THE COMPLEX RELATIONSHIP
BETWEEN PERSONALITY AND FUNCTIONING

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Abstract

In recent decades, psychopathology research has established significant evidence in support of a dimensional diagnostic model, in which maladaptive personality traits underlie and predict clusters of mental health symptoms. In this framework, psychopathology may be defined as maladaptively high or low levels of a personality trait causing distress and/or impairment. This literature, however, has yet to characterize the specific relationship between these traits and impairments in functioning (e.g., physical functioning, social functioning, mental health functioning). The current study aims to address this gap in the literature by (a) augmenting the measurement of personality traits along their full range by integrating cognate traits from the "maladaptive" and "normative" personality literature onto unidimensional personality spectra; (b) modeling the nonparametric relationship between newfound personality traits with functioning; (c) explore how these relationships are moderated by age and sex; and (d) validating initial findings using replication and confirmatory procedures in a second sample. Data for this study were collected, using item-sampling techniques, from an online personality questionnaire where individuals self-selected to participate in exchange for feedback on their personality profiles. The overall sample included 214,420 people (split into two samples of 107,210 individuals each) from 223 countries. Results provide support for the replicability of the relationships between personality and functioning. Evidence suggests these relationships are not linear and monotonic, but rather optimal functioning occurs between the extreme ends of the trait. Age and/or sex play different roles in moderating these relationships depending on the personality trait of interest. Future research is needed to address measurement problems which interfere with measuring the full spectrum of each personality trait.

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Introduction

Contemporary research efforts in the field of psychopathology and the associated personality literature have attempted to develop dimensional, trait-based alternatives to traditional diagnostic models of psychopathology (Kotov et al., 2017; Krueger, Tackett, & MacDonald, 2016). Research in this line of study aims to accomplish several goals, including empirically deriving a reliable and valid nosology of psychological disorders, improving the prediction, detection, and treatment of poor outcomes associated with mental illness, and augmenting the construct validity of traits of interest by demonstrating convergence of alike constructs from diverse areas in research psychology (i.e., psychopathology and personality). Early findings from this research suggest psychopathology may be best understood as hierarchically-structured dimensional constructs rather than traditional, categorical, neo-Krapelinian diagnoses (Wright & Krueger, 2018).

Despite initial progress made in empirically-deriving the dimensional variables underlying psychopathology, such as maladaptive personality traits (Ball, 2001; Krueger, Derringer, Markon, Watson, & Skodol, 2012; Livesly & Jackson, 1992), the literature has yet to delineate the specific relationship of these latent psychopathological constructs with the functional impairment associated with mental health diagnoses. Notably, the most current edition of the Diagnostic and Statistical Manual of Mental Disorders (*DSM-5*; American Psychiatric Association [APA], 2013) proposes an Alternative Model of Personality Disorders (*DSM-5* AMPD) in which personality disorders are designated by 1) deficiencies in self- and interpersonal-functioning and 2) maladaptive personality traits (*DSM-5* Trait Model). This model suggests that contemporary conceptualizations of psychopathology include both impairment in day-to-day functioning as well as dimensional constructs of psychopathology. Thus, research elucidating the relationship between these two domains of mental illness is undoubtedly vital and timely. Moreover, it is an important first step in eventually clarifying the mechanism of dysfunction associated with psychopathology, which may facilitate the development of effective, trans-diagnostic interventions to mental illness.

While some previous research has worked to clarify the relationship between functioning and personality in general (e.g., Ozer & Benet-Martinez, 2006), findings are limited in two significant ways. First, the majority of this literature has evaluated the linear relationship between personality and functioning, overlooking the possibility of a curvilinear or non-monotonic relationship. Second, the research has neglected to address how the relationship between functioning and personality may change at far ends of the personality spectrum. Recent literature has operationalized this outlying personality variance using so-called "maladaptive personality traits." Given the building evidence supporting the psychometric and biometric overlap of previously-distinguished models of "normative" versus "maladaptive" personality (Wright & Kruger, 2018), it is fitting to expand upon the previous literature by extending the range of typical personality traits to include maladaptive levels of those traits. In doing so, research investigating the relationship between personality and functioning will have a more comprehensive lens through which to examine the relationship as it truly exists in nature.

As such, this study sets out to address the current gaps in the literature by characterizing the true relationship between comprehensive personality traits and functioning, with an emphasis on how that relationship may be specifically quantified at maladaptive levels of those personality traits. First, this introduction will review the current literature and outline the empirical premise for the current study.

Movement Towards a Dimensional Approach to Psychopathology

Shortcomings of the Current Diagnostic System

Historically, the taxonomy of mental disorders has been heavily influenced by the neo-Krapelinian approach, which is characterized by categorical and polythetic diagnoses reminiscent of a traditional medical model (Blashfield, 1984). This approach designates individuals who meet criteria for a certain disorder as distinct from those who do not. Of note, the development and modification of neo-Krapelinian diagnostic categories has relied disproportionately on the consensus of experts who based their conceptualizations on anecdotal, versus empirical, evidence (see Clark, 2005; Widiger & Clark, 2000; Widiger, Gore, Crego, Rojas, & Oltmanns, 2017; Wright & Krueger, 2017). This approach inherently begets arbitrary diagnostic criteria.

The influence of the neo-Krapelinian approach, which was popularized in the 1970's (e.g., Feighner, Robins, Guze, Woodruff, Winokur, & Munoz, 1972), is palpable in the diagnostic descriptions of mental disorders dating back to *DSM-III*. The neo-Krapelinian philosophy has not only set the current diagnostic framework for mental disorders, but also has acted as the foundation upon which most psychopathological research is based, seemingly tethering empirical research to early a priori hypotheses (Krueger & Markon, 2006; Widiger & Mullins-Sweatt, 2009; Wright, Krueger, Hobbs, Markon, Eaton, & Slade, 2013). Despite contemporary efforts to develop a new, empirically-based nosology of psychopathology, the *DSM-5* maintains traditional, neo-Krapelinian categories as the principal diagnostic framework to this day.

Categorical delineation of mental disorders predisposes the current diagnostic system to significant limitations. Existing research provides substantial evidence for the poor inter-rater and cross-temporal reliability of traditional diagnostic categories (Clark, 2007; Markon, Chmielewski, & Miller, 2011; Wright & Krueger, 2018). Diminished reliability is attributable in part to the loss of variance and measurement precision resulting from discretizing diagnostic constructs, and in part to the arbitrary criteria by which these diagnostic categories are distinguished (Markon et al., 2011). Importantly, the low reliability of the current diagnostic system makes it challenging to empirically evaluate its validity because traditional diagnoses are not reliably assigned to individuals.

As aforementioned, neo-Krapelinian diagnostic delineations are generally based on the deliberation of a committee of experts. As a result, subjective diagnostic criteria (i.e., arbitrary thresholds for clinically-meaningful symptom intensity, frequency, duration, or onset) lead to problematic diagnostic heterogeneity (Widiger & Mullins-Sweatt, 2009). In other words, a disorder may be diagnosed from markedly different clinical presentations. For example, an individual with sad mood, feelings of worthlessness, weight gain, excessive sleep, and suicidal thoughts would receive the same diagnosis (Major Depressive Disorder [MDD]) as an individual with anhedonia, fatigue, trouble concentrating, psychomotor agitation, and trouble sleeping (APA, 2013).

Paradoxically, distinct disorders may manifest in very similar clinical presentations. For instance, an individual experiencing restlessness, fatigue, trouble concentrating, and sleep disturbance may qualify for either a diagnosis of MDD or Generalized Anxiety Disorder (GAD) depending entirely on one additional symptom: depressed mood versus uncontrolled worry (APA, 2013). This is further complicated by likelihood that an individual may experience co-occurring symptoms of both MDD and GAD. This example illustrates the comorbidity problem (Clark, 2007; Hopwood, Zimmerman, Pincus, & Krueger, 2015; Markon, et al., 2011; Widiger & Mullins-Sweatt, 2009; Wright et al., 2013).

Comorbidity is the co-occurrence of two or more disorders in a single individual. The comorbidity problem refers specifically to the inexplicably high rate (a rate higher than due to chance) of this co-occurrence, suggesting that mental disorders are correlated (Krueger, 1999; Krueger & Markon, 2006). In fact, research suggests that "diagnostic purity" is rare, and individuals are more likely to meet criteria for multiple disorders than they are to meet criteria for a single disorder (Widiger & Clark, 2000). This phenomenon is not simply a circumstantial inconvenience obstructing the reliable and accurate diagnosis of mental disorders. Rather, it is a symptom of the current diagnostic system: even objectively-defined diagnostic criteria can produce unreliable diagnoses in the context of overlapping symptoms (Hyman, 2010). In addition to highlighting shortcomings in the current diagnostic model, the comorbidity problem can elucidate the true nosology and etiology of psychopathology. By analyzing structural models of comorbidity, contemporary research has clarified that covariance between disorders is best explained by a liability spectrum model (Krueger & Markon, 2006), highlighting the importance of using latent vulnerability factors to establish a dimensional model of psychopathology.

Emerging Diagnostic Model

Recent research in the field of diagnostic psychopathology has utilized the high rates of covariance between traditional diagnostic categories to reveal the structure of latent vulnerabilities to psychopathology. In identifying these continuous, unidimensional variables which underline and predict clusters of mental disorder symptoms, this body of literature has offered an alternative, data-driven diagnostic model for psychopathology (e.g., Blanco et al., 2013; Krueger et al., 2012; Kotov, Ruggero, Krueger, Watson, Yuan, & Zimmerman, 2011; Wright et al., 2013).

Significant research has demonstrated that these psychopathological dimensions, often referred to as pathological or maladaptive personality traits, can reliably be organized into a hierarchical model characterized by multi-level liabilities embedded within one another (Kotov et al., 2017; Hopwood et al., 2015; Wright & Krueger, 2018; Wright, Thomas, Hopwood, Markon, Pincus, & Krueger, 2012). The number, specificity, and content of distinct traits vary depending on the level of the hierarchy. Varying input data across different studies (e.g., a particular sample or inventory) may cause trait models to diverge slightly at particular levels of the hierarchy (Kotov et al., 2017). Ample evidence, however, suggests the convergence of factor solutions at more parsimonious levels of the hierarchy. For example, the literature supports robust one-factor (i.e., general pathology domain), two-factor (i.e., internalizing and externalizing domains), and three-factor (i.e., externalizing, detachment, and negative affectivity domains) solutions of dimensional psychopathology (Caspi et al., 2014; Wright & Krueger, 2018). Of note, a three-factor solution sometimes manifests as a thought disorder domain accompanying the two-factor solution domains (i.e., internalizing and externalizing).

The five-factor solution of psychopathological liability is the solution with the greatest number of factors that is reliably replicated in the literature, boasting the most content-specific pathological traits shared by a majority of maladaptive personality measures (e.g., PID-5, PSY-5, CAT-PD, FFM-PD). Due to its popularity and accessibility (Al-Dajani, Gralnick, & Bagby, 2016), the current study utilizes the factors denoted by the *DSM-5* Trait Model, a model proposed with the *DSM-5* AMPD (APA, 2013). This model designates the five major domains as Antagonism, Detachment, Disinhibition, Negative Affectivity, and Psychoticism (Krueger et al., 2012). Inherent to the hierarchical structure of maladaptive personality, these five domains load onto the higher-order traits at upper levels of the hierarchy and operate as latent vulnerabilities for lower-order facets at lower levels of the hierarchy. Due to the balance of reliability, specificity, and predominance in the literature of the five-factor solution of dimensional psychopathology, the current study chooses to focus on this level of the hierarchy.

Incremental Validity of a Dimensional Approach

Maladaptive personality traits delineated by a dimensional model of psychopathology (at all levels of the hierarchy) demonstrate improved reliability, validity, and utility over categorical diagnoses as delineated in the neo-Krapelinian approach. Empirical research comparing pathological trait models to traditional diagnostic categories testify to the improved psychometric properties of a dimensional approach, including better model fit (e.g., Wright et al., 2013; Wright & Krueger, 2018), improved reliability and validity (e.g., Clark, 2005, 2007; Hopwood et al., 2015; Livesley, 2001; Markon et al., 2011; Widiger & Clark, 2000), increased predictive validity for future maladaptive outcomes (e.g., Hopwood, Thomas, Markon, Wright, & Krueger, 2012; Kim & Eaton, 2015; Widiger, 2011), and consistency of these properties across both clinical and non-clinical settings (e.g., Kotov et al., 2011; Markon et al., 2011).

Emerging evidence for the convergence of hierarchical models of dimensional psychopathology support the stability and generalizability of the pathological trait model (Kotov et al., 2017; Wright & Krueger, 2018). Research identifying latent diagnostic indicators using only personality disorders (e.g., Krueger et al., 2012), using a combination of *DSM-IV* Axis I and Axis II disorders (e.g., Kotov et al., 2011), and using psychopathological symptoms with low base rates (e.g., Forbush & Watson, 2012) all result in similar dimensional models. Furthermore, evidence suggests that even previously-established dimensional models of psychopathology converge readily with traditional diagnostic categories and symptoms not utilized in their initial development (Kotov et al., 2011, 2017; Wright et al., 2013; Wright, et al., 2012).

In addition to hierarchical convergence, evidence for the reliability of the pathological trait model is demonstrated by the re-emergence of the same traits, and relationships between those traits, in different samples. Similar structural models of pathological traits are identified in both normative and clinical samples (e.g., Kotov et al., 2011), in samples possessing ethnic and racial diversity (e.g., Forbush & Watson, 2012), and in samples outside of the USA (e.g., Thimm, Jordan, & Bach, 2017; Wright et al., 2013; Zimmerman et al., 2014).

Given the mounting evidence for their superior reliability and validity, pathological trait models have begun to gain traction as the diagnostic system of choice among researchers, clinicians, and academic organizations alike. This is evidenced by significant steps taken in recent years to revise the current diagnostic system (e.g., *DSM-5* Alternative Model [APA, 2013], Research Domain Criterion [RDoC; Insel et al., 2010], Hierarchical Taxonomy of Psychopathology [HiTOP; Kotov et al., 2017]). Emerging research even provides support for the clinical utility of dimensional over traditional diagnostic models (Rettew, 2013; Rodriguez-Seijas, Ruggero, Eaton, & Krueger, 2019; Ruggero et al., 2019; Samuel & Widiger, 2006). Such benefits include streamlining comprehensive case conceptualization (due to increased validity), augmenting coordination of care (due to increased reliability), and providing a quantifiable framework to standardize the nuanced and individualized ways in which clinicians already conceptualize their patients' clinical presentations.

Without competing evidence to support the continued use of neo-Krapelinian diagnoses, an integration of the reviewed literature advises a significant paradigm shift in the way mental disorders are conceptualized. Dimensional models of psychopathology propose maladaptive personality traits as an improvement on the traditional model in their ability to account for the taxonomy and etiology of mental illness, describe psychopathological symptoms, and predict the development of future disorders. Of note, however, research has yet to look past specific psychopathological symptoms to identify the direct relationship between maladaptive personality and impairment in functioning.

Dimensional Psychopathology and Normative Personality

The research efforts to establish dimensional models of psychopathology were, in part, inspired by early literature suggesting that personality models appear to be a useful tool in predicting mental disorders (e.g., Ball, 2001; Bagby et al., 1999; Coker, Samuel, & Widiger, 2002; Livesley, 2001; Reynolds & Clarke, 2001; Saulsman & Page, 2004; Warner et al., 2004). While maladaptive personality traits were developed independently from the so-called "normative" personality literature, these models seemingly share commonalities in their development, hierarchical taxonomy, and even trait descriptors

(Wright & Krueger, 2018). This is particularly apparent at the five-factor solutions of these respective models (Clark 2007; Widiger, 2011; Widiger, Costa, Gore, & Crego, 2012). Maladaptive personality domains of the *DSM-5* trait model (i.e., Antagonism, Detachment, Disinhibition, Negative Affectivity, and Psychoticism) seemingly reflect content from related personality domains in the Five Factor Model (i.e., Agreeableness, Extraversion, Conscientiousness, Neuroticism, and Openness to Experience, respectively). Of note, the Five Factor Model of normative personality (FFM; Digman, 1990; Costa & McCrae, 1990; McCrae & John, 1992) is the most ubiquitously used model of personality in the individual differences literature.

Given these theorized similarities, a significant body of research has been dedicated to clarifying the empirical relationship between maladaptive and normative personality models. Not only does this research support the robust psychometric overlap between psychopathological traits and normative personality (Thomas, Yalch, Krueger, Wright, Markon, & Hopwood, 2013; Watson, Stasik, Ro, & Clark, 2013; Wright & Simms, 2014), but also it indicates that "maladaptive" personality traits are well-conceptualized as extreme levels of normative personality traits (Gore & Widiger, 2013; Haigler & Widiger, 2001; Suzuki, Griffin, & Samuel, 2017; Suzuki, Samuel, Pahlen, & Krueger, 2015). In addition to the psychometric overlap of particular traits, research also indicates that the structure of normative personality dictates the hierarchical structures of dimensional psychopathology (Widiger et al. 2019).

The well-established phenotypic relationship between maladaptive and normative personality models is further supported by behavioral genetics research. Twin research provides support for the coheritability of maladaptive and normative personality traits, suggesting that pairs of related traits from the two models share overlapping genetic factors which simultaneously contribute to variance in both (Kendler, Aggen, & Gillespie, 2017; Wright, Pahlen, & Krueger, 2017). As such, there is substantial support to suggest Antagonism may be best conceptualized as low Agreeableness, Detachment as low Extraversion, Disinhibition as low Conscientiousness, and Negative Affectivity as high Neuroticism.

Of note, while evidence supports the empirical relationships between the above four pairs of maladaptive and normative personality domains, the relationship between Psychoticism and Openness to Experience is more nuanced. Whereas some studies report a positive correlation between Psychoticism and Openness to Experience, others have failed to identify any measurable relationship between these domains (Chmielewski, Bagby, Markon, Ring, & Ryder, 2014). Research aimed at further clarifying this relationship has identified that subfactors of Openness to Experience relate in different ways to Psychoticism. Sub-traits characterized by creativity, imagination, and artistic engagement are positively related to Psychoticism, while sub-traits characterized by intellect, literary pursuits, and philosophical engagement are negatively related to Psychoticism (Chmielewski et al., 2014; DeYoung, Grazioplene, & Peterson, 2012; Krueger & Markon, 2014; Watson et al., 2013; Wright et al., 2017). Psychoticism's opposing relationships with different facets of Openness to Experience appear to nullify any reliable domain-level relationship. Nevertheless, this evidence suggests that Psychoticism may be well-conceptualized as high levels of the artistic and perceptual sub-factors of Openness to Experience. By contrast, the intellectual sub-factors of

Openness to Experience may act as a protective factor against Psychoticism or psychotic-spectrum symptomatology (Wright & Krueger, 2018).

Bipolarity of Maladaptive Personality

The literature on the relationship between so-called “normative” and “maladaptive” personality traits has almost exclusively focused on maladaptive personality as the unipolar extreme variants of normative personality traits (e.g., maladaptively-low Agreeableness [i.e., Antagonism] in the absence maladaptively-high Agreeableness). This is due, in part, to a mischaracterization of maladaptive personality traits as the opposite of adaptive and healthy personality traits (APA, 2013). It may also be attributed, however, to limitations in measurement. Many maladaptive personality instruments lack adequate language to characterize and quantify maladaptive levels at both ends of a given personality trait (Coker et al., 2002; Widiger & Crego, 2019). Furthermore, even research testifying to the bipolar structure of maladaptive personality warns that the structure of that bipolarity is fragile, and it may decompensate under factor-analytic techniques (Crego, Oltmanns, & Widiger, 2020).

Nevertheless, a growing body of literature has begun to establish support for the bipolarity of maladaptive personality, particularly at the five-factor solution (Crego et al., 2020; Rojas, Crego, & Widiger, 2019; Widiger et al., 2012; Widiger et al. 2017; Widiger & Crego, 2019; Widiger & Mullins-Sweatt, 2009). This research suggests that, at both high and low ends of personality spectra, extreme levels of a given trait are associated with maladaptive functioning and psychopathological outcomes. In other words, the further out an individual’s personality trait level is from the average, the more likely he or she is to experience psychological symptoms, impairments in functioning, and/or distress.

Take, for instance, the case of Conscientiousness. Low Conscientiousness is well-characterized by Disinhibition in the *DSM-5* Trait Model. Deficits in self-control and behavioral restraint associated with Disinhibition predict a variety of maladaptive outcomes, including low academic achievement, financial instability, and criminal behavior (Moffitt et al., 2011), as well as various psychopathology, such as Substance Abuse Disorders and Antisocial Personality Disorder (Kotov et al., 2017). On the other hand, the *DSM-5* Trait Model does not delineate a domain characterized by abnormally high levels of Conscientiousness. Nevertheless, the rigidity, perfectionism, and compulsivity associated with high levels of Conscientiousness also predict maladaptive outcomes, such as obsessive-compulsive disorders (Carter, Guan, Maples, Williamson, & Miller, 2016; Samuel & Widiger, 2011) and distress (e.g., Chang, Watkins, & Banks, 2004; Enns, Cox, & Clara, 2002). Individuals may experience psychopathological symptoms as the result of either low or high Conscientiousness.

This pattern can be generalized to other Big Five personality domains. The *DSM-5* Trait Model only has the domains to characterize low Agreeableness, low Extraversion, high Neuroticism, and high sensory-perceptual Openness (Antagonism, Detachment, Negative Affectivity, and Psychoticism, respectively). However, research supports that maladaptive correlates are also associated with high Agreeableness (e.g., naivety, excessive self-sacrifice), high Extraversion (e.g., risk-taking, emotional intrusiveness, dependence), low Neuroticism (e.g., failure to predict negative outcomes, diminished empathy), and low Openness (e.g., inflexibility, reduced capacity for learning) (Widiger & Crego, 2019).

Taken together, the emerging evidence suggests that unipolar models of maladaptive personality variants are not sufficiently comprehensive, capturing only a partial range of the maladaptive correlates of personality. It is therefore vital that current models of dimensional psychopathology include maladaptive variants of both ends of normative personality traits in order to appropriately measure, operationally define, and utilize the full spectrum of psychopathological vulnerability.

The Relationship Between Personality and Functioning

Personality refers to the manifestation of individual differences between people as a result of underlying dispositions, intrapersonal processes, self-identity, and social-cultural and situational environmental factors (McAdams & Pals, 2006). Personality traits, specifically, are the latent variables that reliably predict individual patterns of emotion, cognition, and behavior. As is inherent to its definition, it follows that personality would be a reliable predictor of various outcomes, including an individual's capacity to effectively function in various life domains.

A significant body of literature has provided the empirical evidence supporting personality's efficacy in predicting life outcomes and behavioral trends (McAdams & Pals, 2006). Findings from this research suggest personality is related to a variety of outcomes, including happiness, identity cohesion, spirituality, health, mortality, quality of interpersonal relationships, academic achievement, vocational success, political ideology, pro- versus anti-social behavior, and even complex, specific behaviors (e.g., Ozer & Benet-Martinez, 2006; Paunonen, 2003; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007; Shiner, Masten, & Roberts, 2003). The predictive validity of personality is robust, as evidenced by a capacity to predict several life outcomes (e.g., mortality, divorce, occupational attainment) as well as cognitive ability and socio-economic status (Roberts et al., 2007). Moreover, the predictive validity of personality is stable over time: childhood personality not only predicts personality in adulthood, but also it predicts adaptive behavior up to 20 years in the future (Shiner et al., 2003).

Above and beyond specific behavioral outcomes, personality has been shown to predict broader conceptualizations of functioning. Personality is related to social and interpersonal functioning (e.g., Eisenberg, Fabes, Guthrie, & Reiser, 2000; Gallo, Smith, & Ruiz, 2003; Ghaed & Gallo, 2006; Gifford & O'Connor, 1987; McCrae & Costa, 1989), occupational and task functioning (e.g., Michon, Ten Have, Kroon, Van Weeghel, De Graaf, & Schene, 2008; Milgram & Tenne, 2000; Ones, 2005), physical health (e.g., Finch, Baranik, Liu, & West, 2012; Smith, 2006; Van Heck, 1997), and mental health (e.g., Kotov et al., 2017; Österberg, Persson, Karlson, Eek, Örbaek, 2007; Ozer & Benet-Martinez, 2006; Widiger & Costa, 1994; Wright & Krueger, 2018).

Of note, the grand majority of the literature examining the relationship between personality and functioning has done so through the lens of a linear relationship. In other words, research has identified personality traits that are positively or negatively correlated with adaptive and maladaptive outcomes. However, the research has yet to assess how the relationship between personality and functioning may change at different levels of the trait. If the true relationship between personality and functioning is curvilinear and/or non-monotonic, then there is a need for future research to use nonlinear analyses to appropriately characterize this relationship as it exists in nature.

Rationale for the Current Study

The current study represents an effort to validly quantify the true relationship between personality and various domains of functioning by addressing relevant gaps in the literature.

Given the contemporary movement toward pathological trait models in psychodiagnostic research, there is a substantial need to assess how pathological traits relate directly to adaptive and maladaptive outcomes often associated with the mental illness they underlie. Traditional categorical diagnoses are operationally defined as clusters of psychological symptoms accompanied by distress or functional impairment (APA, 2013). Similarly, in the *DSM-5* AMPD, personality disorders are designated by deficiencies in self- and interpersonal-functioning and maladaptive personality traits from the *DSM-5* Trait Model. As such, there is clear impetus for delineating the specific relationship between pathological traits and functioning, both to understand the interrelationship between diagnostic criteria in the *DSM-5* AMPD and also to identify how the underpinnings of psychopathology may influence various outcomes.

Furthermore, while research has examined the relationship between personality and functioning, the literature has yet to address how this relationship changes at maladaptive levels of those personality traits. A recent line of study has provided substantial support for being able to appropriately characterize maladaptive personality traits as extreme variants of normative personality traits. Thus, there is a precedent to combine cognate "normative" and "maladaptive" personality traits into a single trait in order to effectively measure functioning across the full range of personality spectra. The importance of expanding the range of personality spectra is further supported by the emerging research on the bipolarity of maladaptive personality, which suggests that personality is associated with maladaptive outcomes at both ends of the spectrum.

Current Study Aims

The current study was designed to address some of the gaps in the literature described above. Using domain-level traits from normative personality, maladaptive personality, and functioning literature, this study aims to (a) augment the measurement of full-spectrum personality traits by integrating items which index both a normative-level personality trait and its hypothesized maladaptive variant, (b) characterize the true relationship between domain-level personality traits and broad domains of functioning, (c) assess the extent to which the relationships between personality and functioning may be moderated by age and/or sex, and (d) validate findings in a second sample using a combination of exploratory and confirmatory procedures.

It was hypothesized that, in general, the functions characterizing the relationships between personality and functioning will exhibit an "inverted U-shape," indicating that functioning becomes impaired at either extremity of a personality spectrum. It was further hypothesized that the functions of these relationships would reliably predict outcomes in new data. Age and sex moderations of these relationships were hypothesized to improve the fit of these functions. Of note, the current study's analyses were limited to domain-level personality traits in an effort to focus the scope of this paper.

Methodology

Procedure

The SAPA Technique

The currently proposed study utilized a sample of participants from the Synthetic Aperture Personality Assessment method (SAPA; see SAPA-Project.org; Revelle & Laun, 2004; Revelle, Wilt, & Rosenthal, 2010; Wilt, Condon, & Revelle, 2011). SAPA is a telemetric method of assessing individual differences in which participants across the globe self-select to participate in self-report individual difference inventories in exchange for feedback on their personality data.

Importantly, SAPA is a psychometric technique that employs item sampling, a procedure in which every participant is given a random subset of inventory items from a larger item bank. This type of item-sampling produces data that is massively missing completely at random (MMCAR). When random item-sampling is repeated for enough participants, each item is eventually administered with every other item once (also known as a pairwise administration). With a large enough sample, item sampling produces a sufficient number of pairwise administrations to estimate the full item correlation matrix, in which the number of pairwise administrations functions as the effective *N* for each corresponding item. Additionally, since participants do not have to answer every item of a survey, subject attrition and unsustainable financial compensation are obsolete concerns for even the longest inventories.

The SAPA method has many advantages over traditional data-collection techniques. For instance, the utilization of the internet allows for much larger and more diverse samples. On average, over 230 people answer personality questions each day.

Additionally, advanced psychometric techniques (e.g., Item Response Theory [IRT], nonparametric regression) that are typically limited by inadequate sample sizes are not only possible with the substantial SAPA samples, but also allow for highly reliable parameter estimates for numerous variables (Revelle, Condon, & Wilt, 2011; Revelle et al., 2010; Wilt et al., 2011).

Administration

Participants self-selected to participate in the online-survey in exchange for feedback on their personality profiles. Given intrinsic motivation to be attentive and truthful in order to receive accurate feedback, results are likely valid and representative of individuals' true internal states. Participants were first administered several demographic questions. Required demographic questions include age and sex. Next, participants were presented with a page of 25 inventory items, including 22 items targeting personality and functioning and three items assessing IQ. Participants were able to answer up to 250 items across 10 pages, including 220 personality and functioning items and 30 IQ items (out of a potential 60). Each participant was administered a full normative-level personality inventory of 135 items. Additionally, each participant was administered a random subset of 85 items chosen from a bank of 220 potential maladaptive-level personality items and 108 potential functioning items (see section 2.1.2 Measures).

Participants were able to skip items or opt to receive their feedback before completion of all 250 items, but it was recommended to participants to answer at least 100 items to receive accurate feedback on their "Big-Five" personality scores, at least 150 items to receive accurate feedback on facet personality scores, and over 200 items to receive accurate feedback for both. Of note, participants answered all 250 items at a higher frequency than any other number of items (Figure 1).

Measures

The proposed study utilized both normative- and maladaptive-level personality inventories to assess functioning across the full spectrum of personality traits. Of note, while the inventories discussed below each index traits at a superordinate domain level and a subordinate facet level, the current study focused on the broader, domain-level traits in an effort to balance parsimony and comprehensiveness.

SAPA Personality Inventory-135-27&5 Version 1.1 (SPI-5)

The normative-level of the personality spectra was operationalized by the full SAPA Personality Inventory, Version 1.1 (SPI-135-27&5; Condon, 2018). This inventory, which will henceforth be referred to as the SPI, consists of a total of 135 items. Though relatively novel in comparison to other well-established Big-Five personality measures, the SPI represents a contemporary effort to, via fully transparent scientific procedures, empirically identify hierarchically organized personality scales from public domain personality items (e.g., International Personality Item Pool [IPIP]). The least-parsimonious factor solution of the SPI demarcates 27 a posteriori factors, with five items each, designed to account for optimal variance in individual differences while also augmenting the unidimensionality of resulting personality traits. Moreover, the SPI can reliably delineate traditional Big Five factors of Agreeableness, Conscientiousness, Extraversion, Neuroticism, and Openness to Experience (each domain measured with between 16 to 27 items). While the 27 facets of the SPI were not originally derived as subordinate factors to the Big Five, correlations demonstrate the 27 factors discriminate well between Big-Five personality factors (Condon, 2018). As aforementioned, the current analysis focuses on the domains from the five-factor solution of this inventory.

Personality Inventory for the DSM-5 (PID-5)

Parallel to the normative-level personality inventory, maladaptive-level personality traits were quantified using the Personality Inventory for the *DSM-5* (PID-5; Krueger et al., 2012). This measure was created in an effort to operationalize Criterion B (i.e., the maladaptive personality traits associated with personality dysfunction) of the *DSM-5* AMPD (APA, 2013). The PID-5 consists of a total of 220 items which index the five higher-order personality domains of Antagonism, Detachment, Disinhibition, Negative Affectivity, and Psychoticism (measured using between 35 to 74 items). While the PID-5 also indexes 25 hierarchically-structured subordinate facets (measured using between 4 to 14 items), the current analyses concentrates on the higher-order traits of the five-factor solution. Of note, substantial phenotypic and etiological research efforts have established robust relationships between the five superordinate domains indexed by the PID-5 and the traditional Big Five Factors of personality (Wright & Krueger, 2018).

The Patient-Reported Outcomes Measurement Information System (PROMIS)

In addition to personality items, participants will be administered a variety of health-related items in domains of Physical, Social, Mental, and Global Functioning. Items are taken from the Patient-Reported Outcomes Measurement Information System (PROMIS; PROMIS, 2017), an open-source item bank of functioning scales empirically derived with research funded by the National Institutes of Health (NIH). The PROMIS consists of over 300 measures of Physical, Mental, and Social Functioning aimed at helping patients to accurately communicate their subjective experience of distress and impairment to their providers. Scales were developed in a step-wise process in the mid-2000's, during which researchers 1) conducted comprehensive literature reviews identifying existing items and scales with strong content-validity, 2) explored the utility of hundreds of potential new items, 3) piloted qualitative and quantitative item review process (e.g., conducting cognitive interviews to incorporate participant feedback, classifying extant items, confirming factor structure, and using IRT to identify psychometrically strong versus weak items), and finally 4) continue to conduct empirical research to establish construct validity (PROMIS, 2017). Confirmatory research continues to demonstrate the ability of the PROMIS scales to quantify the domains of functioning they claim to measure (Cella et al, 2007; Cella et al., 2010; Reeve et al., 2007).

Given the large number of PROMIS measures, a subset of these scales was selected to be included in the current study's data collection. Scales were chosen based on item content in order to appropriately assess a wide range of functional impairment while minimizing content overlap. Measures selected were included from measures of Mental Functioning (i.e., "Anger" [5 items], "General Life Satisfaction" [5 items], and "Meaning and Purpose" [12 items]), measures of Physical Functioning (i.e., "Fatigue" [7 items] and "Sleep Disturbance" [5 items]), and measures of Social Functioning (i.e., "Ability to Participate in Social Roles and Activities" [4 items], "Companionship" [6 items], "Emotional Support" [4 items], "Informational Support" [4 items], "Instrumental Support" [4 items], "Satisfaction with Participation in Discretionary Social Activities" [7 items], "Satisfaction with Social Roles and Activities" [4 items], and "Social Isolation" [6 items]). Additionally, two PROMIS scales which assess functioning in Mental, Physical, and Social domains were included ("Global Health" [9 items] and "Profile 29" [28 items]). Between the "Global Health" and "Profile 29" scales, 10 items evaluate Mental health (e.g., mood, cognition), 19 items evaluate Physical health (e.g., pain, physical disability), five items evaluate Social health (e.g., social-occupational engagement), and one item evaluates Global health (i.e., "In general would you say your quality of life is:"). Of note, two items were dropped from the "Global Health" scale due to a lack of empirically derived IRT calibration statistics for those items.

Together, 108 PROMIS items were utilized in the current study's final analysis, including 108 items indexing global functioning, 32 items indexing Mental Functioning, 31 items indexing Physical Functioning, and 44 items indexing Social Functioning. Importantly, while the PROMIS scales were designed to be used as individual measures, these scales are organized into the three broad domains of health (Mental, Physical, and Social health) as designated by the World Health Organization (WHO) framework of health (Cella et al., 2007). Emerging research of the psychometric properties of PROMIS items and scales support the construct validity of broader Mental, Physical, and Social domains of functioning (Carle, Riley, Hays, & Cella, 2015; Hahn et al., 2010; Hays, Biorner, Revicki, Spritzer, & Cella, 2009; Hays, Spritzer, Schalet, & Cella, 2018). These domains represent the common, reliable variances within certain clusters of PROMIS scales. As such, the below analyses were conducted on latent Global, Mental, Physical, and Social domains of functioning by using all of the items with content corresponding to a designated domain.

Sample

Data were collected from an overall sample of 214,420 people. For the purposes of split-sample validity analysis, the full sample was divided into two equal samples of 107,210 individuals, in which data collected from the earliest 50% of participants comprise Sample 1. For all SPI, PID-5, and PROMIS items in the full sample (463 items in total), pairwise administrations ranged from 2,269 to 148,100 (*M* = 15,012, *Mdn* = 2,592). Of note, the distribution of pairwise administrations (see Figure 1) is not even because items from the SPI were sampled at a much higher rate than items from the PID-5 and the PROMIS. Pairwise administrations range from 1,113 to 74,198 in Sample 1 (*M* = 7,518, *Mdn* = 1,320) and from 1,110 to 73,902 in Sample 2 (*M* = 7,493, *Mdn* = 1,314).

The breakdown of demographic variables in the full sample is proportionally equivalent to the breakdown of demographic variables in Sample 1 and Sample 2 (Table 1). As such, the following description of demographic variables in the full sample well-characterizes the demographic distribution in the subsamples.

Of the 214,420 total participants, 64.75% identified their biological sex as female, 35.06% as male, and .19% identified as a different gender. One percent of participants declined to answer. Participants ranged in age from 11 to 90 years old (*M* = 30.19, *Mdn* = 25, *SD* = 14.88). See Figure 2 for distribution of age by sex. Of the 95% of participants who identified country of origin, 37% report being from the United States. A total of 223 countries were represented within the sample, including 97 countries with 100 or more participants and 17 countries with 1,000 or more participants (Figure 3). See Table 1 for the distribution of ethnicity, level of education, and self-report estimate of overall health.

Analysis

Analyses were conducted in R 1.0.153 (R Core Team, 2019). Principle packages used include *car* (Fox & Weisberg, 2019), *devtools* (Wickham, Hester, & Chang, 2019), *fANCOVA* (Wang, 2010), *ggplot2* (Wickham, 2016), *gss* (Gu, 2014), *lavaan* (Rosseel, 2012), *ltm* (Rizopoulos, 2006), *MASS* (Venables & Ripley, 2002), *mgcv* (Wood, 2017), *mice* (van Buuren, & Groothuis-Oudshoorn, 2011), *mvtnorm* (Genz et al., 2019), *npreg* (Helwig, 2020), *plyr* (Wickham, 2011), *PLRModels* (Perez & Cheda, 2014), *polycor* (Fox, 2019), *psych* (2018), *tidyr* (Wickham & Henry, 2020), and *VIM* (Kowarik, & Templ, 2016). These were used for a combination of data cleaning and organization, psychometric analysis, item-response theory scoring, multiple imputation, generalized cross-validation, nonparametric regression and other smoothing techniques, post-hoc comparison of nonparametric models, and plotting of nonparametric models.

As aforementioned, the current study's sample was split into two equal subsamples in order to facilitate validation analyses. Analytic procedures are detailed further below.

Results

Sample 1

Data Preparation and Psychometric Analyses

Prior to nonparametric analyses, trait variables were cleaned and prepped for scoring. As aforementioned, the Big Five factors of personality (i.e., Agreeableness, Conscientiousness, Extraversion, Neuroticism, and Openness to Experience) were estimated using the SPI, the corresponding five domains of maladaptive-level personality (i.e., Antagonism, Detachment, Disinhibition, Negative Affectivity, and Psychoticism) were estimated using the PID-5, and broad domains of functioning (i.e., Global, Mental, Physical, and Social Functioning) were estimated using items from a diverse subset of PROMIS scales. Of note, while PID-5 domain scores are typically estimated using subordinate facet-level scores as indicators (Krueger et al., 2012), PID-5 domain scores were estimated directly from the items that hierarchically load onto each domain so that these traits could later be scored using IRT.

Structure of Latent PROMIS Domains

Since the PROMIS was designed with the intention of using scale-level scores rather than assessing broad domains of functioning, psychometric analyses were conducted to confirm the reliability, validity, and unidimensionality of the three domains of Global Functioning (namely Mental, Physical, and Social Functioning). Exploratory factor analyses were conducted, including an oblique rotation, an orthogonal rotation, and a Schmid-Leiman transformation on the three-factor solution of all PROMIS items. The factor structure of each of these models reflects the factor structure hypothesized by the a priori three-factor solution of the PROMIS. All 108 items of the PROMIS load between .20 and .63 (M = .43, SD = .10) onto a general factor of Global Functioning (see Appendix A for visualization).

Of note, however, empirical factor models of the PROMIS did not exhibit a simple structure, and items were likely to have one or two significant cross-loadings. Moreover, in each factor solution, approximately 20 to 25% of items loaded more strongly on a domain other than the expected, a priori domain (with $\geq .10$ difference in factor loadings). These deviations from the hypothesized factor structure, as dictated by the taxonomy of PROMIS scales (PROMIS, 2017), appear to be the result of significant general factor saturation, as well as double-barreled items with content targeting multiple domains (see Appendix B). It is worth noting that in each model, the Physical Functioning factor was most likely to line up with the hypothesized items, followed by the Mental Functioning factor, and lastly the Social Functioning factor. Despite some divergence from the hypothesized factor structure, the current study persisted in estimating Mental, Physical, and Social Functioning using the item subsets originally hypothesized to index these domains in an effort to maintain the integrity of the PROMIS scales. As discussed later in this section, psychometric analysis of these a priori PROMIS domains suggest these broad variables are reliable, unidimensional, latent traits which explain common variance in assorted PROMIS scales.

Item-Pruning

In preparation for IRT analysis, variables of interest (e.g., five SPI domains, five PID-5 domains, and four PROMIS domains) were analyzed for unidimensionality. In an effort to augment unidimensionality of these broad trait domains, item pruning was conducted on the five domains measured by the SPI and the five domains measured by the PID-5. Only items that loaded ≥ .30 on their corresponding domain were kept as indicators. See Table 2 for the difference in the number of indicators for full versus reduced SPI and PID-5 scales.

Table 2 also demonstrates that reduced-item domains, despite having fewer indicators, produce identical or slightly better psychometric properties compared to their full-item counterparts in nine out of 10 cases (i.e., all but Openness to Experience). Psychometric properties were compared using estimates of unidimensionality (i.e., the ratio of communalities to uniquenesses) and estimates of reliability (i.e., Cronbach's alpha [Cronbach's α], signal-to-noise ratio, and average inter-item correlation).

The differences between reliability and unidimensionality parameter estimates in full-item versus reduced-item SPI domains is negligible, including the slight decrease in the Cronbach's α and signal-to-noise ratio of Openness to Experience. Nevertheless, the lack of improvement in Openness to Experience's reliability estimates, even after eliminating over 25% of low-loading items, indicates a high degree of heterogeneity in the Openness to Experience domain. Reliability and unidimensionality estimates of the other four SPI traits likely did not change significantly after item pruning because only one or two items were removed from each domain. Compared to SPI domains, PID-5 domains saw slightly bigger improvements in reliability estimates after item pruning (Table 2). This is particularly true for Disinhibition and Negative Affectivity domains, the two domains which lost the highest proportion of items during item pruning. See a table of the items jettisoned from SPI and PID-5 domains in Appendix C.

Despite, at best, modest psychometric improvements over full-item domains, the reduced-item domains were retained for future analysis for several reasons. While small, increases in reliability and unidimensionality would facilitate validity in IRT scoring. Moreover, these psychometric properties were enriched using fewer indicators and without risking the integrity of the original construct. The latter is exemplified in Tables 3 and 4, which demonstrate that SPI and PID-5 domain correlations remain largely robust to item pruning (see Tables 3 and 4). While PID-5 domain correlations were nearly identical with and without low-loading items (Table 4), the SPI domain correlations were slightly augmented by using the reduced-item domains (Table 3). This improvement in performance may be explained by the slight increase in the inter-item correlation and the ratio of communalities to uniquenesses in SPI domains (see Table 2).

Of note, no items were dropped from the functioning domains indexed by the PROMIS. In separate factor analyses of Mental, Physical, and Social Functioning domains, all items loaded ≥ .30 onto the single-factor solution of their hypothesized domain. Furthermore, of all 108 PROMIS items that estimate Global Functioning, only two items loaded < .30 (i.e., .27 and .29). As these items were not dropped from their respective PROMIS domains, and because the only two outliers were just below the factor loading threshold, all PROMIS items were retained for estimating Global Functioning.

Evaluation of Psychometric Properties

Psychometric properties of target variables (i.e., five revised SPI domains, five revised PID-5 domains, and four original PROMIS domains) can be seen in Table 5, including attributes of the distribution, estimates of reliability, and estimates of unidimensionality. Of note, distribution parameters were estimated following IRT scoring and transformation to T-Scores (discussed in more detail below). As such, all variables in Table 5 have standardized mean and variance parameters (M = 50 and SD = 10), in addition to unique skewness and kurtosis estimates as indicated in the table.

Reliability and unidimensionality estimates, on the other hand, were made directly from raw data and correlation matrices. Results from the psychometric analysis of reduced-item SPI domains, reduced-item PID-5 domains, and full-item PROMIS domains can be seen in Table 5. Reliability was estimated with a variety of measures, including Cronbach's α, range of split-half reliabilities, the average inter-item correlation, and signal-to-noise ratio. All variables of interest exhibit sufficient internal consistency.

Unidimensionality was also estimated with a variety of measures, including the ratio of communalities to uniquenesses, variance accounted for by a one-factor solution, variance attributable to a general hierarchical factor (omega hierarchical), and the variance attributable to both general and specific hierarchical factors (omega total). Of note, omega hierarchical and omega total estimates were based on the best-fitting hierarchical factor solution for each trait. Appropriate factor models were chosen based on scree plot analysis, maximizing proportion of variance in the data explained, attending to parsimony and simple structure, and comparing fit statistics. The number of subfactors in each specified omega model is dictated in the final column of Table 5. All variables demonstrate sufficient unidimensionality for IRT analysis.

It is worth nothing that the reliability and unidimensionality estimates of SPI domains are slightly lower, on average, than PID-5 and PROMIS domains. Nevertheless, psychometric parameters of SPI domains indicate sufficient internal consistency and unidimensionality for IRT scoring.

Combining Domains

In addition to the individual SPI and PID-5 domains, integrated, broad-spectrum personality traits were estimated by modeling indicators from both traits in a pair of cognate normative- and maladaptive-level domains (i.e., Agreeableness and Antagonism, Conscientiousness and Disinhibition, Extraversion and Detachment, Neuroticism and Negative Affectivity, and Openness to Experience and Psychoticism). As discussed in the literature review, a significant body of literature supports the empirical relationships between the stated pairs of "normative" personality and "maladaptive" personality domains.[1] Assuming overlap in domain information, integrating items from linked personality domains would augment the variance within, the range of, and the psychometric stability of the new personality variable.

Thus, personality domains were estimated using both the full-item indicators and the reduced-item indicators (as detailed above) to compare psychometric soundness. Table 6 highlights that the psychometric parameters of combined SPI and PID-5 domains are similar for both the full-item traits and reduced-item traits. According to the data in Table 6, all combined domain pairs exhibit robust α-reliability and strong evidence of unidimensionality. For instance, estimates omega hierarchical suggest that 63 to 76% of variance in each of the five combinations of reduced-item domains is attributable to one general factor. In line with the psychometric analysis of separated domain scores, omega hierarchical and omega total were estimated based on unique factor solutions for each domain pair. See number of subfactors in each omega solution in Table 6.

Importantly, however, properties of the combined Openness to Experience and Psychoticism domain indicate some signs of problematic heterogeneity, such as low average interitem correlation and low ratio of communalities to uniquenesses. The reduced-item estimation of the combined Openness to Experience and Psychoticism domain did not appear to significantly improve estimates of reliability or unidimensionality. On the other hand, two combined domains appear to benefit from item

[1] As discussed in the introduction, the authors recognize that the emerging evidence is unable to support a stable relationship between Openness to Experience and Psychoticism due to the heterogeneity of Openness to Experience. Research, however, has provided support for multiple relationships between Psychoticism and subfactors of Openness to Experience.

pruning. The reduced-item Conscientiousness and Disinhibition domain pair and the Neuroticism and Negative Affectivity domain pair each demonstrated higher average inter-item correlation, stronger signal-to-noise ratio, higher ratio of communalities to uniquenesses, and greater variance accounted for by a one-factor solution, suggesting improved reliability and unidimensionality in the revised domains. Since some reduced-item domain pairs represent a slight psychometric improvement over their full-item counterparts, the reduced-item versions of the combined domains will be retained for analysis. Not only is this practice consistent with how individual personality domains are scored, but also the structure of the correlations between combined domains appears to be generally robust to dropping low-loading items (Table 7).

IRT Scoring

Generally speaking, IRT is a family of psychometric analytic models that, in comparison to classical test theory, attempts to account for the variance in how people respond to different items designed to tap into a single trait. IRT techniques assume that individual items have unique relationships to a given trait and that those relationships can be quantified. It follows that IRT scoring is necessary for the current study for two reasons: First, the additional parameters in IRT amplify the variance in scores, thus counteracting floor, ceiling, and range-restriction effects inherent in data that is MMCAR. Second, IRT allows for the integration of items from multiple scales to act as indicators for a unified construct, which both maximizes the range of variance captured in the trait and minimizes the amount of measurement error influencing trait scores. As such, IRT scoring was used to attempt to integrate paired SPI and PID-5 domains in order to delineate more stable, more comprehensive personality spectra.

Specifically, the current analysis utilized the 2-parameter Graded Response IRT Model (GRM; (Samejima, 1968; Samejima, 1997), which assumes a unidimensional trait measured with polytomous data. In this model, items are assumed to have two parameters: different locations on the trait (i.e., variation in endorsement difficulty), and different sensitivities to distinguish between individuals at certain trait levels (i.e., variation in discrimination). In this study, item difficulty and item discrimination parameters were estimated using an oblimin-rotated, minimum residual factor analysis on the polychoric correlations of the data. Next, empirically-derived IRT parameters were used to estimate IRT-scaled scores (i.e., in which items are weighted based on estimated calibrations). During this process, scores were also rescaled to fit a T-score distribution (i.e., $M = 50$, $SD = 10$). Only items with a discrimination ≥ .30 were used for scoring.

As intended, IRT analyses were first conducted on combined SPI/PID-5 domain pairs (e.g., Agreeableness with Antagonism) in order to establish comprehensive, integrated personality domains. Despite evidence for the overlapping content of paired domains (e.g., moderate to strong unidimensionality estimates [see Table 6], moderate correlations between paired domains [see Table 8]), IRT analysis of combined domains revealed limitations in integrating domains across these measures. As pictured via item information curves in Figure 4, PID-5 items are substantially over-represented at each level of the estimated trait. SPI items did not contribute to indexing novel information about their respective trait above and beyond what was already indexed by PID-5 items. Note that this is taken to the extreme in the case of the Openness to Experience and Psychoticism domain pair, in which SPI Openness to Experience items provide very little information about the trait indexed by Psychoticism items. This splitting of SPI and PID-

5 item information is clearly visualized in Figure 5, in which the average item information curve for each SPI domain falls entirely under the average item information curve for the corresponding PID-5 domain (with the exception of the combined Neuroticism and Negative Affectivity domain). It is also worth noting that PID-5 domains were indexed by up to three or four times as many items as their corresponding SPI domains. Thus, the differences observed between PID-5 and SPI item information curves in the Figure 5 plots are attenuated by sample size standardization.

Due to the high ratio of PID-5 to SPI items in each domain pair, combined exploratory factor analysis of all indicators for given trait pairs demonstrated the tendency for factor solutions to be rotated toward the PID-5 domain being measured (i.e., PID-5 items were more likely to load on the general factor than were SPI items). As a result, the IRT analysis of combined domains functionally tests how well SPI items can capture content from a corresponding PID-5 domain. This was in contrast to the intended purpose of the IRT analysis, which was to use a combination of PID-5 and SPI items to index a trait that explains the common variance between cognate domains.

Due to these measurement barriers, corresponding SPI and PID-5 domains could not be scored as integrated dimensions. As such, IRT scoring was conducted on the five SPI domains and the five PID-5 domains independently, in addition to the four PROMIS domains as anticipated. IRT domain scores were estimated for all participants who answered at least one item that particular domain. Of note, SPI Neuroticism was reversed to correlate positively with the four other Big Five factors of personality. Reversed Neuroticism with henceforth be referred to as Emotional Stability. Similarly, Global

Functioning and Physical Functioning were reversed to correlate positively with Mental and Social Functioning (i.e., so that higher scores indicate more adaptive functioning).

Properties of the IRT-Scored Variables

Psychometric properties and distribution parameters of IRT-scored SPI, PID-5, and PROMIS domains can be viewed in Table 5 (of note, reliability and unidimensionality measures were estimated pre-IRT scoring using raw data matrices). Relatedly, density plots for these variables can be seen in Figure 6. The linear relationships between target variables, as quantified by Pearson's *r*, are presented in Table 8. Of note, all correlations displayed are statistically significant due to the large sample size for these estimates (see Table 9).

Correlations between SPI domains are small to moderate in effect size, while correlations between PID-5 domains are moderate to strong. Of note, the relationships between intra-SPI and intra-PID-5 domains reflect the general pattern and magnitude of normative personality domain correlations and maladaptive personality domain correlations in previous literature. PROMIS domains were also moderately to strongly correlated with each other, reflective of the hierarchical structure inherent to the Global, Mental, Physical, and Social Functioning domains. Also notable in Table 8 are the correlations between SPI and PID-5 domains, which suggest mild to strong linear relationships between the different trait models. Correlations between anticipated trait pairs from SPI and PID-5 domains are moderate to strong in magnitude, providing further evidence for the psychometric overlap of the estimated latent traits. Openness to Experience and Psychoticism are an exception to this pattern, however, and have a null relationship. It is worth highlighting that the other PID-5 variables are least correlated with Openness to Experience compared to other Big Five traits.

Finally, Table 8 also highlights the linear relationships between personality (at the normative and maladaptive level) and functioning. All domains of functioning correlate modestly to moderately with all normative- and maladaptive-level personality traits. Global Functioning and Mental Functioning, in particular, are most likely to be strongly correlated with personality dimensions. Moreover, functioning variables appear to correlate most strongly and reliably with particular personality domains, specifically Emotional Stability, Detachment, and Negative Affectivity.

Despite moderate correlations between functioning and personality variables, the true relationship (i.e., one unrestricted by linear form) between these variables still needs to be defined. It is unclear if Pearson's correlation is the appropriate quantification of the relationship between functioning and personality. As such, nonparametric regression analyses were conducted to elucidate possible non-linear, non-monotonic relationships between target variables.

Handling Missingness

Prior to nonparametric analysis, missingness was analyzed. As aforementioned, domain IRT scores were estimated for every subject who answered at least one item from the domain of interest. Consequently, domains with the fewest number of indicators had the highest proportion of missing subjects (Disinhibition, Psychoticism, Mental Functioning, Physical Functioning, and Global Functioning). See Table 9 for the proportion of missing subjects in each domain.

Complete case data (i.e., dropping missing items) were compared to mean imputation and multiple imputation data. Of note, five imputations were used for multiple imputation procedures (Rubin, 1978; van Buuren & Groothuis-Oudshoorn, 2011). Importantly, five imputations were sufficient to replicate standard error estimates within .01 of the complete case standard error estimates.

The density distributions for multiple-imputed data were nearly identical to the density distributions of complete case data (see Figure 6). The differences in distribution parameters (such as mean, standard deviation, median, skew, and kurtosis) between complete cast and multiple-imputed data were negligible. On the other hand, the density distribution of mean-imputed data varied substantially, particularly around the mean. Note that due to a trivial proportion of missingness, mean- and multiple-imputed data exhibited the exact density distribution as complete-cases data.

The robustness of correlations to different methods of handling missingness was tested. Both mean- and multiple-imputed data produced correlations similar to complete case data. Nevertheless, multiple imputation data was somewhat more reliable, with correlations differencing by .02 on average (*SD* = .02, range = 0 - .11) compared to .04 on average in mean-imputed data (*SD* = .02, range = 0 - .16). See Table 8 for the inter- and intra- domain correlations for multiple-imputed data (upper-right diagonal).

Finally, methods of handling missingness were compared following nonparametric analysis (disused in more detail below). See Figure 7, which shows how different methods of handling missingness (i.e., complete cases versus mean imputation versus multiple imputation) impact nonparametric regression. This is demonstrated both in the personality trait with the highest proportion of missingness (Disinhibition) and in the personality trait with the lowest proportion of missingness (Openness to Experience). As demonstrated in Figure 7, nonparametric regression models of compete case data were better approximated by models using multiple-imputed data than models using mean-imputed data.

Given the above evidence, which suggests that multiple-imputed data can maximize *N* without significantly deviating from the distribution and properties of the complete-case data, the current study maintained multiple-imputed data for the remainder of analyses.

Univariate Nonparametric Regression

Nonparametric regression was utilized in an effort to model the true relationship between personality and functioning domains without being restricted to a particular form (e.g., linear, quadratic, cubic… etcetera), which in turn would help identify nuances in the shape of the curve and rate of change in the slope. The initial nonparametric model used in the current analysis is a locally-weighted regression (LOESS; Cleveland, 1979; Cleveland & Devlin, 1988). This regression model performs a series of weighted regression analyses only using observations that fall near the current point of evaluation on the independent variable, allowing for different shapes along the range of the independent variable (i.e., personality). Perhaps the most widely used nonparametric method, LOESS has garnered a substantial body of literature in support of its validity and robustness as a modeling technique, as well as its ability to generalize to multivariate data (Jacoby, 2000).

For each LOESS model, the polynomial degree was set to two, which uses quadratic equations to enhance local fitting (versus linear equations with a polynomial degree of 1). While it makes the fitting more complex, a degree of two can detect more nuances in the distribution by improving the efficiency of smoothing in non-monotonic relationships (Jacoby, 2000). As such, using a degree of two is common practice in LOESS literature. Of note, using a cubic polynomial (degree of three) added little incremental value to the LOESS curve fit with a quadratic polynomial, and was much more computationally complex. Additionally, LOESS spans (i.e., the smoothing parameter) were estimated for each model using Generalized Cross Validation (GCV, Craven & Wahba, 1978), a form of leave-one-out cross validation, to minimize the root mean-squared error of prediction (RMSEP). Refer to Table 10 for the spans of each LOESS Model which minimize GCV criteria.

See Figures 8 – 13 for visualization of LOESS models. Each figure consists of a pair of personality traits (i.e., associated domains from the SPI and PID-5) and their independent relationships with Global, Mental, Physical, and Social Functioning. In Figures 8 – 12, PID-5 domains were reversed and situated to the left (i.e., lower-end) of the corresponding SPI domains in order to visualize an approximation of the theorized continuum of cognate traits. Correspondingly, Psychoticism was left un-reversed, and was situated to the right (i.e., upper end) of Openness-to-Experience (see Figure 13). Of note, however, while correlational (Table 8) estimates suggest a significant portion of shared variance between corresponding SPI and PID-5 domains in four of five cases, these domains were scored independently and thus must not be presumed to quantify the same latent variable (particularly in Openness to Experience and Psychoticism domains). Overall, the relationships between PID-5 and functioning domains are far more jagged than the relationships between SPI and functioning domains, despite using GCV in all cases to optimize the smoothing parameter.

See Table 11 for estimates of adjusted R^2 for each of the univariate models. While R^2 effect sizes are null to small, significant patterns emerge. For example, Emotional Stability, Negative Affectivity, and Detachment appear to account for more variance in functioning domains than do other SPI and PID-5 domains. It is also worth noting that personality traits are more likely to, on average, explain variance in Global and Mental Functioning versus Physical and Social Functioning.

In addition to the LOESS, the nonparametric relationships between personality and Global Functioning were estimated a smoothing spline, a one-dimensional, piece-wise polynomial smoother (cubic in this case) defined over a designated number of knots that balances minimizing sum of squares with a roughness penalty. This was done for several reasons, the first of which was to determine if the relationships delineated by LOESS are reliable and reproduceable different nonparametric procedures. Moreover, since the smoothing spline functions used were designed to handle large datasets (Helwig, 2020; Helwig & Ma, 2015; 2016), this technique was utilized in order to ease the computational burden associated with multivariate nonparametric models and predicting outcomes in new data. In an effort to minimize the number of nonparametric models, and given that Global Functioning inherently captures some of the variance in subdomains of functioning, smoothing spline analyses were only conducted on the relationship between personality domains and Global Functioning.

As in the LOESS, the smoothing parameters used for each smoothing spline were chosen based on minimizing GCV criteria. Furthermore, utilizing trial and error, knots were set at 100 for each spline in order to approximate the smoothness of the LOESS functions. As anticipated, the shape of the LOESS functions versus the smoothing spline functions had substantial overlap (Figure 13). Furthermore, adjusted R^2 estimates for the univariate smoothing spline models (see Table 12) are identical to those from corresponding LOESS models.

Multivariate Nonparametric Regression

Smoothing Spline Analysis of Variance (SSANOVA) was utilized for multivariate nonparametric analyses. This technique parallels a typical, univariate smoothing-spline, though allows for multiple predictors (Helwig, 2020). Of note, while estimation of the SSANOVA function does not assume Gaussian errors, inference using standard errors of the function does. Residuals of the present study's nonparametric models, however, are positively skewed because of the propensity for large MMCAR datasets to have outliers. As such, significance testing of the nonparametric effects in each SSANOVA were used not for interpretative purposes, but in guiding model selection. A combination of other tools was used to assess for the validity of nonparametric effects, including optimization of adjusted R^2, minimization of GCV estimate, interpretation of mean squares, and interpretation of interaction plots.

Multivariate nonparametric analyses were conducted to assess the moderating role of age and sex effects in predicting Global Functioning. First, each personality domain was fit with a three-way interaction model between sex, age, and the domain of interest. See Figures 14 – 18 for three-dimensional visualization of interactions between sex, age, and a given personality trait in predicting Global Functioning.

Models were reduced, where appropriate, to only include terms that contributed meaningful variance in the predicted variable (i.e., Global Functioning). Of the SPI and PID-5 domains, Agreeableness, Conscientiousness, Openness to Experience, and Disinhibition retained the full model (i.e., domain X age X sex interaction). Emotional Stability and Psychoticism domains each retained a near-full model, only dropping the three-way interaction term (i.e., domain X age + domain X sex + sex X age). Antagonism, Detachment, and Negative Affectivity domains each retained the both age-interaction terms, but dropped the domain X sex interaction term (i.e., domain X age + sex X age). Finally, Extraversion's retained model was reduced the most, dropping all interactive effects with Extraversion (i.e., domain + age X sex). See Table 12 for the adjusted R^2 and GCV estimates, for each of the above reduced-term models. Of note, GCV was minimized and adjusted R^2 remained consistent for each of the personality domains that retained a reduced-term model. For each of these domains, see Figure 19 for comparisons of the nonparametric effects among full model terms versus among reduced model terms. As is apparent in these comparisons, the three-dimensional distribution of Global Functioning predictors (i.e., age, sex, and a given personality trait) is not altered significantly by dropping the jettisoned model terms because those effects were not truly present.

Next, SSANOVA was also conducted on clusters of related personality traits. First, cognate trait pairs from the SPI and the PID-5 were modeled simultaneously. See the graphical depiction of the interaction between SPI and PID-5 domain pairs in Figure 20. The full, interactive model for each domain pair was retained. See Table 12 for adjusted R^2 and GCV estimates for each of these models. The adjusted R^2 in each of these models was approximately .02 - .03 larger than the largest R^2 of the two corresponding univariate models. Notably, relative mean squares were consistently largest for the main effect of the SPI domain in all but one case. In the Openness to Experience and Psychoticism trait pair, the mean squares was highest for Psychoticism.

Finally, SSANOVA was used to model multivariate, nonparametric prediction of Global Functioning using all domains from a given personality scale (i.e., one model for domains in the SPI and one model for domains in the PID-5). Since the SSANOVA function could not support a five-way, nonparametric interaction, the additive models were evaluated (e.g., Agreeableness + Conscientiousness + Extraversion + Emotional Stability + Openness to Experience).

Mean squares suggested that the nonparametric effects of Agreeableness and Antagonism should be dropped in the SPI scale model and PID-5 scale model, respectively. The GCV estimate, however, was minimized by about .01 in the full-term models for both SPI domains and PID-5 domains. Nevertheless, when Agreeableness and Antagonism were removed as predictors, adjusted R^2 was reduced by only .01 in the SPI domain model, and it was not reduced at all in the PID-5 domain model. As such, these reduced-term scale models were retained.

See the adjusted R^2 and GCV estimates for these reduced-term scale models in Table 12. Importantly, the additive effects of the remaining four SPI domains accounts for approximately 21% of the variance in a nonparametric model of Global Functioning, only slightly more than the 18% accounted for by the remaining four PID-5 domains. In other words, the Big Five factor model and the *DSM-5* Trait model each account for approximately a fifth of the variance in Global Functioning.

Sample 2

Replication of Sample 1 Procedures

All data-preparation and scoring procedures in Sample 1 were replicated in Sample 2. First, item-pruning was conducted on SPI and PID-5 domains so that items with < .30 loading onto the one-factor solution were removed. All of the items removed during this procedure in Sample 1 were also removed in Sample 2 with the exception of two items in Negative Affectivity. These items were retained in the current sample. No items were removed in Sample 2 that were not removed in Sample 1. See Appendix C for items removed in item pruning. As in Sample 1, no items were removed from PROMIS functioning domains because no items loaded < .30 on their respective domains. Of note, three items loaded between .26 to .29 a one-factor solution of all functioning items, though these items were retained because they were not dropped from their respective subordinate domains. Furthermore, since only three of 108 items were below the designated loading threshold, and all three are close to that threshold, retaining these items does not affect reliability and unidimensionality estimates.

As in Sample 1, traits were scored using IRT and rescaled into T-scores (and dimension reversals where appropriate). Then missing data values were estimated using multiple imputation. The psychometric parameters, distribution properties, and inter-correlational estimates for all traits in Sample 2 were nearly identical to those in Sample 1, deviating by no more than .02 from estimates of standard error, Cronbach's α, average inter-item correlation, ratio of communalities to uniquenesses, variance accounted for by a one-factor solution, (see Table 5) and inter-domain correlations (see Table 8).

Replication of Exploratory Nonparametric Analysis

Exploratory univariate LOESS models run in Sample 1 were replicated in Sample 2 to determine if the form of the nonparametric regression was robust to random deviations in sample characteristics. Paralleling Sample 1 analysis, LOESS models were fit using a degree polynomial of 2 and a smoothing parameter estimated using GCV. The shapes of the relationships between various personality domains and domains of functioning, as quantified by an exploratory LOESS model, are nearly identical across samples (see Sample 2 models plotted in Figure 21 compared to Sample 1 models in Figures 8 – 12). Aside from slight, apparent deviations at the tail ends of certain models, LOESS curves in Sample 2 exhibit similar characteristic features to the LOESS models in Sample 1 (e.g., unique relationships between Emotional Stability and Physical and Social Functioning [approximately monotonic and linear] compared to the relationships between Emotional Stability and Global and Mental Functioning [approximately cubic]) Furthermore, R^2 values estimated from Sample 2 LOESS models were equal to or .01 smaller than the corresponding estimated R^2's in Sample 1 (see Table 11 for Sample 1 R^2 estimates).

In addition to the similarity in LOESS models, exploratory univariate smoothing splines (i.e., individual personality domains predicting Global Functioning) were nearly identical across Sample 1 and Sample 2 data (refer to Table 12 for adjusted R^2 and GCV estimates for these models in both Sample 1 and Sample 2). As in Sample 1, smoothing spline models were estimated with knots = 100 and smoothing parameters optimized by GCV. Altogether, univariate nonparametric relationships between personality and functioning appear to be reliable across ways of handling missingness, various smoothing techniques, and also across unique samples.

Exploratory multivariate nonparametric models were also conducted on Sample 2 data. First, SSANOVA was employed to evaluate the main and interactive effects of age and sex. Data were originally fit for a three-way interaction model like in Sample 1 (i.e., domain X age X sex interactions), though model terms were reduced where appropriate.

It is worth noting that, as in Sample 1, decisions made about what terms to drop and what terms to keep were based on a combination of factors, including optimization of adjusted R^2, minimization of GCV estimate, interpretation of mean squares, and interpretation of interaction plots. Given multiple variables to assess, sometimes this data was somewhat contradictory. As such, there are a couple of cases in Sample 2 for which the full-term model had slightly lower GCV criterion (a difference of .56 and less) than the retained, reduced-term model (i.e., age-by-sex SSANOVA models for Agreeableness, Extraversion, Detachment, and Psychoticism. It is also worth highlighting that the adjusted R^2 estimates for each of the reduced-term Sample 2 models were identical to the adjusted R^2 estimates for the corresponding full-term models (except for in the retained Agreeableness model, which saw only a .01 decrease in R^2 from the full-term model).

The reduced-term age-by-sex SSANOVA models retained in Sample 2 deviated somewhat from the reduced-term models retained in Sample 1. Nevertheless, adjusted R^2 estimates for the SSANOVA models in Sample 2 suggest that these models predict a similar amount of variance in Global Functioning to the parallel models in Sample 1 (see Table 12).

Next, paralleling Sample 1, SSANOVA models were estimated in Sample 2 using clusters of related personality traits as predictors. First, pairs of traits from the SPI and PID-5 that are hypothesized to fall on the same trait spectrum were modelled simultaneously to predict Global Functioning. As in Sample 1, the full, interactive model was retained for each of these trait pairs. Importantly, the adjusted R^2 estimates of these models were within .01 of the adjusted R^2 estimates for corresponding models in Sample 1. The models estimated in Sample 2 exhibited similar patterns to those in Sample 1, including generally larger effects associated with the SPI domain compared to the PID-5 domain, except for in the case of the Openness to Experience and Psychoticism domain pair.

Finally, SSANOVA models were conducted using all domains in a given personality measure (e.g., SPI, PID-5) as simultaneous indicators. As aforementioned in the review of this analysis in Sample 1, only additive models were evaluated due to limitations in computing a five-way, nonparametric interaction. Mean squares and GCV estimates provided support for the same reduced-term SPI model retained in Sample 1 (i.e., Conscientiousness + Extraversion + Emotional Stability + Openness to Experience). Of note, dropping Agreeableness from this model only reduced the adjusted R^2 estimate by .01). Mean squares and GCV estimates also provided support for a reduced-term PID-5 model. However, unlike dropping Antagonism in Sample 1 model, Antagonism was retained and Psychoticism was dropped in the Sample 2 model (e.g., Antagonism + Detachment + Disinhibition + Negative Affectivity). Adjusted R^2 estimates for PID-5 domain SSANOVA models were identical in both the full-term and reduced-term models in both Sample 1 and 2. See Table 12 for the adjusted R^2 and GCV estimates for each of the retained models.

Split-Sample Validation of Nonparametric Models

In addition to repeating exploratory procedures to confirm replicability of the nonparametric models run in Sample 1, confirmatory analyses were also used to evaluate the fit, generalizability, and predictive ability of the models established in Sample 1. Specifically, univariate smoothing spline models from Sample 1 were utilized to predict outcomes in the Sample 2 data. As depicted in Figure 22, Sample 2 data predicted with Sample 1 smoothing spline models very closely approximate exploratory smoothing splines modeled with the Sample 2 data. Divergences in the predicted value between these two models appear to occur most frequently in tail ends of the distribution where there are fewer data points available to reliably model the data.

The mean-squared differences between the predicted values from the Sample 1 versus Sample 2 models are as follows: .01 for Agreeableness, .02 for Conscientiousness, .01 for Extraversion, .01 for Emotional Stability, .01 for Openness to Experience, .02 for Antagonism, .42 for Disinhibition, .46 for Detachment, .14 for Negative Affectivity, and .21 for Psychoticism. Of note, these differences are contextualized by the scale of the variables, each of which has $M = 50$ and $SD = 10$. Predictive analyses were not conducted using multivariate SSANOVA models (e.g., including age and sex effects) because the combination of interaction and main effects detected were less reliable between samples.

Discussion

Modern, empirically-supported diagnostic models of mental illness suggest that psychopathology may be best conceptualized as psychological symptoms, distress, and/or impairments in functioning associated with maladaptive levels of the personality variables which underlie mental disorders (APA, 2013). Characterizing the relationships between personality variables (normative- and maladaptive-range) and domains of functioning is an important next step in the dimensional psychopathology literature because it elucidates the direct clinical implications associated with the latent constructs that underlie psychopathology. The research above investigated this relationship between broad-range personality domains and functioning by estimating univariate and multivariate nonparametric relationships in a large sample. The results of these analyses are discussed and interpreted below.

Interpretations from Scoring and Data Preparation

Prior to conducting the nonparametric analysis central to the aims of this paper, analyses used for data preparation and scoring suggest several key take-aways about the psychometric properties of the measures used and the overlap between hypothesized pairs of normative- and maladaptive-level personality domains. In general, SPI and PID-5 domain traits exhibit strong reliability and unidimensionality. Removing the subset of items that load the lowest onto the one-factor solution of a given domain modestly improves reliability and unidimensionality estimates in some cases, without measurably changing the content of the trait. PID-5 domains, in particular, saw improved psychometric properties because a larger number of items was removed from these domains compared to SPI domains. Overall, reliability and unidimensionality estimates are slightly more attenuated in SPI domains compared to PID-5 and PROMIS domains, which is likely the result of fewer items indexing each SPI trait.

In line with previous literature on the overlap between normative- and maladaptive- personality traits (Wright & Krueger, 2018), linked SPI and PID-5 trait pairs (i.e., Agreeableness and Antagonism, Conscientiousness and Disinhibition, Extraversion and Detachment, Neuroticism and Negative Affectivity, and Openness to Experience and Psychoticism) demonstrate strong shared variance, as well as healthy internal reliability and unidimensionality when scored as one trait. Of note, correlations between Openness to Experience and Psychoticism, and the psychometric properties of the combined domain pair, suggest a lower degree of content overlap and homogeneity between these traits compared to the other four combined trait pairs. This pattern was anticipated due to the unique relationship between Openness to Experience and Psychoticism in which different components of Openness to Experience relate differently to Psychoticism (Chmielewski et al., 2014).

Based on the hypothesis that maladaptive personality traits (as operationalized by the PID-5) are well-conceptualized as extreme variants of normative Big Five personality traits (as operationalized by the SPI), one might expect that the average item information curves for SPI and PID-5 items on all theorized integrated traits would resemble those for Neuroticism and Negative Affectivity. Put another way, it was anticipated that SPI items cover unique information at a certain level of the theorized integrated trait, while PID-5 items cover unique information at a different (and theoretically more extreme) level of the theorized integrated trait.

Nevertheless, despite some evidence to suggest content overlap between four out of five sets of paired SPI and PID-5 domains, factor analyses suggest that joint-factor solutions are rotated heavily toward PID-5 content due to the disproportionally high number of PID-5 items (versus SPI items) indexing each combined domain. Subsequently, IRT item analyses reveal that SPI items are contributing little to no unique information in the presumed "combined" domain. As such, paired SPI and PID-5 domains could not be integrated onto unified personality spectra because variance unique to the SPI would be lost.

Given the other psychometric evidence suggesting substantial shared variance between all SPI and PID-5 domain pairs (except Openness to Experience and Psychoticism), it is theorized that the inability to integrate cognate domains onto a single continuum is not due to a lack of content overlap in linked traits, but rather to problems in measurement specific to this study. It appears vital to use normative- and maladaptive-personality measures that share the same approximate number of items indexing each domain so that the trait estimated more closely quantifies the common variance between the domain pair.

Following IRT scoring, and eventually multiple imputation of missing-data, correlations were estimated between all variables of interest (five SPI, five PID-5, and four PROMIS domains) in order to evaluate the structure of and linear relationships between these variables. Of note, correlations were higher between PID-5 domains than they were between SPI domains, which is likely explained by a hierarchical model of dimensional psychopathology, marked by general-factor saturation accounting for a proportion of the variance in all PID-5 domains (see Caspi et al., 2014).

Also noteworthy are the correlations between SPI and PID-5 domains, which suggest significant overlap in variance in normative- and maladaptive-personality domains, in line with the dimensional psychopathology research (Wright & Krueger, 2018). As anticipated, correlations between hypothesized trait pairs (e.g., Agreeableness and Antagonism), were generally highest in magnitude. The exception, however, was the null correlation between Openness to Experience and Psychoticism, in line with previous literature (Chmielewski et al., 2014). Moreover, while Detachment was moderately (and appropriately) correlated with Extraversion, it correlated more strongly with Emotional Stability. Emotional Stability is correlated moderately to strongly with all PID-5 variables, thus providing support for the capacity for Neuroticism to explain common variance in psychopathology. As such, the higher correlation between Detachment and Emotional Stability (compared to Detachment and Extraversion) may best explained by a large general-factor saturation in Detachment. This is further supported by the strong correlation between Detachment and Negative Affectivity, the latter of which is theorized to be an extreme, maladaptive variant of Neuroticism (i.e., Emotional Stability).

Finally, these correlations also highlight the small to moderate linear relationships between personality and functioning. Notably, Global and Mental Functioning tend to be more strongly related to personality dimensions than do Physical and Social Functioning. While the cause of this difference is unclear, it is hypothesized that variance in Physical and Social Functioning is more subject to external factors not related to personality (e.g., disability, injury, limited access, learned skills). It is also worth highlighting that three of the 10 personality domains, namely Emotional Stability, Detachment, and Negative Affectivity, appear to more reliably and strongly correlate with various domains of functioning. Given the presumed (and empirically-supported) relationship between Emotional Stability and Negative Affectivity, it can be assumed that the variance shared between functioning and Emotional Stability overlaps with the variance shared between functioning and Negative Affectivity. Furthermore, as mentioned above, Detachment also shares significant variance with both Negative Affectivity and Emotional Stability. As such, and given the ability of Neuroticism (i.e., reversed Emotional Stability) to quantify the shared variance in psychopathology dimensions, it is induced that PROMIS Functioning domains are tapping in to the common factor underlying psychopathology.

Importantly, these analyses support the existence of a linear relationship between personality traits and functioning. However, correlation estimates do not allow for more unique relationships between the predictor variables and the outcome criteria. As such, nonparametric analyses were conducted to characterize the true relationship between personality and functioning without restricting the model to a certain function or shape. The results of these models are interpreted below.

Univariate Nonparametric Analysis

First, LOESS models were fit to all combinations of personality domains and domains of functioning, resulting in 40 independent LOESS models in each sample. In Sample 1, Antagonism appears to be approximating a linear relationship, relating negatively and near-monotonically to all domains of functioning. The flattening of Global and Mental Functioning at low levels of Antagonism, however, might allow these models to retain slightly quadratic forms. On the other hand, the relationship between Agreeableness and functioning appears likely quadratic, and clearly demonstrates the inverted U-shape hypothesized to characterize the relationship between personality and functioning.

This pattern of the relationships between PID-5 and SPI domains with domains of functioning appears somewhat replicated in all domain pairs. Overall, PID-5 traits appear to more closely approximate a linear relationship than their SPI counterparts. It is theorized that this is the case because variance is restricted in PID-5 domains because of the positive skew inherent in maladaptive personality traits. Furthermore, LOESS models of PID-5 traits appeared a lot more jagged, on average, than LOESS models of SPI traits, despite the smoothing parameter for all models being estimated using GCV. This may be explained by the substantial portion of missing data in the PID-5 domains (due to lower sampling probabilities in item sampling). Even though multiple imputation was used to estimate missing values, the imputed data estimates the original distribution of PID-5 domains. This original distribution of the PID-5 domains are also jagged, because low base-rate item sampling attenuates the variance in the trait (i.e., there is less variance between participants if each participant answers only one, two, or three items).

Despite significant overlap in the shape of the LOESS functions for all SPI and PID-5 trait pairs, it is still worth highlighting the small idiosyncrasies that make these distributions unique. For instance, the relationships between Disinhibition and functioning domains in Sample 1 more closely resemble quadratic form than in other PID-5 domains, as is exhibited in the slight drop-offs in functioning at extremely low levels of Disinhibition. Relationships between functioning and other PID-5 domains (Detachment, Negative Affectivity, and Psychoticism) more closely resemble the relationships between functioning and Agreeableness in that they appear generally monotonic, linear, and with some evidence for asymptotic stabilization of functioning at extremely low levels of these traits. One possible explanation for stronger quadratic form of Disinhibition is that this domain includes items from Rigid Perfectionism, a scale that loads negatively onto Disinhibition and represents a tendency towards over-constraint. As such, the maladaptively of low levels of this trait is not only more evident, but also is more easily assessed due to items targeting trait levels at both extremes.

Regarding differing relationships among SPI domains and functioning in Sample 1, decreases in functioning at high levels of Conscientiousness were somewhat attenuated compared to the relationships between Agreeableness and Mental and Physical Functioning. This attenuation is even more evident in Openness to Experience, in which both tails of the nonparametric relationships to functioning domains appear to asymptotically approach a limit. As such, the relationships between Openness to Experience and domains of functioning might be better characterized by a cubic form. While the Sample 1 relationships between Extraversion and various domains of functioning also exhibit asymptotic tendencies at high levels of the trait, the U-shape at low levels of Extraversion indicate the relationships may retain a quadratic form. The attenuation in the LOESS models at the tail-ends of certain personality traits may be the result a truly monotonic relationship, or the result of measurement issues (e.g., range restriction due to heteroscedasticity).

Finally, in Sample 1, the relationships between Emotional Stability and functioning vary somewhat depending on the domain of functioning. More specifically, while Physical and Social Functioning are monotonically and approximately linearly related to Emotional Stability, Global and Mental Functioning exhibit both slight decreases at extremely high levels and slight increases at extremely low levels of Emotional Stability, indicating a potentially cubic form in these relationships. It is unclear why there are differences in the shapes of the LOESS models for predicting different domains of functioning, and why this pattern is not replicated across other personality traits.

In Sample 2, estimated LOESS models are remarkably similar to those estimated in Sample 1. Nevertheless, notable deviations are discussed here. For example, Antagonism and Detachment appear to exhibit more of a local maximum in Sample 2 models than in Sample 1 models, where the distributions appeared to become somewhat asymptotic at extremely low levels of these traits. The decreases in functioning at high levels of Agreeableness appear attenuated in Sample 2 compared to Sample 1, while the decreases in functioning at high levels of Conscientiousness are more apparent. Taken together, these slight deviations across LOESS models in the tail-ends of certain personality trait suggest that estimation of the tail ends of the distribution may be less reliable. Interestingly, in the unique shapes of the Extraversion, Emotional Stability, and Openness to Experience LOESS models are nearly identical across samples, suggesting that these distributions are reliably estimating these relationships as they truly are.

Results from both samples indicated that domains from the PID-5 and domains from the SPI perform equally well in predicting functioning variables, with related domain pairs appearing to account for similar proportions of variance in functioning. Of note, Emotional Stability, Negative Affectivity, and Detachment appeared to account for more variance in functioning domains than do other SPI and PID-5 domains. This is unsurprising because, as previously discussed, these three variables appear to share a substantial proportion of common variance that may be related to the neuroticism-like underpinnings of psychopathology. As such, it is inferred that personality variables are more likely to explain variance in functioning when saturated with the variance shared between psychopathological dimensions.

Moreover, on average, personality traits are more likely to explain variance in Global and Mental Functioning than Physical and Social Functioning. The cause of this pattern is unclear, but it is hypothesized that personality plays a more important role in Global and Mental Functioning because Physical and Social Functioning may be more easily influenced by other factors (e.g., situational circumstances, individual abilities). Nevertheless, Detachment and Extraversion appear to explain variance in Social Functioning more so than other personality factors, as would be expected given the content of these constructs.

Paralleling LOESS modelling, univariate smoothing-spline models predicting Global Functioning were estimated for each of the ten personality domains of interest. The shape of the smoothing spline functions and the proportion of variance explained in each model is nearly, if not perfectly, identical to the shape of and proportion of variance accounted for by the corresponding LOESS Model. Importantly, this provides support for the reliability of the modeled nonparametric relationships between the personality and functioning: they appear to be robust not only to different ways of handling missingness, but also across unique samples and using various nonparametric smoothing techniques.

Lastly, in addition to replication of exploratory analysis, confirmatory analysis was used to further evaluate and validate the fit of the modelled nonparametric relationships between personality domains and functioning. When Sample 1 models were estimated using Sample 2 data, the predicted values of Global Functioning were estimated nearly as well as the model developed specifically for Sample 2. Minimal squared differences between Sample 1 versus Sample 2 predicted scores suggest that the Sample 1 model was just as effective at predicting outcomes in new data. This speaks to the reliability of the nonparametric relationships quantified in the current study.

Multivariate Nonparametric Analysis

Following univariate smoothing spline models, various forms of multivariate smoothing spline models were fit using SSANOVA. First, three-way interaction models were fit in which domains were accompanied by additional predictors age and sex.

Six of the 10 personality domains in Sample 1 (and eight of the 10 in Sample 2) retained reduced-term models. While terms included in the retained models varied somewhat between samples, estimates of adjusted R^2 and GCV for a given model were nearly identical across samples. This suggests that the terms dropped from or added to the retained Sample 2 models from the retained Sample 1 models have relatively small effect sizes, which is further supported by the observed mean squares estimates for these effects. This, in turn, explains the lack of reliability of the model terms that differ between samples. Since the estimates of these particular model terms are relatively small, the existence of the effect is detected only variably.

The most robust effects in these interaction models are consistent across Sample 1 and Sample 2 models. The only variable that reliably had a three-way interaction effect across samples was Conscientiousness. Emotional Stability retained a full or near-full model across samples, reliably delineating all three, two-way interaction effects (i.e., domain X age + domain X sex + sex X age). Openness to Experience, Disinhibition, and

Negative Affectivity each retained at least two interaction terms (i.e., domain X age and age X sex) in both samples. Extraversion, Antagonism, and Psychoticism, on the other hand, only retained one interaction term (i.e., age X sex) in addition to the main effect of each respective domain. Finally, the effect of sex was not reliably measured in Detachment and Agreeableness, and each model only retained domain and age terms (i.e., interactive domain X age in Detachment, and additive domain + age in Agreeableness). Taken together, interactive sex effects, particularly the domain X sex effect, appear to be the least robust across various personality traits and different samples. Age demonstrates a reliable, interactive effect with personality domains and/ or sex. Aside from the lack of a sizeable sex effect in Agreeableness and Detachment, all three predictor variables tend to have reliable main effects in these age-by-sex SSANOVA models.

In both samples, adjusted R^2 estimates for these multivariate SSANOVA models demonstrate either modest improvement or no change when compared to R^2 estimates in the univariate smoothing spline models. Nevertheless, the main and interactive effects of age, and intermittently sex, appear to play a reliable role in predicting Global Functioning and, at times, moderating the relationship between Global Functioning and various personality domains. Even with demographic covariates included in the model, each personality domain contributes to unique variance in Global Functioning. Altogether, personality factors were more likely to interact with age than with sex, though the interaction between age and sex was the most reliably detected interactive effect across all models.

In addition to multivariate analysis of nonparametric age and sex effects, SSANOVA models were used to simultaneously model pairs of cognate SPI and PID-5 domains as predictors of Global Functioning. Full, interactive models were retained for all domain pairs in both samples. Of note, the variance in Global Functioning accounted for in these paired domain models exhibited only slight improvements over the variance accounted for in either one of the corresponding univariate domain models. This suggests that the variance in Global Functioning explained by a normative personality trait shares substantial overlap with the variance in Global Functioning explained by a parallel maladaptive personality trait. In other words, cognate maladaptive and normative personality traits account for much of the same variance in functioning (assuming both traits independently explain variance in functioning).

While the interactive and main effects of paired domains each reliably contribute to unique variance in Global Functioning, mean squares were consistently largest for the main effect of the SPI domain in all but one case in both samples. In the Sample 1 Openness to Experience and Psychoticism trait pair, the mean squares was highest for Psychoticism. This may be the result of normative personality domains covering a wider range of the trait than their maladaptive counterparts (which typically explain variance in only one end of the trait spectrum). Of course, this is not the case for Psychoticism and Openness to Experience, as operationalized by the PID-5 and SPI, because Psychoticism does not share significant overlapping information with Openness to Experience. Additionally, since Psychoticism indexes more extreme psychopathological experiences than other maladaptive personality traits (e.g., delusional thinking, hallucinogenic experiences), individuals who endorse these items are more likely to experience a larger range of impairments in functioning. Compared to the Sample 1 model in which the main effect of Psychoticism appears to be the largest effect, the Sample 2 model suggests the interactive effect between Openness to Experience and Psychoticism is the largest effect.

Finally, SSANOVA was used to simultaneously model the additive effects of all five domains from a given personality measure (i.e., SPI and PID-5, respectively). In both Sample 1 and Sample 2, the SPI SSANOVA model retained a reduced-term model by dropping Agreeableness from the model. The additive effect of the SPI domains in both samples explains 21% of the variance in Global Functioning, with or without Agreeableness included in the model. On the other hand, the PID-5 SSANOVA model behaved slightly differently in Sample 1 than it did in Sample 2. Both models retained a reduced-term model, though Antagonism was dropped in Sample 1 while Psychoticism was dropped in Sample 2. Nevertheless, both Sample 1 and Sample 2 full- and reduced-term models explained an equal proportion of variance in Global Functioning (18%). This suggests that Antagonism and Psychoticism do not reliably contribute unique variance in functioning above and beyond the variance explained by the other PID-5 variables. Of note, the small magnitude of nonparametric effects seen Agreeableness and Antagonism reflect a similar pattern seen in previous univariate models and multivariate models, in which Agreeableness and Antagonism models consistently have the lowest R^2 estimate.

According to these results, the Big Five factor model (as quantified by the SPI) and the *DSM-5* Trait model (as quantified by the PID-5) each account for approximately a fifth of the variance in Global Functioning. Given evidence of substantial psychometric overlap in paired SPI and PID-5 domains, it is presumed that the two personality models account for similar variance in Global Functioning. This is further supported by an adjusted R^2 = .26 when all SPI and PID-5 domains are modelled simultaneously to predict variance in Global Functioning. Including domains from both personality scales in the SSANOVA model does not drastically increase the amount of variance explained in Global Functioning, suggesting that so-called "normative" and "maladaptive" personality traits contribute to overlapping variance in functioning.

Taken together, exploratory nonparametric analyses support the general reliability of observed relationships between personality functioning. While models varied slightly between samples, divergences only occurred in assessing small nonparametric effect sizes (e.g., the shape in the tail-ends of personality distributions, three-way-interaction effects). The effects replicated across samples, however, are robust to changes in sample characteristics, methods of handling missingness, and smoothing techniques. In general, there is evidence for non-monotonic, possibly quadratic relationships between personality traits and functioning, particularly in traits that quantify a wide range of trait levels. These relationships tend to be moderated by age and, at times, sex effects. While associated SPI and PID-5 domain pairs could not be combined into new, integrated personality traits, significant evidence suggests that four of five of these domain pairs are highly related traits that predict approximately the same variance in Global Functioning.

Strengths, Limitations, and Future Directions

The current study design and analysis has several unique strengths. Perhaps the most apparent of these strengths is the large sample size. Not only does the large sample size allow for stabilization and reliability of multivariate statistical estimates and split-sample analysis, but also it holds the assumption that sample distributions well-approximate distributions as the exist in the population. For example, it can be assumed that frequencies of various mental health diagnoses are exhibited in similar proportions in the current study's sample as they are in the greater population. Moreover, given significant diversity of demographic variables, the results from the current study are considered to be highly generalizable to the population at large.

The employment of item sampling has both strengths and weaknesses. On one hand, item-sampling produces highly reliable estimates and allows for the administration of a large number of items. On the other hand, however, MMCAR data may have attenuated variance if items are sampled at a low rate. If participants only answer a couple of items meant to index a broader trait, there are fewer permutations of potential outcomes, and nuances in the trait might not be accurately quantified. Unique challenges are presented when the proportions of missing data are different among different variables, which may exacerbate pre-existing differences between variables (e.g., skew, range-restriction) that may interfere with close approximation of the true relationship.

In addition, the current study was limited by measurement problems associated with the particular combination of scales used to assess normative and maladaptive personality. Maladaptive personality domains, as operationalized by the PID-5, were indexed by significantly more items than were normative personality domains, as operationalized by the SPI. As a result, conjoined factor analysis resulted in a general factor heavily weighted by specifically PID-5 variance, hindering the ability to integrate SPI and PID-5 items onto unified personality spectra that span normative- and maladaptive-levels of a given trait. As such it is recommended that future research replicate the analysis of the current study using different combinations of normative and maladaptive personality measures. Utilizing measures with a similar number of indicators on each trait is recommended to avoid the measurement problems addressed in this paper.

Relatedly, while PID-5 domains are theorized to operationalize maladaptive variants of normative personality domains, these traits only quantify maladaptive personality at one side of the personality trait spectrum. Due to the lack of measures indexing maladaptive personality traits on the opposite side of the spectrum, the current study was unable to characterize the full, comprehensive range of personality domains of interest. Without tools that can quantify extremely high levels of Agreeableness, Conscientiousness, and Extraversion, or extremely low levels of Neuroticism and Openness to Experience, the bipolarity of maladaptive personality cannot be validly assessed. Future research should work on establishing a model (and associated measurement tools) of the maladaptive variants on the opposite side of the personality spectra from PID-5 domains. Establishing such a model would enhance the ability of personality and dimensional psychopathology research to elucidate how these models relate to one another.

Finally, future directions in research should focus on further clarifying the relationship between psychopathological dimensions and functioning by evaluating how these traits may moderate or mediate the effect of mental health treatments on changes in functional impairment. Not only would this research allow for the analysis of the interaction between personality and mental health treatment in predicting outcomes, but also it may clarify the mechanism through which mental health treatments improve patient outcomes (e.g., by targeting and shifting personality trait levels versus other variables that account for variance in functioning).

Table 1

Sample Demographics

Variable (% answered)	Category	Sample 1 Count	Sample 2 Count	Full Sample Count	Proportion of Each Sample
Sex (99%)	Female	37,086	37,288	74,374	35%
	Male	68,768	68,609	137,377	65%
	Other	202	205	407	0%
Ethnicity (22%)	White	18,279	18,318	36,597	78%
	Hispanic[§]	1,659	1,643	3,302	7%
	Asian[†]	1,025	922	1,947	4%
	African American	890	944	1,834	4%
	Indigenous[‡]	183	173	356	1%
	Other[*]	1,430	1,455	2,885	6%
Overall Health (91%)	Poor	2,168	2,079	4,247	2%
	Fair	13,745	13,832	27,577	14%
	Good	35,472	35,437	70,909	36%
	Very Good	31,795	31,659	63,454	32%
	Excellent	14,945	14,981	29,926	15%
Level of Education (85%)	<12 Years	7,689	7,622	15,311	8%
	High School	11,000	10,970	21,970	12%
	In College	19,406	19,487	38,893	21%
	Some College	6,452	6,519	12,971	7%
	Associate's	3,336	3,211	6,547	4%
	Bachelor's	21,186	21,048	42,234	23%
	In Graduate School	3,666	3,592	7,258	4%
	Graduate Degree	18,243	18,253	36,496	20%

Note. Full sample N = 214,420. Sample 1 N and Sample 2 N = 107,210. (& answered) = proportion of full sample that answered that item. [§]includes Mexican-American, Puerto-Rican, Cuban American, and Other Hispanic. [†]includes Chinese, Indian, Filipino, Korean, Japanese, other Asian, and other Pacific Islander. [‡]includes Native American, Alaskan Native, and Native Hawaiian. [*]includes multiracial, other, and "none of these." "Overall Health" based on self-report answer to one-item inquiring about overall health.

Table 2

Comparison of Psychometric Properties of SPI and PID-5 Domains Before and After Item Pruning (Sample 1)

Model	Trait	Full Item Domains						Reduced Item Domains					
		N	# of Items	α	S/N	Avg IIC	Unid	*N*	# of Items	α	S/N	Avg IIC	Unid
SPI	Agree	107,209	16	.83	4.80	.23	.58	107,209	14	.83	4.92	.26	.64
	Consc	107,208	19	.84	5.10	.21	.57	107,208	18	.84	5.14	.22	.60
	Extra	107,204	27	.89	7.80	.22	.62	107,204	26	.89	7.92	.23	.65
	Neuro	107,206	18	.88	7.07	.28	.68	107,206	17	.88	7.35	.30	.72
	Open	107,210	27	.85	5.49	.17	.49	107,210	19	.84	5.27	.22	.58
PID-5	Antag	80,344	53	.94	16.04	.23	.71	79,813	51	.94	16.27	.24	.73
	Detach	78,348	52	.95	18.60	.26	.69	77,743	47	.95	20.21	.30	.78
	Disinh	66,305	46	.90	9.33	.17	.42	64,645	29	.93	12.34	.30	.75
	NegAff	86,638	74	.96	23.53	.24	.67	84,167	60	.96	27.23	.31	.82
	Psychot	68,722	33	.94	16.76	.34	.81	68,722	33	.94	16.76	.34	.81

Note. Reduced Item Domains created by removing items loading < .30 onto one-factor solution. α = Chronbach's α; S/N = signal-to-noise ratio; Avg. IIC = average inter-item correlation; Unid = unidimensionality (ratio of communalities to uniquenesses). Agree = SPI Agreeableness; Consc = SPI Conscientiousness; Extra = SPI Extraversion; Neuro = SPI Neuroticism; Open = SPI Openness to Experience; Antag = PID-5 Antagonism; Detach = PID-5 Detachment; Disinh = PID-5 Disinhibition; NegAff = PID-5 Negative Affectivity; Psychot = PID-5 Psychoticism.

Table 3

Correlations of SPI Domains, Comparison Across Reduced vs. Full Item Indicators (Sample 1)

		Full Item Domain					Reduced Item Domain				
		Agree	Consc	Extra	Emot	Open	Agree	Consc	Extra	Emot	Open
Full Item Domain	Agree	1.00									
	Consc	.23	1.00								
	Extra	.13	.07	1.00							
	Emot	.08	.22	.16	1.00						
	Open	.16	.16	.14	.10	1.00					
Reduced Item Domain	Agree	.99	.23	.13	.10	.15	1.00				
	Consc	.22	.96	.07	.21	.16	.23	1.00			
	Extra	.19	.13	.92	.22	.23	.19	.12	1.00		
	Emot	.11	.25	.17	.98	.11	.13	.23	.23	1.00	
	Open	.18	.24	.18	.18	.91	.18	.23	.28	.20	1.00

Note. All traits IRT-scored. Reduced Item Domains created by removing items loading < .30 onto one-factor solution. Agree = SPI Agreeableness; Consc = SPI Conscientiousness; Extra = SPI Extraversion; Emot = SPI Emotional Stability (reverse Neuroticism); Open = SPI Openness to Experience.

Table 4

Correlations of PID-5 Domains, Comparison Across Reduced vs. Full Item Indicators (Sample 1)

		Full Item Domain					Reduced Item Domain				
		Antag	Detach	Disin	NegAff	Psychot	Antag	Detach	Disin	NegAff	Psychot
Full Item Domain	Antag	1.00									
	Detach	.24	1.00								
	Disinh	.33	.31	1.00							
	NegAff	.37	.68	.36	1.00						
	Psychot	.28	.35	.37	.38	1.00					
Reduced Item Domain	Antag	1.00	.24	.33	.38	.29	1.00				
	Detach	.24	1.00	.32	.69	.35	.24	1.00			
	Disinh	.33	.32	.99	.37	.37	.33	.32	1.00		
	NegAff	.37	.68	.36	.99	.39	.37	.68	.37	1.00	
	Psychot	.28	.35	.37	.38	1.00	.29	.35	.37	.39	1.00

Note. All traits IRT-scored. Reduced Item Domains created by removing items loading < .30 onto one-factor solution. Antag = PID-5 Antagonism; Detach = PID-5 Detachment; Disinh = PID-5 Disinhibition; NegAff = PID-5 Negative Affectivity; Psychot = PID-5 Psychoticism.

Table 5

Psychometric Properties of Personality and Functioning Domains (Sample 1)

	Trait	N	Distribution			Reliability				Unidimensionality				
			Skew	Kurt	SE	α	Split Half Range	Ave IIC	S/N	Unid	Var Acc	ω_T	ω_H	FA_ω
SPI	Agree	107,209	-.75	.73	.03	.83	.63 - .88	.26	4.92	.64	.27	.88	.57	3
	Consc	107,208	-1.11	2.19	.03	.84	.64 - .89	.22	5.14	.60	.24	.88	.59	4
	Extra	107,204	.72	.65	.03	.89	.71 - .94	.23	7.92	.65	.24	.93	.66	6
	Emot	107,206	.26	-.63	.03	.88	.70 - .92	.30	7.35	.72	.32	.91	.71	4
	Open	107,210	-.88	1.16	.03	.84	.66 - .90	.22	5.27	.58	.24	.88	.51	3
PID-5	Antag	79,813	.49	-.47	.04	.94	.87 - .96	.24	16.27	.73	.26	.96	.66	5
	Detach	77,743	.35	-.80	.04	.95	.88 - .97	.30	20.21	.78	.32	.97	.66	5
	Disinh	64,645	.21	-.86	.04	.93	.79 - .95	.30	12.34	.75	.32	.95	.72	4
	NegAff	84,167	.16	-.90	.03	.96	.92 - .98	.31	27.23	.82	.33	.97	.75	5
	Psychot	68,722	-.10	-1.05	.04	.94	.80 - .97	.34	16.76	.81	.36	.96	.72	4
PROMIS	Global	85,745	-.49	-.23	.03	.98	.95 - .99	.28	42.27	.80	.30	.98	.63	3
	Mental	63,255	-.86	.85	.04	.96	.86 - .98	.41	22.58	.86	.43	.97	.80	4
	Physical	62,583	-.28	-.73	.04	.94	.84 - .97	.35	16.74	.79	.37	.96	.71	4
	Social	62,041	.70	-.30	.04	.95	.86 - .97	.30	18.63	.76	.31	.96	.75	5

Note. Distribution estimates made following IRT scoring. Traits T-scored (*M*=50; *SD*=10). SE = standard error; α = Chronbach's α; S/N = signal-to-noise ratio; Avg. IIC = average inter-item correlation; Unid = unidimensionality (ratio of communalities to uniquenesses); VarAcc = variacnce accounted for by one-factor solution; ω_T = omega total; ω_H = omega hierarchical; FA_ω = factor solution used to estimate omega. Agree = SPI Agreeableness; Consc = SPI Conscientiousness; Extra = SPI Extraversion; Emot = SPI Emotional Stability (reverse Neuroticism); Open = SPI Openness to Experience; Antag = PID-5 Antagonism; Detach = PID-5 Detachment; Disinh = PID-5 Disinhibition; NegAff = PID-5 Negative Affectivity; Psychot = PID-5 Psychoticism.

Table 6

Psychometric Properties of Combined Personality Domains, Comparison Across Reduced vs. Full Item Indicators (Sample 1)

	Trait	N	# of Items	Distribution		Reliability				Unidimensionality				
				Skew	Kurt	α	Split Half Range	Ave IIC	S/N	Unid	Var Acc	ω_T	ω_H	FA_ω
Full Items	Agree / Ant	107,208	69	.66	.33	.95	.89 - .97	.21	18.61	.68	.23	.96	.66	5
	Consc / Dis	107,201	65	.25	-.47	.91	.74 - .95	.14	10.26	.34	.18	.94	.61	5
	Extra / Det	106,893	79	.36	-.33	.95	.89 - .97	.21	21.11	.60	.25	.97	.64	4
	Neuro / Neg	107,209	92	-.08	-.71	.97	.93 - .98	.24	28.97	.66	.28	.98	.76	6
	Open / Psy	101,601	60	-.36	-.62	.91	.77 - .95	.15	10.45	.38	.21	.94	.67	6
Reduced Items	Agree / Ant	107,208	65	.70	.37	.95	.89 - .97	.22	18.50	.70	.24	.96	.67	5
	Consc / Dis	107,201	47	.26	-.48	.93	.83 - .96	.22	13.40	.62	.25	.95	.63	5
	Extra / Det	106,885	73	.36	-.30	.96	.88 - .97	.23	22.37	.67	.26	.97	.64	4
	Neuro / Neg	107,209	77	-.19	-.73	.97	.94 - .98	.30	33.10	.80	.32	.98	.76	5
	Open / Psy	95,385	52	-.40	-.81	.91	.69 - .95	.17	10.71	.42	.23	.94	.70	5

Note. Reduced Items found by removing items loading < .30 onto one-factor solution of each individual trait. Distribution estimates made following IRT scoring. Traits T-scored (*M*=50; *SD*=10). Standard error for all traits = .03. α = Chronbach's α; S/N = signal-to-noise ratio; Avg. IIC = average inter-item correlation; Unid = unidimensionality (ratio of communalities to uniquenesses); VarAcc = variacnce accounted for by one-factor solution; ω_T = omega total; ω_H = omega hierarchical; FA_ω = factor solution used to estimate omega. Agree / Ant = SPI Agreeableness and PID-5 Antagonism; Consc / Dis = SPI Conscientiousness and PID-5 Disinhibition; Extra / Det= SPI Extraversion and PID-5 Detachment; Neuro / Neg = SPI Neuroticism and PID-5 Negative Affectivity; Open / Psy= SPI Openness to Experience / PID-5 Psychoticism.

Table 7

Correlations of Combined Personality Domains, Comparison Across Reduced vs. Full Item Indicators (Sample 1)

		Full Items					Reduced Items				
		Agree/ Ant	Consc/ Dis	Extra/ Det	Neuro/ Neg	Open/ Psy	Agree/ Ant	Consc/ Dis	Extra/ Det	Neuro/ Neg	Open/ Psy
Full Items	Agree / Ant	1.00									
	Consc / Dis	.35	1.00								
	Extra / Det	.27	.31	1.00							
	Neuro / Neg	.29	.41	.47	1.00						
	Open / Psy	.26	.32	.24	.34	1.00					
Reduced Items	Agree /Ant	.98	.34	.29	.29	.23	1.00				
	Consc / Dis	.35	1.00	.31	.41	.32	.34	1.00			
	Extra / Det	.27	.30	1.00	.47	.23	.29	.30	1.00		
	Neuro / Neg	.28	.41	.47	1.00	.34	.29	.41	.47	1.00	
	Open / Psy	.23	.27	.19	.32	.91	.20	.27	.19	.32	1.00

Note. All traits IRT-scored. Reduced Item Domains created by removing items loading < .30 onto one-factor solution. Agree / Ant = SPI Agreeableness and PID-5 Antagonism; Consc / Dis = SPI Conscientiousness and PID-5 Disinhibition; Extra / Det= SPI Extraversion and PID-5 Detachment; Neuro / Neg = SPI Neuroticism and PID-5 Negative Affectivity; Open / Psy= SPI Openness to Experience / PID-5 Psychoticism.

Table 8

Inter- and Intra- Trait Correlations (Sample 1)

		Agree	Consc	Extra	Emot	Open	Antag	Detach	Disinh	NegAff	Psychot	Global	Mental	Physical	Social
SPI-5	Agree	1.00	.23	.19	.13	.18	-.32*	-.26	-.18	-.18	-.18	.20	.22	.12	.19
	Consc	.23	1.00	.12	.23	.23	-.14	-.22	-.34*	-.22	-.20	.25	.27	.19	.18
	Extra	.19	.12	1.00	.23	.28	.08	-.32*	-.01	-.16	-.08	.24	.24	.15	.26
	Emot	.13	.23	.23	1.00	.20	-.20	-.40	-.30	-.55*	-.32	.39	.42	.33	.25
	Open	.18	.23	.28	.20	1.00	-.01	-.16	-.12	-.15	.04*	.19	.22	.13	.15
PID-5	Antag	-.33*	-.15	.08	-.21	-.01	1.00	.23	.33	.36	.27	-.14	-.15	-.11	-.10
	Detach	-.28	-.23	-.33*	-.41	-.18	.24	1.00	.28	.69	.33	-.37	-.39	-.28	-.28
	Disinh	-.20	-.35*	-.01	-.31	-.12	.33	.32	1.00	.35	.36	-.25	-.24	-.21	-.17
	NegAff	-.18	-.22	-.16	-.56*	-.16	.37	.68	.37	1.00	.37	-.35	-.38	-.30	-.22
	Psychot	-.18	-.21	-.08	-.32	.03*	.29	.35	.37	.39	1.00	-.26	-.24	-.23	-.20
PROMIS	Global	.21	.26	.25	.41	.20	-.17	-.41	-.28	-.39	-.28	1.00	.68	.76	.65
	Mental	.24	.29	.26	.46	.24	-.19	-.45	-.30	-.44	-.28	.68	1.00	.44	.35
	Physical	.13	.21	.17	.37	.14	-.16	-.34	-.26	-.36	-.27	.73	.38	1.00	.39
	Social	.22	.19	.29	.27	.18	-.14	-.36	-.21	-.29	-.23	.61	.35	.28	1.00

Note. All correlations have a *p*-value = 0. Complete case correlations below the diagonal and multiple imputation data correlations above the diagonal. Traits item-pruned, IRT-scored, and T-scored. *Correlations between hypothesized trait pairs from SPI and PID-5. Higher magnitude correlations shaded in darker gray. Agree = SPI Agreeableness; Consc = SPI Conscientiousness; Extra = SPI Extraversion; Emot = SPI Emotional Stability (reverse Neuroticism); Open = SPI Openness to Experience; Antag = PID-5 Antagonism; Detach = PID-5 Detachment; Disinh = PID-5 Disinhibition; NegAff = PID-5 Negative Affectivity; Psychot = PID-5 Psychoticism.

Table 9

Missingness and Effective N for Traits and Trait Pairs (Sample 1)

% Missing		Agree	Consc	Extra	Emot	Open	Antag	Detach	Disinh	NegAff	Psychot	Global	Mental	Physical	Social
0%	Agree	107,209													
0%	Consc	107,207	107,208												
0%	Extra	107,203	107,202	107,204											
0%	Emot	107,206	107,204	107,200	107,206										
0%	Open	107,209	107,208	107,204	107,206	107,210									
26%	Antag	79,812	79,812	79,808	79,809	79,813	79,813								
27%	Detach	77,742	77,743	77,737	77,739	77,743	61,015	77,743							
40%	Disinhi	64,645	64,643	64,643	64,644	64,645	53,191	52,373	64,645						
21%	NegAff	84,166	84,165	84,161	84,163	84,167	66,346	68,598	54,906	84,167					
36%	Psychot	68,722	68,721	68,720	68,720	68,722	55,753	54,776	48,760	57,535	68,722				
20%	Global	85,744	85,743	85,740	85,742	85,745	68,141	66,820	57,355	71,203	60,465	85,745			
41%	Mental	63,255	63,255	63,253	63,254	63,255	54,175	53,467	48,016	55,757	49,724	63,255	63,255		
42%	Physical	62,583	62,583	62,581	62,582	62,583	53,580	52,971	47,521	55,335	49,373	62,583	47,866	62,583	
42%	Social	62,040	62,039	62,036	62,039	62,041	53,876	53,215	48,063	55,462	49,835	61,941	48,482	48,251	62,041

Note. Numbers correspond to *N* complete cases in designated trait pair. Numbers on diagonal correspond to *N* with a non-missing score for corresponding domain. Percent of missing scores from each domain in first column. Agree = SPI Agreeableness; Consc = SPI Conscientiousness; Extra = SPI Extraversion; Emot = SPI Emotional Stability (reverse Neuroticism); Open = SPI Openness to Experience; Antag = PID-5 Antagonism; Detach = PID-5 Detachment; Disinh = PID-5 Disinhibition; NegAff = PID-5 Negative Affectivity; Psychot = PID-5 Psychoticism.

Table 10

Smoothing Parameters for LOESS Models (Sample 1)

		Global	Mental	Physical	Social
SPI	Agreeableness	.04	.05	.02	.04
	Conscientiousness	.07	.08	.04	.04
	Extraversion	.07	.06	.03	.07
	Emotional Stability	.16	.19	.11	.06
	Openness to Experience	.04	.05	.02	.02
PID-5	Antagonism	.02	.03	.01	.01
	Detachment	.07	.06	.05	.03
	Disinhibition	.14	.16	.08	.09
	Negative Affectivity	.13	.15	.09	.05
	Psychoticism	.07	.06	.05	.04

Note. Smoothing parameters (i.e., spans) optimized using generalized cross-validation (GCV) criterion. Each LOESS model uses a degree polynomial of 2.

Table 11

R^2 Estimates for LOESS Models (Sample 1)

		Global	Mental	Physical	Social	Trait Average R^2
SPI	Agreeableness	.04	.05	.02	.04	.04
	Conscientiousness	.07	.08	.04	.04	.06
	Extraversion	.07	.06	.03	.07	.06
	Emotional Stability	.16	.19	.11	.06	.13
	Openness to Experience	.04	.05	.02	.02	.03
PID-5	Antagonism	.02	.03	.01	.01	.02
	Detachment	.14	.16	.08	.09	.12
	Disinhibition	.07	.06	.05	.03	.05
	Negative Affectivity	.13	.15	.09	.05	.11
	Psychoticism	.07	.06	.05	.04	.06
	SPI Average R^2	.08	.09	.04	.05	.06
	PID-5 Average R^2	.09	.09	.06	.04	.07
	Total Average R^2	.08	.09	.05	.05	.07

Note. Each LOESS model uses a degree polynomial of 2 and smoothing parameter which minimizes generalized cross-validation (GCV) criterion. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Table 12

Fit of Smoothing Spline in Predicting Global Functioning (Samples 1 & 2)

		Sample 1			Sample 2		
		Retained Model	Adj R^2	GCV	Retained Model	Adj R^2	GCV
Univariate Models		Agreeableness	.04	94.58	Agreeableness	.04	94.52
		Conscientiousness	.07	92.16	Conscientiousness	.07	92.11
		Extraversion	.07	92.34	Extraversion	.07	92.03
		Emotional Stability	.16	83.21	Emotional Stability	.16	82.91
		Openness to Experience	.04	95.21	Openness to Experience	.04	95.11
		Antagonism	.02	96.64	Antagonism	.02	96.55
		Detachment	.14	84.97	Detachment	.14	84.76
		Disinhibition	.07	92.39	Disinhibition	.06	92.49
		Negative Affectivity	.13	86.33	Negative Affectivity	.12	86.51
		Psychoticism	.07	92.15	Psychoticism	.06	92.35
Multivariate Models	Trait*Age (A)*Sex (S)	[§]Agree*S*A	.07	92.25	Agree + A	.06	92.67
		[§]Consc*S*A	.09	90.18	[§]Consc*S*A	.09	90.05
		Extra + S*A	.10	88.83	Extra + S*A	.10	88.44
		Emot*S + Emot*A + S*A	.16	82.57	[§]Emot*S*A	.17	82.22
		[§]Open*S*A	.07	92.40	Open*A + S*A	.07	92.19
		Antag*A + S*A	.05	93.91	Ant + S*A	.05	93.75
		Detach*A + S*A	.15	83.98	Detach*A	.15	83.86
		[§]Disinh*S*A	.08	90.74	Disinh*A + S*A	.08	90.71
		Neg*A + S*A	.13	85.58	Neg*A + Neg*S + S*A	.13	85.58
		Psyc*S + Psyc *A + S*A	.08	90.54	Psy + S*A	.08	90.66
	SPI_{Trait} *PID_{Trait}	[§]Agree * Antag	.05	93.80	[§]Agree * Antag	.05	93.74
		[§]Consc * Disinh	.10	89.10	[§]Consc * Disinh	.10	89.26
		[§]Extra * Detach	.16	82.95	[§]Extra * Detach	.16	82.72
		[§]Emot * Neg	.19	80.39	[§]Emot * Neg	.19	80.30
		[§]Open * Psyc	.10	88.17	[§]Open * Psyc	.10	88.36
	Scale	SPI Additive Model (C+Ex+Em+O)	.21	77.96	SPI Additive Model (C+Ex+Em+O)	.21	76.93
		PID-5 Additive Model (De+Di+N+P)	.18	81.04	PID-5 Additive Model (An+De+Di+N)	.18	81.06

Note. Models predict PROMIS Global Functioning. [§]Full SSANOVA model retained. S = Sex; A = Age; GCV = generalized cross validation criteria (identifies smoothing parameter which minimizes root mean-squared error of prediction); Agree = SPI Agreeableness; Consc (C) = SPI Conscientiousness; Extra (Ex) = SPI Extraversion; Emot (Em) = SPI Emotional Stability (reverse Neuroticism); Open (O) = SPI Openness to Experience; Antag (An) = PID-5 Antagonism; Detach (De) = PID-5 Detachment; Disinh (Di) = PID-5 Disinhibition; Neg (N) = PID-5 Negative Affectivity; Psyc (P)= PID-5 Psychoticism. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 1

Histograms of Response Data (Full Sample)

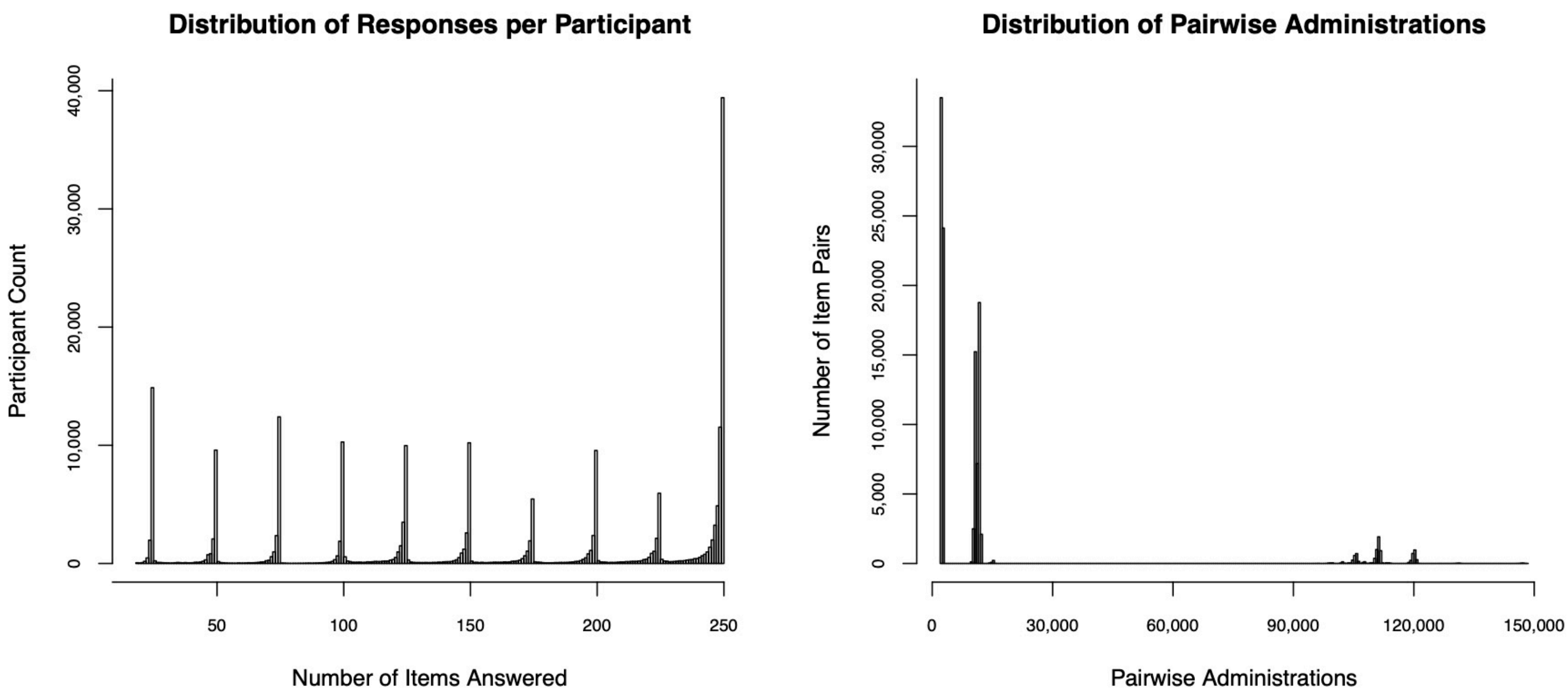
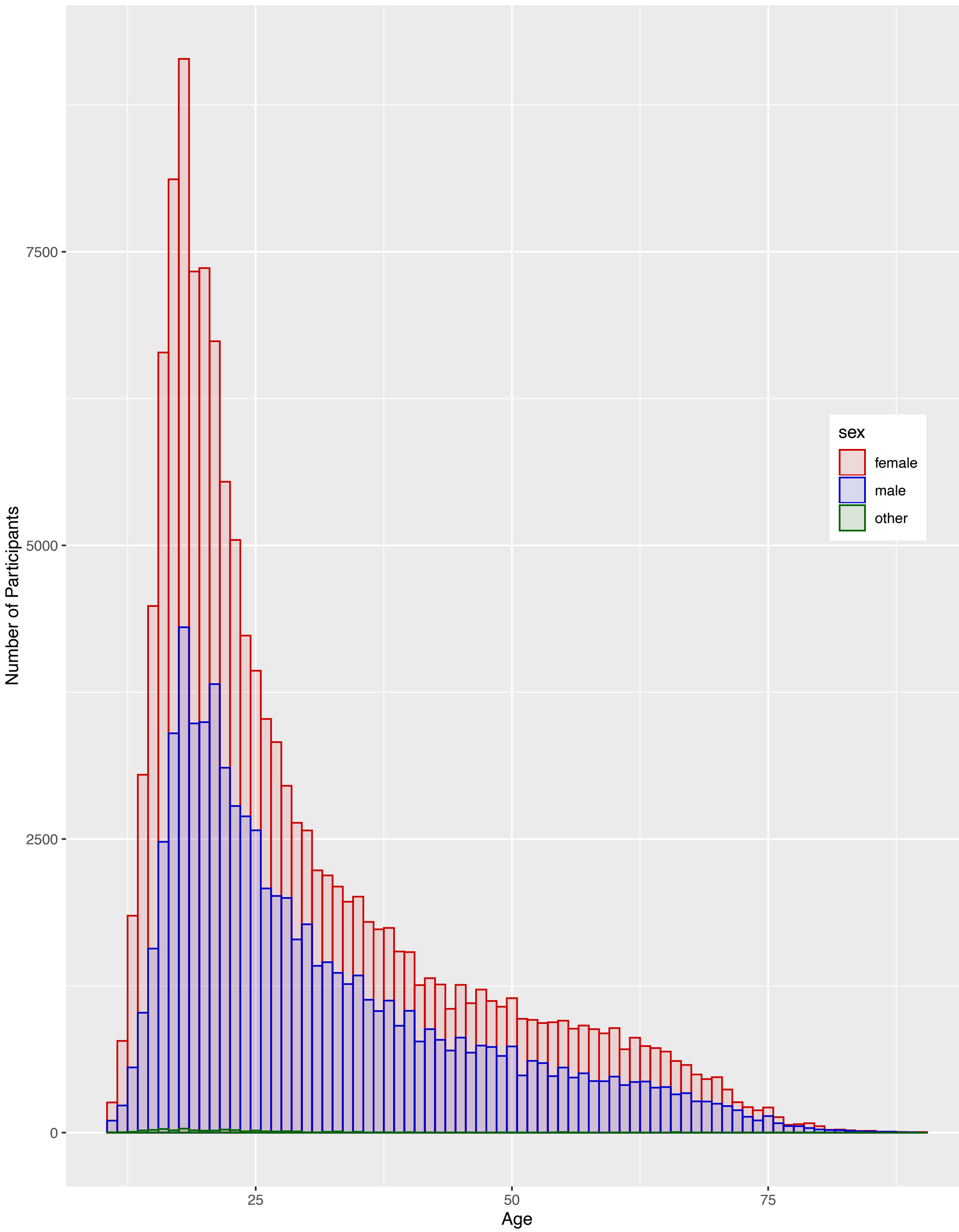


Figure 2

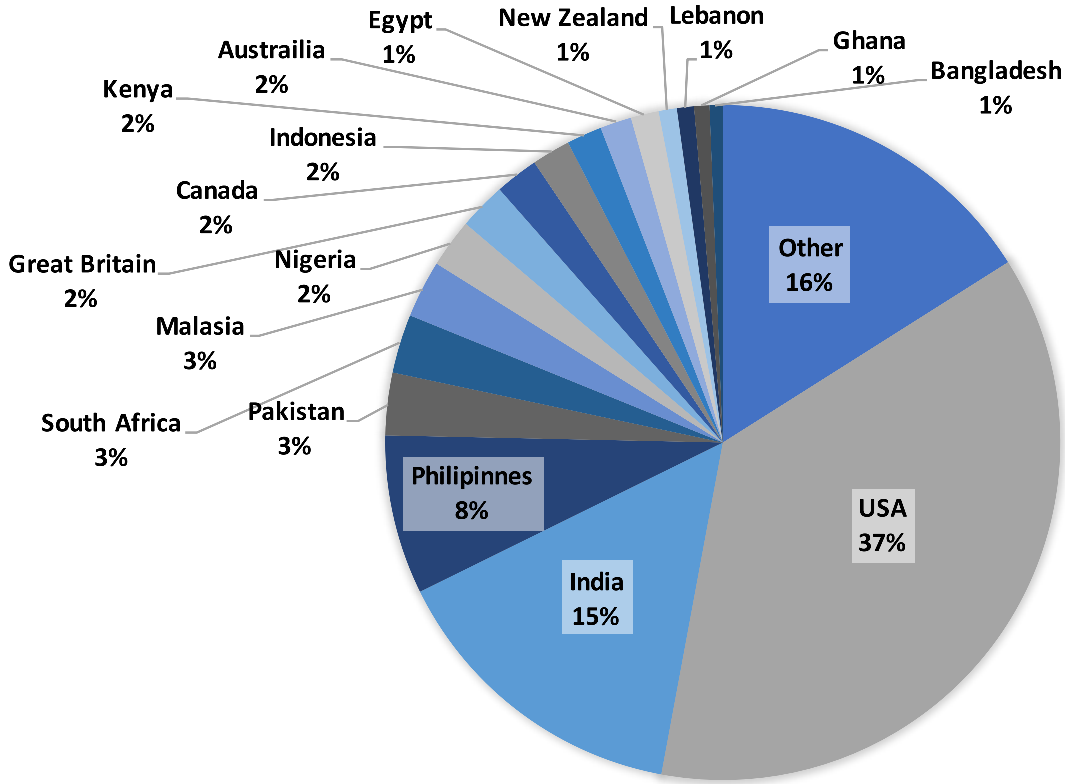
Histogram of Age Split by Sex (Full Sample)



Note. N = 212,158, M = 30.19, and SD = 14.88 in the full sample.

Figure 3

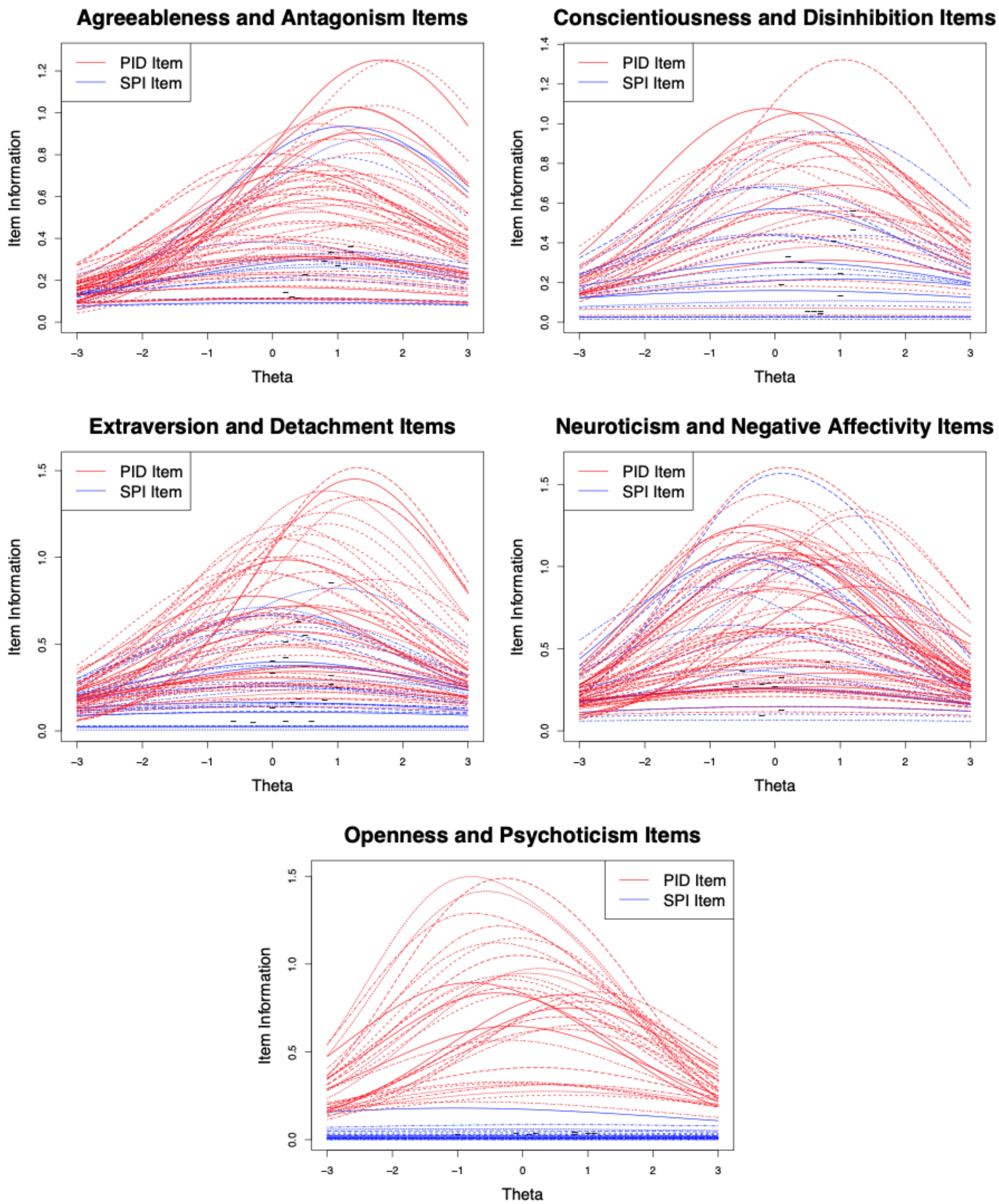
Proportion of Participants by Country of Origin (Full Sample)



Notes. N = 196,964 individuals (92% of full sample) identified country of origin. A total of 223 countries were represented. Countries were included in the pie chart if they had at least 1,000 participants in the full sample.

Figure 4

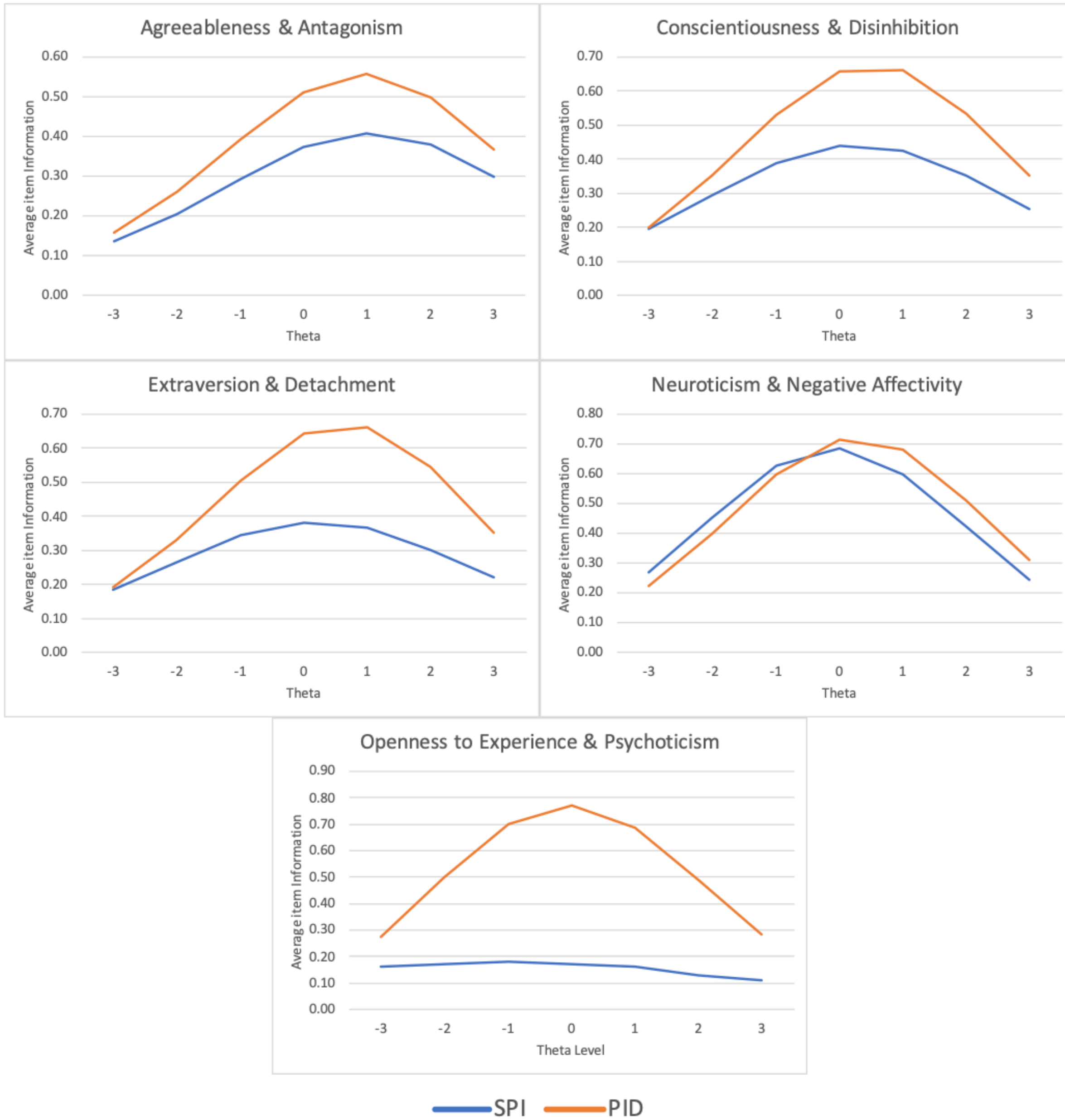
IRT Item Information Curves for Combined SPI and PID-5 Domains (Sample 1)



Note. Estimated using the two-parameter logistic Graded Response Model. Following item-pruning.

Figure 5

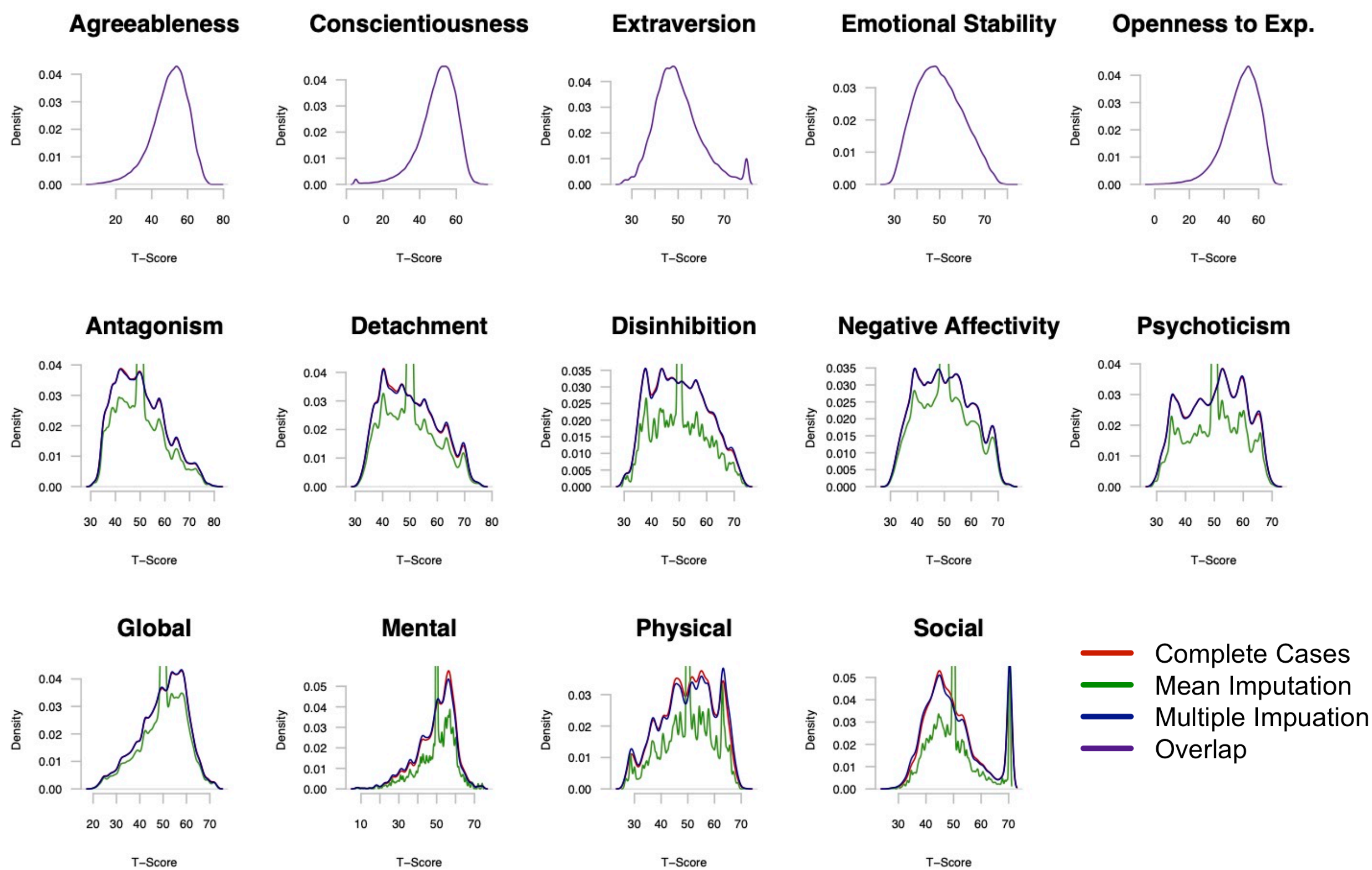
Average Item Information Curves for Combined SPI and PID-5 Domains (Sample 1)



Note. Estimated using the two-parameter logistic Graded Response Model. Following item-pruning.

Figure 6

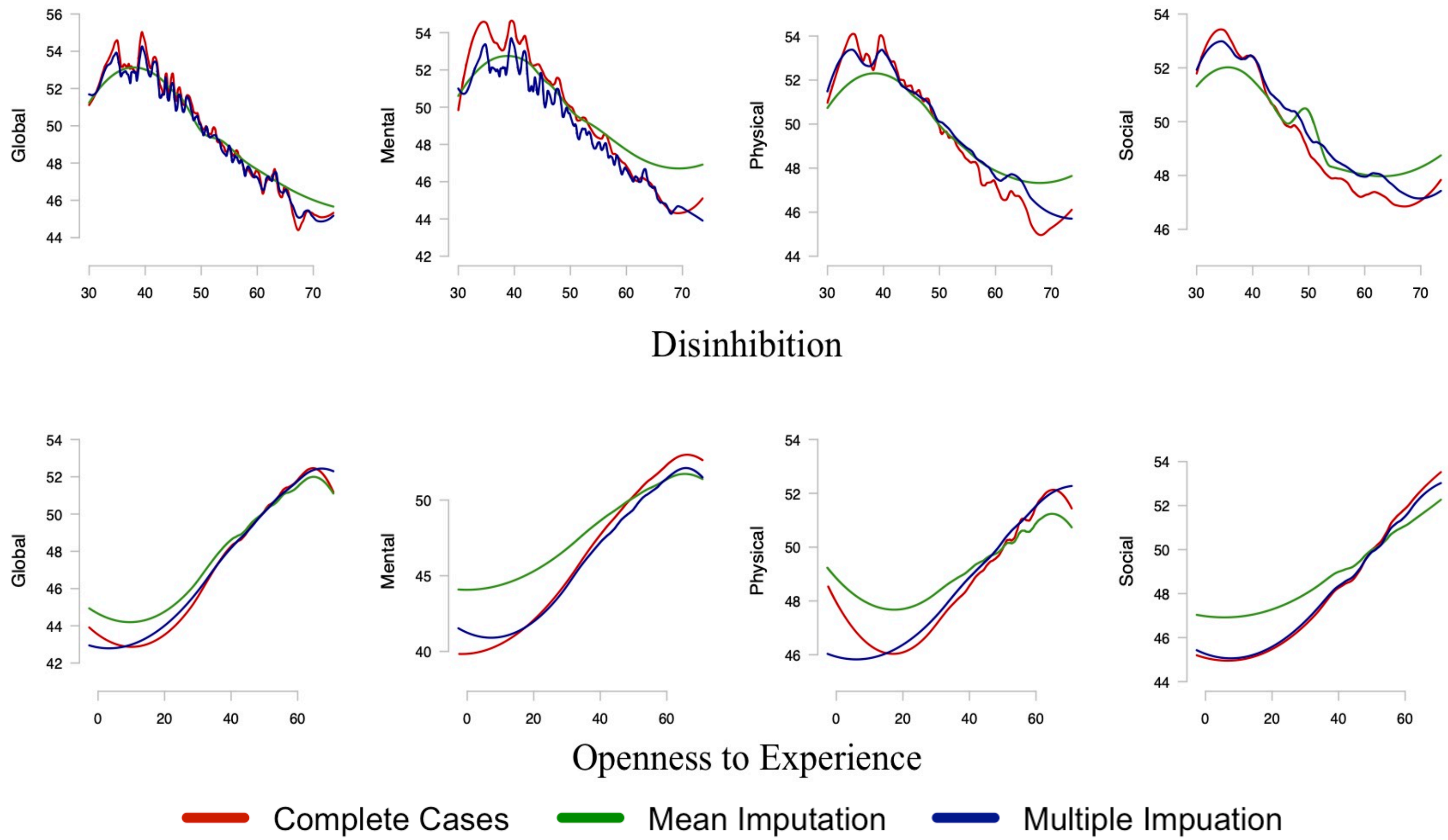
Comparing Density Plots Across Ways of Handling Missingness (Sample 1)



Note. Due to trivial proportion of missingness, SPI traits (depicted in the first row) have identical distributions for all ways of handling missingness.

Figure 7

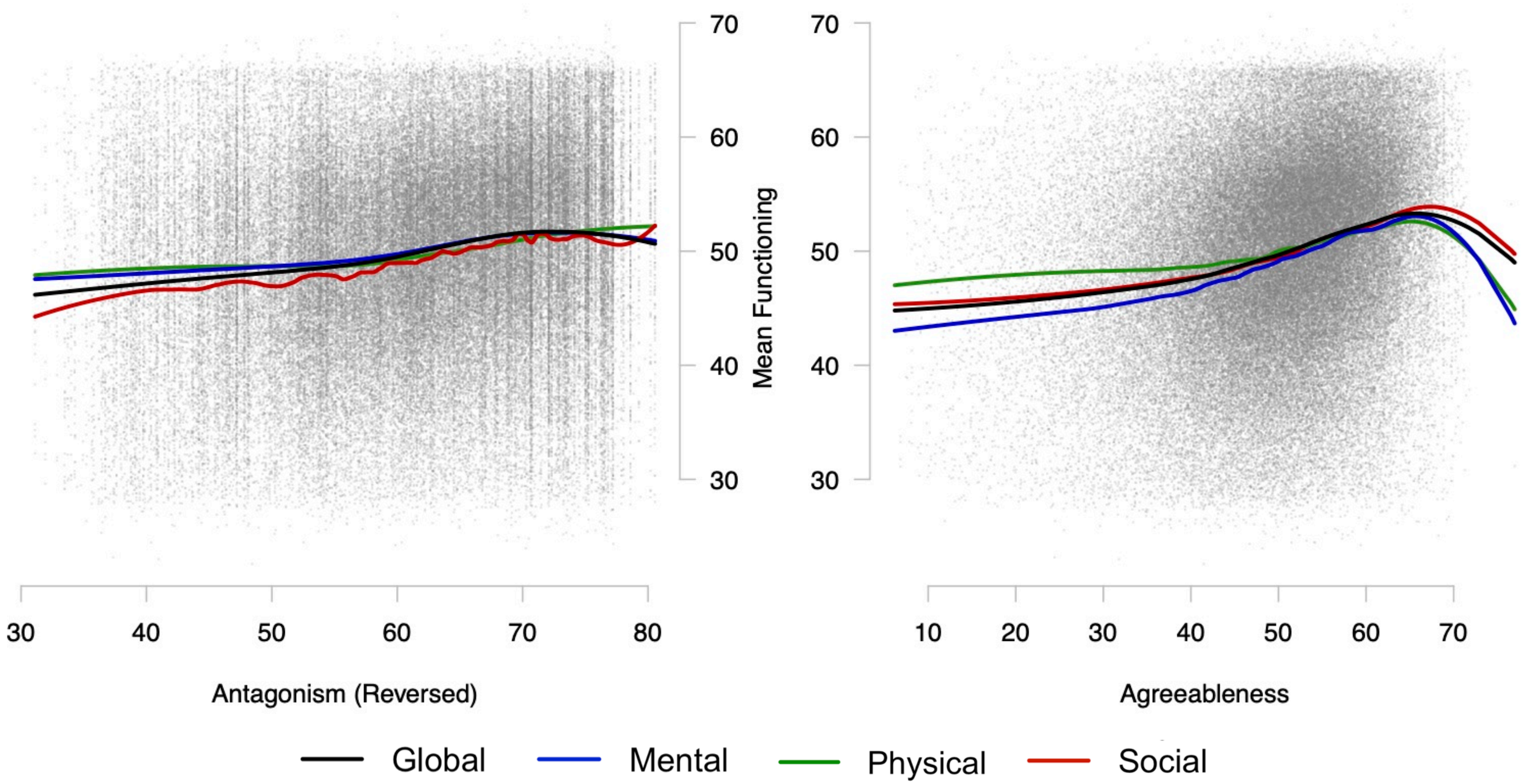
Comparing LOESS Models Across Ways of Handling Missingness, Examples of Disinhibition and Openness to Experience (Sample 1)



Note. Disinhibition and Openness to Experience have the highest and lowest proportion of missing data, respectively. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 8

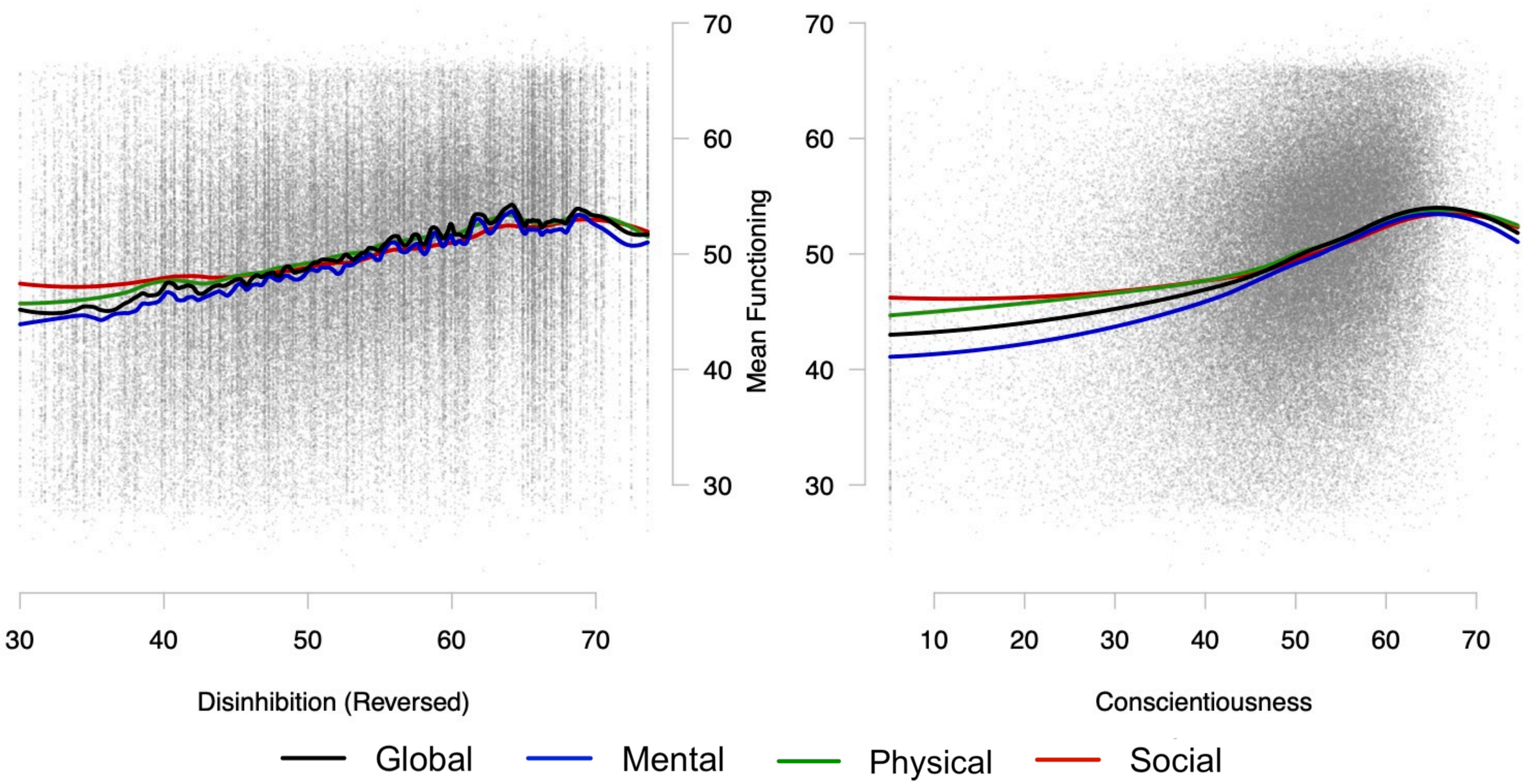
LOESS Models – PID-5 Antagonism (Reversed) and SPI Agreeableness Predicting Domains of Functioning (Sample 1)



Note. Model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation. Mean functioning score plotted on *y*-axis; differently colored lines correspond to the four PROMIS domains of functioning. PID-5 domain was reverse-scored to demonstrate the hypothesized trait spectrum underlying the pair of domains.

Figure 9

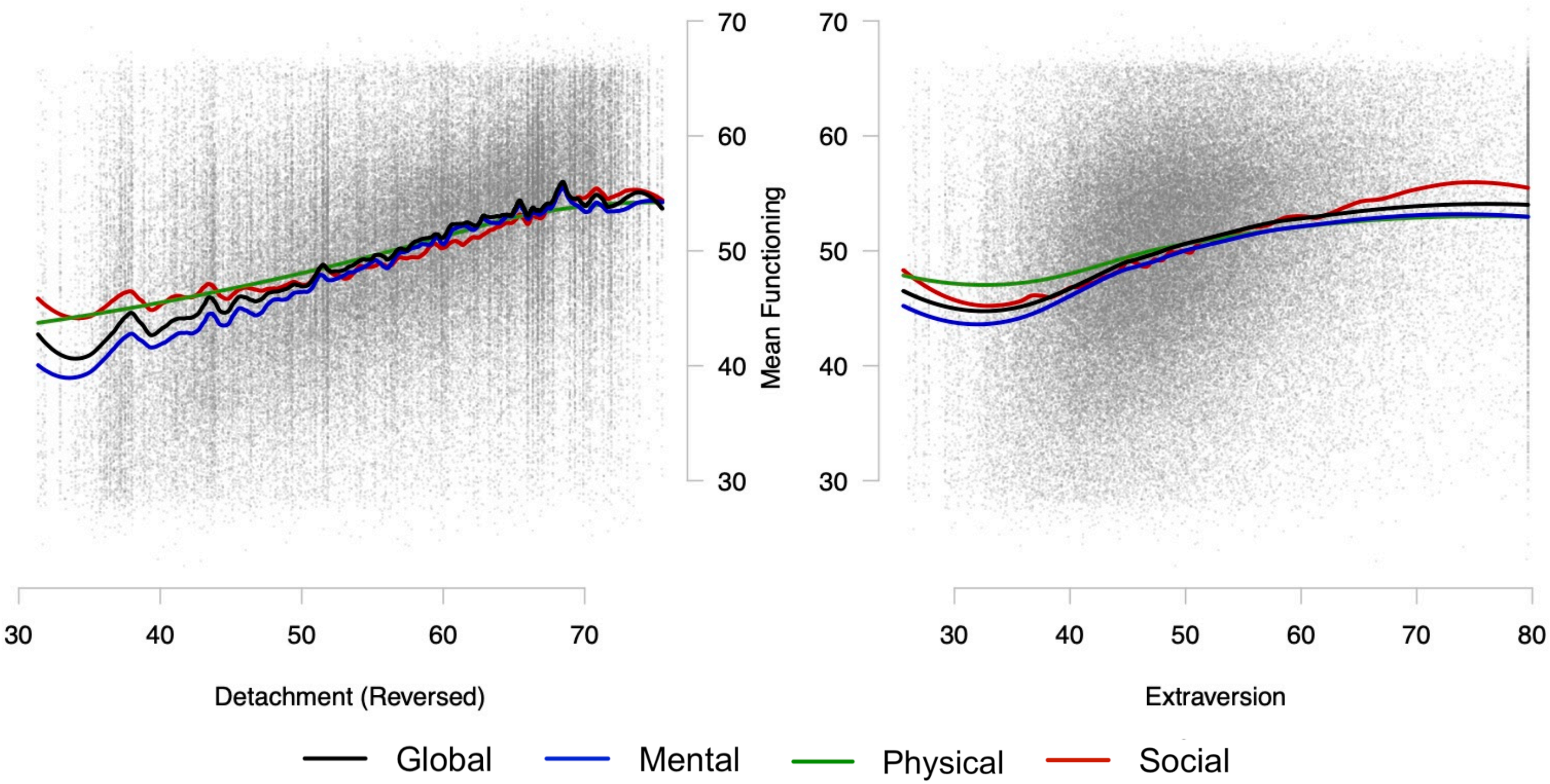
LOESS Models – PID-5 Disinhibition (Reversed) and SPI Conscientiousness Predicting Domains of Functioning (Sample 1)



Note. Model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation. Mean functioning score plotted on *y*-axis; differently colored lines correspond to the four PROMIS domains of functioning. PID-5 domain was reverse-scored to demonstrate the hypothesized trait spectrum underlying the pair of domains.

Figure 10

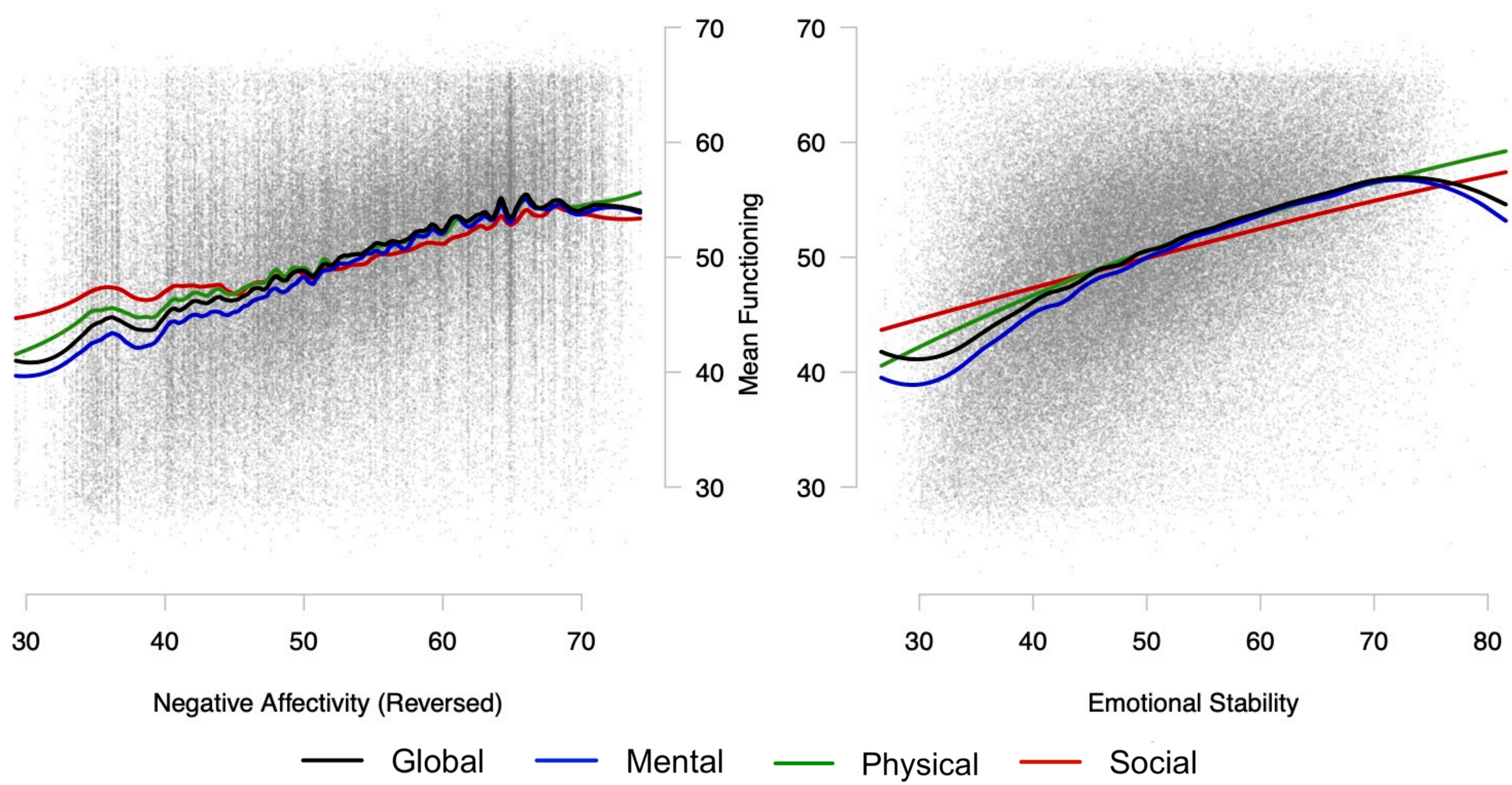
LOESS Models – PID-5 Detachment (Reversed) and SPI Extraversion Predicting Domains of Functioning (Sample 1)



Note. Model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation. Mean functioning score plotted on *y*-axis; differently colored lines correspond to the four PROMIS domains of functioning. PID-5 domain was reverse-scored to demonstrate the hypothesized trait spectrum underlying the pair of domains.

Figure 11

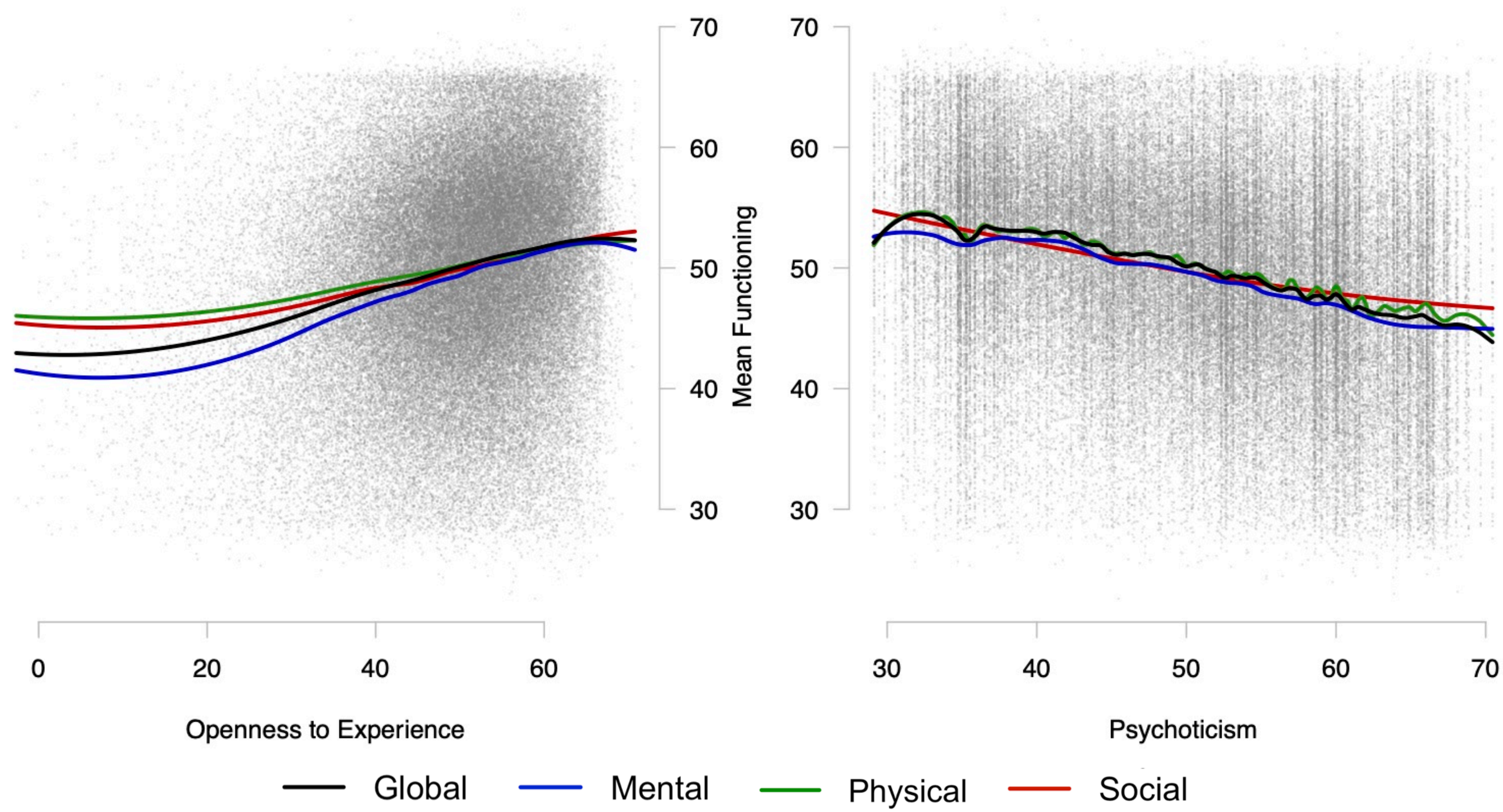
LOESS Models – PID-5 Negative Affectivity (Reversed) and SPI Emotional Stability Predicting Domains of Functioning (Sample 1)



Note. Model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation. Mean functioning score plotted on *y*-axis; differently colored lines correspond to the four PROMIS domains of functioning. PID-5 domain was reverse-scored to demonstrate the hypothesized trait spectrum underlying the pair of domains.

Figure 12

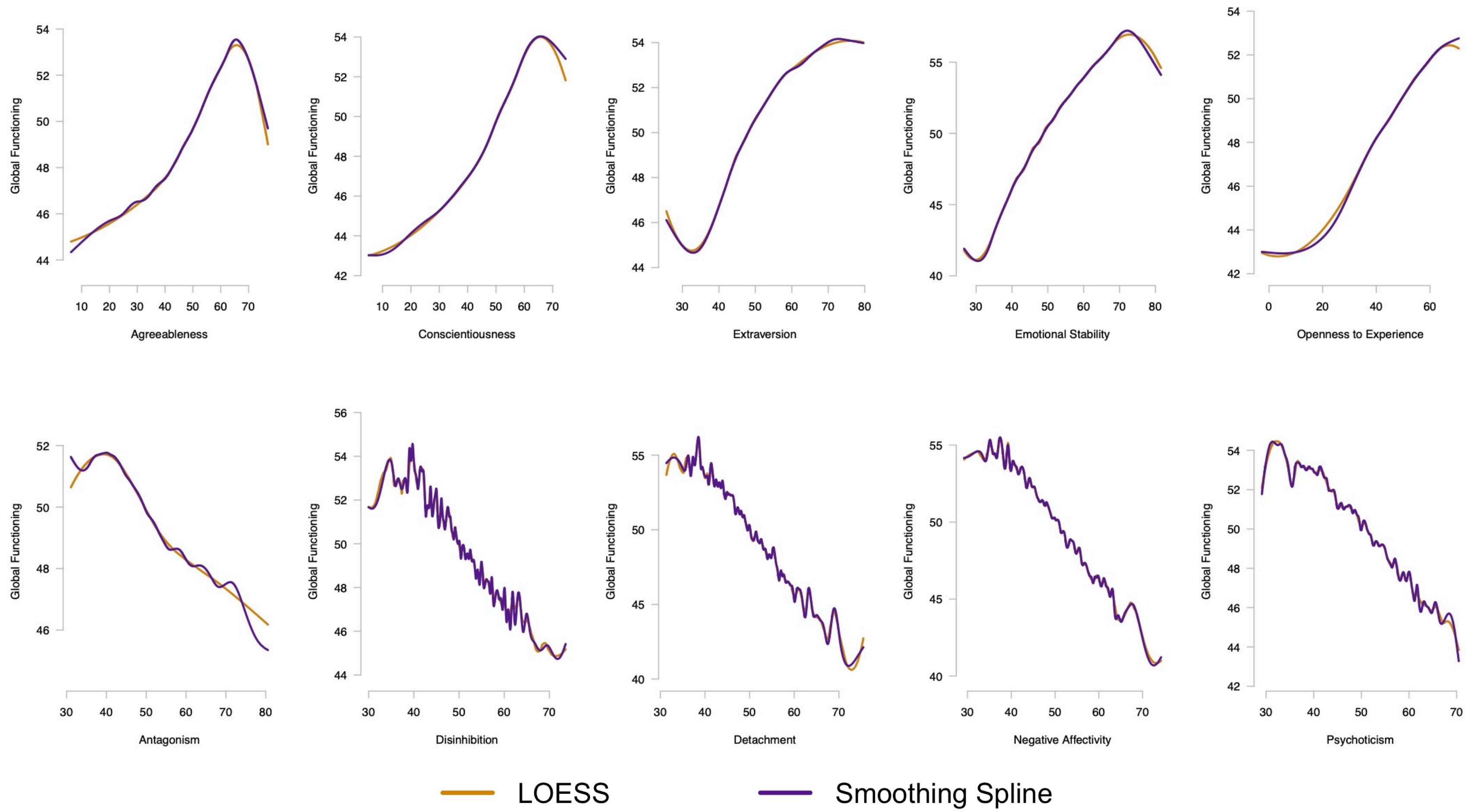
LOESS Models – SPI Openness to Experience and PID-5 Psychoticism Predicting Domains of Functioning (Sample 1)



Note. Model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation. Mean functioning score plotted on *y*-axis; differently colored lines correspond to the four PROMIS domains of functioning. PID-5 domain was depicted on the right side of the SPI domain to demonstrate the hypothesized trait spectrum underlying the pair of domains.

Figure 13

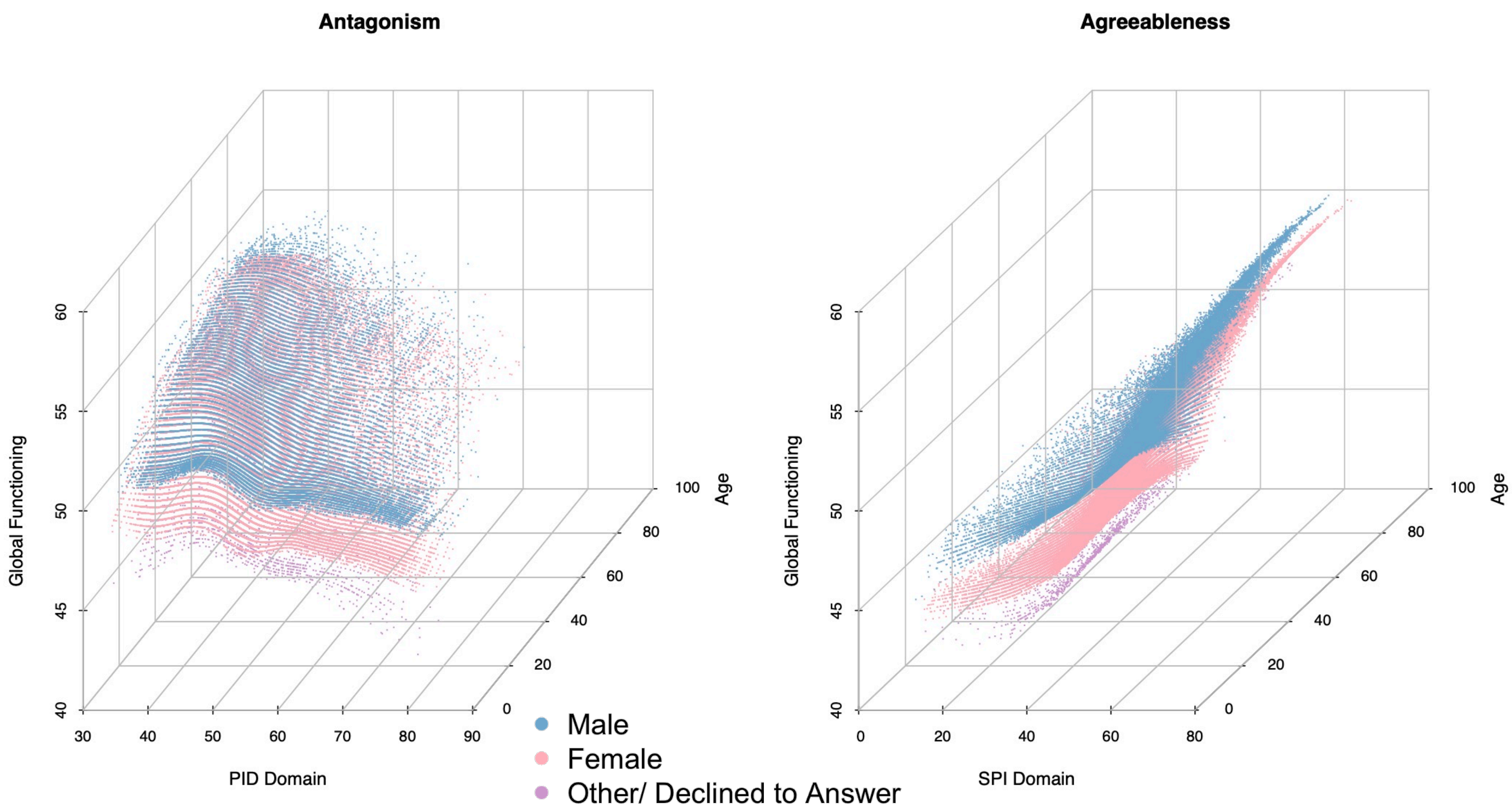
Comparison of LOESS and Smoothing Spline Models (Sample 1)



Note. LOESS model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Smoothing spline estimated using knots = 100 and using generalized cross-validation to minimized smoothing parameters. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 14

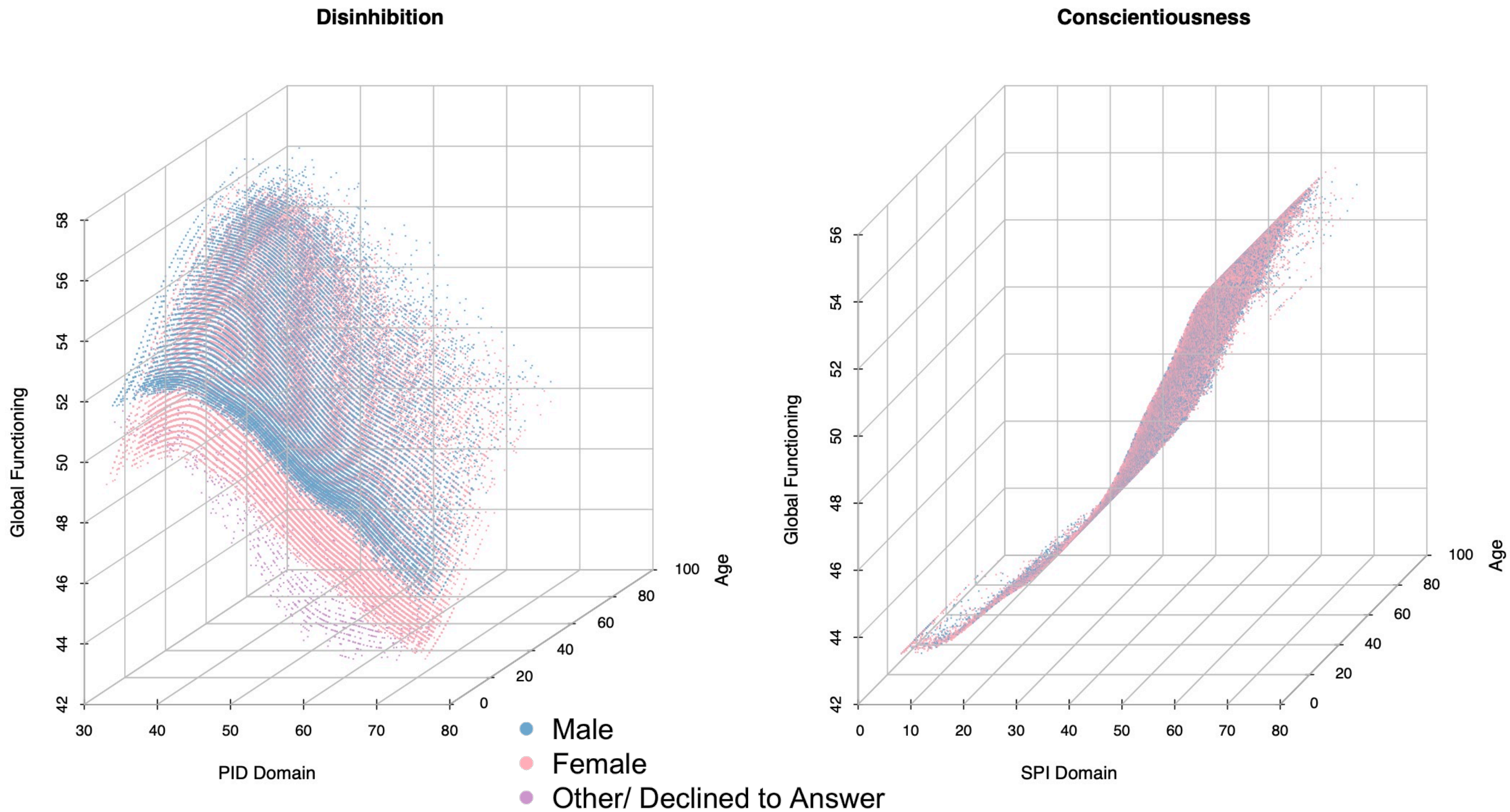
*SSANOVA Models –Trait*Age*Sex Predicting Global Functioning, PID-5 Antagonism and SPI Agreeableness (Sample 1)*



Note. Full-term SSANOVA models plotted (trait*age*sex). Agreeableness full-term interaction model retained (Agreeableness*age*sex). Antagonism full-term model not retained (reduced terms = Antagonism*age + age*sex). Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 15

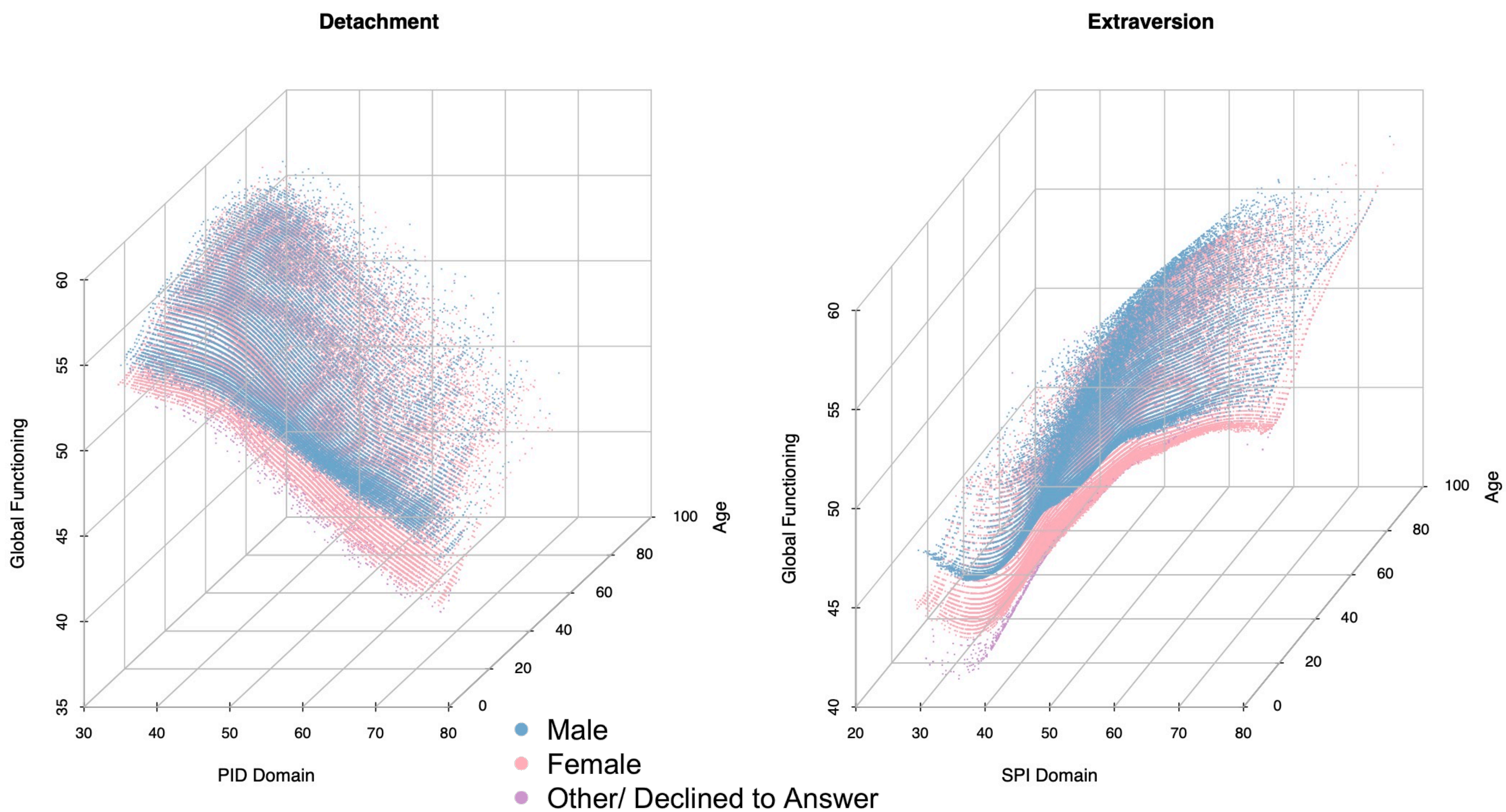
*SSANOVA Models –Trait*Age*Sex Predicting Global Functioning, PID-5 Disinhibition and SPI Conscientiousness (Sample 1)*



Note. Full-term SSANOVA models plotted (trait*age*sex). Conscientiousness full-term interaction model retained (Conscientiousness*age*sex). Disinhibition full-term model retained (Disinhibition*age*sex). Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 16

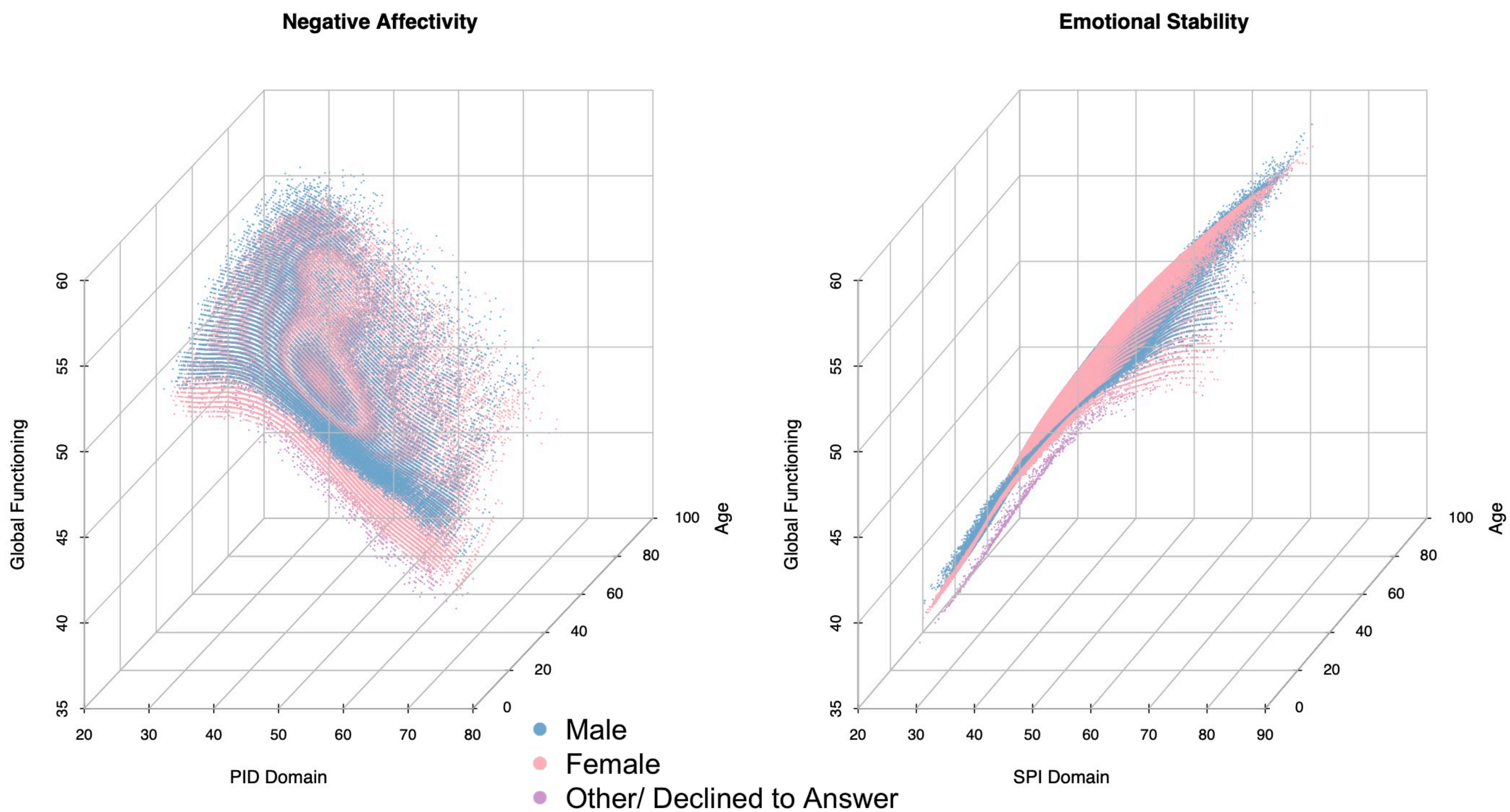
*SSANOVA Models –Trait*Age*Sex Predicting Global Functioning, PID-5 Detachment and SPI Extraversion (Sample 1)*



Note. Full-term SSANOVA models plotted (trait*age*sex). Extraversion full-term interaction model not retained (reduced terms = Extraversion + age*sex). Detachment full-term model not retained (reduced terms = Detachment*age + age*sex). Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 17

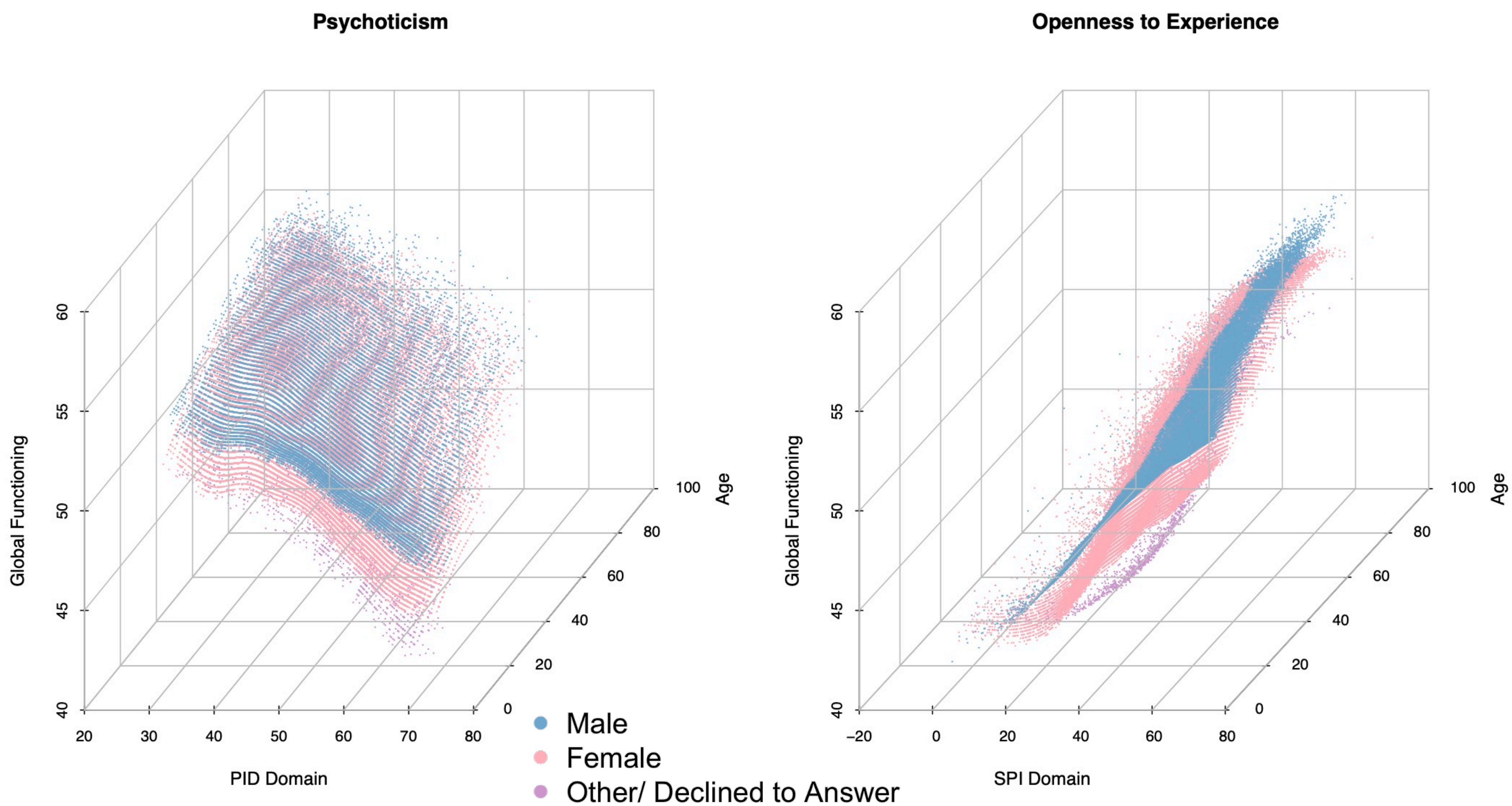
*SSANOVA Models –Trait*Age*Sex Predicting Global Functioning, PID-5 Negative Affectivity and SPI Emotional Stability (Sample 1)*



Note. Full-term SSANOVA models plotted (trait*age*sex). Emotional Stability full-term interaction model not retained (reduced terms = Emotional Stability*age + Emotional Stability*sex + age*sex). Negative Affectivity full-term model not retained (reduced terms = Negative Affectivity*age + age*sex). Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 18

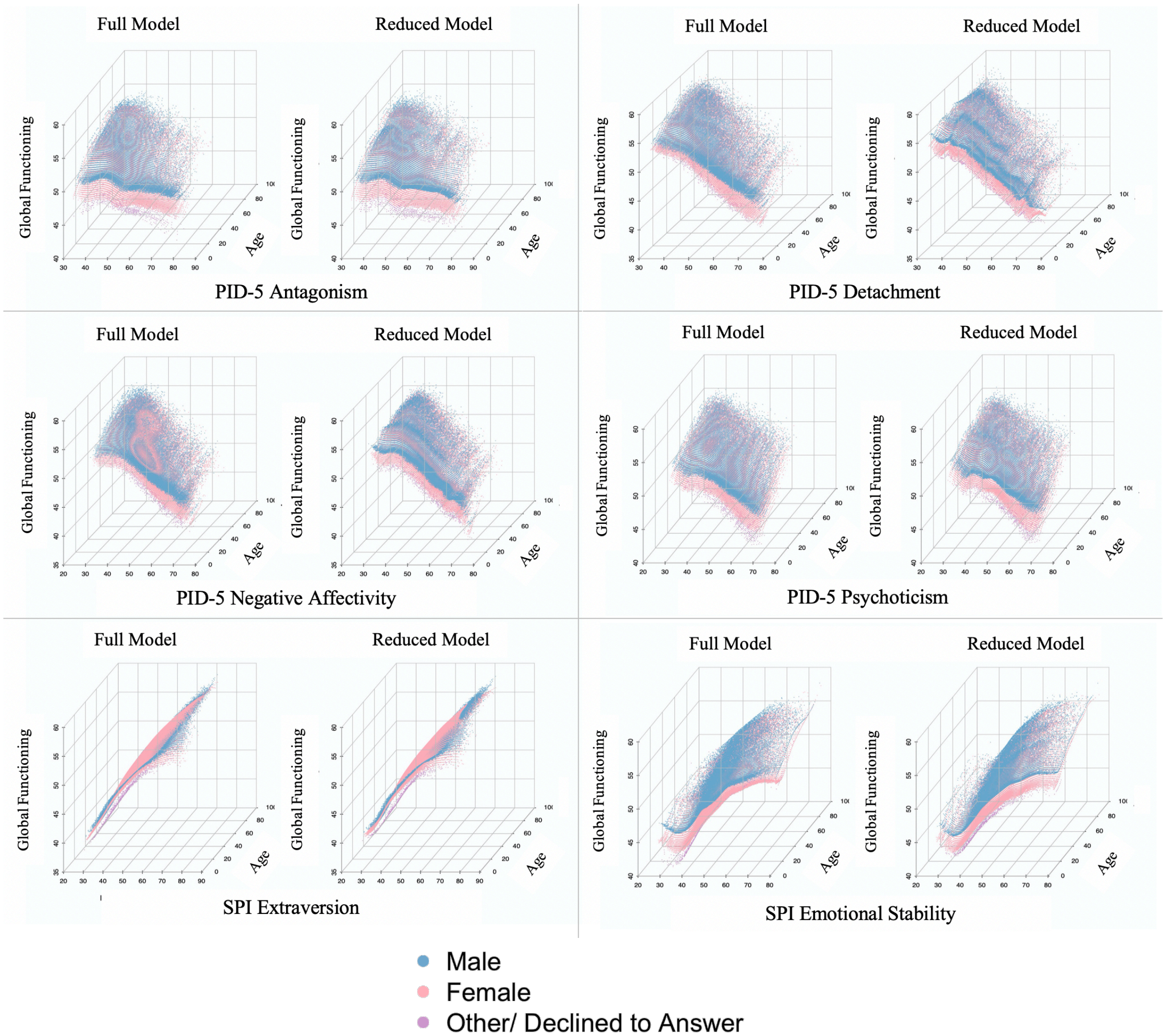
*SSANOVA Models –Trait*Age*Sex Predicting Global Functioning, PID-5 Psychoticism and SPI Openness to Experience (Sample 1)*



Note. Full-term SSANOVA models plotted (trait*age*sex). Openness to Experience full-term interaction model retained (Openness to Experience*age*sex). Psychoticism full-term model not retained (reduced terms = Psychoticism*age + Psychoticism*sex + age*sex). Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 19

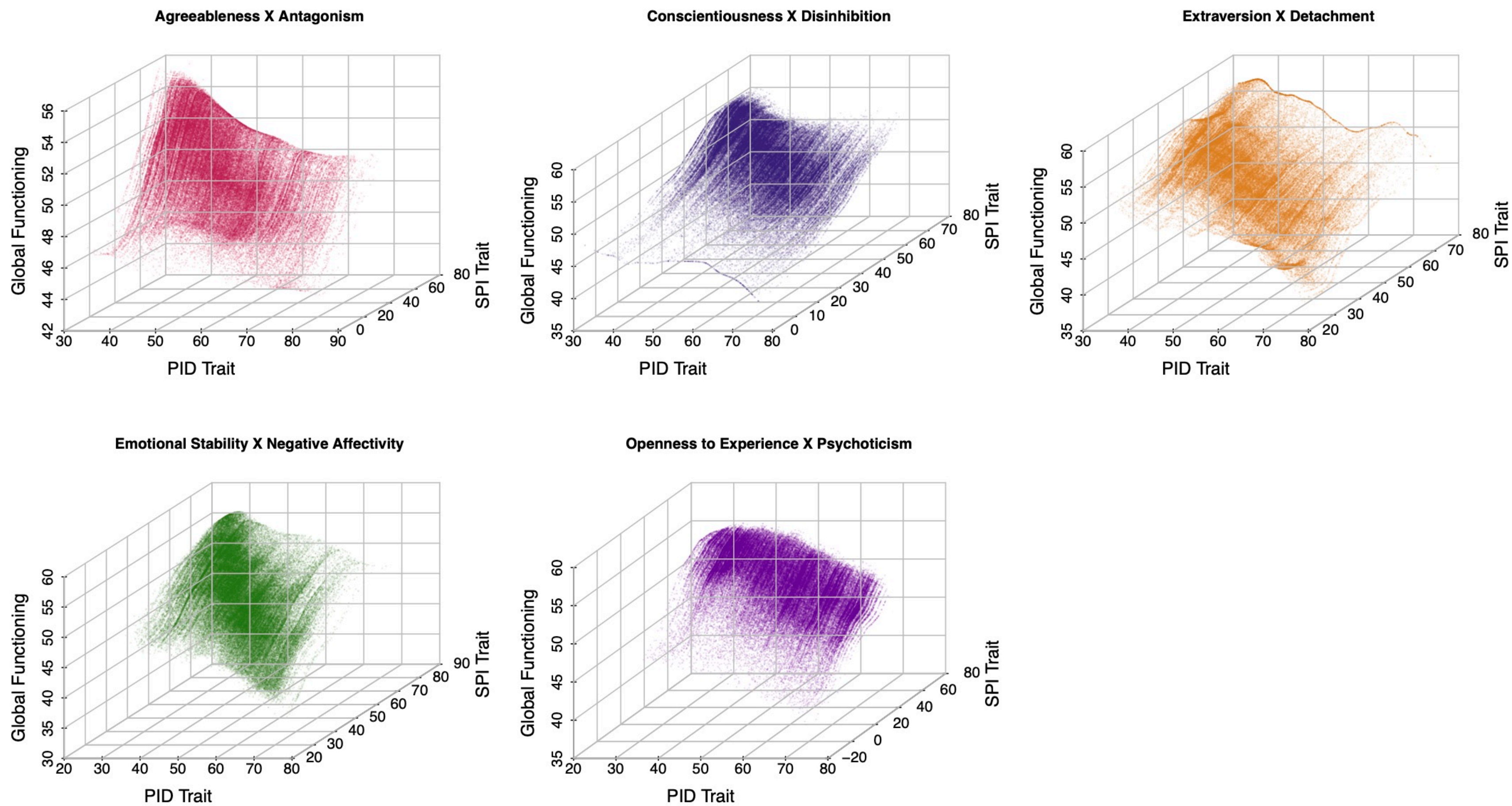
*Comparison of Full-Term versus Reduced-Term SSANOVA, Trait*Age*Sex Plots (Sample 1)*



Note. Full-term model = trait*age*sex. PID-5 Antagonism reduced-term model = Antagonism*age + age*sex; PID-5 Detachment reduced-term model = Detachment*age + age*sex; PID-5 Negative Affectivity reduced-term model = Negative Affectivity*age + age*sex; PID-5 Psychoticism reduced-term model = Psychoticism*age + Psychoticism*sex + age*sex; SPI Extraversion reduced-term model = Extraversion + age*sex; SPI Emotional Stability reduced-term model = Emotional Stability*age + Emotional Stability*sex + age*sex. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 20

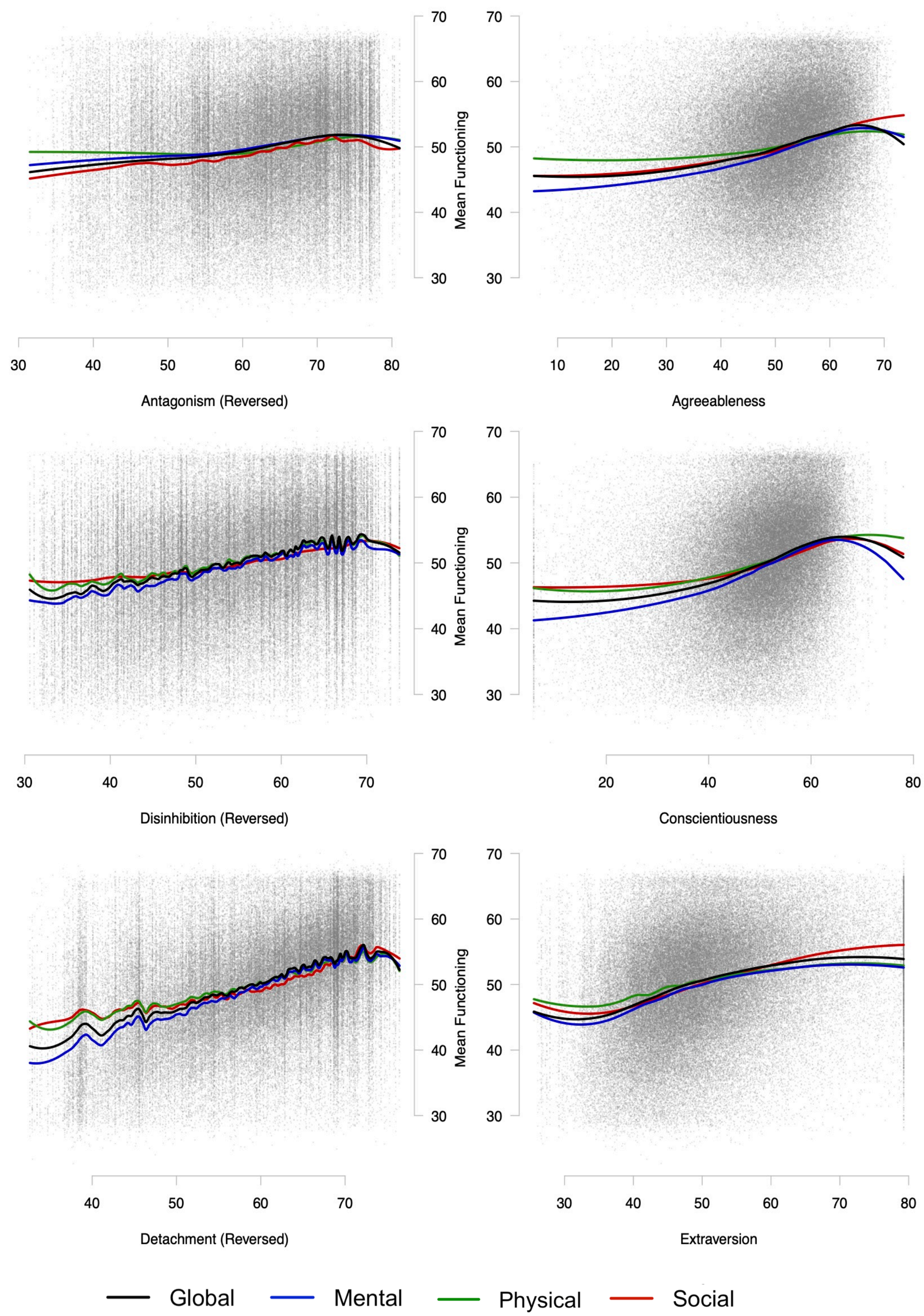
SSANOVA Interaction Models – SPI and PID-5 Domain Pairs Predicting Global Functioning (Sample 1)

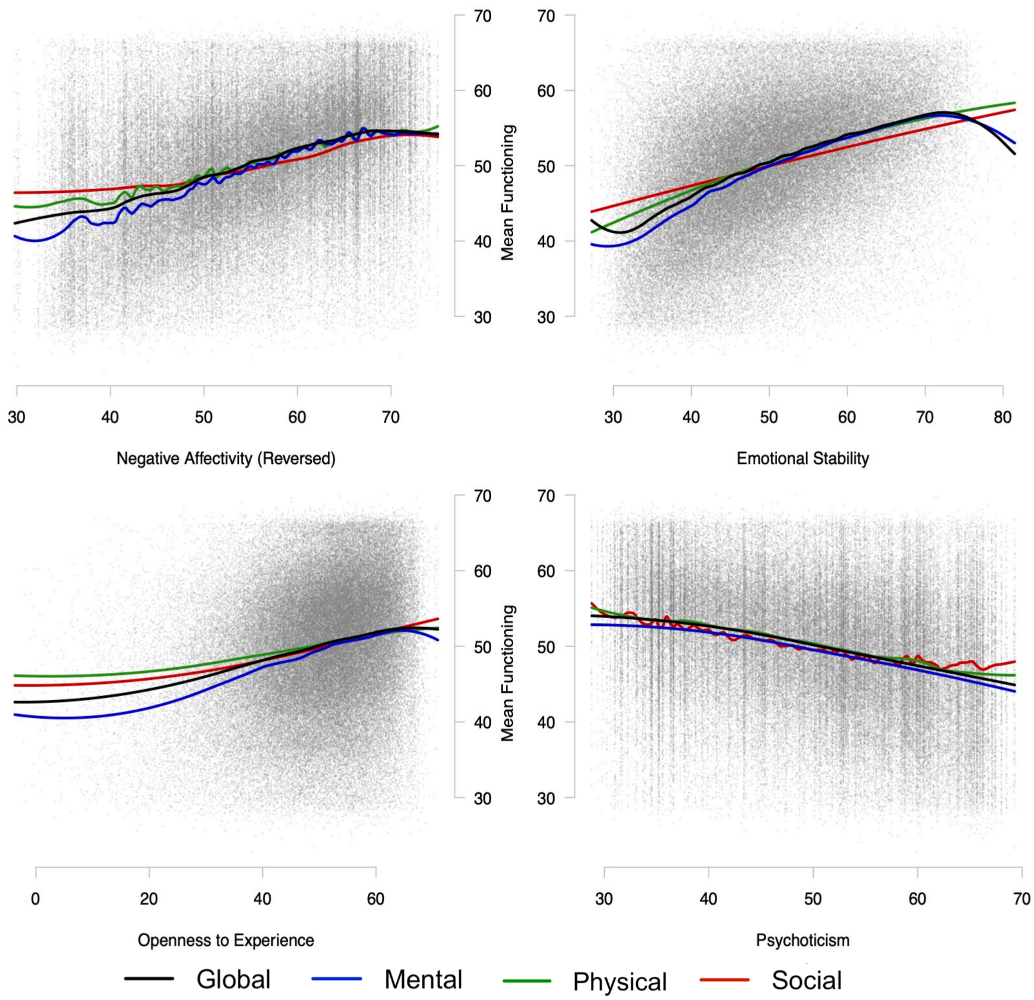


Note. Interactive model retained for all domain pairs. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

Figure 21

LOESS Models – SPI and PID-5 Domains Predicting Domains of Functioning (Sample 2)

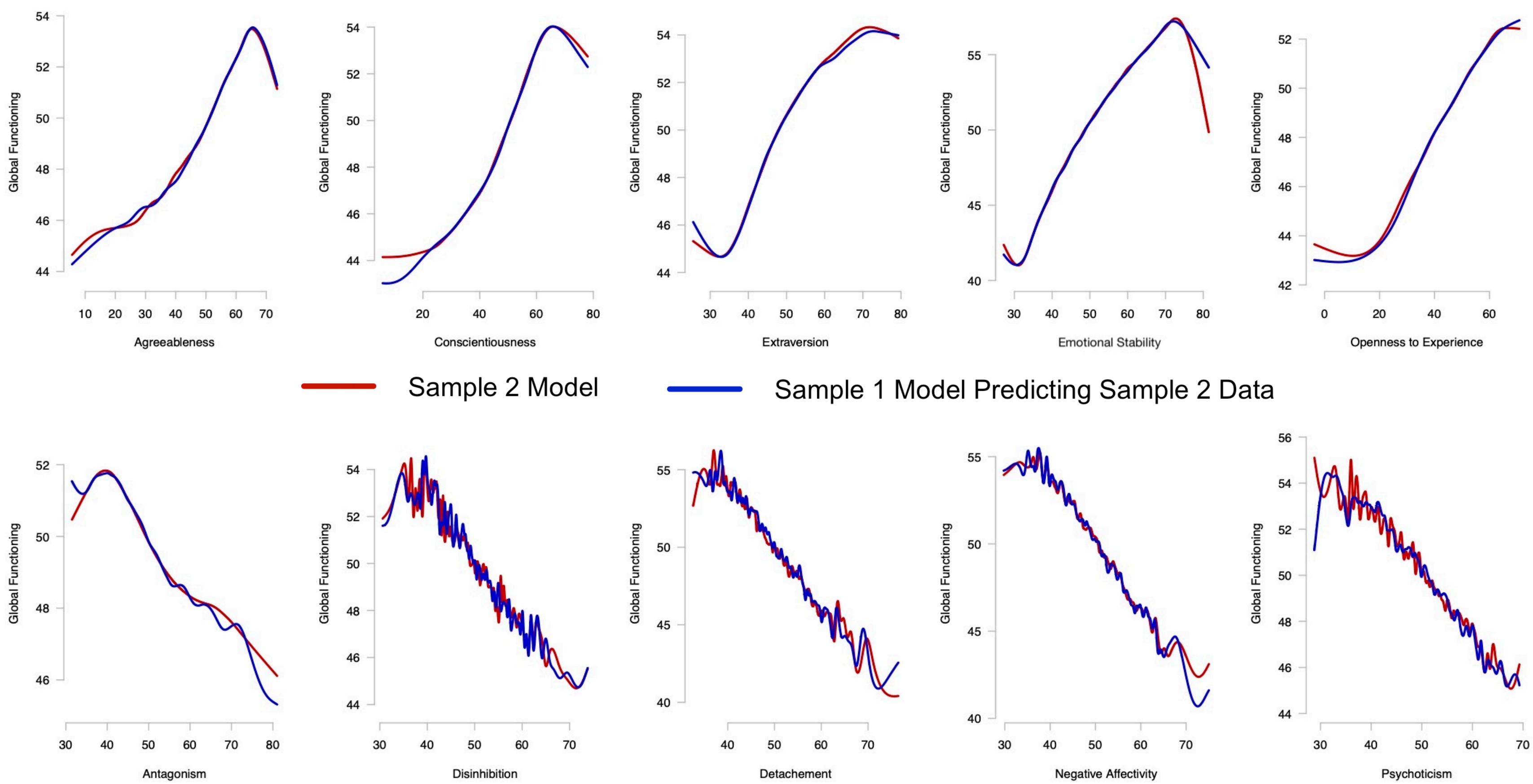




Note. Model estimated using degree = 2 and span which minimized generalized cross-validation criteria. Traits item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation. Mean functioning score plotted on *y*-axis; differently colored lines correspond to the four PROMIS domains of functioning. PID-5 domains reversed, when appropriate, and placed on appropriate end of SPI domain spectrum in order to demonstrate the hypothesized trait spectrum underlying the pair of domains.

Figure 22

Comparison of Sample 2 Smoothing Spline Model versus Sample 1 Smoothing Spline Model Predicting Sample 2 Data



Note. Mean-squared differences between the Sample 2 model predicted score and Sample 1 model predicted score = .01, .02, .01, .01, .01, .02, .42, .46, .14, and .21 (corresponding with plots as they are read from left to right). Smoothing spline in both samples estimated using knots = 100 and using generalized cross-validation to minimized smoothing parameters. Traits in both samples item-pruned, IRT-scored, and T-scored, and missing values were replaced using multiple imputation.

References

Al-Dajani, N., Gralnick, T. M., & Bagby, R. M. (2016). A psychometric review of the Personality Inventory for DSM–5 (PID–5): Current status and future directions. Journal of Personality Assessment, 98, 62-81.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-5 (5th ed.). Arlington, VA: American Psychiatric Publishing.

Ball, S. A. (2001). Reconceptualizing personality disorder categories using personality trait dimensions: Introduction to special section. Journal of Personality, 69, 147-153.

Bagby, R. M., Costa, P. T., McCrae, R. R., Livesley, W. J., Kennedy, S. H., Levitan, R. D., Levitt, A. J., Joffe, R. T., & Young, L. T. (1999). Replicating the five factor model of personality in a psychiatric sample. Personality and Individual Differences, 27, 1135-1139.

Blanco, C., Krueger, R. F., Hasin, D. S., Liu, S. M., Wang, S., Kerridge, B. T., Saha, T., & Olfson, M. (2013). Mapping common psychiatric disorders: Structure and predictive validity in the NESARC. JAMA Psychiatry, 70, 199-208.

Blashfield, R. K. (1984). Classification of psychopathology. New York, NY: Plenum.

Carle, A. C., Riley, W., Hays, R. D., & Cella, D. (2015). Confirmatory factor analysis of the patient-reported outcomes measurement information system (PROMIS) adult domain framework using item response theory scores. Medical care, 53(10), 894.

Carter, N. T., Guan, L., Maples, J. L., Williamson, R. L., & Miller, J. D. (2016). The downsides of extreme conscientiousness for psychological wellbeing: The role of obsessive compulsive tendencies. Journal of Personality, 84(4), 510-522.

Caspi, A., Houts, R. M., Belsky, D. W., Goldman-Mellor, S. J., Harrington, H., Israel, S., ... & Moffitt, T. E. (2014). The p factor: one general psychopathology factor in the structure of psychiatric disorders? Clinical Psychological Science, 2, 119-137.

Cella, D., Riley, W., Stone, A., Rothrock, N., Reeve, B., Yount, S., ... & Cook, K. (2010). The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. Journal of Clinical Epidemiology, 63(11), 1179-1194.

Cella, D., Yount, S., Rothrock, N., Gershon, R., Cook, K., Reeve, B., … Rose, M. (2007). The Patient-Reported Outcomes Measurement Information System (PROMIS): Progress of an NIH Roadmap Cooperative Group During its First Two Years. Medical Care, 45(5 Suppl 1), S3–S11.

Chang, E. C., Watkins, A., & Banks, K. H. (2004). How Adaptive and Maladaptive Perfectionism Relate to Positive and Negative Psychological Functioning: Testing a Stress-Mediation Model in Black and White Female College Students. Journal of Counseling Psychology, 51(1), 93.

Chmielewski, M., Bagby, R. M., Markon, K., Ring, A. J., & Ryder, A. G. (2014). Openness to experience, intellect, schizotypal personality disorder, and psychoticism: Resolving the controversy. Journal of Personality Disorders, 28, 1-17.

Clark, L. A. (2005). Temperament as a unifying basis for personality and psychopathology. Journal of Abnormal Psychology, 114, 505-521.

Clark, L. A. (2007). Assessment and diagnosis of personality disorder: Perennial issues and an emerging reconceptualization. Annual Review of Psychology, 58, 227-257.

Cleveland, W. S. (1979). Robust locally weighted regression and smoothing scatterplots. Journal of the American Statistical Association, 74(368), 829-836.

Cleveland, W. S., & Devlin, S. J. (1988). Locally weighted regression: an approach to regression analysis by local fitting. Journal of the American Statistical Association, 83(403), 596-610.

Coker, L. A., Samuel, D. B., & Widiger, T. A. (2002). Maladaptive personality functioning within the Big Five and the Five-Factor model. Journal of Personality Disorders, 16, 385-401.

Condon, D. M. (2018, January 10). The SAPA Personality Inventory: An empirically-derived, hierarchically-organized self-report personality assessment model. https://doi.org/10.31234/osf.io/sc4p9

Costa, P. T., & McCrae, R. R. (1990). Personality disorders and the five-factor model of personality. Journal of Personality Disorders, 4, 362-371.

Craven, P., & Wahba, G. (1978). Smoothing noisy data with spline functions. Numerische mathematik, 31(4), 377-403.

Crego, C., Oltmanns, J. R., & Widiger, T. A. (2020). Obtaining and losing the bipolarity of the five-factor model through factor analysis. Personality Disorders: Theory, Research, and Treatment, 11(2), 119–130.

DeYoung, C. G., Grazioplene, R. G., & Peterson, J. B. (2012). From madness to genius: The Openness/Intellect trait domain as a paradoxical simplex. Journal of Research in Personality, 46, 63-78.

Digman, J. M. (1990). Personality structure: Emergence of the five-factor model. Annual Review of Psychology, 41, 417-440.

Eisenberg, N., Fabes, R. A., Guthrie, I. K., & Reiser, M. (2000). Dispositional emotionality and regulation: their role in predicting quality of social functioning. Journal of Personality and Social Psychology, 78(1), 136.

Enns, M. W., Cox, B. J., & Clara, I. (2002). Adaptive and maladaptive perfectionism: Developmental origins and association with depression proneness. Personality and Individual Differences, 33(6), 921-935.

Feighner, J. P., Robins, E., Guze, S. B., Woodruff, R. A., Winokur, G., & Munoz, R. (1972). Diagnostic criteria for use in psychiatric research. Archives of General Psychiatry, 26, 57-63.

Finch, J. F., Baranik, L. E., Liu, Y., & West, S. G. (2012). Physical health, positive and negative affect, and personality: A longitudinal analysis. Journal of Research in Personality, 46(5), 537-545.

Forbush, K., & Watson, D. (2012). The structure of common and uncommon mental disorders. Psychological Medicine, 43, 1-12.

Fox, J. (2019). polycor: Polychoric and Polyserial Correlations. R package version 0.7-10. Retrieved from: https://CRAN.R-project.org/package=polycor

Fox, J. & Weisberg, S. (2019). An {R} Companion to Applied Regression, Third Edition. Thousand Oaks CA: Sage. Retrieved from: https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Gallo, L. C., Smith, T. W., & Ruiz, J. M. (2003). An interpersonal analysis of adult attachment style: Circumplex descriptions, recalled developmental experiences, self-representations, and interpersonal functioning in adulthood. Journal of Personality, 71(2), 141-182.

Genz, A., Bretz, F., Miwa, T., Mi, X., Leisch,F., Scheipl, F., & Hothorn, T. (2019). mvtnorm: Multivariate Normal and t Distributions. R package version 1.0-11. Retrieved from: http://CRAN.R-project.org/package=mvtnorm

Ghaed, S. G., & Gallo, L. C. (2006). Distinctions among agency, communion, and unmitigated agency and communion according to the interpersonal circumplex, five-factor model, and social-emotional correlates. Journal of personality assessment, 86(1), 77-88.

Gifford, R., & O'Connor, B. (1987). The interpersonal circumplex as a behavior map. Journal of Personality and Social Psychology, 52(5), 1019.

Gore, W. L., & Widiger, T. A. (2013). The DSM-5 dimensional trait model and five-factor models of general personality. Journal of Abnormal Psychology, 122, 816-821.

Gu, C. (2014). Smoothing Spline ANOVA Models: R Package gss. Journal of Statistical Software, 58(5), 1-25. Retrieved from: http://www.jstatsoft.org/v58/i05/.

Haigler, E. D., & Widiger, T. A. (2001). Experimental manipulation of NEO-PI-R items. Journal of Personality Assessment, 77, 339-358.

Hahn, E. A., DeVellis, R. F., Bode, R. K., Garcia, S. F., Castel, L. D., Eisen, S. V., ... & PROMIS Cooperative Group. (2010). Measuring social health in the patient-reported outcomes measurement information system (PROMIS): item bank development and testing. Quality of Life Research, 19(7), 1035-1044.

Hays, R. D., Bjorner, J. B., Revicki, D. A., Spritzer, K. L., & Cella, D. (2009). Development of physical and mental health summary scores from the patient-reported outcomes measurement information system (PROMIS) global items. Quality of Life Research, 18(7), 873-880.

Hays, R. D., Spritzer, K. L., Schalet, B. D., & Cella, D. (2018). PROMIS®-29 v2. 0 profile physical and mental health summary scores. Quality of life Research, 27(7), 1885-1891.

Helwig, N.E. (2020). npreg: Nonparametric Regression. R package version 1.0-2. Retrieved from: https://CRAN.R-project.org/package=npreg

Helwig, N. E., & Ma, P. (2015). Fast and stable multiple smoothing parameter selection in smoothing spline analysis of variance models with large samples. Journal of Computational and Graphical Statistics, 24(3), 715-732.

Helwig, N. E., & Ma, P. (2016). Smoothing spline ANOVA for super-large samples: Scalable computation via rounding parameters. arXiv preprint arXiv:1602.05208.

Hopwood, C. J., Zimmermann, J., Pincus, A. L., & Krueger, R. F. (2015). Connecting personality structure and dynamics: Towards a more evidence-based and clinically useful diagnostic scheme. Journal of Personality Disorders, 29, 431-448.

Hyman, S. E. (2010). The diagnosis of mental disorders: The problem of reification. Annual Review of Clinical Psychology, 6, 155-179.

Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D. S., Quinn, K., ... & Wang, P. (2010). Research domain criteria (RDoC): Toward a new classification framework for research on mental disorders. American Journal of Psychiatry, 167, 748-751.

Jacoby, W. G. (2000). Loess: a nonparametric, graphical tool for depicting relationships between variables. Electoral Studies, 19(4), 577-613.

Kendler, K. S., Aggen, S. H., Gillespie, N., Neale, M. C., Knudsen, G. P., Krueger, R. F., Czajkowski, N., Ystrom, E., & Reichborn-Kjennerud, T. (2017). The genetic and environmental sources of resemblance between normative personality and personality disorder traits. Journal of Personality Disorders, 31, 193-207.

Kim, H., & Eaton, N. R. (2015). The hierarchical structure of common mental disorders: Connecting multiple levels of comorbidity, bifactor models, and predictive validity. *Journal of abnormal psychology*, *124*(4), 1064.

Kotov, R., Krueger, R. F., Watson, D., Achenbach, T. M., Althoff, R. R., Bagby, R. M., ... & Eaton, N. R. (2017). The Hierarchical Taxonomy of Psychopathology (HiTOP): A dimensional alternative to traditional nosologies. Journal of Abnormal Psychology, 126, 454-477.

Kotov, R., Ruggero, C. J., Krueger, R. F., Watson, D., Yuan, Q., & Zimmerman, M. (2011). New dimensions in the quantitative classification of mental illness. Archives of General Psychiatry, 68, 1003-1011.

Kowarik, A., & Templ, M. (2016). Imputation with the R Package VIM. Journal of Statistical Software, 74(7), 1-16.

Krueger, R. F. (1999). The structure of common mental disorders. Archives of General Psychiatry, 56, 921-926.

Krueger, R. F., Derringer, J., Markon, K. E., Watson, D., & Skodol, A. E. (2012). Initial construction of a maladaptive personality trait model and inventory for DSM-5. Psychological Medicine, 42, 1879-1890.

Krueger, R. F., & Markon, K. E. (2006). Reinterpreting comorbidity: A model-based approach to understanding and classifying psychopathology. Annual Review of Clinical Psychology, 2, 111-133.

Krueger, R. F., & Markon, K. E. (2014). The role of the DSM-5 personality trait model in moving toward a quantitative and empirically based approach to classifying personality and psychopathology. Annual Review of Clinical Psychology, 10, 477-501.

Krueger, R. F., Tackett, J. L., & MacDonald, A. (2016). Toward validation of a structural approach to conceptualizing psychopathology: A special section of the Journal of Abnormal Psychology. Journal of Abnormal Psychology, 125, 1023-1026.

Livesley, W. J. (2001). Commentary on reconceptualizing personality disorder categories using trait dimensions. Journal of Personality, 69, 253-276.

Livesley, W. J., & Jackson, D. N. (1992). Guidelines for developing, evaluating, and revising the classification of personality disorders. Journal of Nervous and Mental Disease, 180, 609-618.

Markon, K. E., Chmielewski, M., & Miller, C. J. (2011). The reliability and validity of discrete and continuous measures of psychopathology: A quantitative review. Psychological Bulletin, 137, 856-879.

McAdams, D. P., & Pals, J. L. (2006). A new Big Five: Fundamental principles for an integrative science of personality. American Psychologist, 61, 204–217.

McCrae, R. R., & Costa, P. T. (1989). The structure of interpersonal traits: Wiggins's circumplex and the five-factor model. Journal of personality and social psychology, 56(4), 586.

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. Journal of Personality, 60(2), 175–215.

Michon, H. W. C., Ten Have, M., Kroon, H., Van Weeghel, J., De Graaf, R., & Schene, A. H. (2008). Mental disorders and personality traits as determinants of impaired work functioning. Psychological Medicine, 38(11), 1627-1637.

Milgram, N., & Tenne, R. (2000). Personality correlates of decisional and task avoidant procrastination. European journal of Personality, 14(2), 141-156.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., ... & Sears, M. R. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. Proceedings of the national Academy of Sciences, 108(7), 2693-2698.

Ones, D. S. (2005). Personality at work: Raising awareness and correcting misconceptions. Human Performance, 18(4), 389-404.

Österberg, K., Persson, R., Karlson, B., Eek, F. C., & Örbaek, P. (2007). Personality, mental distress, and subjective health complaints among persons with environmental annoyance. Human & Experimental Toxicology, 26(3), 231-241.

Ozer, D. J., & Benet-Martinez, V. (2006). Personality and the prediction of consequential outcomes. Annu. Rev. Psychol., 57, 401-421.

Paunonen, S. V. (2003). Big Five factors of personality and replicated predictions of behavior. Journal of Personality and Social Psychology, 84(2), 411–424.

Perez, G.A. & Cheda, A.L. (2014). PLRModels: Statistical inference in partial linear regression models. R package version 1.1. Retrieved from: https://CRAN.R-project.org/package=PLRModels

PROMIS (2017) Retrieved from http://www.healthmeasures.net/explore-measurement-systems/promis

R Core Team (2019). R: A language and environment for statistical computing. [Computer Software]. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from: https://www.R-project.org/.

Reeve, B. B., Hays, R. D., Bjorner, J. B., Cook, K. F., Crane, P. K., Teresi, J. A., ... & Liu, H. (2007). Psychometric evaluation and calibration of health-related quality of life item banks: plans for the Patient-Reported Outcomes Measurement Information System (PROMIS). Medical Care, 45(5), S22-S31.

Rettew, D. (2013). Child temperament. New York, NY: Norton.

Revelle, W. (2018) psych: Procedures for Personality and Psychological Research. Version = 1.8.12. Evanston, Illinois, USA: Northwestern University. Retrieved from: https://CRAN.R-project.org/package=psych.

Revelle, W., Condon, D.M., & Wilt, J. (2011). Methodological advances in differential psychology. In T. Chamorro-Premuzic, S. von Stumm, & A. Furnham (Eds.), The Wiley-Blackwell Handbook of Individual Differences (p. 39-72). Malden, Massachusetts: Blackwell Publishing Ltd.

Revelle, W. & Laun, G. (2004). Synthetic aperture personality assessment: a progress report and a proposal. Presented at the annual meeting of the Society of Multivariate Experimental Psychology, October, 2004.

Revelle, W., Wilt, J., & Rosenthal, A. (2010). Individual differences in cognition: New methods for examining the personality-cognition link. In A. Gruszka, G. Matthews, & B. Szymura (Eds.), Handbook of Individual Differences in Cognition: Attention, Memory and Executive control (p. 27-49). Springer.

Reynolds, S. K., & Clark, L. A. (2001). Predicting dimensions of personality disorder from domains and facets of the five factor model. Journal of Personality, 69, 199-222.

Rizopoulos, D. (2006). ltm: An R package for Latent Variable Modelling and Item Response Theory Analyses. Journal of Statistical Software, 17 (5), 1-25. Retrieved from: http://www.jstatsoft.org/v17/i05/

Roberts, B. W., Kuncel, N. R., Shiner, R., Caspi, A., & Goldberg, L. R. (2007). The power of personality: The comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. Perspectives on Psychological Science, 2(4), 313-345.

Rodriguez-Seijas, C., Ruggero, C., Eaton, N. R., & Krueger, R. F. (2019). The DSM-5 Alternative Model for Personality Disorders and Clinical Treatment: a Review. Current Treatment Options in Psychiatry, 1-15.

Rojas, S. L., Crego, C., & Widiger, T. A. (2019). A conceptual dismantling of the Five Factor Form: Lexical support for the bipolarity of maladaptive personality structure. Journal of Research in Personality, 80, 62-71.

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. Journal of Statistical Software, 48(2), 1-36. Retrieved from: http://www.jstatsoft.org/v48/i02/.

Rubin, D. B. (1987). Multiple imputation for nonresponse in surveys. New York: Wiley.

Ruggero, C. J., Kotov, R., Hopwood, C. J., First, M., Clark, L. A., Skodol, A. E., ... & Docherty, A. (2019). Integrating the Hierarchical Taxonomy of Psychopathology (HiTOP) into clinical practice. Journal of Consulting and Clinical Psychology, 87(12), 1069.

Samejima, F. (1968). Estimation of latent ability using a response pattern of graded scores. ETS Research Report Series.

Samejima, F. (1997). Graded response model. In Handbook of modern item response theory (pp. 85-100). Springer New York.

Samuel, D. B., & Widiger, T. A. (2011). Conscientiousness and obsessive-compulsive personality disorder. Personality Disorders: Theory, Research, and Treatment, 2(3), 161.

Samuel, D. B., & Widiger, T. A. (2006). Clinicians' judgments of clinical utility: A comparison of the DSM-IV and five-factor models. Journal of Abnormal Psychology, 115, 298-308.

Saulsman, L. M., & Page, A. C. (2004). The five-factor model and personality disorder empirical literature: A meta-analytic review. Clinical psychology review, 23(8), 1055-1085.

Shiner, R. L., Masten, A. S., & Roberts, J. M. (2003). Childhood personality foreshadows adult personality and life outcomes two decades later. Journal of personality, 71(6), 1145-1170.

Smith, T. W. (2006). Personality as risk and resilience in physical health. Current directions in psychological science, 15(5), 227-231.

Suzuki, T., Griffin, S. A., & Samuel, D. B. (2017). Capturing the DSM-5 alternative personality disorder model traits in the five-factor model's nomological net. Journal of Personality, 85, 220-231.

Suzuki, T., Samuel, D. B., Pahlen, S., & Krueger, R. F. (2015). DSM-5 alternative personality disorder model traits as maladaptive extreme variants of the five-factor model: An item-response theory analysis. Journal of Abnormal Psychology, 124, 343-354.

Thimm, J. C., Jordan, S., & Bach, B. (2017). Hierarchical structure and cross-cultural measurement invariance of the Norwegian version of the personality inventory for DSM–5. Journal of personality assessment, 99(2), 204-210.

Thomas, K. M., Yalch, M. M., Krueger, R. F., Wright, A. G. C., Markon, K. E., & Hopwood, C. J. (2013). The convergent structure of DSM-5 personality trait facets and Five-Factor Model trait domains. Assessment, 20, 308-311.

Van Heck, G. L. (1997). Personality and physical health: toward an ecological approach to health-related personality research. European Journal of Personality, 11(5), 415-443.

van Buuren, S. & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. Journal of Statistical Software, 45(3), 1-67. Retrieved from: https://www.jstatsoft.org/v45/i03/.

Venables, W. N. & Ripley, B. D. (2002) Modern Applied Statistics with S. Fourth Edition. Springer, New York.

Wang, X. (2010). fANCOVA: Nonparametric Analysis of Covariance. R package version 0.5-1. Retrived from: https://CRAN.R-project.org/package=fANCOVA

Warner, M. B., Morey, L. C., Finch, J. F., Gunderson, J. G., Skodol, A. E., Sanislow, C. A., ... & Grilo, C. M. (2004). The longitudinal relationship of personality traits and disorders. Journal of Abnormal Psychology, 113, 217-227.

Watson, D., Stasik, S. M., Ro, E., & Clark, L. A. (2013). Integrating normal and pathological personality: Relating the DSM-5 trait-dimensional model to general traits of personality. Assessment, 20, 312-326.

Wickham, H. (2011). The Split-Apply-Combine Strategy for Data Analysis. Journal of Statistical Software, 40(1), 1-29. Retrieved from: http://www.jstatsoft.org/v40/i01/.

Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

Wickham, H. & Henry, L. (2020). tidyr: Tidy Messy Data. R package version 1.0.3. Retrived from: https://CRAN.R-project.org/package=tidyr

Wickham, H., Hester, J., & Chang, W. (2019). devtools: Tools to Make Developing R Packages Easier. R package version 2.2.0. Retrieved from: https://CRAN.R-project.org/package=devtools

Widiger, T. A. (2011). Personality and psychopathology. World Psychiatry, 10, 103-106.

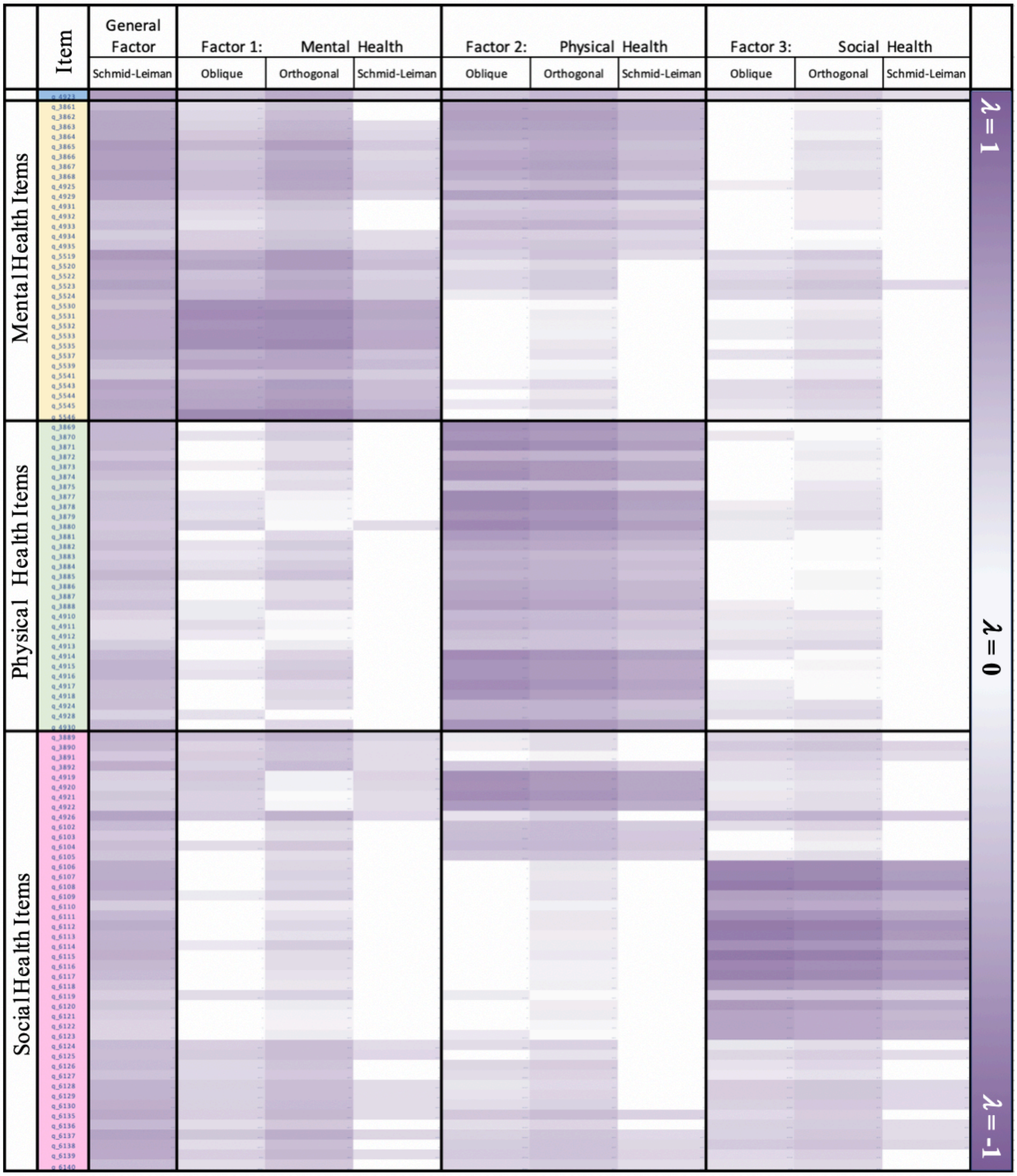
Widiger, T. A., & Clark, L. A. (2000). Toward DSM-V and the classification of psychopathology. Psychological Bulletin, 126, 946-963.

Widiger, T. A., & Costa Jr, P. T. (1994). Personality and personality disorders. Journal of Abnormal Psychology, 103(1), 78.

Widiger, T. A., Costa, P. T., Gore, W. L., & Crego, C. (2012). Five-factor model personality disorder research. In P. T. Costa & T. A. Widiger (Eds.), Personality

disorders and the five-factor model of personality (2nd ed., pp. 59-87). Washington, DC: American Psychological Association.
Widiger, T. A., & Crego, C. (2019). The bipolarity of normal and abnormal personality structure: Implications for assessment. Psychological Assessment, 31(4), 420.
Widiger, T. A., Gore, W. L., Crego, C., Rojas, S. L., & Oltmanns, J. R. (2017). Five-factor model and personality disorder. In T.A. Widiger (Ed.). The Oxford handbook of the five factor model. (pp. 449-478). New York, NY: Oxford University Press.
Widiger, T. A., & Mullins-Sweatt, S. N. (2009). Five factor model of personality disorder: A proposal for DSM-V. Annual Review of Clinical Psychology, 5, 197-220.
Widiger, T. A., Sellbom, M., Chmielewski, M., Clark, L. A., DeYoung, C. G., Kotov, R., ... & Samuel, D. B. (2019). Personality in a hierarchical model of psychopathology. Clinical Psychological Science, 7(1), 77-92.
Wilt, J., Condon, D.M., & Revelle, W. (2011). Telemetrics and data collection: Collecting data at a distance. In B. Laursen, T.D. Little, & N.A. Card (Eds.), The Handbook of Developmental Research Methods (Edition 1, pp. 163-180). New York, New York: The Guilford Press.
Wood, S.N. (2017) Generalized Additive Models: An Introduction with R (2nd edition). Chapman and Hall/CRC.
Wright, A. G. C., Krueger, R. F., Hobbs, M. J., Markon, K. E., Eaton, N. R., & Slade, T. (2013). The structure of psychopathology: Toward an expanded quantitative empirical model. Journal of Abnormal Psychology, 122, 281-294.
Wright, A. G., Thomas, K. M., Hopwood, C. J., Markon, K. E., Pincus, A. L., & Krueger, R. F. (2012). The hierarchical structure of DSM-5 pathological personality traits. Journal of Abnormal Psychology, 121, 951-957.
Wright, A. G., & Simms, L. J. (2014). On the structure of personality disorder traits: Conjoint analyses of the CAT-PD, PID-5, and NEO-PI-3 trait models. Personality Disorders: Theory, Research, and Treatment, 5, 43-54.
Wright, Z. E. & Krueger, R.F. (2017) Personality disorder. In A. Wenzel (Ed.), The SAGE Encyclopedia of Abnormal and Clinical Psychology. Thousand Oaks, CA: SAGE Publications.
Wright, Z. E., Pahlen, S., & Krueger, R. F. (2017). Genetic and environmental influences on Diagnostic and Statistical Manual of Mental Disorders- Fifth Edition (DSM–5) maladaptive personality traits and their connections with normative personality traits. Journal of Abnormal Psychology, 126, 416-428.
Wright, Z. E. & Krueger, R.F. (2018). Pathological personality traits: The movement towards dimensional approaches to psychopathology. In V. Zeigler-Hill & T.K. Shackelford (Eds.), The SAGE Handbook of Personality and Individual Differences. Thousand Oaks, CA: SAGE Publications.
Zimmermann, J., Altenstein, D., Krieger, T., Holtforth, M. G., Pretsch, J., Alexopoulos, J., ... & Leising, D. (2014). The structure and correlates of self-reported DSM-5 maladaptive personality traits: Findings from two German-speaking samples. Journal of Personality Disorders, 28(4), 518-540.

Appendix A
Visualization of PROMIS Items Loadings on Functioning Domains for Oblique, Orthogonal, and Schmid-Leiman Models



Note. λ = level of factor loading. Items split into presumed Mental Health (yellow), Physical Health (green), and Social Health (pink) items, with one uniquely Global Health item (blue). First column represents the magnitude of item loadings on general, hierarchical factor from a Schmid-Leiman rotation. Next three columns are the magnitudes of the loadings onto the presumed Mental Health factor for the three-factor oblique, orthogonal, and Schmid-Leiman rotations, respectively. This pattern is repeated twice more for the presumed Physical Health factor and Social Health factor.

Appendix B
PROMIS Items with Lower Loadings on Anticipated Domain for Oblique, Orthogonal, and Schmid-Leiman Models

PROMIS Scale	Item Content	A Priori Domain (λ)	Nwq Domain (λ)	General Factor λ
Profile 29	In the past 7 days I felt fearful.	Mental (0.18)	Physical (0.36)	0.44
Profile 29	In the past 7 days I found it hard to focus on anything other than my anxiety.	Mental (0.21)	Physical (0.39)	0.53
Profile 29	In the past 7 days my worries overwhelmed me.	Mental (0.30)	Physical (0.45)	0.54
Profile 29	In the past 7 days I felt uneasy.	Mental (0.34)	Physical (0.43)	0.53
Profile 29	In the past 7 days I felt helpless.	Mental (0.36)	Physical (0.43)	0.58
Profile 29	In the past 7 days I felt depressed.	Mental (0.38)	Physical (0.46)	0.59
Global Health	In the past 7 days how often have you been bothered by emotional problems such as feeling anxious, depressed, or irritable?	Mental (0.34)	Physical (0.46)	0.55
Anger	In the last 7 days I felt angry.	Mental (0.16)	Physical (0.24)	0.37
Anger	In the last 7 days I felt like I was ready to explode.	Mental (0.15)	Physical (0.30)	0.41
Satisfaction with Social Roles and Activities	I am satisfied with my ability to do things for my family.	Social (0.18)	Mental (0.37)	0.46
Satisfaction with Social Roles and Activities	I feel good about my ability to do things for my friends.	Social (0.25)	Mental (0.29)	0.33
Satisfaction with Social Roles and Activities	I am satisfied with my ability to perform my daily routines.	Social (0.13)	Mental (0.30)	0.48
Profile29	Due to my health I have trouble doing all of my regular leisure activities with others.	Social (0.12)	Physical (0.61)	0.29
Profile29	Due to my health I have trouble doing all of the family activities that I want to do.	Social (0.09)	Physical (0.61)	0.27

Profile29	Due to my health I have trouble doing all of my usual work (include work at home).	Social (0.11)	Physical (0.64)	0.34
Profile29	Due to my health I have trouble doing all of the activities with friends that I want to do.	Social (0.12)	Physical (0.56)	0.30
Ability to Participate in Social Roles & Activities	I have trouble doing all of my regular leisure activities with others.	Social (0.15)	Physical (0.36)	0.41
Ability to Participate in Social Roles & Activities	I have trouble doing all of the family activities I want to do.	Social (0.05)	Physical (0.38)	0.33
Ability to Participate in Social Roles & Activities	I have trouble doing all of my usual work (include work at home).	Social (0.03)	Physical (0.39)	0.40
Ability to Participate in Social Roles & Activities	I have trouble doing all of the activities with friends that I want to do.	Social (0.11)	Physical (0.33)	0.35
Satisfaction Discretionary Social Activities*	In the past 7 days, I am satisfied with my ability to do things for fun at home (like reading, listening to music, etc.).	Social (0.12)	Mental (0.30)	0.41
Satisfaction Discretionary Social Activities*	In the past 7 days, I am satisfied with my ability to do things for my friends.	Social (0.25)	Mental (0.31)	0.40
Satisfaction Discretionary Social Activities*	In the past 7 days, I am satisfied with my ability to do leisure activities.	Social (0.14)	Mental (0.20)	0.41
Satisfaction Discretionary Social Activities*	In the past 7 days, I am satisfied with the amount of time I spend doing leisure activities.	Social (0.11)	Mental (0.19)	0.37
Social Isolation	I feel left out.	Social (0.17)	Physical (0.33)	0.52
Social Isolation	I feel isolated from others.	Social (0.27)	Mental (0.35)	0.56
Social Isolation	I feel isolated even when I am not alone.	Social (0.17)	Physical (0.31)	0.51
Social Isolation	I feel that people avoid talking to me.	Social (0.14)	Physical (0.18)	0.41

Note. λ= factor loading. Factor loadings estimated by averaging the loading of each item onto a given factor across three different three-factor solutions (oblique, orthogonal, and Schmid-Leiman rotations. 28 of 107 items loaded more strongly onto a functioning domain other than the expected domain. *Full scale name = Satisfaction with Participation in Discretionary Social Activities

Appendix C

SPI and PID-5 Items Removed During Item Pruning

Scale	Domain	Item Content
SPI (Invariant Domain Scale)	Agreeableness	I love dangerous situations
	Agreeableness	I seek danger
	Conscientiousness	I believe that we should be tough on crime
	Extraversion	I put on a show to impress people
	Neuroticism	I show my sadness
	Openness to Experience	I like to be thought of as a normal kind of person
	Openness to Experience	I like to get lost in thought
	Openness to Experience	I prefer variety to routine
	Openness to Experience	I rebel against authority
	Openness to Experience	I would hate to be considered odd or strange
	Openness to Experience	I do not enjoy going to art museums
	Openness to Experience	I do not like poetry
	Openness to Experience	I enjoy being thought of as a normal mainstream person
PID-5	Antagonism	I have outstanding qualities that few others possess.
	Antagonism	I've achieved far more than almost anyone I know.
	Detachment	I don't have very long-lasting emotional reactions to things.
	Detachment	I don't get emotional.
	Detachment	I don't show emotions strongly.
	Detachment	I'm just not very interested in having sexual relationships.
	Detachment	I don't get emotional.
	Disinhibition	I avoid risky situations.
	Disinhibition	I've been told that I spend too much time making sure things are exactly in place.
	Disinhibition	I avoid risky sports and activities.
	Disinhibition	People tell me that I focus too much on minor details.
	Disinhibition	I avoid anything that might be even a little bit dangerous.
	Disinhibition	I prefer to play it safe rather than take unnecessary chances.
	Disinhibition	If something I do isn't absolutely perfect, it's simply not acceptable.
	Disinhibition	I don't mind a little risk now and then.

	Disinhibition	People complain about my need to have everything all arranged.
	Disinhibition	Even though it drives other people crazy, I insist on absolute perfection in everything I do.
	Disinhibition	I check things several times to make sure they are perfect.
	Disinhibition	It is important to me that things are done in a certain way.
	Disinhibition	I never take risks.
	Disinhibition	I keep trying to make things perfect, even when I've gotten them as good as they're likely to get.
	Disinhibition	I simply won't put up with things being out of their proper places.
	Disinhibition	I hate to take chances.
	Disinhibition	I have a strict way of doing things.
	Negative Affectivity	When it comes to my emotions, people tell me I'm a "cold fish".
	Negative Affectivity	I change what I do depending on what others want.
	Negative Affectivity	I usually do what others think I should do.
	Negative Affectivity	I can be mean when I need to be.
	Negative Affectivity	I don't have very long-lasting emotional reactions to things.
	Negative Affectivity	It is hard for me to stop an activity, even when it’s time to do so.
	Negative Affectivity	I’d rather be in a bad relationship than be alone.
	Negative Affectivity	I do what other people tell me to do.
	**Negative Affectivity	I resent being told what to do, even by people in charge.
	Negative Affectivity	I don't show emotions strongly.
	Negative Affectivity	I never show emotions to others.
	**Negative Affectivity	I rarely feel that people I know are trying to take advantage of me.
	Negative Affectivity	I don't react much to things that seem to make others emotional.
	Negative Affectivity	I try to do what others want me to do.

Note. ** indicates item was dropped from Sample 1, but not Sample 2. No items were dropped from Sample 2 but not Sample 1.