little research has done so in older adulthood or the WTC responder population (Oltmanns et al., 2020; Schwaba et al., 2022).

Current Study

The current study adds to the literature on personality change in later adulthood by examining personality changes over time at the facet-level in WTC responders. Prior findings of change in this age group are declines in extraversion, openness, neuroticism, and declines (in participants’ mid-50s) in agreeableness and conscientiousness (Bleidorn et al., 2022; Costa et al., 2019; Oltmanns et al., 2020; Terracciano et al., 2005). The nature of WTC trauma allows for rigorous research, as exposure happened at the same time and its effects can be referenced to this common event. The trauma has had a significant impact on the responders’ group as a whole over 15 years later (Bromet et al., 2016), indicating that it may affect findings of personality changes as well. Similarly, Oltmanns et al., 2023 found that as WTC responders advance through middle age, Big-Five personality traits are associated with objective outcomes such as BMI, daily activity, and healthcare-related costs; including, personality facets such as

Positive Temperament, Empathy, and Dutifulness. To our knowledge, this is the first study to longitudinally examine personality change in a large number of WTC responders. Based on the literature, we asked the question, how has FFM personality at the domain and facet-level changed across four years in older adults who have been exposed to the same trauma (responding to the WTC on 9/11)?

This was a pre-registered exploratory study (link: https://aspredicted.org/PMB_ZF4). We expected to find similar personality changes into older adulthood as have been found previously. However, less consistent findings exist at the facet-level in middle-to-older age, and little in individuals with a common trauma history. After the pre-registration, we updated our hypotheses to reflect domain level changes in older adults, in particular. Further, we had originally sought to examine anxiety sensitivity in addition to personality, but have focused here only on the domains and facets of the FFM. Finally, samples sizes for each follow-up varied slightly based on available data, and therefore fluctuate to a small degree. In sum, our study is exploratory in nature.

Method

Procedure

Recruitment took place at the WTC Health Program (Dasaro et al., 2017) at the Stony Brook location, which was established by the National Institute for Occupational Safety and Health. From 2017 to 2021, responders participated in an IRB-approved four-year longitudinal WTC Personality and Health (WTC-P&H) study. An unselected sample of the WTC program was obtained for the present study. Participants completed personality assessments at four waves across four years. Data collection began 16 years after the WTC attacks and started in the beginning of 2017 and officially ended at the end of 2021. Wave 1 was collected from 2017 to 2018, wave 2 from 2018 to 2019, wave 3 from 2019 to 2020, and wave 4 from 2020 to 2021. Participants did not complete the assessment at the same time, and data was collected throughout the year based on participant schedules and availability. Exclusion criteria consisted of limited comprehension of English language or major cognitive impairment.

Participants

Responders to the World Trade Center (WTC) attacks in New York on September 11th, 2001 are a particularly unique group of individuals who have been exposed to the same trauma.

There were more than 50,000 individuals who worked on the recovery and rescue of the WTC attacks in New York City. WTC responders as a whole consist of police officers, firefighters, emergency medical service technicians, paramedics, telephone and cable technicians, port authority, construction workers, railroad workers, medical examiner staff, asbestos cleaners, administrators, American Red Cross volunteers and unexpected responders (Dasaro et al., 2017; Wisnivsky et al., 2011). The program is available to WTC responders who (a) had qualifying involvement in the WTC

clean-up and recovery effort; and (b) were not eligible to participate in other federally funded programs offered to the New York City Fire Department or to federal or state employees (Dasaro et al., 2017). Responders who are accepted into WTC Health Program (i.e., the program where our participants were recruited from) are offered treatment for problems associated with their involvement in the recovery effort following the WTC attacks, including PTSD symptoms, depression, substance use disorders, COPD, heart disease, and certain types of cancer (Dasaro et al., 2017).

Demographics

Participants were only eligible for this study if they were certified through the WTC Health Program, as all the participants were enrolled in the program described above at the time of data collection. The present study enrolled a total of $n = 452$ in wave 1, $n = 368$ in wave 2, $n = 342$ in wave 3, and $n = 306$ in wave 4. In the pre-registration link, we reported different number of participants at each wave; however, at the time of the pre-registration data was being finalized from four-year study and the exact numbers slightly changed. It is important to add that firefighters were not included in the present sample because they are monitored in a separate program. The responders in this sample mainly consisted of former law enforcement employees (i.e., 67% identified as law enforcement), and 33% were non-traditional responders (e.g., construction workers, electricians, medical personnel, etc.). At wave 1, participant ages ranged from 32 to 82, with a mean of 55 years old; 89% identified as men and 11% identified as women. Education level varied: less than 1% had not completed high school, 14% were high school graduates, 42% completed some college, 25% were college graduates, 6% were professional academy graduates, 4% completed some graduate or professional schooling, and 8% were Master/Doctoral or other advanced degree graduates.

Materials

Lower-order facets of the FFM personality domains of neuroticism, extraversion, conscientiousness, and agreeableness were measured using the Faceted Inventory of the Five-Factor Model (FI-FFM, Watson et al., 2019). Openness facets were measured using the Big Five Inventory-2 (BFI-2, Soto & John, 2017). The FI-FFM contains 207 items each rated on a 5-point scale: 0 (*strongly disagree*), 1 (*disagree*), 2 (*neutral or cannot decide*), 3 (*agree*), and 4 (*strongly agree*). The FI-FFM contains 22 facets; however, only 19 facets were used in the WTC-P&H to minimize participant burden. Item counts for each facet ranged between seven (i.e., Achievement Striving) to eleven (i.e., Trust and Straight Forwardness). Neuroticism had three facets (i.e., Anxiety, Depression, Anger Proneness), four facets for Extraversion (i.e., Positive Temperament, Sociability, Ascendancy, Venturesomeness), three facets for agreeableness (i.e., Empathy, Trust, Straightforwardness), and five facets for conscientiousness (i.e., Self-Discipline, Dutifulness, Deliberation, Achievement-Striving, and Order). The BFI-2 contains 60 items each rated on a five-point scale: 1 (*disagree strongly*), 2 (*disagree a little*), 3 (*neutral; no opinion*), 4 (*agree a little*), and 5 (*agree strongly*).

Openness was the only domain measured through the BFI-2. Three facets were measured (i.e., Intellectual Curiosity, Aesthetic Sensitivity, and Creative Imagination), each containing four items. Facet scores were computed as means of corresponding items, and domain values were computed as means of corresponding facets. The FI-FFM and BFI-2 both show strong evidence of construct validity and internal consistency (Soto & John, 2017; Watson et al., 2019). In the pre-registration link, we stated that anxiety sensitivity was measured. Although this measure was collected for the overall study, it was not included in the analysis of the specific paper.

Exposure Level

Wisniewsky et al. (2011) conducted a large cohort study on over 27,000 participants in the WTC responders' population and examined prevalence of various illnesses and disorders associated with this population, as well as investigated exposure level in responders. This exposure level variable created by Wisniewsky et al. (2011) was shared with the authors of the present study at baseline for our sample. Exposure level (i.e., Exp4 variable) of the responders was based on time spent at the site, in the dust cloud, and working on the pile of debris. There were four total groups assigned based on exposure level (i.e., very high, high, intermediate, and low). As stated by Wisniewsky et al. (2011), the group assignment of participants was based on the total time spent working at the WTC site, exposure to the cloud of debris from the collapse of the WTC buildings, and work on the pile of debris. Moreover, there were four groups created based on these criteria. The low exposure group consisted of those who worked less than 40 days, were not exposed to dust from the collapse, and did not work in the debris pile. The intermediate exposure group included workers who were not exposed to the dust cloud and who either worked between 40 days and 90 days, or did not work on the pile. The high exposure group was comprised of rescue workers who were exposed to the dust cloud, but either worked less than 90 days or did not work on the pile. The highest group (i.e., the very high exposure group) included those who worked more than 90 days, were exposed to the dust cloud, and worked at least some time on the pile (Wisniewsky et al., 2011).

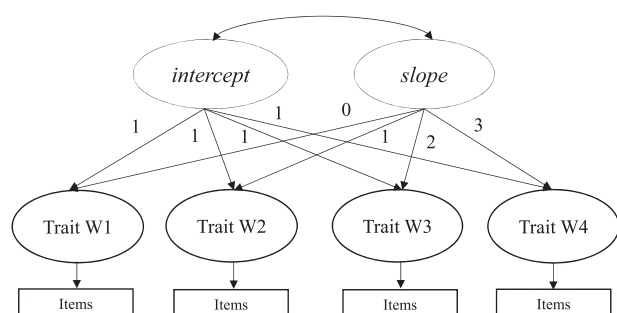


Figure 1. Latent growth curve model. Note. This is the general latent growth model that was implemented for each facet in all four waves. The number of items varied per facet. W1 = wave 1. W2 = wave 2. W3 = wave 3. W4 = wave 4. Item residuals not displayed in figure.

Data Analysis

Measurement invariance of the personality constructs across time were tested. At the domain level, the facet scales were used as indicators of the five latent domains. At the facet-level, items were used as indicators of the respective facet. Loadings on the latent factors were constrained to be equal across time (i.e., weak invariance), then the intercepts were specified to be equal across time (i.e., strong invariance); lastly, the residual variances were constrained to be equal across time (i.e., strict invariance) (Kim et al., 2016; Stark et al., 2006). Guidelines for invariance testing were followed based on specific criteria between testing steps. According to Chen (2007) a change of .01 in CFI between less restrictive to more restrictive models, supplemented with a change of either .015 of RMSEA or .030 in SRMR would indicate a significant difference. A change of .010 in SRMR was used as a supplement instead of .030, in-order to achieve strong and strict invariance (Chen, 2007). Personality traits were analyzed using latent growth curve modeling for all of the domains and facets (see Figure 1). Linear and quadratic models examined mean-level change and variability in change. Latent growth modeling (LGM) (Bollen & Curran, 2006; Newsom, 2015) was completed using the lavaan package (Rosseel, 2012) in R statistical software (Team, 2013) to examine longitudinal personality change. Missing items were addressed using ipsative mean imputation (Schafer & Graham, 2002), if at least 80% of items on the corresponding scale had valid responses at that wave. Missing scale scores were addressed using expectation maximization (Enders, 2006). Full-information maximum likelihood (FIML) estimation was used to account for missing data across waves in LGMs. Data and syntax used to run analysis are shared on the Open Science Framework (link: <https://osf.io/pxfeq/>).

Results

Descriptive statistics for all scales across the study can be seen in Supplemental Tables S1-S4. Reliability measures for the personality scales for each wave can be seen in Table S5. Due to the substantial number of paths estimated, significant results were only reported at $p < .01$ to correct for multiple testing and reduce type I errors. Results of latent growth models are presented in Table 1 and Figure 2. Results of measurement invariance testing are presented in the Supplemental Materials.

Measurement Invariance

Demonstrating that measurement models are invariant across time is a necessary step in pre-latent growth modeling. A series of tests imposing increasingly restrictive constraints on the models was executed, as described in the Method section. We examined measurement invariance at the domain and facet-level for the FI-FFM and BFI-2. According to the invariance criteria, all facet and domain-level models achieved strict invariance; except Dutifulness (i.e., strong invariance was used for analysis). Model fit indices for all measurement invariance tests are presented in the Supplemental Materials.

Table 1. Latent Growth Analysis Results for all Domains and Facets.

Personality traits	Std. i~s	Mean s	CI low s	CI up s	Var. i	Var. s
Openness	-.10	-.054***	-.075	-.033	.43***	.008*
Aesthetic sensitivity	-.02	-.045***	-.071	-.019	.71***	.014*
Creative imagination	.00	-.069***	-.095	-.043	.44***	.010
Intellectual curiosity	-.18	-.033**	-.057	-.009	.36***	.003
Neuroticism	-.40***	-.022*	-.042	-.002	.76***	.012***
Anxiety	-.43***	-.027**	-.047	-.007	.62***	.007*
Depression	-.33***	.004	-.019	.026	.70***	.022***
Anger proneness	-.36***	-.033**	-.055	-.012	.76***	.013**
Extraversion	-.19	-.046***	-.061	-.031	.39***	.006**
Positive temperament	-.20*	-.043***	-.063	-.024	.48***	.011***
Sociability	-.18	-.007	-.024	.011	.45***	.004
Venturesomeness	-.15	-.062***	-.082	-.043	.50***	.009**
Ascendence	-.05	-.041***	-.059	-.023	.44***	.005
Agreeableness	-.38***	-.008	-.024	.008	.24***	.006**
Empathy	-.19	-.026***	-.041	-.012	.21***	.003
Trust	-.16	-.018*	-.034	-.001	.36***	.004
Straightforwardness	-.36**	.015	-.001	.032	.33***	.004
Conscientiousness	-.25**	-.013	-.027	.001	.33***	.008***
Achievement striving	-.11	-.047***	-.067	-.027	.44***	.009**
Deliberation	-.40	.002	-.014	.019	.31***	.002
Dutifulness	.25	-.012	-.025	.001	.15***	.003
Order	-.32***	-.008	-.027	.012	.67***	.011***
Self-discipline	-.19	-.020	-.040	.001	.55***	.009*

Note. *** = $p < .001$; ** = $p < .01$; * = $p < .05$. "Std. i~s" = standardized correlation between the intercept and slope. "Mean s" = mean slope value. "CI low s" = slope confidence interval lower level. "CI up s" = slope confidence interval upper level. "Var. i" = variance of the intercept. "Var. s" = variance of the slope.

Openness

Fit statistics demonstrated good model fit for Openness and all corresponding facets (see Table S6 in Supplemental Materials). At the Openness domain level, a significant negative mean slope change was found; the standardized decrease indicated a moderate effect. Therefore, participants significantly decreased in their overall Openness levels from Wave 1 ($M = 3.76$, $SD = .60$) to Wave 4 ($M = 3.69$, $SD = .62$). Within Openness, Aesthetic Sensitivity (Wave 1: $M = 3.57$, $SD = .82$; Wave 4: $M = 3.52$, $SD = .87$), Creative Imagination (Wave 1: $M = 4.02$, $SD = .69$; Wave 4: $M = 3.92$, $SD = .71$), and Intellectual Curiosity (Wave 1: $M = 3.69$, $SD = .70$; Wave 4: $M = 3.64$, $SD = .68$) significantly decreased at the mean level. Aesthetic Sensitivity had a small to moderate effect size, Creative Imagination had a large effect size, and Intellectual Curiosity had a moderate effect size. The intercept of the domain and all three facets significantly varied among the participants; however, none of the facets nor the domain showed significant variability in the slope. None of the correlations between the intercept and slope for the Openness domain or facets were significant. Therefore, initial status was not associated with changes in slope values.

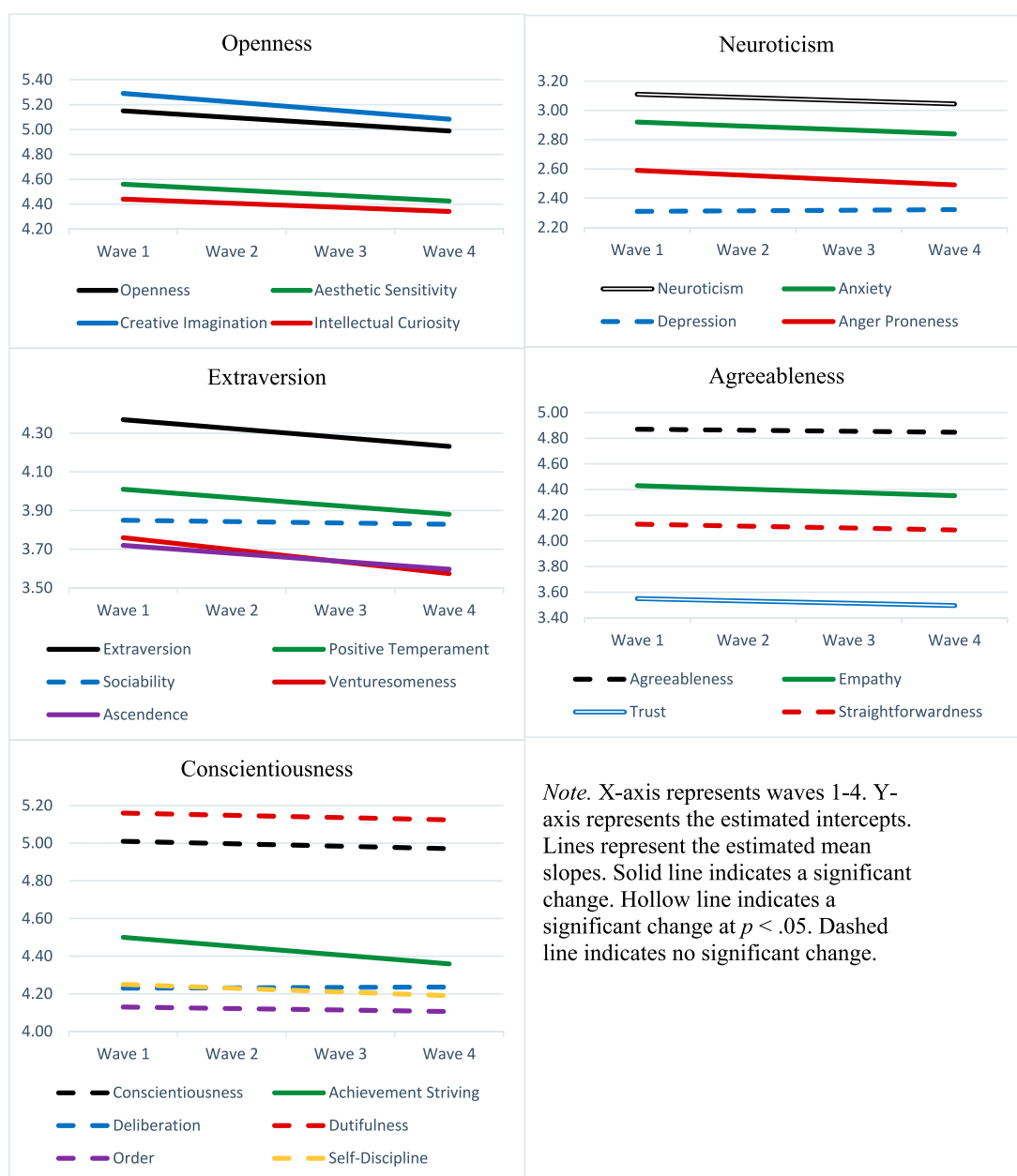
Neuroticism

Fit statistics demonstrated good model fit for Neuroticism and all corresponding facets (see Table S6 in Supplemental Materials). The latent growth model did not find a significant mean slope change for Neuroticism, meaning the

participants did not significantly change at the domain level of Neuroticism. Within the domain, only the Anxiety (Wave 1: $M = 2.56$, $SD = .80$; Wave 4: $M = 2.45$, $SD = .69$) and Anger Proneness (Wave 1: $M = 2.31$, $SD = .88$; Wave 4: $M = 2.15$, $SD = .80$) facets showed a significant change (i.e., declines). Anxiety had a small to moderate effect size, and Anger Proneness had a small to moderate effect size. The intercept of the domain and all three facets significantly varied between the participants. The slopes significantly varied between participants for the domain and all facets (i.e., except anxiety). All of the correlations between the intercept and slope for the domain and each facet were significant, negative, and indicated moderate correlation sizes. Therefore, a higher initial status associated with lower slope values.

Extraversion

Fit statistics demonstrated good model fit for Extraversion and all corresponding facets (see Table S6 in Supplemental Materials). For Extraversion, there was a significant negative mean slope at the domain level; the standardized decrease indicated a moderate effect. Therefore, participants significantly decreased in Extraversion levels from Wave 1 ($M = 3.40$, $SD = .57$) to Wave 4 ($M = 3.34$, $SD = .58$). Within the domain, the Positive Temperament (Wave 1: $M = 3.58$, $SD = .72$; Wave 4: $M = 3.50$, $SD = .71$), Ascendence (Wave 1: $M = 3.29$, $SD = .72$; Wave 4: $M = 3.23$, $SD = .73$), and Venturesomeness (Wave 1: $M = 3.31$, $SD = .72$; Wave 4: $M = 3.21$, $SD = .73$) facets significantly decreased at the mean level. Positive Temperament had a moderate effect



Note. X-axis represents waves 1-4. Y-axis represents the estimated intercepts. Lines represent the estimated mean slopes. Solid line indicates a significant change. Hollow line indicates a significant change at $p < .05$. Dashed line indicates no significant change.

Figure 2. Estimated slope change for domains & facets. Note. X-axis represents waves 1–4. Y-axis represents the estimated intercepts. Lines represent the estimated mean slopes. Solid line indicates a significant change. Hollow line indicates a significant change at $p < .05$. Dashed line indicates no significant change.

size, Ascendence had a moderate effect size, and Venturesomeness had a moderate to large effect size. Sociability was the only facet that did not show a significant change. The intercept of the domain and all four facets also significantly varied among the participants; however, only Extraversion, Positive Temperament, and Venturesomeness had significant variability in slope values. None of the correlations between the intercept and slope at the domain or facet-level were significant. Therefore, initial status in Extraversion was not correlated with change at any level.

Agreeableness

Fit statistics demonstrated good model fit for Agreeableness and all corresponding facets (see Table S6 in

Supplemental Materials). For Agreeableness, there was not a significant mean slope change at the domain level, meaning the participants did not significantly change in their mean level of Agreeableness. Within Agreeableness, only the Empathy (Wave 1: $M = 4.06$, $SD = .54$; Wave 4: $M = 4.03$, $SD = .50$) facet showed a significant negative change (i.e., moderate effect size). Straightforwardness and Trust did not significantly change. The intercept of the domain and all three facets significantly varied among the participants; however, only Agreeableness showed significant variability in the slope. The intercept and slope of Agreeableness and Straightforwardness showed a significant negative correlation, and both indicated moderate correlation sizes. Therefore, initial status was associated with lower changes in slope values for those specific traits.

Conscientiousness

Fit statistics demonstrated good model fit for Conscientiousness and all corresponding facets (see Table S6 in Supplemental Materials). For Conscientiousness, the domain level slope value was not significant. Therefore, participants did not significantly change in their overall mean Conscientiousness level throughout the study. Within the domain, only the Achievement Striving (Wave 1: $M = 3.80$, $SD = .66$; Wave 4: $M = 3.72$, $SD = .69$) facet significantly decrease at the mean level slope (i.e., moderate effect size). The Deliberation, Dutifulness, Order, and Self-Discipline facets did not significantly change over time. The intercept of the domain and all five facets significantly varied among the participants. The domain score, Achievement Striving, and Order had significant variability in the slope. The intercept and slope of Conscientiousness and Order showed a significant negative correlation, and indicated low to moderate correlation sizes. Therefore, higher initial status associated with lower slope values.

Age and Sex

We ran the latent growth model for each domain controlling for both age and sex (see Table S7 through S9 in Supplemental Materials). Age and sex were regressed on both the intercept and slope level for all domains and facets. In these models, the mean slope values were not statistically significant. Aesthetic Sensitivity, Trust, and Agreeableness intercepts were significantly predicted by Wave 1 age,

indicating age explained variance in initial status for these traits. However, age did not significantly predict any slopes. See Table 2 for full results of age regressions at the intercept and slope.

Exposure Level

The level of exposure to the WTC attacks was examined as a predictor for personality change. See Table 3 for correlations of exposure level and personality at each wave. We examined whether or not responders worked in the dust cloud immediately after the attacks and if that alone would be predictive of change; however, none of the regressions were significant (see Supplemental Table S10). We then ran the latent growth model for each trait while regressing the intercept and slope on total exposure level. After accounting for multiple testing, exposure level was also not significantly associated with the intercepts nor the slopes for any of the domains and facets. If interested in the significant findings prior correcting for multiple testing, see Supplemental Table S11.

Average Standardized Rate of Change

Time was rescaled into two age group comparisons to facilitate the assessment of average standardized rates of change based on age range. Rates of change per age group and personality domain were examined. Participants were categorized into two age groups. The median age of the sample was 55; therefore, the two age groups

Table 2. Intercept and Slope Regressions for Age.

Personality traits	Intercept			Slope		
	Stan. est.	CI low	CI up	Stan. est.	CI low	CI up
Openness	.064	−.047	.174	.077	−.168	.322
Aesthetic sensitivity	.145**	.040	.250	.036	−.199	.270
Creative imagination	.046	−.068	.160	.025	−.247	.296
Intellectual curiosity	.055	−.069	.179	.095	−.362	.552
Neuroticism	−.051	−.152	.051	.030	−.163	.224
Anxiety	−.044	−.146	.058	.046	−.203	.295
Depression	−.089	−.189	.011	.010	−.151	.172
Anger proneness	−.064	−.165	.037	.042	−.166	.249
Extraversion	.075	−.030	.179	−.102	−.314	.111
Positive temperament	.093	−.010	.197	−.116	−.308	.076
Sociability	.010	−.094	.114	−.019	−.304	.267
Venturesomeness	.084	−.020	.188	−.176	−.397	.046
Ascendence	−.010	−.115	.095	−.058	−.333	.216
Agreeableness	.166**	.052	.281	−.112	−.318	.094
Empathy	.056	−.052	.165	−.085	−.356	.185
Trust	.234***	.137	.332	−.113	−.385	.159
Straightforwardness	.100	−.007	.207	−.239	−.512	.033
Conscientiousness	.027	−.076	.129	−.158	−.330	.013
Achievement striving	−.090	−.195	.016	−.207	−.435	.020
Deliberation	−.017	−.124	.089	.040	−.367	.446
Dutifulness	.044	−.065	.152	−.189	−.455	.077
Order	.044	−.057	.144	−.172	−.367	.022
Self-discipline	.039	−.065	.143	−.176	−.404	.053

Note. *** = $p < .001$; ** = $p < .01$; * = $p < .05$. "Stan. est." = standard estimate value of age for each trait aligned to the left. "CI low" = intercept confidence interval lower level. "CI up" = intercept confidence interval upper level.

were set as, 54 or younger ($n = 228$), and 55 or older ($n = 223$). After regrouping the participants based on age groups, scores were standardized and the average rate of change were determined at the domain levels (see Table 4). Extraversion was the only trait that had a significant rate of change for either age group. In the 54 or younger group, Extraversion significantly decreased ($\beta = -.42$), and significantly decreased even more so for the 55 or older group ($\beta = -.89$).

In relation to a normative comparison group, standard point estimates for M openness change = -1.010 in the 54 or younger group, $M = -.376$ in the 55 or older group, and $M = -.007$ in Bleidorn et al. (2022). Standard point estimates for M neuroticism change = $-.196$ in the 54 or younger group, $M = -.178$ in the 55 or older group, and M

emotional stability = $.041$ in Bleidorn et al. (2022). Standard point estimates for M extraversion change = $-.423$ in the 54 or younger group, $M = -.890$ in the 55 or older group, and $M = -.048$ in Bleidorn et al. (2022). Standard point estimates for M agreeableness change = $.056$ in the 54 or younger group, $M = -.190$ in the 55 or older group, and $M = .003$ in Bleidorn et al. (2022). Standard point estimates for M conscientiousness change = $.056$ in the 54 or younger group, $M = .016$ in the 55 or older group, and $M = -.002$ in Bleidorn et al. (2022).

Discussion

The results highlight multiple significant declines at the domain level; including, Openness and Extraversion, both decreases indicated moderate effects sizes. Several facets within the domains were also found to significantly decrease over the course of the study: Aesthetic Sensitivity, Creative Imagination, and Intellectual Curiosity from Openness, Anxiety and Anger Proneness from Neuroticism, Positive Temperament, Venturesomeness, and Ascendence from Extraversion, and Empathy from Agreeableness, and Achievement Striving from Conscientiousness. These findings indicate that facets sometimes changed differently from domain-level scores. Age and sex did not affect rate of personality change, but they predicted individual differences in initial personality levels. Exposure level did not predict either change or intercepts.

It is important to note that not all responders changed in the same ways, as evidenced by significant differences in slope variances. There were differences in change across all FFM domains, but Neuroticism in particular, and most of its facets, showed significant variability in change. This finding may indicate that WTC responders show variability, in particular, in how their neurotic traits change years after responding to the same disaster. Prior studies many responders still suffer from posttraumatic stress, while others do not (Bromet et al., 2016). Future studies should make further attempts to predict change variability, thereby providing knowledge about what factors might allow some responders to improve in emotional stability while others may not.

Comparison to Normative Groups

Previous literature on personality development at middle-to-later age shows declines in openness, extraversion,

Table 3. Correlations of WTC Exposure Level and Personality.

Personality traits	W1	W2	W3	W4
	r	r	r	r
Openness	-.030	-.035	-.033	-.020
Aesthetic sensitivity	.017	-.013	-.079	-.070
Creative imagination	-.028	-.033	.021	.042
Intellectual curiosity	-.069	-.041	-.018	-.009
Neuroticism	-.007	.025	-.029	-.017
Anxiety	.007	.010	-.054	-.046
Depression	-.034	.002	-.038	-.006
Anger proneness	.009	.052	.014	.004
Extraversion	.104*	.106	.131*	.098
Positive temperament	.105*	.100	.086	.074
Sociability	.037	.040	.080	-.003
Venturesomeness	.103*	.085	.104	.085
Ascendence	.082	.111*	.139*	.149*
Agreeableness	.003	-.039	-.018	-.068
Empathy	.026	.029	.039	.009
Trust	-.035	-.095	-.041	-.089
Straightforwardness	.021	-.013	-.028	-.062
Conscientiousness	.063	.029	.058	-.007
Achievement striving	.045	.050	.052	.035
Deliberation	.003	-.012	-.016	-.042
Dutifulness	.074	.040	-.024	-.036
Order	.063	.030	.070	-.023
Self-discipline	.053	.006	.095	.026

Note. *** = $p < .001$; ** = $p < .01$; * $p < .05$. All correlations are between the Exp4 variable and the personality traits from each wave. "r" = Pearson Correlation. "W1" = wave 1. "W2" = wave 2. "W3" = wave 3. "W4" = wave 4.

Table 4. Average Standardized Rates of Change for Two Age Groups.

Personality traits	Age Group 1			Age Group 2		
	Std. s	CI low s	CI up s	Std. s	CI low s	CI up s
Openness	-1.010	-2.241	.222	-.376*	-.692	-.061
Neuroticism	-.196	-.443	.051	-.178	-.478	.122
Extraversion	-.423**	-.724	-.121	-.890**	-1.472	-.308
Agreeableness	.056	-.224	.337	-.190	-2.428	2.047
Conscientiousness	.056	-.163	.276	.016	-.287	.319

Note. *** = $p < .001$; ** = $p < .01$; * $p < .05$. "Std. s" = standardized slope estimate. "CI low s" = slope confidence interval lower level. "CI up s" = slope confidence interval upper level.

neuroticism, and decreases for agreeableness and conscientiousness (Bleidorn et al., 2022; Oltmanns et al., 2020). Declines in Openness and Extraversion scales were seen here; however, Neuroticism, Agreeableness, and Conscientiousness did not significantly decrease. These findings highlight the importance of also examining the facet-level, as they provide nuanced information.

At the domain level, including a comparison group in longitudinal post-traumatic data is critical to better understand if the results found are similar to other groups or are unique to a trauma-exposed population (Anusic & Yap, 2014; Jayawickreme & Blackie, 2014; Jayawickreme et al., 2021). When comparing to personality change in normative groups, similar to the findings from a large and recent meta-analysis (Bleidorn et al., 2022), WTC responders also decreased in extraversion and openness. However, while normative findings significantly decreased in neuroticism, agreeableness, and conscientiousness, WTC responders did not. Concurring comparisons are also found in several other studies with similar age ranges, including Oltmanns et al. (2020), Roberts and Mroczek (2008), and Schwaba et al. (2022).

In terms of rate of change, each domain was separated into two age groups (i.e., 54 or younger, and 55 or older). Standardized point estimates for the age splits from this study were directed compared to the meta-analysis from Bleidorn et al. (2022) in the Results section. Moreover, from the 54 or younger group, the direction of the change was similar to Bleidorn et al. (2022) for all domains except Conscientiousness. From the 55 or older group, the direction of the change was similar to Bleidorn et al. (2022) for all domains except Agreeableness and Conscientiousness. Despite findings similar trends for majority of the domains, the standardized estimates were noticeably different than those from Bleidorn et al. (2022), which further solidifies that WTC responders are a unique population and compare differently to normative data. Importantly, Extraversion was the only trait that had a significant rate of change for either age group.

Facet-level development was somewhat similar to what has been found in previous facet level studies (Schwaba et al., 2022; Soto & John, 2012; Terracciano et al., 2005); however, there were noticeable differences between our sample and those studies. Facet change comparison was a focus of Schwaba et al. (2022) which had a similar age range (30–70 age range from Schwaba et al. (2022) and our age range is between 32 and 82). Differences between groups include the Empathy and Intellectual Curiosity facets that increased in the comparison group; however, neither of those facets decreased in this WTC sample. However, different scales for Empathy and Intellectual Curiosity were used in the comparison. Similarities between groups included decreases in the Creative Imagination, Venturesomeness, and Anger Proneness facets, all of which were found in the present WTC sample during the course of the study. However, different scales for Creative Imagination, Venturesomeness, and Anger Proneness were used in the comparison. It is important to note that only findings that were significant in our sample and the comparison's sample are discussed here. What was reported in these comparisons were the estimated mean differences from the

latent model used in this paper and the mean slopes from Schwaba et al. (2022). There were also differences in the two papers, as Schwaba et al. (2022) had a larger sample size and had varying measurement differences, such as the use of various scales compared to this paper; however, the scales that most closely correspond to ours were compared.

Explanation of the personality change differences between WTC responders and comparison groups are difficult to pinpoint theoretically. A plausible explanation is the notable trauma exposure difference and the resulting chronic physical health issues (Ruggero et al., 2013; Wisnivesky et al., 2011). These long-term health consequences from the 9/11 attacks also may have had long-term effects on personality traits (Oltmanns et al., 2023; Waszczuk et al., 2018). Indeed, many responders report significant life changes stemming from performing their duties during that time (Hammock et al., 2019).

Theoretical Interpretations

Previous literature on the *maturity* principle in personality development would indicate that responders should have become more emotionally stable over time (Roberts & Nickel, 2021; Specht et al., 2014). However, the Neuroticism domain and the Depression facet did not significantly decrease during the study. Despite decreasing trends for depression facet scales typically seen (Schwaba et al., 2022; Soto & John, 2012), Depression was the only Neuroticism facet that did not significantly change. It is possible that declines in Depression scores were less likely to be found in our population given the higher prevalence of long-term depression in WTC responders nearly 20 years after the attacks (Bromet et al., 2016). Similarly, Zvolensky et al. (2015) found depression scores in WTC responders remained stable over the course of nearly three years. The lack of significant change in the Depression facets may explain why the Neuroticism domain did not significantly decrease. In terms of extraversion, our findings corroborate prior research at both the domain and facet levels. Sociability was the only facet within extraversion that did not significantly change. This could reflect an already existing value of social network that responders had built, perhaps among each other after experiencing the same traumatic event and feeling a sense of connection as a group. Many of them also had similar careers and experiences in their jobs, such as those who were policemen and firemen; therefore, possibly creating a space where they can share and bond over stories. Studies have found that social support can also be a strong coping mechanism for individuals with experienced trauma (Laffaye et al., 2008). Interestingly, agreeableness and conscientiousness did not decline in our sample, but facets within both domains did. For Achievement Striving and Empathy, it is possible that the responders were above average in those traits to begin with. Indeed, these may have been reasons that influenced their decisions to become WTC responders in the first place. Therefore, high initial scores on these traits may have increased the likelihood of showing a decline over time. Our lack of finding significant increases in neuroticism,

agreeableness, and conscientiousness align with the notion of refining the *maturity* principle at the facet level (c.f., Schwaba et al., 2022).

Exposure Moderation

This population is unique in that it involved individuals who came together (many of which volunteered) with a shared goal and motivation (i.e., to help others impacted from the attacks and for their national pride) and now experienced this shared trauma in their own unique way. Their reasonability's that each one of them held varied; for example, their duties, the time spent there, being in the dust cloud, working on the pile, security purposes, general clean up, for example. Therefore, dust cloud presence and exposure level on personality change were investigated.

Our findings indicated that exposure to the dust cloud or total exposure level were not moderating factors on personality change. We theorize that these variables were non-significant due to the long period of time that has passed since the trauma occurred (i.e., over 15 years have passed). Although the impact of the exposure on personality change was not significant after correcting for multiple testing, it is important to consider its potential impact due to recent literature on post-traumatic growth and positive personality change (Jayawickreme & Blackie, 2014; Jayawickreme et al., 2021; Weststar et al., 2022). It is possible the shared trauma impacted responders in various ways, possibly fostering unique opportunities for post-traumatic growth at an individual level. However, it is crucial to acknowledge that other factors such as personal health history, genetics, environmental factors, and individual differences also play significant roles in post-traumatic growth. Nevertheless, these considerations present intriguing possibilities for replication and further exploration in future research.

Implications

Personality change can have important clinical implications to consider for age and trauma. Personality predicts future onset of disorders and worsening physical and mental health (Jeronimus et al., 2016; Kopala-Sibley et al., 2016; Waszczuk et al., 2022). Considering the shared exposure to trauma experienced by WTC responders, it is important to discuss the possible implications these results can have on the relation between trauma exposure and personality traits. Importantly, trauma patients have shown elevated scores on personality traits that are predictive of internalizing psychopathology (Møller et al., 2021). The findings from the current study are especially important to consider for professions that are exposed to high-levels of trauma (e.g., police officers, firemen, first-responders). For instance, more accumulated stress and trauma can lead to unique change in personality (Suliman & Einat, 2018). Understanding the link between trauma exposure and personality development might inform therapeutic interventions aimed at fostering resilience and facilitating growth in trauma survivors. These clinical implications illustrate the need for a comprehensive and holistic approach in addressing the complex interplay between trauma, personality, and mental

health outcomes in this and similar populations (Cleven et al., 2021; Lowell et al., 2018; Waszczuk et al., 2018; Wisnivesky et al., 2011).

Limitations and Future Directions

Although there are many strengths of the present study, it has limitations. This study relied solely on self-report measures. Evidence suggests that informant-reports of personality provide unique perspectives on personality change and prediction of trauma-related outcomes in responders (Oltmanns et al., 2020, 2023), but were not available for the present study to examine change. Another limitation to the study is that the WTC attacks happened over 20 years ago, with much time having passed. Therefore, the exact mechanisms that might have led to this change are unknown; especially since data on the responders prior to the attacks does not exist. However, responders still suffer the consequences of experiencing the 9/11 trauma (Bromet et al., 2016), and these findings help contextualize those consequences. Due to the high prevalence of PTSD in responders (Dasaro et al., 2017; Ruggero et al., 2013; Wisnivesky et al., 2011), it will also be important for future studies to also incorporate PTSD-related measures and how they influence the personality change of WTC responders. Finally, the WTC responder population is unique and thus generalizability to other populations might not be realistic. However, the uniqueness of this sample in the context of shared trauma also provides a much-needed and rare perspective on personality change in this age group.

Conclusion

The purpose of this study was to examine how personality has changed over the course of four years in WTC responders. Personality change was analyzed longitudinally at both the domain and facet level, thus providing a more specific understanding of how personality continues to develop in middle-to-later stages of age and in a unique population. Findings indicated significant decreases at multiple higher-order domains of the Big-Five Factor model of personality, and change within several of the lower-order facets that correspond. Openness and Extraversion all declined, and decreases were also observed for their facets (Aesthetic Sensitivity, Creative Imagination, Intellectual Curiosity, Anxiety, Anger Proneness, Positive Temperament, Venturesomeness, Ascendence, Empathy, and Achievement Striving). The results highlight the importance of facet-level analysis, as significant change was found only for certain facets within domains, and for some facets where the corresponding domain did not show change. Implications from the study could be relevant for trauma researchers and clinicians, as WTC responders have a shared unique trauma and personality-specific findings may lay the groundwork for clarifying the on-going physical and mental well-being of responders.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was supported by the National Institutes of Occupational Safety and Health under Award Number U01OH011321 (PI: Roman Kotov). NIOSH had no role in the conduct of the study or preparation of the manuscript. The findings and conclusions in this article are those of the authors and do not represent the official positions of NIOSH.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: National Institutes of Occupational Safety and Health (U01OH011321).

Open Science Statement

 The data and syntax used to run analysis for this study are shared on the Open Science Framework (link: <https://osf.io/pxfeq/>).

Supplemental Material

Supplemental material for this article is available online.

References

- Anusic, I., & Yap, S. C. Y. (2014). Using longitudinal studies to understand post-traumatic growth. *European Journal of Personality*, 28(4), 332–333.
- Bleidorn, W., Kandler, C., Riemann, R., Spinath, F. M., & Angleitner, A. (2009). Patterns and sources of adult personality development: Growth curve analyses of the NEO PI-R scales in a longitudinal twin study. *Journal of Personality and Social Psychology*, 97(1), 142–155. <https://doi.org/10.1037/a0015434>
- Bleidorn, W., Schwaba, T., Zheng, A., Hopwood, C., Sosa, S., Roberts, B., & Briley, D. (2022). Personality stability and change: A meta-analysis of longitudinal studies. *Psychological Bulletin*, 148(7-8), 588–619. <https://doi.org/10.1037/bul0000365>
- Bollen, K. A., & Curran, P. J. (2006). *Latent curve models: A structural equation perspective*. John Wiley & Sons.
- Bromet, E. J., Hobbs, M. J., Clouston, S. A. P., Gonzalez, A., Kotov, R., & Luft, B. J. (2016). DSM-IV post-traumatic stress disorder among World Trade Center responders 11–13 years after the disaster of 11 September 2001 (9/11). *Psychological Medicine*, 46(4), 771–783. <https://doi.org/10.1017/S0033291715002184>
- Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology*, 56, 453–484. <https://doi.org/10.1146/annurev.psych.55.090902.141913>
- Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 14(3), 464–504. <https://doi.org/10.1080/10705510701301834>
- Cleven, K. L., Rosenzvit, C., Nolan, A., Zeig-Owens, R., Kwon, S., Weiden, M. D., Skerker, M., Halpren, A., & Prezant, D. J. (2021). Twenty-year reflection on the impact of World Trade Center exposure on pulmonary outcomes in Fire Department of the City of New York (FDNY) rescue and recovery workers. *Lung*, 199(6), 569–578. <https://doi.org/10.1007/s00408-021-00493-z>
- Costa, P. T., McCrae, R. R., & Löckenhoff, C. E. (2019). Personality across the life span. *Annual Review of Psychology*, 70(1), 423–448. <https://doi.org/10.1146/annurev-psych-010418-103244>
- Costello, C., Srivastava, S., & Saucier, G. (2017, June 27). Stability and change in the Big Five and Big Six: New tests of the maturity and cumulative continuity principles. <https://doi.org/10.31234/osf.io/b36tv>
- Dasaro, C. R., Holden, W. L., Berman, K. D., Crane, M. A., Kaplan, J. R., Lucchini, R. G., Luft, B. J., Moline, J. M., Teitelbaum, S. L., Tirunagari, U. S., Udasin, I. G., Weiner, J. H., Zigrossi, P. A., & Todd, A. C. (2017). Cohort profile: World Trade Center health program general responder cohort. *International Journal of Epidemiology*, 46(2), Article e9. <https://doi.org/10.1093/ije/dyv099>
- Enders, C. K. (2006). A primer on the use of modern missing-data methods in psychosomatic medicine research. *Psychosomatic Medicine*, 68(3), 427–436. <https://doi.org/10.1097/01.psy.0000221275.75056.d8>
- Hammock, A. C., Dreyer, R. E., Riaz, M., Clouston, S. A., McGlone, A., & Luft, B. (2019). Trauma and relationship strain: Oral histories with World Trade Center disaster responders. *Qualitative Health Research*, 29(12), 1751–1765. <https://doi.org/10.1177/1049732319837534>
- Human, L. J., Biesanz, J. C., Miller, G. E., Chen, E., Lachman, M. E., & Seeman, T. E. (2013). Is change bad? Personality change is associated with poorer psychological health and greater metabolic syndrome in midlife. *Journal of Personality*, 81(3), 249–260. <https://doi.org/10.1111/jopy.12002>
- Jackson, J. J., Bogg, T., Walton, K. E., Wood, D., Harms, P. D., Lodi-Smith, J., Edmonds, G. W., & Roberts, B. W. (2009). Not all conscientiousness scales change alike: A multi-method, multisample study of age differences in the facets of conscientiousness. *Journal of Personality and Social Psychology*, 96(2), 446–459. <https://doi.org/10.1037/a0014156>
- Jayawickreme, E., & Blackie, L. E. R. (2014). Post-traumatic growth as positive personality change: Evidence, controversies and future directions. *European Journal of Personality*, 28(4), 312–331. <https://doi.org/10.1002/per.1963>
- Jayawickreme, E., Infurna, F. J., Alajak, K., Blackie, L. E. R., Chopik, W. J., Chung, J. M., Dorfman, A., Fleeson, W., Forgeard, M. J. C., Frazier, P., Furr, R. M., Grossmann, I., Heller, A. S., Laceulle, O. M., Lucas, R. E., Luhmann, M., Luong, G., Meijer, L., McLean, K. C., & Zonneveld, R. (2021). Post-traumatic growth as positive personality change: Challenges, opportunities, and recommendations. *Journal of Personality*, 89(1), 145–165. <https://doi.org/10.1111/jopy.12591>
- Jeronimus, B. F., Kotov, R., Riese, H., & Ormel, J. (2016). Neuroticism's prospective association with mental disorders halves after adjustment for baseline symptoms and psychiatric history, but the adjusted association hardly decays with time: A meta-analysis on 59 longitudinal/prospective studies with 443 313 participants. *Psychological Medicine*, 46(14), 2883–2906. <https://doi.org/10.1017/S0033291716001653>
- John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative Big Five trait taxonomy: History, measurement, and conceptual issues. In O. P. John, R. W. Robins, &

- L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (pp. 114–158). The Guilford Press.
- Kim, E. S., Joo, S. H., Lee, P., Wang, Y., & Stark, S. (2016). Measurement invariance testing across between-level latent classes using multilevel factor mixture modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, 23(6), 870–887. <https://doi.org/10.1080/10705511.2016.1196108>
- Kopala-Sibley, D. C., Kotov, R., Bromet, E. J., Carlson, G. A., Danzig, A. P., Black, S. R., & Klein, D. N. (2016). Personality diatheses and hurricane Sandy: Effects on post-disaster depression. *Psychological Medicine*, 46(4), 865–875. <https://doi.org/10.1017/S0033291715002378>
- Laffaye, C., Cavella, S., Drescher, K., & Rosen, C. (2008). Relationships among PTSD symptoms, social support, and support source in veterans with chronic PTSD. *Journal of Traumatic Stress*, 21(4), 394–401. <https://doi.org/10.1002/jts.20348>
- Lowell, A., Suarez-Jimenez, B., Helpman, L., Zhu, X., Duroskey, A., Hilburn, A., Schneier, F., Gross, R., & Neria, Y. (2018). 9/11-related PTSD among highly exposed populations: A systematic review 15 years after the attack. *Psychological Medicine*, 48(4), 537–553. <https://doi.org/10.1017/S0033291717002033>
- Møller, L., Sogaard, U., Elklit, A., & Simonsen, E. (2021). Differences between ICD-11 PTSD and complex PTSD on DSM-5 section III personality traits. *European Journal of Psychotraumatology*, 12(1), Article 1894805. <https://doi.org/10.1080/20008198.2021.1894805>
- Newsom, J. T. (2015). *Longitudinal structural equation modeling: A comprehensive introduction* (1st ed.). Routledge. <https://doi.org/10.4324/9781315871318>
- Oltmanns, J. R., Jackson, J. J., & Oltmanns, T. F. (2020). Personality change: Longitudinal self-other agreement and convergence with retrospective-reports. *Journal of Personality and Social Psychology*, 118(5), 1065–1079. <https://doi.org/10.1037/pspp0000238>
- Oltmanns, J. R., Ruggero, C., Miao, J., Waszczuk, M., Yang, Y., Clouston, S. A. P., Bromet, E. J., Luft, B. J., & Kotov, R. (2023). The role of personality in the mental and physical health of World Trade Center responders: Self-versus informant-reports. *Clinical Psychological Science*, 11(6), 1075–1089. <https://doi.org/10.1177/21677026221132552>
- Ozer, D. J., & Benet-Martinez, V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology*, 57, 401–421. <https://doi.org/10.1146/annurev.psych.57.102904.190127>
- Roberts, B. W., & Mroczek, D. (2008). Personality trait change in adulthood. *Current Directions in Psychological Science*, 17(1), 31–35. <https://doi.org/10.1111/j.1467-8721.2008.00543.x>
- Roberts, B. W., & Nickel, L. B. (2021). Personality development across the life course: A neo-socioanalytic perspective. In O. P. John, & R. W. Robins (Eds.), *Handbook of personality: Theory and research* (pp. 259–283). The Guilford Press.
- Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, 48(2), 1–36. <https://doi.org/10.18637/jss.v048.i02>
- Ruggero, C. J., Kotov, R., Callahan, J. L., Kilmer, J. N., Luft, B. J., & Bromet, E. J. (2013). PTSD symptom dimensions and their relationship to functioning in World Trade Center responders. *Psychiatry Research*, 210(3), 1049–1055. <https://doi.org/10.1016/j.psychres.2013.08.052>
- Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, 7(2), 147–177.
- Schwaba, T., Bleidorn, W., Hopwood, C. J., Manuck, S. B., & Wright, A. G. C. (2022). Refining the maturity principle of personality development by examining facets, close others, and comaturation. *Journal of Personality and Social Psychology*, 122(5), 942–958. <https://doi.org/10.1037/pspp0000400>
- Soto, C. J., & John, O. P. (2012). Development of Big Five domains and facets in adulthood: Mean-level age trends and broadly versus narrowly acting mechanisms. *Journal of Personality*, 80(4), 881–914. <https://doi.org/10.1111/j.1467-6494.2011.00752.x>
- Soto, C. J., & John, O. P. (2017). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. *Journal of Personality and Social Psychology*, 113(1), 117–143. <https://doi.org/10.1037/pspp0000096>
- Specht, J., Bleidorn, W., Denissen, J. J. A., Hennecke, M., Hutteman, R., Kandler, C., Luhmann, M., Orth, U., Reitz, A. K., & Zimmermann, J. (2014). What drives adult personality development? A comparison of theoretical perspectives and empirical evidence. *European Journal of Personality*, 28(3), 216–230. <https://doi.org/10.1002/per.1966>
- Stark, S., Chernyshenko, O. S., & Drasgow, F. (2006). Detecting differential item functioning with confirmatory factor analysis and item response theory: Toward a unified strategy. *Journal of Applied Psychology*, 91(6), 1292–1306. <https://doi.org/10.1037/0021-9010.91.6.1292>
- Suliman, N., & Einat, T. (2018). Does work stress change personalities? Working in prison as a personality-changing factor among correctional officers. *Criminal Justice and Behavior*, 45(5), 628–643. <https://doi.org/10.1177/0093854818758141>
- Team, R. C. (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.
- Terracciano, A., McCrae, R. R., Brant, L. J., & Costa, P. T. Jr. (2005). Hierarchical linear modeling analyses of the NEO-PI-R scales in the Baltimore longitudinal study of aging. *Psychology and Aging*, 20(3), 493–506. <https://doi.org/10.1037/0882-7974.20.3.493>
- 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). *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 67(1), 4–12. <https://doi.org/10.1093/geronb/gbr072>
- Waszczuk, M. A., Hopwood, C. J., Luft, B. J., Morey, L. C., Perlman, G., Ruggero, C. J., Skodol, A. E., & Kotov, R. (2022). The prognostic utility of personality traits versus past psychiatric diagnoses: Predicting future mental health and functioning. *Clinical Psychological Science: A Journal of the Association for Psychological Science*, 10(4), 734–751. <https://doi.org/10.1177/21677026211056596>
- Waszczuk, M. A., Li, K., Ruggero, C. J., Clouston, S. A., Luft, B. J., & Kotov, R. (2018). Maladaptive personality traits and 10-year course of psychiatric and medical symptoms and functional impairment following trauma. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, 52(8), 697–712. <https://doi.org/10.1093/abm/kax030>

- Watson, D., Nus, E., & Wu, K. D. (2019). Development and validation of the faceted Inventory of the five-factor model (FI-FFM). *Assessment*, 26(1), 17–44. <https://doi.org/10.1177/1073191117711022>
- Weisberg, Y. J., DeYoung, C. G., & Hirsh, J. B. (2011). Gender differences in personality across the ten aspects of the Big Five. *Frontiers in Psychology*, 2, 178–189. <https://doi.org/10.3389/fpsyg.2011.00178>
- Weststrate, N. M., Jayawickreme, E., & Wrzus, C. (2022). Advancing a three-tier personality framework for posttraumatic growth. *European Journal of Personality*, 36(4), 704–725. <https://doi.org/10.1177/08902070211062327>
- Wisnivesky, J. P., Teitelbaum, S. L., Todd, A. C., Boffetta, P., Crane, M., Crowley, L., de la Hoz, R. E., Dellenbaugh, C., Harrison, D., Herbert, R., Kim, H., Jeon, Y., Kaplan, J., Katz, C., Levin, S., Luft, B. J., Markowitz, S., Moline, J. M., Ozbay, F., & Landrigan, P. J. (2011). Persistence of multiple illnesses in World trade center rescue and recovery workers: A cohort study. *Lancet (London, England)*, 378(9794), 888–897. [https://doi.org/10.1016/S0140-6736\(11\)61180-X](https://doi.org/10.1016/S0140-6736(11)61180-X)
- Zvolensky, M. J., Kotov, R., Schechter, C. B., Gonzalez, A., Vujanovic, A., Pietrzak, R. H., Crane, M., Kaplan, J., Moline, J. M., Southwick, S. M., Feder, A., Udasin, I., Reissman, D. B., & Luft, B. J. (2015). Post-disaster stressful life events and WTC-related posttraumatic stress, depressive symptoms, and overall functioning among responders to the World Trade Center disaster. *Journal of Psychiatric Research*, 61, 97–105. <https://doi.org/10.1016/j.jpsychires.2014.11.010>