

Can the Five Factor Model of Personality Account for the Variability of Autism Symptom Expression? Multivariate Approaches to Behavioral Phenotyping in Adult Autism Spectrum Disorder

Abstract: The present study aimed to determine the extent to which the five factor model of personality (FFM) accounts for variability in autism spectrum disorder (ASD) symptomatology in adults and whether behavioral phenotypes may exist within ASD based upon patterns of variation within the FFM. A sample of 828 adults with and without self-reported ASD diagnoses was recruited via the internet and through ASD social networks. Adults completed an online questionnaire which included the International Personality Item Pool Representation of the NEO-PI-R (IPIP-NEO-120; <http://ipip.ori.org>) and the Ritvo Autism/Asperger's Diagnostic Scale Revised (RAADS-R; Ritvo et al., 2011). Using the RAADS-R cutoff score, 364 adults from the sample scored above the clinical threshold and were considered to be the Elevated ASD Traits group in this study and the remainder of the sample was considered to be the typical comparison group. The two groups statistically significantly differed on most FFM factors and facets as measured by the IPIP-NEO-120. FFM *facets* accounted for 70% of the variance in ASD symptomatology in the RAADS, whereas FFM *factors* accounted for 47% of variance. Neuroticism and its facets positively correlated with ASD severity, while extraversion, openness to experience, agreeableness, and conscientiousness negatively correlated with ASD severity. At the facet level, salient individual difference variables related to sociability, emotion regulation, emotionality, and connectedness to others (e.g., altruism) emerged as significant correlates of ASD symptomatology. Four FFM subtypes emerged within adults with elevated ASD traits, with three subtypes characterized by both high neuroticism and low extraversion. Low agreeableness characterized two of the subtypes, and low conscientiousness was seen in just one subtype. The four FFM subtypes differed from one another in several quality of life indicators. Overall, this study suggests a strong correspondence between established personality traits and ASD symptomatology. The study also sheds light on the multiplicity of phenotypic manifestations of elevated ASD traits in adults, reflecting a striking heterogeneity of psychosocial presentations among those with elevated ASD traits.

Although the prevalence of autism spectrum disorder (ASD) in adults is unknown, the prevalence rate in children has dramatically risen over the last two decades, and those who were diagnosed at the beginning of this growth period have now reached adulthood (Mazefsky & White, 2014). Affecting as many as 1 out of every 68 children, ASD is a lifelong neurodevelopmental condition characterized by core deficits in social communication and restricted, repetitive patterns of behavior (Centers for Disease Control, 2014). Autism is referred to as a “spectrum disorder” due to the heterogeneity of symptoms and symptom severity that individuals experience (American Psychiatric Association, 2013; Wing, 1997). In the literature, there is increasing discussion of the possibility that ASD is actually composed of multiple and separable clinical syndromes, sometimes referred to as the autisms (Geschwind & Levitt, 2007), with distinct underlying pathology and, possibly, differing patterns of overt expression that simply have yet to be discovered and distinguished. However, valid subtypes of ASD have not been identified (Grzadzinski, Huerta, & Lord, 2013). Research suggests studying the personalities of individuals with autism could give better insight into the heterogeneity that exists within the autism phenotype, offering an empirical approach to identifying behavioral subtypes within ASD that might provide the basis for hypotheses about differential underlying origins of the general ASD clinical phenotype (Eaves, Ho, & Eaves, 1994; Ozonoff, Garcia, Clark, & Lainhart, 2005; Hepburn & Stone, 2006; Schwartz et al., 2009; Wing, 1997).

Based on extensive research from a variety of cultures and age groups, there is a well-established consensus among personality researchers that the five factor model of personality (McCrae & Costa, 1987) provides a relatively comprehensive account of the dimensions of human personality variation and behavior (e.g. Goldberg, 1990; McCrae & John, 1992; Ozer & Benet-Martinez, 2006). The five factor model of personality has been suggested as a useful framework for studying psychopathology due to the fact that the “big five” solution appears even when measures of abnormal and normal personality traits are factor analyzed together (Markon, Krueger, & Watson, 2005). The five factors of the FFM are categorized as (a) conscientiousness (i.e., self-discipline, impulse control, task completion), (b) extraversion (i.e., sensation-seeking behavior, assertiveness), (c) agreeableness (i.e., cooperative behaviors, empathy), (d) neuroticism (i.e., anxiety, dysphoria, anger), and (e) openness to experience (intellectual curiosity, creativity, preference for novelty) and are most often measured using self-report questionnaires (De Pauw, Mervielde, Van Leeuwen, & De Clercq, 2011; McCrae & John, 1992). To date, very little is known about the personality traits associated with ASD and even less is known regarding how individuals with

ASD present in terms of the five factor model of personality, specifically (Ozonoff et al., 2005; De Pauw et al., 2011).

Each of the five factors contain subcomponents known as facets (e.g., facets of neuroticism include anxiety, anger, depression, self-consciousness, impulsiveness, and vulnerability) and many studies have found that facet-level traits can be even more effective than the broadband five factors alone in predicting behavior (e.g., Mershon & Gorsuch, 1988; Paunonen & Ashton, 2001). For example, Paunonen (2003) conducted a study comparing the FFM factors and facets in predicting a variety of behaviors, and results showed that low conscientiousness was a predictor of alcohol consumption. However, this negative correlation was mainly due to the association between alcohol consumption and self-discipline (a facet of conscientiousness), and had no relationship with other facets of conscientiousness. Thus combining all these facets together into a broad factor of conscientiousness to determine the prediction of alcohol consumption provided a weaker correlation than if each individual facet was treated as a separate predictor (Paunonen, 2003).

A variety of FFM facet-level personality studies have found multiple regression to be useful in delineating FFM facets most indicative of particular personality disorders (e.g., Trull, Widiger, & Burr, 2001; De Clercq & De Fruyt, 2003; Ross et al., 2004). De Clercq and De Fruyt (2003) found that FFM facets accounted for an average of 54% of the variance in personality disorders. To fully describe the variability in psychopathology, the facet level of the FFM often performs most adequately (e.g., Ross, Benning, Patrick, Thompson, & Thurston, 2009). Previous research on the FFM and autistic traits indicates the importance of further exploring personality at the facet level. Two studies have explored the relationship between the FFM and autism symptoms as measured by the Autism Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). In a sample of 201 typically-developing undergraduates living in the United Kingdom, the five factors of the FFM, as measured with a 40-item scale of trait-descriptive adjectives (8 items per FFM factor) accounted for 37% of AQ scores, with high neuroticism and low extraversion and agreeableness specifically associated with high scores on the AQ (Austin, 2005). However, the FFM scale used in this study did not provide any facet-level scores. Wakabayashi and colleagues (2006) compared autistic traits with FFM factors and facets, using the AQ and the NEO-PI-R (Costa & McCrae, 1992), in a sample of 320 typically-developing Japanese undergraduate students and found that the NEO-PI-R predicted 24% of the variability in AQ scores, with high neuroticism, low extraversion, and low conscientiousness scores linked with higher AQ scores. All six facets of neuroticism were found to positively correlate with AQ

scores, while all six facets of both extraversion and conscientiousness negatively correlated with AQ scores. All six agreeableness facets except for Modesty negatively correlated with AQ scores, while openness to experience facet results were mixed. However, both studies were unable to draw autism-specific conclusions due to the use of non-clinical samples.

Only three studies have explored the FFM in adults diagnosed with ASD (i.e., Kanai et al., 2011; Schriber et al., 2014; Strunz et al., 2014), though only Strunz and colleagues (2014) examined facet-level personality profiles. Kanai and colleagues (2011) conducted a study of 64 Japanese adults diagnosed with Asperger's syndrome compared to 65 typically-developing adults and found that neuroticism scores on the NEO-FFI were significantly higher in adults with Asperger's syndrome than in controls, while extraversion, agreeableness, and conscientiousness scores were significantly lower, and scores on openness to experience did not significantly differ between groups. Schriber and colleagues' (2014) study of 37 American adults with ASD and 43 typically-developing adults found similar results. According to personality scores on an FFM inventory, adults with ASD scored significantly higher on neuroticism, while scoring lower on extraversion, openness to experience, agreeableness, and conscientiousness than typically-developing adults. Strunz and colleagues (2014) compared the FFM profiles of 59 adults with ASD, 62 adults with narcissistic personality disorder, 80 adults with borderline personality disorder, and 106 nonclinical controls using the NEO-PI-R. Results from this study showed that individuals with ASD showed higher neuroticism, lower extraversion, lower openness to experience, lower agreeableness, and similar levels of conscientiousness when compared to nonclinical controls. Adults with ASD scored higher than nonclinical controls on all six facets of neuroticism except for impulsiveness (which is equivalent to immoderation on other FFM scales), lower on all six facets of extraversion, lower on all six facets of openness to experience except for ideas (equivalent to intellect on other FFM scales), lower on all six facets of agreeableness except for straightforwardness (equivalent to morality on other FFM scales) and modesty, and higher or equal to nonclinical controls on the order, dutifulness, and deliberation (equivalent to cautiousness on other FFM scales) facets of conscientiousness. Based on the existing literature, the characterization of ASD at the FFM factor-level appears to be somewhat consistent, with neuroticism, extraversion, and agreeableness findings being stable across studies, while openness to experience and conscientiousness results have been relatively inconsistent (e.g., with even a few facets of conscientiousness higher than the comparison group in the Strunz et al., 2014 study). Due to these inconsistencies, it is important to further investigate FFM factor and facet-level results in a larger sample.

Using the FFM to Identify Subtypes within Psychological Disorders

Within-disorder phenotyping with the FFM has helped elucidate distinct manifestations, or subtypes, of several psychological disorders. For example, Ross and colleagues (2009) conducted a study aiming to identify the FFM characteristics of two distinct underlying dimensions of psychopathy (fearless dominance and antisocial impulsivity, which respectively contribute to the primary and secondary subtypes of psychopathy: Patrick, Fowles, & Krueger, 2009; Polaschek, 2015) using a sample of 134 undergraduates and 169 incarcerated men and women. Results showed that impulsive antisociality was predicted by *high* neuroticism, low agreeableness, and low conscientiousness, whereas fearless dominance was predicted by *low* neuroticism and *high* extraversion. These results illustrate two fundamentally different trait-level profiles of the same general clinical taxon, psychopathy, highlighting the potential utility of personality factors and facets as measured by the FFM in elucidating core subtypes of a disorder. Of particular interest in this type of work is the possibility that core etiological elements of differing subtypes of a disorder might be identified through FFM phenotyping. For example, the FFM research used to illustrate the distinct, largely non-overlapping personality substrates of the two core manifestations of psychopathy has been a precursor to a comprehensive developmental model of psychopathy that accounts for a vast body of behavioral research on infants, children, and adults (Patrick et al., 2009) and has also informed the hypotheses in genetic, neuroimaging, and psychophysiological studies that generally confirm the differential presence of biological markers of these FFM traits in adults exhibiting the two distinct psychopathy phenotypes (e.g., Hyde, Byrd, Votruba-Drzal, Hariri, & Manuck, 2014; Sadeh et al., 2010). In short, employing the FFM in this way represents an empirical approach to identifying possible subtypes of ASD and generating corresponding hypotheses about the potential genetic, neurobiological, and developmental origins of these subtypes, given that the FFM traits and facets already have several fairly well-identified genetic and neurobiological correlates.

Little research of this type has yet been undertaken in adults with ASD or elevated ASD traits. ASD has been subtyped in a variety of ways: according to cognitive and language abilities, genetic and medical conditions, and comorbidities (Ousley & Cermak, 2014); though, what is at the root of the heterogeneity of ASD is unknown, and consistent subtypes have not been well-established like in other disorders (e.g., psychopathy). Previous research on children with autism, conducted by Wing and Gould (1979), identified three putative subtypes of children with autism characterized by their quality of social interaction: “active-but-odd,” “aloof,” and “passive.” When comparing the groups based on IQ, 28% in the “passive” group experienced intellectual disability, as compared to

43% in the “active-but-odd” group, and 88% in the “aloof” group, suggesting that there were at least some external correlates related to these subtypes. Research has not shown whether these subtypes are otherwise valid and reliable, if they remain stable into adulthood for individuals with ASD, how these subtypes may affect adaptive functioning and outcomes later in life, or if other subtypes may exist within ASD. Identifying phenotypic subtypes within ASD could provide, among other benefits, valuable guidance in the development of personalized supports for members of this population, especially supports that consider co-occurring conditions (Ousley & Cermak, 2014).

Current Study

The present study aims to assess and compare personality traits of adults with and without elevated ASD traits using the FFM in order to (a) assess differences in average FFM personality profiles of adults with and without elevated ASD traits at the factor and facet levels, (b) determine the extent to which the FFM and its facets account for variability in ASD symptomatology in adults with and without elevated ASD traits, and (c) empirically identify distinct behavioral phenotypes that may exist within adults with elevated ASD traits in terms of FFM traits. There are several advantages to studying adults with elevated ASD traits; one is that personality traits are most stable in adulthood after the age of 30 (e.g., Costa & McCrae, 1988); a second is that adults with ASD-related challenges are greatly understudied in comparison to younger individuals; and, correspondingly, a third is that there are far fewer personalized intervention approaches developed for adults with ASD-related challenges, necessitating research that illustrates the specific needs and characteristics of this adult population. Given the factor-level findings from the small number of previous studies of the FFM and ASD, it was hypothesized that adults with elevated ASD traits would most likely exhibit low agreeableness, low conscientiousness, low extraversion, and high neuroticism as compared to adults without elevated ASD traits, and a substantial proportion of the variance in ASD symptomatology would be linked with FFM factors and facets. Lastly, mirroring the emerging concept of multiple “autisms”, it was predicted that there would be a variety of behavioral phenotypes common among adults with elevated ASD traits that can be represented by distinct, empirically derived FFM-based profiles, which may be associated with a variety of functional life outcomes such as relationship status, employment status, life satisfaction, and employment satisfaction (e.g., Ozer & Benet-Martinez, 2006). A main focus of personality psychology is to understand the link between life outcomes and subjective well-being and personality traits (Ozer & Benet-Martinez, 2006). Because personality traits are independent of context and reflect what an individual is like and how that individual most often behaves, they are thought to be useful in predicting life outcomes because life outcomes can

be thought of an aggregation of acts and events occurring through time. Employment satisfaction, overall happiness, and other variables related to quality of life are addressed in this study in order to better understand the outcomes that adults with elevated ASD traits experience (Henniger & Taylor, 2013).

Methods

Participants

Participants were recruited via flyers (electronic and paper-based), listserv emails, and postings on blogs, forums, online classified pages (e.g., Craigslist, Backpage, and Oodle) and social networking sites (e.g., Facebook, Twitter, Tumblr, and Meetup). In order to specifically target adults with elevated ASD traits, flyers and messages were posted on autism-related websites, forums, blogs, and social networking pages. Furthermore, emails were sent to autism support groups and centers all over the world.

Participants included 828 adults with and without self-identified ASD aged 18 to 87 years with a mean age of 36 years ($SD = 13.5$). Of these participants, 152 reported having been formally diagnosed with ASD, while 676 reported not having a formal diagnosis of ASD. In addition, 226 participants considered themselves to be on the autism spectrum, while 122 participants indicated that they did not know if they considered themselves to be on the autism spectrum, and 480 participants reported that they did not consider themselves on the spectrum. Of the 828 participants, 73% were female, 24% were male, and 3% chose “other.” Education ranged from “less than high school” to “professional degree (JD or MD)”, with 92% of the sample ($n = 755$) having completed at least “some college” and 60% ($n = 491$) graduating with at least a 4-year college degree. With regard to ethnicity, 80% were Caucasian, 5% were Asian, 4.5% were Hispanic, 2% were of African descent, 2% were Middle Eastern, and 5% were multi-ethnic (with 1.5% preferring not to answer). Questionnaire responses came in from 31 different countries with 84% of the participants from the United States. Participants in the elevated ASD traits group and participants in the comparison group, based on RAADS-R cut off scores, are compared in Table 1. For the primary analyses, the adults that score above 65 on the RAADS-R were considered to be in the elevated ASD trait group, while those scoring 65 or lower were considered to be in the comparison group. [Table 1]

Measures

The International Personality Item Pool Representation of the NEO-PI-R (IPIP-NEO-120; <http://ipip.ori.org>). The IPIP-NEO-120 is an online, public domain tool for personality measurement which reports

the individual level of personality under each of the five domains in the FFM. The shortened 120-item version of the IPIP-NEO was created by John A. Johnson and, following the full-length version of the NEO (McCrae & Costa, 1992), breaks down each factor into six sub-factors, known as facets. The IPIP-NEO-120 consists of 24 items per factor and 4 items per facet for a total of 120 items. For example, conscientiousness facets include: Self-Efficacy, Orderliness, Dutifulness, Achievement Striving, Self-Discipline, and Cautiousness. Responses are made using a Likert scale indicating level of agreement, ranging from 1 (*Very Inaccurate*) to 5 (*Very Accurate*). The IPIP-NEO-120 has been used in a variety of studies and has been found to be a valid and reliable measure of the FFM (e.g., Lo, Repin, & Steenbarger, 2005; McDonald & Donnellan, 2012).

The Ritvo Autism Asperger's Diagnostic Scale Revised (RAADS-R; Ritvo et al., 2011). The RAADS-R is an 80-item self-rated scale of autism-related symptoms reflecting the three areas of ASD-related challenges denoted in the DSM-IV and ICD-10 diagnostic manuals (Ritvo et al., 2011). The RAADS-R consists of four subscales: Social Relatedness, Circumscribed Interests, Sensory Motor, and Social Anxiety. The RAADS-R asks respondents to rate themselves on each item currently as well as when they were younger than 16 years old. The authors of the RAADS-R recommend that clinicians administer the instrument as a screener as part of the diagnostic process for adults who have not been previously diagnosed with ASD, and not as a complete diagnostic system. In the present study, the RAADS-R was adapted so that items were rated on the same Likert scale 1 (*Very Inaccurate*) to 5 (*Very Accurate*) as the IPIP-NEO-120 rather than the yes/no ratings given in the original RAADS-R in order to create a dimensional measure of ASD traits that reflected both the diversity of autism symptoms and their severity. For the current items, a response of 4 (*Accurate*) or 5 (*Very Accurate*) was counted toward the cumulative cut-off score for being classified as ASD-positive on the RAADS as a 1 or 2 respectively; for responses to the same items regarding when participants were younger than 16 years old, 1 (*Accurate*) was scored as a 1 and 2 (*Inaccurate*) was scored as a 0. For example, on the item "People tell me that I give too much detail," if a participant answered "Very Accurate" for his/her current status, and "Accurate" for "When I was younger than 16," he or she received 3 points on that item. Because this scaling mirrors the original scaling used by Ritvo and colleagues (2011) for classification purposes, we utilized their previously established cut-off score of 65 to classify participants as ASD-positive. A variety of studies have evaluated the RAADS-R and determined it to be a reliable and valid measure of autism in adults (Andersen et al., 2011; Enticott et al., 2012), suggesting its suitability, particularly given the psychometric limitations identified in other measures (Nishiyama et al., 2014).

Demographics. The demographics portion of the questionnaire consisted of questions addressing gender, relationship status, employment status, ethnicity, level of education, living situation (i.e., living on own, with roommates, at home with parents, or with other relatives), and questions addressing life satisfaction and happiness.

Procedures

After obtaining study approval from a university-based institutional review board, an anonymous online questionnaire was posted on <http://www.Qualtrics.com>. The first page of the online questionnaire consisted of an informed consent form which participants had to complete before advancing to the rest of the questionnaire. Participants were not provided compensation for completing the questionnaires. Kapp and colleagues (2013) used an internet-based questionnaire to assess individuals' perceptions of their autism diagnosis and identity, and were able to obtain responses from over 200 adults with autism; similar procedures were used in the present study. In addition, Schriber and colleagues (2014) found that individuals with ASD exhibited similar levels of self-insight as compared to individuals without ASD in their study of ASD symptomatology and FFM personality. Similarly, Hesselmark and colleagues (2015) tested the reliability and validity of self-reported personality questionnaire data using the NEO-PI-R in adults with ASD diagnoses with intelligence within the average range. Results showed adults with ASD responded with satisfactory reliability and validity as compared to adults without ASD, thus supporting the ability of adults with ASD to capably self-report (Hesselmark et al., 2015).

After completing the informed consent form, participants began the RAADS-R, which was followed by the IPIP-NEO-120, and then lastly, the demographics questions (many of which were also used in the Kapp et al., 2013, study). Participants were not informed when one questionnaire began and another ended, as there were no separate titles for each of the questionnaires. Participants who were interested in seeing their results on the IPIP-NEO-120 were given the option to provide their email addresses to be sent their personality profiles based on IPIP norms, and a brief description of how to interpret it.

Before analyzing any of the data, IPIP-NEO-120 raw scores were converted into T-scores using IPIP-NEO-120 reference sample means and standard deviations (provided by Dr. Johnson) based on age and gender. For this reference sample, no claim of population representation is made by the author of the IPIP-NEO-120. This reference sample is assumed to be typical of the population of adults that use the internet regularly.

To verify differences in average FFM personality profiles of adults with and without ASD at both the factor and facet-levels, RAADS-R scores were correlated with factor and facet-level IPIP-NEO-120 scores. All

correlations were evaluated against a critical alpha of .05. Significant differences between groups (i.e., those who scored above and below the RAADS-R cut off) and between clusters were determined using post-hoc t-tests.

To determine the extent to which the FFM and its facets account for variability in ASD symptomatology in adults with and without ASD (i.e., variability in RAADS-R scores that can be accounted for by scores on the IPIP-NEO-120), factor and facet-level scores were analyzed in terms of percent of RAADS-R variance explained by personality traits considered together using multiple regression analysis. After accounting for gender and age, all regression coefficients were then evaluated against a critical alpha of .05 in order to determine the best IPIP-NEO-120 factor and facet-level predictors of RAADS-R scores.

To empirically identify distinct behavioral phenotypes that exist within ASD in terms of FFM factor and facet-level variability, cluster analyses were performed on the IPIP-NEO-120 factors within the group with elevated ASD traits. Cluster analysis is a widely-used type of data analysis for sorting cases into groups (i.e., clusters) so that associations are strong within members of the same cluster and weak between members of different clusters (Eaves et al., 1994). Specifically in the current study, *k*-means cluster analysis was employed to sort cases based on their relative distance from cluster means using an algorithm (Cannon & Weems, 2006). Cluster analysis has been used in a variety of psychopathology studies aiming to identify sub-groups within disorders. For example, cluster analysis has been used to identify distinct behavioral phenotypes within autism in a study conducted by Eaves and colleagues (1994).

Results

A total of 828 participants completed the online questionnaire, with RAADS-R scores ranging from 0 to 203, and an average score of 67.6 ($SD=48.1$). When dividing the groups based upon the RAADS-R cutoff score of 65, the 364 participants in the elevated ASD traits group (those who scored 66 or above) scored an average of 113.5 ($SD=33.1$) with scores ranging from 66 to 203. The 464 participants in the comparison group (those who scored 65 or below) scored an average of 31.6 ($SD=17.9$) with scores ranging from 0 to 65. To account for the gender and age variability in the current sample, gender- and age-referenced scores were utilized for analyses. Also, there were conflicting sources of ASD diagnostic information between having received a formal diagnosis, self-diagnosis, and using the RAADS-R diagnostic cut-off score; the RAADS-R cut-off score approach was determined to be the most empirically sound for designating individuals as having elevated ASD traits.

Average FFM Profiles of Adults With and Without ASD

In comparing IPIP-NEO-120 score means between groups, the elevated ASD trait group and comparison group significantly differed on all factors and facets except for the Activity Level, Liberalism, Modesty, and Dutifulness facets (as shown in Table 2 below). Significant group mean differences were determined using independent samples *t*-tests to compare average IPIP-NEO-120 T-scores between groups. All significant group differences were in the hypothesized direction. [Table 2]

Effect sizes (ES) for significant differences were calculated using Cohen's *d*. Group difference ES ranged from .34 to 1.23 for factor scores and .07 to 1.54 for facet scores. The majority of facet group difference ES were above .52.

Variability in ASD Symptomatology Accounted for by the FFM

Before conducting correlation and regression analyses, RAADS-R distribution data was evaluated for normality and found to be significantly skewed with a Shapiro-Wilk statistic of .93 at $p=.00$. Nonparametric correlation and regression analyses were conducted and found to have equivalent results to Pearson correlations and ordinary least-squares regression. Pearson correlations testing the magnitude of association between RAADS-R scores and IPIP-NEO-120 FFM factor scores are presented in Table 3. RAADS-R scores were significantly and positively correlated with IPIP-NEO-120 Neuroticism scores and negatively correlated with Extraversion, Openness to Experience, Agreeableness, and Conscientiousness scores. A comparable set of correlations for IPIP-NEO-120 facets are presented in Table 4. [Table 3] [Table 4]

A multiple regression was then conducted including the 5 IPIP-NEO-120 factor-level scores as predictors of RAADS-R scores after checking for multicollinearity (diagnostic tests for the latter were negative). This regression model indicated that four of the IPIP-NEO-120 FFM factors (Neuroticism, Extraversion, Conscientiousness, and Agreeableness) significantly predicted RAADS-R scores at $p < .05$ (see Table 3). Together, the FFM factors, as measured by the IPIP-NEO-120, accounted for 48% of the variability in amount of autism symptoms, as measured by the RAADS-R. In a comparable model using the 30 IPIP-NEO-120 facet-level scores as predictors (see Table 4), 70% of the variability in RAADS-R scores was accounted for, collectively.

Several suppressor effects were noted in the regression model for the IPIP-NEO-120 factors and facets (Tables 3 and 4). For Conscientiousness in the factor-level regression model, the significant negative Pearson correlation with RAADS-R scores became modestly positively correlated with RAADS-R scores after controlling for the simultaneous effects of the other factors. Post-hoc analysis of potential contributors to this suppressor effect

revealed that when Agreeableness scores were removed from the factor-level regression model, Conscientiousness scores had a nonsignificant association with RAADS-R scores. Similar suppressor effects were seen for Activity Level, Cheerfulness, Achievement Striving and Dutifulness in the facet-level regression models, and each of these effects became nonsignificant when other facets from the same factor construct were removed in post-hoc analyses.

Empirically Identifying Behavioral Phenotypes in Adults with Elevated ASD Traits Using the FFM

K-means cluster analysis was conducted for the group of participants that scored above the cutoff on the RAADS-R in order to determine potential subgroups of adults with elevated ASD traits based on IPIP-NEO-120 personality scores. A four-cluster solution emerged as the best solution after reiterating the *k*-means cluster analyses using between 3 and 10 group solutions with both the IPIP-NEO-120 factors and facets. After comparing the variety of group solutions to one another via ANOVA and post-hoc significance tests, the 4-group solution emerged as having the most distinct and consistent factor and facet-level personality profiles across a range of criteria for ASD status (e.g., RAADS score > 65; formal ASD diagnosis; self-diagnosis). After comparing the 4-group solution using the factor-based clusters with the 4-group solution using facet-based clusters, similarities across both models emerged: the *n* distributions for the 4 clusters were almost identical, as were the differing elevations on the indicators of the five factors, and both the factor-based and facet-based clusters contained a group that was within the “average range” (within one standard deviation) on all FFM factors and facets. Given that in the regression analysis, the facets accounted for 70% of the variance, the facet-based clusters are discussed further. The 4 distinct personality clusters that emerged are illustrated and further characterized in Table 5 and Table 6. [Table 5] [Table 6]

For reporting of results, designations of “very low,” “low,” “borderline-low,” “average,” “borderline high,” “high,” and “very high” were used in reference to the IPIP-NEO-120 reference-group means as follows: “very low” refers to a mean T-score more than 1.5 standard deviations below the mean ($T < 35$), “low” refers to a mean T-score between 1.01 and 1.5 standard deviations below the mean ($T = 35$ to 39), “borderline low” refers to a mean T-score between .85 and 1 standard deviation below the mean ($T = 40$ to 41.5), “average” refers to a mean T-score between .85 standard deviations above or below the mean ($T = 41.6$ to 58.4), “borderline high” refers to a mean T-score between .85 and 1 standard deviation above the mean ($T = 58.5$ to 60), “high” refers to a mean T-score between 1 and 1.5 standard deviations above the mean ($T = 61$ to 65), and “very high” refers to a mean T-score greater than or equal to 1.5 standard deviations above the mean ($T > 65$).

As shown in Tables 5 and 6, numerous significant differences (at $p < .05$) emerged between clusters on IPIP-NEO-120 factors and facets, RAADS-R subscales, and on a variety of demographic and life satisfaction measures. Cluster 1 exhibited the highest Anxiety, Self-consciousness, and Vulnerability scores of any cluster. Interestingly, Cluster 2 had the lowest proportion of individuals who either had previously received diagnoses or considered themselves to be on the spectrum, coupled with the highest RAADS-R scores. In addition, Cluster 2 uniquely exhibited a combination of high Neuroticism, very low Conscientiousness, and low Agreeableness, resembling a typical borderline personality disorder FFM profile at the factor level (Strunz et al., 2014). Cluster 3 presented with average scores on all facets of Neuroticism and Conscientiousness, but low Agreeableness and Extraversion. Cluster 4 exhibited scores within 1 standard deviation of the mean on all domains and facets.

Exploratory Analyses

Gender analyses. Correlations between FFM and ASD traits were examined separately for men and women, and no significant differences were found in the direction or significance of these correlations for the FFM factors. For the facets, only Artistic Interests was not significantly correlated with RAADS-R scores for women, while for men only Dutifulness was not significantly correlated with RAADS-R scores. All other facets correlated the same as reported in Table 4. Regression analyses were also compared for men and women. For men, the FFM facets accounted for 77.1% of variance in RAADS-R scores, while for women the FFM facets accounted for 69.2% of variance in RAADS-R scores. For men, only five facets were not significant predictors as they were in the full sample: Anxiety, Adventurousness, Self-Efficacy, Trust, and Altruism. In addition, Cooperation was a significant (negative) predictor of RAADS-R scores for men. For female participants, three facets were significant predictors in addition to the facets that were significant predictors in the full sample: Activity Level, Cheerfulness, and Dutifulness. Given the relatively minimal differences in results between genders, we are confident in the results presented from the full sample.

ASD Diagnosis. Correlations between FFM and ASD traits were compared between individuals who considered themselves to be on the autism spectrum, individuals who reported as having been formally diagnosed, and those who scored above the RAADS-R cut-off. For those who considered themselves to be on the autism spectrum (with or without a formal diagnosis), every factor and facet correlated in the same direction as for those who scored above the RAADS-R cut-off except for Conscientiousness and its facets, which did not have any significant correlations with RAADS-R scores. Individuals who reported having been formally diagnosed with ASD

exhibited the same direction and significance level of correlations between FFM and ASD traits as those who considered themselves to be on the spectrum, including the lack of significant Conscientiousness correlations.

In regards to regression analyses, FFM facets accounted for 64% of the variance in the RAADS-R scores of those who considered themselves to be on the spectrum. For those who reported as having previously received formal diagnoses, FFM facets accounted for 68% of the variance in RAADS-R scores. Due to the relatively minute differences between those who scored above the cut-off, those who reported as having received formal diagnoses, and those who considered themselves to be on the spectrum regardless of diagnoses, we were confident in using the RAADS-R cut-off to distinguish our groups for analyses.

Regression with RAADS-R subscales. Regression analyses were conducted for each of the four RAADS-R subscales to determine if FFM factors and facets differentially predicted each of the subscales. At the factor level, higher Neuroticism, lower Extraversion, and lower Agreeableness significantly predicted higher scores on all four RAADS-R subscales. Higher Conscientiousness significantly predicted higher Sensory Motor and Social Anxiety scores, while lower Openness to Experience did not significantly predict any of the subscales.

FFM facet scores significantly predicted 66% of the variance in the Social Relatedness, 65% of the variance in Circumscribed Interests, 52% of the variance in Sensory Motor, and 75% of the variance in Social Anxiety scores.

Discussion

In this study, we found that in accordance with previous studies investigating personality and ASD, neuroticism was positively correlated with ASD symptomatology, while extraversion, openness to experience, conscientiousness, and agreeableness were negatively correlated with ASD symptomatology. Also, variability in ASD symptomatology appeared to be well accounted by the five factor model of personality, with about 70% of the variance in RAADS scores accounted for by the IPIP-NEO-120 facets, collectively. Our findings also suggest that, on average, adults with elevated ASD traits present with significantly different personality profiles than other adults. A great deal of variability in personality traits also emerged within the elevated ASD traits group, as four distinct clusters of FFM personality types emerged, suggesting that there is not a unidimensional personality type associated with elevated ASD traits.

As expected, significant differences emerged between groups on all FFM factors and most facets. At the factor level, the two groups differed in expected ways (i.e., the group with elevated ASD traits exhibited higher

neuroticism scores, and lower extraversion, conscientiousness, openness, and agreeableness scores than the comparison group), as found in previous studies (e.g., Kanai et al., 2011; Schriber et al., 2014). Almost all of the facet scores mirrored these between-group differences, with mostly medium to large effect sizes. Overall, the pervasiveness of the elevated ASD trait phenotype was reflected in the sheer number of group differences on personality factors and facets seen in these analyses.

A number of participants who reported as not having formally received a diagnosis of ASD exhibited elevated ASD traits. Because global awareness and knowledge of ASD is only recently increasing, it is not surprising that many adults in the current study who scored above the RAADS-R cut-off reported as not having formal diagnoses. Many, if not most, adults who meet criteria for ASD lack a formal diagnosis (Brugha et al., 2011; White et al., 2011). Nevertheless, a diagnosis of ASD in adulthood may be difficult to obtain because many adults lack a reliable report of their clinical history (Brugha et al., 2012). Many adults, especially women, who met criteria as children no longer qualify on behavioral diagnostic tests for ASD (Lai et al., 2011), and the diagnostic process may take years (Jones et al., 2014). Furthermore, meaningful services and supports for adults with ASD are severely lacking, and a diagnosis may fail to lead to such services and supports (Jones et al., 2014). Similarly, some adults identify as “on the autism spectrum” but lack an official ASD diagnosis, in part because they think that ASD helps them understand themselves but that the ASD diagnosis raises stigma (Linton, 2014; Rosqvist, 2012).

Correspondence between ASD Symptomatology and Five Factor Model Personality Scores

One goal of the current study was to estimate the amount of variability in ASD symptomatology that could be explained by personality factors and facets. In our regression models, we found that 70% of ASD symptom variance could be accounted for by variability in the FFM facets. Previous studies that have analyzed manifestations of autistic traits as predicted by personality profiles have found significantly lower percentages (e.g., Austin, 2005; Schriber et al., 2014; Wakabayashi et al., 2006). Most previous studies have relied on FFM factor scores rather than facet scores. Comparatively, the current study also found a lower proportion of variance explained in ASD severity when only the FFM factors, rather than facets, were used in regression analyses (48%), suggesting that our results may not differ substantially from other studies and that the use of facet scores from the FFM may greatly increase the level of precision in predicting autism severity scores.

Findings from extant FFM and psychopathy research further emphasize the importance of facet-level specificity (e.g., Ross, Lutz, & Bailey, 2004; Ross et al., 2009). Ross and colleagues (2004) determined that NEO-

PI-R FFM facets were predictive of 64% of the variance in primary psychopathy symptomatology, and 56% percent of the variance in secondary psychopathy, with lower variance at the factor-level for each. Ross and colleagues' (2009) study found similar results in terms of facet-level specificity with NEO-PI-R facets explaining 72% of the variance on the Psychopathic Personality Inventory (PPI) Fearless Dominance scale, 71% of the variance on the PPI Impulsive Antisociality scale, and 56% of the variance on the PPI Coldheartedness scale, while NEO-PI-R factors explained only 50%, 62%, and 32% of the variances, respectively.

In the current study, multiple regression analysis indicated that increased neuroticism and decreased extraversion and agreeableness were the most predictive of ASD symptomatology at the factor level. These findings are in line with previous FFM and ASD research. Conscientiousness and openness to experience also were negatively correlated with ASD symptomatology, but not in the multiple regression analysis. Openness to experience in previous research does not have a consistent relationship with ASD symptomatology, with Schriber and colleagues (2014) finding adults with ASD to have lower openness to experience on average as compared to adults without ASD, while Kanai and colleagues (2011) found no differences. Conscientiousness has been found to have a mostly consistent negative association with ASD severity (Wakabayashi et al., 2006; Kanai et al., 2011; Schriber et al., 2014), though Strunz and colleagues found ASD severity and conscientiousness to be largely unrelated (with slight evidence of a unexpected positive association at the facet level). The suppressor effects for conscientiousness noted in the current study, mirroring Strunz and colleagues' (2014) differing conscientiousness findings, suggest that the role of conscientiousness in ASD traits may be complex and partly dependent on the degree of emotionality and sociability exhibited by adults with elevated ASD traits.

Further emphasizing what most distinguishes elevated ASD trait profiles from typical development in terms of the FFM, 11 significant FFM facet-level predictors of ASD symptomatology emerged in multiple regression analysis. For the neuroticism domain, increased anxiety and vulnerability were the facets that best predicted ASD, a finding that coincides with a broad set of clinical studies showing that ASD and anxiety disorders are highly comorbid and that individuals with ASD are often unable to cope with their anxiety, which may lead to feelings of vulnerability (e.g., Groden, Baron, & Groden, 2006). Results from a number of studies indicate that 20-57% of children and adolescents with ASD and at least average intellectual abilities exhibit clinical levels of social anxiety, as compared to the 1-5% of typically developing youth that experience symptoms of social anxiety (e.g., Kuusikko et al., 2008; Simonoff et al., 2008).

In the extraversion domain, decreased friendliness and gregariousness were the facets that best predicted ASD severity in this sample. Individuals who score low in friendliness are often reserved and do not eagerly reach out to others; and individuals who score low in gregariousness are generally overwhelmed by situations involving large crowds and prefer to spend time alone (Goldberg et al., 2006). These findings concur with what is known about social difficulties associated with ASD for many affected adults including challenges with developing friendships (Orsmond, Krauss, & Seltzer, 2004) and with large crowds or groups (Ashwin et al., 2007). In previous FFM facet-level research, the concepts of friendliness and gregariousness have been associated with the tendency to experience positive emotions in anticipation or experience of “rewarding” social situations (i.e., being included by a group, receiving a smile from another person, etc.) (DeYoung, Quilty, & Peterson, 2007). It has been hypothesized that individuals with autism, as compared to individuals without autism, exhibit reduced social interest or decreased responsivity to social reward of this type (e.g., Scott-Van Zeeland et al., 2010).

Three openness to experience facets also significantly predicted ASD: increased imagination, decreased emotionality, and decreased adventurousness. Individuals with above-average imagination are described as using fantasy to make the world around them more interesting (Goldberg et al., 2006). Increased imagination as a predictor of ASD does not have as much support in extant literature; however, the majority of relevant studies have reported on pretend play and creative thinking deficits in children rather than adults with ASD (e.g., Craig & Baron-Cohen, 1999; Kasirer & Mashal, 2014). However, Kasari and colleagues (2011) have found that children with ASD, when prompted, can engage in pretend play as capably as their typically developing peers; thus, suggesting that these pretend play deficits lie in performance, not competence. Roth (2008) specifically predicted that various aspects of imagination outside of the realm of “theory of mind” would be intact within ASD, and the present results suggest that if anything, aspects of imagination and creativity may be a strength or preference for adults with elevated ASD traits, on average. Individuals with decreased emotionality are described as being not aware of their own emotions in conjunction with being unable to openly express their feelings (Goldberg et al., 2006). These results are in accordance with previous ASD research in that individuals with ASD often have difficulty with awareness and expression of their own emotions (Silani et al., 2008). Individuals low in adventurousness prefer familiarity and routine (Goldberg et al., 2006), which has been found in previous ASD research to be true of individuals on the spectrum in that they are often insistent upon sticking to routine and resistant to novelty (American Psychiatric Association, 2013; Schriber et al., 2014). In previous facet-level openness to experience

research, imagination, emotionality, and adventurousness are the facets most related to sensation-seeking behaviors, with imagination and emotionality representing internal types of experience seeking, while adventurousness represents external types of experience seeking (Aluja, Garcia, & Garcia, 2003). Given these results, it appears that individuals with elevated ASD traits may be more capable or more interested in seeking sensations of which they themselves are in control (e.g., their own imaginations), while understanding and appreciating sensations out of their control (e.g., emotions and adventure) may be less preferred. It is interesting to consider that some of the motor coordination issues often associated with ASD (e.g., balance and movement planning; Fournier, Hass, Naik, Lodha, Cauraugh, 2010) might magnify a reluctance to engage in adventurous activities in the outside world that would challenge one's physical abilities (e.g., certain outdoor sports and types of travel).

In the conscientiousness domain, decreased self-efficacy and cautiousness were significant predictors of ASD symptomatology. Individuals with low self-efficacy are described as feeling incompetent and not in control their own lives (Goldberg et al., 2006). In previous FFM research, low self-efficacy, also referred to as competence, has been directly related to increased neuroticism, specifically increased vulnerability and anxiety, in that the negative affect associated with feeling vulnerable and anxious would most likely cause an individual to feel less capable or vice-versa (Reed, Bruch, & Haase, 2004). As in the current study, Wakabayashi and colleagues' (2006) study comparing autism symptomology scores using the AQ to FFM scores using the NEO-PI-R also found that higher autism symptomatology scores significantly correlated with lower competence scores. Individuals with low cautiousness are described as often acting impulsively and act without concern for consequences (Goldberg et al., 2006). Cautiousness, also referred to as deliberation in previous FFM research, is considered to be the best and most widely represented facet-level measure of impulsivity (Whiteside & Lynam, 2001). Wakabayashi and colleagues' (2006) study similarly found high AQ scores to be associated with low scores in deliberation. The impulsivity found in the aforementioned study, as well as what was found in the present study, is in concordance with research suggesting that individuals with elevated ASD traits often have difficulties with self-regulation and inhibitory control (Hill, 2004; Solomon, Ozonoff, Cummings, & Carter, 2008).

Decreased trust and altruism were the best facet predictors of ASD symptomatology for the agreeableness area. Previous FFM research on the trust facet, sometimes referred to as the propensity to trust, has found that low scorers in this facet may assume others to be dangerous and dishonest, and experience decreased satisfaction with romantic relationships (Mooradian, Renzl, & Matzler, 2006). Previous FFM research on altruism indicates that

individuals with increased neuroticism more often feel exploited by others and thus are less likely to engage in altruistic behavior (Ashton, Paunonen, Helmes, & Jackson, 1998). Wakabayashi and colleagues (2006) also found decreased trust and altruism to be associated with increased autism symptomatology scores. Due to altruism and trust being such fundamental aspects of forming relationships with others, our results may relate to some of the core deficits in social communication characteristic of elevated ASD traits. It is possible that some individuals with elevated ASD traits could feel less trusting and altruistic towards others, given that many individuals with elevated ASD traits have had difficulties understanding social cues, engaging in reciprocal social interaction, and forming close friendships (APA, 2013; Dawson et al., 2004) and have been rejected and victimized by others in some cases (Sterzing, Shattuck, Narendorf, Wagner, & Cooper, 2012).

It is notable that variations in FFM facets were able to account for such a substantial amount of variance in ASD symptomatology. ASD for some individuals may be well-described as a convergence of specific personality traits. This set of personality traits in some ways parallels the diagnostic or associated characteristics of ASD (e.g., difficulties with socialization coupled with low social reward sensitivity, inflexibility, poor emotion regulation and related anxiety), but is at once both more general (e.g., general neuroticism, not just anxiety) and more specific (e.g., low activity level and cheerfulness, not just low extraversion). Converging with genetics research suggesting that single gene explanations of ASD are unlikely (Geschwind, 2008) and that contributing individual genes may each confer only a small amount to variance in ASD symptomatology, the present findings could be seen as consistent with an additive or interactive individual differences model of the autism phenotype.

Lastly, given the high percentage of females participating in the current study, and the paucity of research on adult females with ASD, it is important to note that this study is the largest of its kind to report on FFM personality profiles of adult females with ASD. Women with ASD having a higher response rate than men with ASD in the current study may seem peculiar given the significantly higher rate in which males are diagnosed than females in the published literature. However, previous online studies have found similar levels of female representation (Kapp et al., 2013; Gilmour, Schalomon, & Smith, 2012), which, as Kapp and colleagues (2013) theorized, may be due to females with ASD actively seeking out social support from online communities more so than males.

Personality Subtypes for Adults with Elevated ASD Traits

An additional goal of the current study was to determine whether there was one uniform personality profile, or multiple characteristic personality profiles, within our sample of adults with elevated ASD traits. Our *k*-means cluster analysis revealed 4 distinct groups based on IPIP-NEO-120 facet clusters. A vast array of statistically significant demographic, ASD symptomatology, and personality differences arose when comparing these 4 clusters to one another, illustrating the variability that exists within those with elevated ASD traits.

Cluster 1 presented with an FFM personality profile, at the factor level, similar to previous FFM research on social phobia which has found that social phobia positively correlated with neuroticism, while negatively correlating with extraversion (e.g., Kotov, Gamez, Schmidt, & Watson, 2010). Cluster 1 also resembled previous research on the FFM profile of social anxiety at the facet level (e.g., self-consciousness, below-average assertiveness, elevated depression, etc.). This cluster's below-average friendliness, excitement-seeking, cheerfulness, and adventurousness may indicate low motivation—both social and nonsocial—and low energy levels. The similarity of this cluster to a prototypical FFM profile for social phobia (not in the context of ASD) is striking.

Cluster 2 also exhibited elevated neuroticism and lower extraversion, but differed from all other clusters in that particularly low conscientiousness was also present. This profile at the FFM factor level has been associated with depression in the general population (e.g., Rosselini & Brown, 2011). Furthermore, the low agreeableness at the factor level for this cluster of adults in the context of these other factor scores resembles to a certain extent FFM profiles of borderline personality disorder (BPD) identified in previous research (e.g., Strunz et al., 2014). Similarly, at the facet level Cluster 2's at least borderline high neuroticism (except average immoderation); low friendliness, assertiveness, and cheerfulness, but average activity level and excitement-seeking; average openness to experience; low conscientiousness except average orderliness; and borderline low morality but average modesty and sympathy all align with previous FFM research of BPD (Miller et al., 2010; Strunz et al., 2014). Thus, consistent with previous discussions of possible overlap between ASD and BPD, this cluster thus may often exhibit emotional dysregulation, poor cognitive empathy alongside intact emotional empathy, and marked difficulties in interpersonal relationships (Smith, 2013; Strunz et al., 2014). Our data do not permit a test of whether the mostly average agreeableness facet and near borderline-high neuroticism scores in areas key to BPD (e.g., trust, cooperation and immoderation, anger, respectively) guard against the intensely angry, impulsive reactions to others that are diagnostic of BPD and may appear similar to emotional over-responsivity in some individuals with ASD (see Smith, 2013, Strunz et al., 2014). Of note, Cluster 2 emerged as the cluster with the most challenges, as this group was characterized by the lowest

employment satisfaction, education, life satisfaction, and happiness of any of the four clusters. Previous FFM research indicates that this exact standing (high neuroticism, in conjunction with low extraversion, conscientiousness, and agreeableness) is most predictive of problematic outcomes (Ozer & Benet-Martinez, 2006). In addition, Cluster 2 also had the highest average RAADS-R scores coupled with the most individuals who did not report awareness of an ASD diagnosis and who self-diagnosed with ASD, a disconnect which points to a potential explanation of the difficulty experienced by this cluster in terms of quality of life and personality profile that for some may share similarities with the identity problems of BPD (Smith, 2013; Strunz et al., 2014).

Cluster 3 was the only other cluster with especially low agreeableness at the factor and facet level, while also presenting with lower-than-average extraversion. Cluster 3 is also set apart from Clusters 1 and 2 with average levels of neuroticism and conscientiousness. Although Cluster 3's low agreeableness maps on to one of the most distinct FFM components of psychopathy (Ross et al., 2009), potentially raising the question of whether this cluster reflects an antisocial disposition, Cluster 3's average neuroticism and conscientiousness does not fit a psychopathic profile. Also, Cluster 3 appears to experience fewer challenges than Cluster 2 in terms of employment, level of education, and happiness. Overall, Cluster 3 appeared to trend toward socially isolated patterns of behavior but not necessarily antisocial ones.

Cluster 4 emerged as the most well-adjusted group in that the average FFM factor and facet scores for this cluster were all within one standard deviation of the reference group mean, and this cluster also reported the highest levels of employment, life satisfaction, and happiness. In addition, though not many differences between clusters emerged in regards to RAADS-R subscales, Cluster 4 exhibited the lowest scores on three of the four subscales. Cluster 4 exhibited the highest extraversion and agreeableness and was the only cluster within 1 SD of the reference group mean on every facet of both extraversion and agreeableness. Their happiness and satisfaction data parallels previous studies of the general population in that more extraverted people tend to report higher life satisfaction (Luhmann, Hawkey, & Cacioppo, 2013). About a quarter of the participants with elevated ASD traits were members of Cluster 4.

In sum, cluster analyses within the group with elevated ASD traits revealed vastly differing personality profiles. Hu and colleagues' (2011) study provides interesting parallel bio-behavioral findings on within-ASD clusters. They identified specific single nucleotide polymorphisms (SNPs; i.e., DNA sequence variation) which were common to two or more ASD subgroups as well as SNPs unique to specific subgroups (e.g., a mild ASD subgroup

shared 3 specific SNPs with a language-impaired ASD subgroup, while there were also 3 additional SNPs unique to the language-impaired ASD subgroup) (Hu, Addington, & Hyman, 2011). Their findings offer a different level of evidence for the hypothesis that multiple ASD taxa may exist, perhaps stemming from combinations or patterns of biological and psychosocial individual differences (e.g., genetically influenced behavioral traits such as sensitivity to social reward and high fear-proneness) (Veatch, Veenstra-VanderWeele, Potter, Pericak-Vance, & Haines, 2014). Indeed, the results of this study suggest potential for identifying the “the autisms” through multiple levels of analysis. Comparatively, subtypes of psychopathy have been empirically supported through the FFM and corresponding differential neurobiological features (c.f., Patrick et al., 2009; Ross et al., 2009). Subtypes of autism may ultimately be found to be distinct combinations of notably differing genetic and neurobiological traits that interact with developmental experiences, producing cognitive, behavioral and emotional traits that form differing, perhaps even partially opposing FFM profiles that still have a final common pathway of elevated ASD features.

Lastly, as found in Schriber and colleagues’ (2014) study, personality traits correlated with ASD traits were similar for men and women. The fact that women with elevated ASD traits had a higher response rate than men in the current study may seem initially peculiar given the significantly higher rate in which males are diagnosed with ASD than females. However, previous online studies have found similar levels of female representation (Kapp et al., 2013; Gilmour, Schalomon, & Smith, 2012), which, as Kapp and colleagues (2013) theorized, may be due to the fact that females with ASD actively seek out social support from online communities more so than males. Kapp and colleagues (2013) additionally suggest that females with ASD can present with subtler symptoms due to having developed coping skills that mask some autistic traits, and thus, they may not meet criteria in some behavior-based diagnostic assessments (Lai et al., 2011). Further, as reported in previous internet-based studies of ASD (e.g., Gilmour et al., 2012; Kapp et al., 2013), adult females with ASD may be overrepresented online in pursuit of social support due to difficulties being recognized or diagnosed as being on the autism spectrum (Jack, 2011).

These findings further emphasize the need and value of individualized intervention that can target specific challenges an individual with elevated ASD traits may have (e.g., some individuals may need more help with overcoming anxieties; other individuals may need more help with organization and self-discipline; others may need help with socialization and empathy). Individual needs are less likely met with a “one size fits all” approach to ASD intervention; a spectrum disorder likely requires a spectrum of supports and interventions. Clearly, many people without a formal ASD diagnosis have functional impairments that challenge their quality of life, some of whom

identify with ASD; FFM research may help to better identify and provide more appropriate support for them as well as adults who already have a formal ASD diagnosis.

Limitations

The sample of participants recruited was a sample of convenience, given that in order to participate in the study, participants needed access to a computer with internet and had to be willing to complete an extensive questionnaire, factors which likely contributed to biasing the sample towards higher developmental and socioeconomic status (Kapp et al., 2013). Therefore, it is likely this sample is not representative of a proportion of adults with elevated ASD traits, which is especially evident due to the high proportion of female participants even though ASD, as a disorder, is reportedly more prevalent among males (Kim et al., 2011). Data reported from a variety of studies suggest that 25-55% of adults with autism are employed (Holwerda, van der Klink, Groothoff, & Brouwer, 2012; Shattuck et al., 2012), whereas our sample was employed at a higher rate (61%), particularly for some clusters of individuals with elevated ASD traits. Similarly, our sample reported a higher likelihood of being in romantic relationships (49%) than is reported in current literature, which has found that between 0-38% of adults with autism are in long-term relationships or marriages (Howlin & Moss, 2012). These findings are not surprising given that we ultimately recruited a sample of adults with and without elevated ASD traits as compared to confirmed ASD diagnoses. Additionally, the current study was remarkable in that it was able to reach a broad age range, as very little research has been conducted on older adults with ASD (Howlin & Moss, 2012).

All data in the current study were obtained from self-report measures, which is another limiting factor often seen in personality research. It is important for future FFM research in ASD to verify diagnoses. However, our use of online administration of self-report questionnaires did allow for a much larger sample than would otherwise be attainable, which was necessary for exploring potential FFM subtypes. As in other solely self-report questionnaire-based studies, it is likely that correlations between measures and constructs could have been inflated due to mono-method bias (Ross et al., 2009). Lastly, in order to maximize the variability of ASD symptomatology scores, a combined sample of individuals with and without self-identified ASD was used in correlation and regression analyses; a similar strategy was employed in Ross and colleagues' (2009) study of FFM personality traits and psychopathy.

Conclusion

The current study extended the findings of previous research on the five factor model of personality and ASD traits. Through this extension of the FFM to autism, we can better relate and connect ASD to other psychological constructs and outcomes that have been associated with the FFM (Schriber et al., 2014). Previous studies of personality in ASD, which focused on the FFM at the factor-level, have suggested a moderate link between FFM personality factors and ASD severity, with some speculation that ASD-like behaviors may reflect a sixth factor of personality. The current study, however, suggests a rather strong correspondence between established personality traits and ASD symptomatology when utilizing FFM facet-level analyses. In these analyses, particularly the simultaneous regression analysis of the FFM facets, salient individual difference variables related to sociability, emotion regulation, emotionality, and connectedness to others (e.g., altruism) emerged as significant correlates of ASD symptomatology, with many of the strongest FFM correlates of ASD symptom severity mapping onto concepts associated with ASD in the clinical literature (e.g., low social motivation). Perhaps most importantly, a person-level analysis using clustering techniques revealed markedly different profiles of individual difference patterns, with two clusters largely mirroring FFM prototypes for social phobia and clinical depression, respectively, one cluster presenting rather uniquely as characterized largely by a lack of sociability in the context of otherwise average-range FFM characteristics, and one cluster with no distinguishing individual difference patterns distinct from the reference group. In summary, this study may shed light on the multiplicity of phenotypic manifestations characterizing ASD in adults, reflecting a striking heterogeneity of phenotypic taxa as opposed to a simpler conceptualization of individuals with ASD as either “low” or “high” functioning.

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Table 1. Demographics and general functioning variables

	Elevated ASD Trait Group (Above RAADS-R Cutoff)	Lowered ASD Trait Group (Below RAADS-R Cutoff)
N	364	464
Formally diagnosed with ASD	38.5%	2.6%
Formally diagnosed or self-diagnosed with ASD	45.9%	3.9%
RAADS-R Mean (Range)	113.5 (66-203)	31.6 (0-65)
Gender	64% Female	79.5% Female
Average Age (Range of Ages)	35.7 Years Old (18-78 Years Old)	36.7 Years Old (18-87 Years Old)
Ethnicity	83% Caucasian; 5% Hispanic; 4% Asian; 4% Multi-ethnic; 2.5% Black	79% Caucasian; 6% Asian; 4.5% Hispanic; 5% Multi-ethnic; 2% Black
Country of Origin	81% United States	87% United States
Education (Completed 4-Year Degree)	50%	67%
Currently Employed	61%	73%
Satisfaction with Employment (Moderately or Very Satisfied)	42% Satisfied	64% Satisfied
Currently in Romantic Relationship	49%	63%
Self-reported Happiness (Somewhat or Very Happy)	50%	77%
General Satisfaction with Life (Somewhat or Very Satisfied)	47%	75%

Table 2. Group mean IPIP-NEO 120 differences between ASD and non-ASD groups

IPIP-NEO-120 factors and facets	Elevated ASD trait group	Comparison group <i>t</i> -scores
	<i>t</i> -scores <i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Neuroticism	59.6 (9.1)**	48.2 (9.5)**
Anxiety	61.3 (9.4)**	52.3 (9.9)**
Anger	54.6 (10)**	48.1 (9.4)**
Depression	56.4 (9.8)**	48.5 (9.3)**
Self-Consciousness	59.5 (7.3)**	48.7 (9)**
Immoderation	52 (10.7)*	50.5 (9.7)*
Vulnerability	63.7 (10.6)**	52.3 (10.3)**
Extraversion	39.5 (9.1)**	49.8 (9.6)**
Friendliness	37.9 (9.4)**	52.3 (9.3)**
Gregariousness	46 (6.8)**	54.4 (7.6)**
Assertiveness	42.6 (11.2)**	48.2 (10.5)**
Activity Level	48.1 (11)	48.9 (10.2)
Excitement-Seeking	42.3 (10.7)**	45.9 (9.5)**
Cheerfulness	42.2 (10.9)**	50.7 (10.3)**
Openness to Experience	49.4 (10.4)**	52.9 (9.9)**
Imagination	51.2 (10.3)**	45.8 (11.1)**
Artistic Interests	49.8 (10.2)**	51.6 (9.3)**
Emotionality	46.2 (11.9)**	53.4 (8.8)**
Adventurousness	42.3 (10.3)**	50.8 (9.2)**
Intellect	47.1 (11.6)**	50 (10)**
Liberalism	54.5 (9.5)	55.7 (9.6)
Conscientiousness	45.1 (10.8)**	50.7 (9.9)**
Self-Efficacy	43.2 (13.7)**	50.6 (11.3)**
Orderliness	46.5 (10.1)**	50.3 (9.7)**
Dutifulness	48.3 (11.6)	49.8 (10.2)
Achievement-Striving	48.3 (11.5)**	50.4 (9.7)**
Self-Discipline	44.9 (9.9)**	49.4 (9.7)**
Cautiousness	48 (11.7)**	52.4 (9.9)**
Agreeableness	45.4 (11)**	52.9 (8.4)**
Trust	45.3 (10.8)**	53.7 (9.3)**
Morality	48.8 (10.6)**	52.2 (8.8)**
Altruism	48.2 (11.3)**	55.8 (8.7)**
Cooperation	49 (9.7)**	53.7 (8.6)**
Modesty	52.6 (11.2)	51.8 (9.3)
Sympathy	51.1 (11.4)**	56.7 (8.2)**

Note: For all analyses, $n = 828$. Groups were determined based on RAADS-R score cut-off of 65. Those scoring above cutoff were placed in elevated ASD trait group, while those scoring below were placed in the lowered ASD trait group. Standard deviations are in parentheses.

**Significant at the 0.01 level (2-tailed).

*Significant at the 0.05 level (2-tailed).

Table 3. IPIP-NEO factor score correlations and regression weights for predicting RAADS-R scores

IPIP-NEO-120 Factors	RAADS-R	
	Correlations	Standardized Regression Weights
Neuroticism	.59**	.36**
Extraversion	-.55**	-.27**
Openness to Experience	-.23**	-.00
Agreeableness	-.46**	-.28**
Conscientiousness	-.31**	.06*
Constant	-	90.26**
R ²	-	.48

Note: For all analyses, $n = 828$. For each total RAADS-R score correlation with IPIP-NEO-120 factor scores, the effects of participant gender and age were partialled out.

**Significant at the 0.01 level (2-tailed).

*Significant at the 0.05 level (2-tailed).

Table 4. IPIP-NEO facet correlations and regression weights for predicting RAADS-R scores

IPIP-NEO-120 facets	RAADS-R	
	Correlations	Standardized regression weights
Neuroticism		
Anxiety	.50**	.07*
Anger	.41**	.03
Depression	.42**	.01
Self-Consciousness	.58**	.02
Immoderation	.09**	-.02
Vulnerability	.56**	.20**
Extraversion		
Friendliness	-.71**	-.26**
Gregariousness	-.57**	-.18**
Assertiveness	-.30**	.00
Activity Level	-.02	.10
Excitement-Seeking	-.19**	-.05
Cheerfulness	-.40**	.12
Openness to Experience		
Imagination	.29**	.18**
Artistic Interests	-.11**	.02
Emotionality	-.43**	-.21**
Adventurousness	-.46**	-.08**
Intellect	-.16**	.01
Liberalism	-.06	-.02
Conscientiousness		
Self-Efficacy	-.32**	-.10**
Orderliness	-.22**	-.03
Dutifulness	-.11*	.09
Achievement-Striving	-.13**	.05
Self-Discipline	-.26**	.05
Cautiousness	-.22**	-.13**
Agreeableness		
Trust	-.49**	-.05*
Morality	-.23**	.02
Altruism	-.46**	-.10**
Cooperation	-.30**	-.05
Modesty	.02	-.03
Sympathy	-.33**	-.01
Constant	-	149.71**
R ²		.70

Note: For all analyses, $n = 828$. For each total RAADS-R score correlation with IPIP-NEO-120 facet scores, the effects of participant gender and age were partialled out.

**Significant at the 0.01 level (2-tailed).

*Significant at the 0.05 level (2-tailed).

Table 5. Characteristics of Elevated ASD trait personality clusters

Cluster characteristics	Personality cluster			
	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Individuals in cluster (<i>n</i>)	104	99	62	99
Average RAADS-R score	120 ^a	121 ^a	116 ^a	98 ^b
RAADS-R Social Relatedness	24 ^a	27 ^{ab}	29 ^b	18 ^c
RAADS-R Circumscribed Interests	48 ^a	50 ^a	45 ^{ab}	41 ^b
RAADS-R Sensory Motor	28 ^a	26 ^a	25 ^a	25 ^a
RAADS-R Social Anxiety	24 ^a	22 ^a	21 ^a	18 ^b
Average age	34	37	39	35
Gender	71% Female ^a	69% Female ^{ab}	61% Female ^{ab}	55% Female ^b
Formally diagnosed with ASD	49% ^a	28% ^b	40% ^{ab}	36% ^{ab}
Formally or self-diagnosed with ASD	68% ^a	50.5% ^b	58% ^{ab}	56.5% ^{ab}
In romantic relationship	54%	45%	45%	37%
Living independently	76%	73%	77%	69%
Currently employed	54%	55%	66%	71%
Satisfied with employment (somewhat or very satisfied)	37.5% ^a	30% ^a	55% ^b	51.5% ^b
Education: completed four year college degree	47% ^{ab}	38% ^a	63% ^b	57% ^{ab}
Self-reported happiness (somewhat or very happy)	38% ^{ab}	33% ^a	61% ^{ab}	71% ^b
Satisfied with life (somewhat or very happy)	36.5% ^a	27% ^a	66% ^b	66% ^b

Note: Means and percentages with the same superscript differ significantly from each other at the 0.05 level (2-tailed).

Table 6. Group mean IPIP-NEO-120 differences between clusters

IPIP-NEO-120 Factors and facets	Mean <i>t</i> -scores			
	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Neuroticism	63.59 ^a	64.58 ^a	52.43 ^b	55.04 ^b
Anxiety	66.75 ^a	63.39 ^b	52.99 ^c	58.69 ^d
Anger	56.22 ^a	58.92 ^a	50.87 ^b	50.89 ^b
Depression	60.59 ^a	60.77 ^a	50.83 ^b	50.96 ^b
Self-Consciousness	63.90 ^a	59.27 ^b	58.33 ^b	55.90 ^c
Immoderation	50.30 ^a	57.89 ^b	45.96 ^c	51.53 ^a
Vulnerability	69.82 ^a	67.02 ^a	55.22 ^b	59.26 ^c
Extraversion	32.55 ^a	38.36 ^b	39.18 ^b	48.33 ^c
Friendliness	34.23 ^a	36.47 ^a	33.49 ^a	46.14 ^b
Gregariousness	43.06 ^a	45.87 ^b	43.19 ^a	50.89 ^b
Assertiveness	36.47 ^a	39.96 ^a	49.10 ^b	47.45 ^b
Activity Level	45.35 ^a	44.41 ^a	51.53 ^b	52.69 ^b
Excitement-Seeking	34.42 ^a	48.03 ^b	39.61 ^c	46.41 ^b
Cheerfulness	37.95 ^a	39.06 ^a	40.08 ^a	51.18 ^b
Openness to Experience	47.59 ^a	48.16 ^a	44.97 ^a	55.34 ^c
Imagination	49.73 ^b	53.90 ^a	47.39 ^b	52.51 ^a
Artistic Interests	49.66 ^a	48.47 ^a	46.91 ^a	53.23 ^b
Emotionality	49.41 ^a	43.48 ^b	33.56 ^c	53.47 ^d
Adventurousness	38.08 ^a	42.14 ^b	42.03 ^b	46.95 ^c
Intellect	46.07 ^a	43.51 ^a	50.45 ^b	49.50 ^b
Liberalism	57.19 ^a	53.52 ^b	52.14 ^b	54.21 ^b
Conscientiousness	46.31 ^a	34 ^b	52.48 ^c	50.16 ^c
Self-Efficacy	39.29 ^a	33.70 ^b	52.05 ^c	51.36 ^c
Orderliness	46.45 ^a	42.42 ^b	50.55 ^c	48.07 ^{ac}
Dutifulness	52.08 ^a	38.75 ^b	49.03 ^c	53.59 ^a
Achievement-Striving	49.16 ^a	39.08 ^b	51.96 ^a	54.39 ^c
Self-Discipline	41.75 ^a	38.10 ^b	51.71 ^c	50.66 ^c
Cautiousness	53.61 ^a	39.58 ^b	54.86 ^a	46.39 ^c
Agreeableness	50.57 ^a	38.23 ^b	37.82 ^b	51.96 ^a
Trust	43.93 ^a	42.71 ^a	39.72 ^b	52.81 ^c
Morality	53.89 ^a	40.63 ^b	47.26 ^c	52.63 ^a
Altruism	52.08 ^a	42.73 ^b	38.53 ^c	55.65 ^d
Cooperation	53.04 ^a	42.97 ^b	47.84 ^c	51.57 ^a
Modesty	60.01 ^a	51.23 ^b	47.77 ^c	49.38 ^{bc}
Sympathy	55.28 ^a	46.07 ^b	40.87 ^c	58.10 ^a

Note: Means with different superscripts differ significantly from each other at the 0.05 level (2-tailed).