Trait Polarity of the Personality Psychopathology 5 (PSY-5-r): A Content Analysis in Relation to the Patient Description Form

Robbert J. Langwerden[1,2] · Paul T. van der Heijden[3,4] · Jan J. L. Derksen[3,5] · Jos I. M. Egger[1,6,7]

Abstract

The maladaptive trait model of personality has gained popularity in the assessment of personality pathology. The Minnesota Multiphasic Personality Inventory (MMPI-2-RF) is a widely used instrument to measure maladaptive traits, by means of the Personality Psychopathology 5 (PSY-5-r) scales. Polarity of these maladaptive trait measures—whether these traits are unipolar or bipolar maladaptive—has not been empirically established in the literature. In a clinical sample ($N=275$), we investigated content polarity of these traits in relation to 25 psychological symptoms, measured by the Patient Description Form. Hierarchical regression analyses were applied to compare linear and curvilinear models and determine optimal fit. The results provided evidence for content unipolarity of all five traits, with small exceptions. We conclude that, in practice, the MMPI-2-RF PSY-5-r scales do not assess the PSY-5 theoretical model as expected, such that the higher the score on these scales the more it is likely impairing or impacting daily functioning. Conceptual and clinical implications are discussed.

Keywords Bipolarity · MMPI-2-RF · Personality psychopathology · Polarity · PSY-5-r

The Personality Psychopatholoy-5 (PSY-5) was originally developed through factor analytic research by Harkness & McNulty in 1994 (Harkness & McNulty, 1994). Five dimensions were identified from research on personality psychopathology and normal personality (Harkness, 1992), which aimed to measure overall functional adaptivity in the general population and clinical practice. Of importance is the notion that these five constructs were developed independently from the MMPI-2 (and subsequent MMPI-2-RF). Later, as component of the MMPI-2 and the MMPI-2-RF (Ben-Porath & Tellegen, 2008); the PSY-5 model has been revised (Harkness et al., 2014a; McNulty & Harkness, 2002), but continues to measure dimensionally-operationalized maladaptive (i.e., pathological) personality traits (Sellbom, 2019; Sellbom et al., 2021). The five traits measured by the PSY-5 model include (1) Aggressiveness (2) Psychoticism, (3) Disconstraint, (4) Negative Emotionality/Neuroticism, and (5) Introversion/Low Positive Emotionality. High levels on these traits are indicative of tendencies toward (1) interpersonal aggression, excessive assertiveness, (2) thought dysfunctionality, reality testing impairment, unrealistic cognitions, (3) behavioral disconstraint, acting-out behaviors, sensation seeking behavior, (4) self-criticism, internalizing, intrusion, guilt-proneness, and (5) anhedonia, pessimism, avoidance of social behavior, respectively. The PSY-5-r scales have been described as the maladaptive extensions of the Big Five personality traits (Ben-Porath & Tellegen, 2008). That is, Psychoticism is associated with openness through apophenia (Blain et al., 2020); Aggressiveness

✉ Robbert J. Langwerden
  robbert.langwerden@donders.ru.nl

1 Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands

2 Community-Based Research Institute, Florida International University, FIU Modesto A Maidique Campus, 11200 SW 8 Street, Miami, FL 33199, USA

3 Behavioral Science Institute, Radboud University Nijmegen, Nijmegen, The Netherlands

4 Centre for Adolescent Psychiatry, Reinier Van Arkel Mental Health Institute, 's-Hertogenbosch, The Netherlands

5 Faculty of Psychology and Educational Sciences, Department of Clinical and Life Span Psychology, Vrije Universiteit Brussels, Brussels, Belgium

6 Vincent Van Gogh Centers of Excellence in Neuropsychiatry, Venray, The Netherlands

7 Stevig Specialized and Forensic Care for People With Intellectual Disabilities, Dichterbij, Oostrom, The Netherlands

resembles (low) agreeableness levels; Disconstraint extends the reverse extreme of conscientiousness; Negative Emotionality/Neuroticism extends the neuroticism trait; and Introversion/Low Positive Emotionality is the extremer side of the extraversion trait (Trull et al., 1995). However, this has yet to be reproduced empirically and there seems to be ambiguity and a lack of empirical support with regard to the polarity of the PSY-5 scales that measure the underlying traits.

Polarity is paramount in psychological testing and the question remains whether the current MMPI-2-RF subscales adequately measure the PSY-5 as originally modelled by Harkness & McNulty. Polarity as psychometric concept refers to the measurable poles on either or both end(s) of scales that measure extremer ends of spectral traits. *Unipolarity* of traits occurs when the scales measure low levels as an average, whereas high levels reflect extremer trait phenotypes (Williams & Simms, 2018). In other words, the extent to which the trait is associated with impairment and other symptomatology is unidirectionally keyed and linear. *Bipolarity* on the other hand, refers to scales on which both low and high scores measure extremer trait ends, and in-between levels that are varyingly adaptive. The association with impairment and symptomatology of such a bipolar trait is curvilinear: both low and high levels could be clinically indicative (Samuel, 2011). In the current study we focus on content or predictive polarity (these terms will be used interchangeably). Content polarity assesses whether one or both poles associated with clinical outcomes: is only one pole indicative of impairment or psychological symptoms or are both poles? The focus lies on content polarity: are clinical symptoms linearly aligned with PSY-5-r scale scores, or are clinical symptoms curvilinearly aligned with PSY-5-r scale scores?

Several scholars have argued that a curvilinear relationship exists between personality trait levels and impairment, such that both high and low levels are associated with impairment (Samuel, 2011). Curvilinear impairment is most indicative clinically, as it means clinical symptoms are associated bidirectionally, at both high and low trait levels (Lambert, 2013). The study of polarity indicators of dimensional traits is theoretically in line with Millon's theory on evolutionary domains (i.e., pleasure vs. pain, passive vs. active, and self vs. other; Millon, 1990) and with major adaptive systems (Harkness et al., 2014b), such that the importance of context and environment are taken into account. As argued by Harkness and colleagues (2014b), the trait levels (and polarity) reflect variation in five adaptive systems, including "reality modeling for action, short-term danger detection, long-term cost–benefit projection, resource acquisition, and agenda protection" (p1, Harkness et al., 2014b). This implies that the polarity of the PSY-5-r

scales is dependent upon the adaptiveness of the extremer trait levels, both low and high. In addition, assessment of levels associated with symptoms can be helpful in determining possibilities and targets for treatment. Thus, it is relevant to further empirically inquire into polarity, maladaptive levels, and co-occurring levels of impairment and symptomatology. For most traits, consensus has not been reached on the matter of trait (bi)polarity (Grossman, 2015; Samuel & Tay, 2018), nor is that the case for the PSY-5 model.

In the literature, other trait models than the PSY-5 have shown majority bipolar clinical characteristics. For example, in the Alternative Model of Personality Disorders (AMPD) in the DSM-5 and PID-5, the traits are stated to be bipolar (American Psychiatric Association, 2013; Krueger et al., 2012). However, evidence in the literature seems to support unipolarity of these traits (Krueger et al., 2012; Williams & Simms, 2018). Further, the traits in the Five Factor Model (FFM) are hypothesized as bipolar as well, such that each of the 10 poles are predictive of life outcomes and many common symptomatology outcomes (Rojas & Widiger, 2014; Widiger & Crego, 2019), although empirical evidence has not been conclusive in this regard either. With dimensional models becoming more popular (Kotov et al., 2017, 2021) and the increasing popularity of dimensional personality trait measurement (Hopwood et al., 2018), empirical assessment of trait polarity becomes increasingly relevant. For the PSY-5-r scales, there is some evidence to suggest that the scales measure bipolar traits, in particular Aggressiveness, Disconstraint and Introversion (Rouse et al., 1999; Samuel & Tay, 2018).

This investigation contributes to literature by empirically investigating whether the MMPI-2-RF PSY-5-r scales adequately measure the content polarity of the PSY-5 theoretical model (Harkness & McNulty, 1994). The original PSY-5 model was developed to measure bipolar constructs, and two of the 5 traits were originally labelled as their opposite poles (Disconstraint was Constraint and Introversion was Extraversion). Theoretically, the adaptive functioning that is measured by this 5-dimensional model is therefore largely bidirectionally framed. Initially, the original PSY-5 scales were not based on the MMPI itemset. However, later the PSY-5 scales were operationalized in the MMPI-2 itemset. Since then, the scales measuring these underlying traits have undergone considerable revisions. As part of the revisions of the latest MMPI version, only 96 of the previous 139 items remained. Therefore, under the assumption the PSY-5-r scales (as included in the MMPI-2-RF) have remained consistent with their theoretical origins, the scales would continue to measure bipolar traits that are increasingly maladaptive at both extreme

ends (i.e., high scores as well as low scores). This is further expected by the item content of each of the scales, all of which have reverse-coded items that are keyed toward the opposite pole of the trait. The reversed coded item proportions of the latest scales are between 3.8 and 100%. It is worth noting that the technical manual of the MMPI-2-RF lists only clinical indications for low scores for the scales Aggressiveness, Disconstraint, and does not give bipolar indications for all scales. However, we expect all five PSY-5-r scales to behave as bipolar scales in relation to clinical symptoms, behavioral characteristics (e.g., being critical / argumentative) and functional domains (e.g., work problems). Our hypotheses are based on the original PSY-5 model and on the PDF correlations reported in the technical manual of the MMPI-2-RF (Ben-Porath & Tellegen, 2008; Van der Heijden et al., 2013) and previous research (Rouse et al., 1999). As outlined by Harkness and McNulty (1994), the PSY-5 underlying traits are intended to be seen as hyperbolic in relation to symptomatic outcomes, such that both ends of the five spectral traits are impairing and/or associated with psychopathological symptoms. In addition, Rouse and colleagues (1999) found that the individual PSY-5 items were psychometrically informative at both high and low levels, mostly in the case of Aggressiveness, Disconstraint, and Introversion. We expect a∩-shaped curvilinear association for PDF scales with which the PSY-5-r have a negative correlation that is small (0.20) or stronger in both men and women. Further, we expect U-shaped curvilinear association for PDF scales with which the PSY-5-r have a positive correlation that is small (0.20) or stronger in both men and women. We refer to Table 1 for an overview of hypotheses by scale.

Table 1 Hypothesized bipolar PSY-5-r scale associations with Patient Description Form (PDF) outcomes

PSY-5-r Scale	Hypothesized content polarity (Hypothesized curvilinear PDF scales[a])
Aggressiveness (AGGR-r)	Aggressive (U), Passive Submissive (∩)
Psychoticism (PSYC-r)	Achievement Oriented (∩)
Disconstraint (DISC-r)	Narcissistic (U), Aggressive (U), Antisocial (U), Family Problems (U)
Negative Emotionality/ Neuroticism (NEGE-r)	Anxious (U), Depressed (U)
Introversion/ Low Positive Emotionality (INTR-r)	Depressed (U), Achievement Oriented (∩), Introverted (U)

∩ refers to a reverse-U-shaped curvilinear relationship, U refers to a U-shaped relationship

[a] Patient Description Form Scales

Method

Participants

The original sample consisted of 342 individuals, of which 30 were excluded based on age (< 18 years) and 37 were excluded from further analysis due to invalid MMPI-2-RF profiles (i.e., we only selected Cannot Say Scale (CNS) < 14, Variable Response Inconsistency (VRIN-r) <= 80T, True Response Inconsistency (TRIN-r) <= 80T, Infrequent Psychopathology Responses (Fp-r) < 100T, Uncommon Virtues (L-r) <= 80T). Participants in the final sample ($n = 275$) were all adults (>18 years) and all completed diagnostic screening instruments in clinical context at outpatient mental health facilities in the Netherlands. The sample consisted of about equal portions of participants who identified as female (49.5%) and male (50.5%), and participants' ages ranged between 18 and 63 years ($M = 35$, $SD = 11.7$). Participants provided consent for their anonymous information to be used in research, and their information was treated with confidentiality.

Measures

Patient Description Form

The Patient Description Form (PDF) is a scientific instrument consisting of 25 scales, originally used to validate the MMPI-2 (Graham, 1990). The English-language version of the PDF has shown internal consistency levels between 0.69 and 0.72 (Cronbach's Alpha). We used the Dutch-translation of the instrument (please see Egger, 2003). Multiple clinician ratings were combined to generate 25 wide-ranging symptomology scale-scores. Ratings were completed by experienced Dutch clinicians. We used raw scale scores in further analyses.

Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF)

Participants completed the Dutch language version of the MMPI-2 (Derksen et al., 2006), and MMPI-2-RF scores were calculated using the raw MMPI-2 scale scores (Van der Heijden et al., 2010). MMPI-2-RF scores were used for further analysis. The MMPI-2-RF is an internationally used self-report measure for personality and psychopathology (Ben-Porath & Tellegen, 2008). For descriptive purposes, T-scores were calculated based on the non-gendered Dutch standardization norm groups. For correlational and regression analyses, raw scale scores were used. The PSY-5-r scales in the Dutch language version of the MMPI-2-RF

have shown medium to strong internal consistency reliability (Cronbach alpha's: 0.40—0.85; Van der Heijden et al., 2010) and medium to strong test–retest reliability (Langwerden et al., 2021). For further psychometric properties of the Dutch language version of the instrument, we refer to the manual of this instrument (Van der Heijden et al., 2013).

Analysis Procedures

We applied three forms of analysis, starting with general descriptive analyses and reliability analyses, then correlational analysis, and then hierarchical regression analysis. Hierarchical regression analyses were applied as statistical methods of assessing content polarity, as outlined below. Regarding statistical power, based on $N = 275$, an alpha error probability of 0.05, 2 predictors, and an estimated R^2 increase of 0.15 (medium sized), the power estimate for regression suffices.

Correlational Analysis

Bivariate zero-order correlations were calculated between raw the PSY-5-r scale scores and raw PDF scale scores to investigate associates between the scales of these two instruments.

Hierarchical Regression

The five PSY-5-r raw scale scores were squared to generate quadratic product terms. Hierarchical linear regression was applied to regress each of the PSY-5-r scales onto the PDF scales using two regression terms. Regression Term 1 included only the PSY-5-r raw scale score as independent variable and Regression Term 2 used the quadratic PSY-5-r product term as independent variable in addition the linear term. Term 1 tested the linear effect between PSY-5-r and PDF scales, whereas Term 2 tested the linear and curvilinear effect combined. We assessed whether the explained variance (R^2) demonstrated a statistically significant increase by adding the quadratic product term in Term 2 to the model, as indicated by the R^2-change and associated p-value. A significant R^2 increase due to the curvilinear model added indicates that the curvilinear model demonstrates a better model fit. We inspected the coefficients to assess whether the trend is $\cap$-shaped or U-shaped.

Curve Estimation

As a second method of testing the model for linearity (unipolarity) or curvilinearity (bipolarity), we utilized the curve estimation function in SPSS version 28 (IBM Corp, 2021) to graphically model and test the linear and quadratic models for relationships between the PSY-5-r scale score and PDF scale score.

In short, two methods were used to indicate 1) the degree to which of each PDF scale variance can be explained by the quadratic product term of the PSY-5-r scale over and beyond the linear term, and whether this variance difference was statistically significant; and 2) whether the curve estimation scatter plots clearly indicate a curvilinear model, which we examined for confirmation of outcomes of method 1. All Curve Estimation Scatter Plots are available upon request from the first and corresponding author.

Results

Descriptive Statistics

MMPI-2-RF descriptive statistics of the current sample are displayed in Table 2. We found comparable internal consistency outcomes to those reported in the manual of the Dutch language version (Van der Heijden et al., 2013). In addition, we found average T-scores between 49.7 (average, AGGR-r) and 67.7 (elevated, NEGE-r), as can be the expected range in a clinical sample.

Table 2 Sample MMPI-2-RF descriptive statistics ($n = 275$)

	Range[a]	M^a	SD^a	# items	# rev. items	α^b
Aggressiveness (AGGR-r)	31 – 88	49.7	12.1	18	2	0.81
Psychoticism (PSYC-r)	37 – 100	61.7	14.5	26	1	0.8
Disconstraint (DISC-r)	32 – 100	59.9	15.6	20	3	0.77
Negative Emotionality/Neuroticism (NEGE-r)	39 – 95	67.7	11.9	20	5	0.79
Introversion/Low Positive Emotionality (INTR-r)	32 – 84	54.2	11.7	20	20	0.76

[a] reflects statistics of Uniform Linear T-scores

[b] Cronbach's Alpha as measure of internal consistency

Table 3 Zero-order correlations between PSY-5-r raw scale scores and PDF scale scores

	Aggressiveness (AGGR-r)	Psychoticism (PSYC-r)	Disconstraint (DISC-r)	Negative Emotionality/ Neuroticism (NEGE-r)	Introversion/Low Positive Emotionality (INTR-r)
Anger Resentment	**0.24****	**0.17****	0.09	**0.17****	-0.04
Critical/Argumentative	**0.43****	**0.13***	**0.26****	0.1	**-0.12***
Narcissistic	**0.44****	0.07	**0.33****	-0.11	**-0.15***
Defensive	**0.12***	**0.17****	0.03	0.04	0.06
Histrionic	0.02	**0.22****	0.04	**0.26****	0.006
Aggressive	**0.35****	0.11	**0.3****	0.11	-0.08
Insecure	**-0.34****	0.07	**-0.17****	**0.34****	**0.18****
Anxious	**-0.22****	**0.14***	**-0.16****	**0.34****	**0.17****
Pessimistic	-0.07	**0.13***	-0.05	**0.26****	**0.17****
Depressed	**-0.23****	0.11	**-0.17****	**0.34****	**0.27****
Achievement-Oriented	**0.28****	-0.04	**0.12***	**-0.14***	**-0.16****
Passive-Submissive	**-0.36****	0.06	**-0.21****	**0.13***	**0.13***
Introverted	**-0.25****	-0.02	**-14***	0.06	**0.18****
Emotionally Controlled	0.02	-0.05	0	-0.06	0.09
Antisocial	**0.42****	**0.24****	**0.42****	0.06	**-0.18****
Negative Treatment Attitudes	**0.21****	**0.13***	0.09	0.03	0.007
Somatic Symptoms	0.04	**0.12***	**-0.13***	**0.22****	0.1
Psychotic Symptoms	**0.14***	**0.21****	0.06	-0.06	-0.01
Family Problems	0.03	**0.13***	-0.02	**0.13***	**0.13***
Obsessive–Compulsive	**-0.21****	-0.06	**-0.24****	**0.18****	**0.23****
Stereotypic Masculine Interests	**0.43****	0.02	**0.46****	**-0.2****	**-0.21****
Procrastinates	0.11	**0.17****	**0.17****	0.03	-0.07
Suspicious	**0.2****	**0.21****	**0.19****	0.03	0.08
Mania	**0.32****	**0.23****	**0.23****	**0.14***	**-0.19****
Work Problems	**0.28****	**0.23****	**0.25****	0.05	**-0.14***

*zero-order correlation is significant at the two-tailed 0.05 level (bolded); ** zero-order correlation is significant at the two-tailed 0.01 level (bolded)

all correlations are based on zero-order/Pearson correlations

Correlational Analysis

Correlational results are displayed in Table 3. We found AGGR-r correlated with 19 PDF scales (76%), PSYC-r with 15 PDF scales (60%), DISC-r with 17 PDF scales (68%), NEGE-r with 13 PDF scales (52%), and INTR-r with 15 PDF scales (60%).

Hierarchical Regression Analysis

Hierarchical regression analysis results are displayed in Table 4 and demonstrated that AGGR-r and INTR-r evidenced no significant R^2 change for curvilinear association with any PDF scales, indicating clear content unipolarity for these scales. For PSYC-r we found a statistically significant R^2 change for Anxious ($\Delta R^2 = 0.014$, $\beta = -0.36$, $p_{curvilinear} = 0.046$) and Depressed ($\Delta R^2 = 0.014$, $\beta = -0.36$, $p_{curvilinear} = 0.05$) after curvilinear addition to the regression, indicating a bipolar relationship between PSYC-r and these two PDF scales. For DISC-r we found a statistically significant R^2 change for Insecure ($\Delta R^2 = 0.014$, $\beta = 0.41$, $p_{curvilinear} = 0.04$), Depressed ($\Delta R^2 = 0.014$, $\beta = 0.4$, $p_{curvilinear} = 0.05$), and for Stereotypical Masculine Interests ($\Delta R^2 = 0.021$, $\beta = -0.49$, $p_{curvilinear} = 0.007$), suggesting content bipolarity in relation to these three PDF scales. For NEGE-r, we found a statistically significant R^2 change for Aggressive ($\Delta R^2 = 0.02$, $\beta = -0.58$, $p_{curvilinear} = 0.03$), suggesting content bipolarity in relation to this single PDF scale. Upon inspection of the curve estimation's scatter plot corroborated these results (see Figs. 1, 2, 3, 4, 5 and 6,

Table 4 R^2-Change, Beta coefficients, and R^2-Change significance for each hierarchical regression

	Aggressiveness (AGGR-r)				Psychoticism (PSYC-r)				Disconstraint (DISC-r)				Negative Emotionality/ Neuroticism (NEGE-r)				Introversion/Low Positive Emotionality (INTR-r)			
	ΔR^2	β	p_{lin}	p_{curv}	ΔR^2	β	p_{lin}	p_{curv}	ΔR^2	β	p_{lin}	p_{curv}	ΔR^2	β	p_{lin}	p_{curv}	ΔR^2	β	p_{lin}	p_{curv}
Anger Resentment	0.000	-0.04	**<0.001**	0.85	0.002	-0.14	**0.01**	0.45	0.007	0.28	0.16	0.17	0.001	-0.1	**0.006**	0.71	0.004	-0.32	0.49	0.27
Critical/Argumentative	0.001	-0.13	**<0.001**	0.5	0.004	-0.18	**0.03**	0.32	0.000	-0.04	**<0.001**	0.85	0.000	-0.05	0.12	0.84	0.002	-0.23	**0.04**	0.43
Narcissistic	0.002	-0.16	**<0.001**	0.42	0.000	0.03	0.22	0.86	0.001	-0.11	**<0.001**	0.56	0.002	-0.2	0.08	0.46	0.000	0.02	**0.01**	0.94
Defensive	0.01	-0.35	**0.049**	0.1	0.005	-0.22	**0.005**	0.24	0.003	-0.17	0.67	0.41	0.000	0.02	0.51	0.96	0.003	-0.27	0.36	0.36
Histrionic	0.001	0.11	0.7	0.6	0.003	-0.16	**<0.001**	0.39	0.004	0.21	0.51	0.31	0.001	-0.15	**<0.001**	0.55	0.004	0.31	0.92	0.29
Aggressive	0.000	-0.01	**<0.001**	0.97	0.004	-0.19	0.07	0.31	0.003	0.18	**<0.001**	0.37	0.018	-0.58	0.06	**0.03**	0.000	-0.09	0.21	0.76
Insecure	0.001	0.12	**<0.001**	0.54	0.003	-0.17	0.26	0.36	0.014	0.41	**0.004**	**0.04**	0.001	-0.12	**<0.001**	0.62	0.005	-0.34	**0.003**	0.24
Anxious	0.000	0.02	**<0.001**	0.92	0.014	-0.36	**0.02**	**0.046**	0.000	-0.02	**0.007**	0.91	0.001	-0.17	**<0.001**	0.5	0.001	-0.11	**0.005**	0.7
Pessimistic	0.003	0.18	0.23	0.4	0.000	0.03	**0.03**	0.86	0.004	0.2	0.37	0.32	0.000	0.04	**<0.001**	0.88	0.001	-0.13	**0.006**	0.67
Depressed	0.009	0.34	**<0.001**	0.1	0.014	-0.36	0.08	**0.05**	0.014	0.4	**0.005**	**0.05**	0.001	-0.13	**<0.001**	0.61	0.000	-0.008	**<0.001**	0.98
Achievement-Oriented	0.000	0.05	**<0.001**	0.82	0.001	-0.07	0.47	0.71	0.007	-0.29	**0.045**	0.16	0.009	0.41	**0.02**	0.12	0.002	-0.22	**0.007**	0.44
Passive-Submissive	0.000	-0.06	**<0.001**	0.78	0.004	-0.2	0.3	0.28	0.005	0.23	**<0.001**	0.25	0.005	0.31	**0.04**	0.24	0.000	0.04	**0.03**	0.9
Introverted	0.001	-0.13	**<0.001**	0.55	0.002	-0.15	0.76	0.41	0.000	-0.05	**0.02**	0.81	0.000	0.01	0.35	0.96	0.008	-0.43	**0.002**	0.13
Emotionally Controlled	0.000	-0.08	0.72	0.72	0.004	-0.19	0.41	0.32	0.000	-0.02	1	0.91	0.004	-0.27	0.33	0.31	0.001	-0.17	0.14	0.57
Antisocial	0.000	-0.03	**<0.001**	0.88	0.000	0.03	**<0.001**	0.85	0.001	0.11	**<0.001**	0.55	0.004	-0.26	0.29	0.32	0.000	0.03	**0.002**	0.91
Negative Treatment Attitudes	0.001	-0.11	**<0.001**	0.59	0.000	-0.05	**0.04**	0.8	0.000	0.02	0.14	0.91	0.001	0.1	0.57	0.71	0.005	-0.33	0.9	0.26
Somatic Symptoms	0.000	0.06	0.55	0.77	0.000	-0.03	**0.049**	0.85	0.002	0.14	**0.03**	0.5	0.000	0.02	**<0.001**	0.95	0.005	-0.35	0.11	0.23
Psychotic Symptoms	0.007	0.29	**0.03**	0.17	0.001	-0.1	**<0.001**	0.59	0.000	0.04	0.31	0.86	0.000	0.06	0.35	0.82	0.003	-0.28	0.86	0.35
Family Problems	0.000	0.08	0.65	0.72	0.000	0.03	**0.03**	0.88	0.005	0.25	0.76	0.23	0.000	-0.002	**0.03**	0.99	0.005	-0.35	**0.04**	0.23
Obsessive–Compulsive	0.000	-0.02	**<0.001**	0.92	0.002	-0.15	0.33	0.42	0.000	-0.06	**<0.001**	0.75	0.003	-0.22	**0.003**	0.39	0.000	0.09	**<0.001**	0.74
Stereotypic Masculine Interests	0.005	-0.25	**<0.001**	0.21	0.000	-0.07	0.73	0.72	0.021	-0.49	**<0.001**	**0.007**	0.001	0.17	**<0.001**	0.52	0.006	-0.37	**<0.001**	0.19
Procrastinates	0.003	-0.2	0.06	0.34	0.002	0.15	**0.004**	0.41	0.007	0.29	**0.005**	0.15	0.004	0.28	0.66	0.28	0.012	-0.52	0.25	0.07
Suspicious	0.001	0.11	**<0.001**	0.6	0.000	-0.06	**<0.001**	0.76	0.003	0.18	**0.001**	0.36	0.000	-0.002	0.59	1	0.002	-0.2	0.18	0.49
Mania	0.002	**0.17**	**<0.001**	0.4	0.012	-0.33	**<0.001**	0.06	0.001	0.11	**<0.001**	0.57	0.000	0.002	**0.02**	0.99	0.004	-0.31	**0.002**	0.29
Work Problems	0.000	-0.05	**<0.001**	0.82	0.001	0.08	**<0.001**	0.66	0.003	-0.18	**<0.001**	0.37	0.007	0.37	0.45	0.16	0.005	-0.34	**0.02**	0.24

p_{lin} = p-value for R^2 of the linear regression term in hierarchical regression, p_{curv} = p-value for R^2 change of added curvilinear regression product term in hierarchical regression, β = standardized regression coefficients for curvilinear regression term in the model results. Bolded indicates statistically significant p-values

Appendix 1). All other curvilinear regression analysis produced statistically non-significant R^2 change for PSYC-r, DISC-r, and NEGE-r.

Discussion

We assessed content polarity of the PSY-5-r scales as a function of broad clinical symptoms, behavioral characteristics and functional domains as operationalized by the PDF. In line with the original PSY-5-model from 1994 and existing literature, we hypothesized bipolarity of the five scales. With some small exceptions, we found that the five PSY-5-r scales demonstrated content unipolarity. Only 6 out of 125 (4.8%) potential curvilinear relationships were found, and two scales did not evidence any curvilinear relationships. Due to the large number of analyses done, this may represent random chance. Counter to our hypotheses, the results in the current study therefore are in support of the constructs measured by the PSY-5-r being unidirectionally predictive of clinical symptoms in a clinical population. The results in the current study imply the PSY-5-r as operationalized in the MMPI-2-RF moved away from the original bipolar constructs as described by Harkness and McNulty (1994), and as such mainly measure constructs in a unipolar manner. As to clinical implications of these findings, the predictive unipolarity of the scales makes for a consistent interpretation when assessing the scale scores in the clinical practice: the higher the score, the more impairing and the more comorbid symptoms likely are (for an overview of linear comorbid symptoms, we refer to Table 4). While this is conceptually not in line with the theoretical model, is it clinically straightforward.

It is worth noting the exceptions to the overwhelming unipolarity, but we underline that the few bipolar relationships should be interpreted with caution. Three PSY-5-r scales evidenced only several bipolar relationships with symptom outcomes, although none of the 6 bipolar associations between the PSY-5-r and PDF that were found were actually hypothesized (see Table 1). The emphasis lies on the fact that the opposite of our findings was hypothesized based on the PSY-5 theoretical model. The findings in this study do not find provide support for bipolarity of PSY-5-r scales and the MMPI-2-RF does not measure the original PSY-5 traits consistently with its theoretical roots. This is important both conceptually and clinically, as it impacts the way the MMPI-2-RF can be used in research and diagnostic contexts. In larger scientific and psychometric context, we hypothesized all scales to measure bipolar constructs, such that the trait levels reflect adaptivity to the outside world: the "middle" trait levels reflect

an optimal average of the adaptive system (Harkness et al., 2014b). However, our results indicate these PSY-5-r scales may not measure a hyperbolic trait, but rather may reflect the outer end of that spectrum, as the manual claims at least three of the scales to be (Ben-Porath & Tellegen, 2008). This is important also in context of the MMPI-2-RF's successor instrument, the MMPI-3. Between 35 to 72% of the items overlap between the MMPI-2-RF PSY-5-r scales and the MMP-3 PSY-5 scales and the traits measured remain consistent conceptually (Ben-Porath & Tellegen, 2020). Therefore, these scales may have similar polarity characteristics to the MMPI-2-RF characteristics found in this study and conceptually not be in line with the PSY-5 model. Moreover, the MMPI-2-RF is and will remain widely used internationally, such that the current study's results will remain directly relevant for its use for the foreseeable future.

We discuss the following curvilinear associations each with caution, as they are few and represent a fraction of the possible bipolar relationships. The curvilinear analyses between Psychoticism and Anxious and Depressive indicate both low and high levels are associated with *low* levels of anxiety and depression, since the relationships are ∩-shaped curvilinear. A certain level of psychosis may be naturally protective from environmental trauma and as such have persisted in evolutionary context (Harkness et al., 2014b; Scheepers et al., 2018). By extension, Psychoticism as the personality trait extension of these symptoms may reflect a similarly adaptive structure, whereas average Psychoticism trait levels are associated with anxiety and depression, as they reflect the most statistically normal level of reality testing. This is counter to clinical expectation and empirical findings (Huppert & Smith, 2005): Psychoticism scale scores are not associated with depression and anxiety scores as expected.

Regarding Disconstraint, high and low levels are associated with elevated scores of Insecure and Depressed (U-shaped relationship). Clinically, low levels of Disconstraint (i.e., high constraint) may be associated with insecurity and depression to illustrate the tension between experience versus expression of these symptoms (Brownhill, 2003). The notion of maladaptive overcontrol, or anankastia (World Health Organization, 2019) is relevant, which wasn't always recognized, and is seen as a transdiagnostic trait (Lynch et al., 2015). The relationship between anankastia and depression has been documented, and might explain the significant curvilinear relationship between Disconstraint and depression levels (Grant et al., 2012). Reversely, high levels of Disconstraint may cause impulsiveness and risky decision making, which in turn could cause clinical expressions of insecurity

and depression as a result of impulsivity and unwanted actions and outcomes, and substance misuse (Wilson et al., 2021). Importantly, low Disconstraint levels have not been tied to rule-following and traditionality (Bagby et al., 2008), despite the MMPI-2-RF manual stating this (Ben-Porath & Tellegen, 2008) and constraint not being commonly found to be correlated with psychopathology. According to the theory of adaptive systems, the Disconstraint construct has been associated with long-term cost–benefit weighing (Harkness et al., 2014b). As such, high Disconstraint levels might be reflective of limited cost–benefit analysis, whereas low Disconstraint levels are by extension associated with overly analyzing cost-benefits. Both extremes could have behavioral consequences and are therefore hypothesized to be associated with elevated depression scores. Both the AMPD and PSY-5 suggest that OCPD and impulsivity are extremes of the same spectrum, yet the ICD-11 added OCPD (anankastia) as an additional unipolar scale for more convenient clinical use.

Third, the ∩-shaped relationship between Negative Emotionality/Neuroticism and Aggressive could be interpreted as aggressive symptoms being low at both high and low levels of neuroticism. In clinical practice, this will likely be most relevant for the high trait levels, as those are most impairing. However, it is also relevant to note that the most adaptive, middle range of neuroticism levels is associated with the highest level of aggression. This is counter to what is expected clinically, since one would expect poor emotion regulation to be associated with both higher neurotic trait levels and aggression, as was found in previous studies (Czarna et al., 2021). Across all curvilinear relationships, these are only few of potential explanations of these associations and we warn ourselves and other scholars that clinicians are generally able to find explanations for (small) statistical associations of any kind. However, these might not be the actual underlying explanation, as has been pointed out in the literature (Forbes et al., 2019).

Several limitations of this study need to be mentioned. First, after post-hoc analysis of statistical power, the present study was underpowered to detect small R^2 increases, such as found in this study (ranging between 0.014—0.021). Despite a reasonably large sample of 275, a larger sample would help to identify small effects like the ones found here without risk of error. However, it is worth noting that small effects may not have clinical significance. Second, while a clinical sample has the benefit of the findings being directly applicable to the clinical practice and allowing for scientific studying of

the elevated levels of the traits, there may also be downsides, such as possibly causing us to see only the clinical levels and interpretations of these five traits (Samuel & Tay, 2018). Third, it is important to note that the items of various PSY-5-r scales might be formulated in context of dysfunction, limiting the likelihood of the overall scale score to be bipolar. Fourth, we used a single measure of maladaptive traits, whereas the use of multiple, variable measures may yield more reliable results. On the other hand, using a self-report measure can reduce evaluative consistency bias. Fifth, we also recognize that what is considered maladaptive personality is not necessarily universal. The MMPI-2-RF items are culture-specific, and may therefore not be generalizable across all individuals, countries, cultures, and contexts. In line with this, we did not discuss the significant curvilinear relationship between "Stereotypical Masculine Interests" and Disconstraint, because it reflects arbitrary and time- and culture specific concepts. Finally, the PSY-5-r items for each scale are few. If the item range were longer, this would potentially evidence different results. In particular there is considerable variance in the proportion positively coded and negatively coded items in each scale, which could further complicate measuring bipolar scales. Larger, more varying scales would be more adequate to measure the whole spectrum of the trait at every level.

Notably, the clinical implications of the present study's results regarding bipolarity are important, as these can be used in clinical practice, where both adaptive and maladaptive personality traits are assessed, incorporated, and used in treatment (Samuel, 2011). It may be that the PSY-5-r scales measure the extreme ends of much longer, not-measured spectrum and other instruments could be needed to measure other trait levels. Further research on the content polarity of the PSY-5-r traits can further elucidate these findings, particularly when 1) comparing multiple, varying measures of symptoms in relation to the MMPI-2-RF, 2) studying this in different populations, and 3) comparing the MMPI-3 and MMPI-2-RF in its conceptualization and measurement.

In conclusion, we conducted curvilinear regression analyses to assess content polarity of the PSY-5-r. All five scales overwhelmingly showed content polarity and as such do not corroborate the original PSY-5 theoretical model. The slight exceptions to this were Psychoticism (bipolar in reference to Anxious and Depressed symptoms), Disconstraint (bipolar in reference Insecure and Depressed symptoms, and Stereotypical Masculine Interests) and Negative Emotionality/Neuroticism (bipolar in reference to Aggressive symptoms).

Appendix 1 Figures
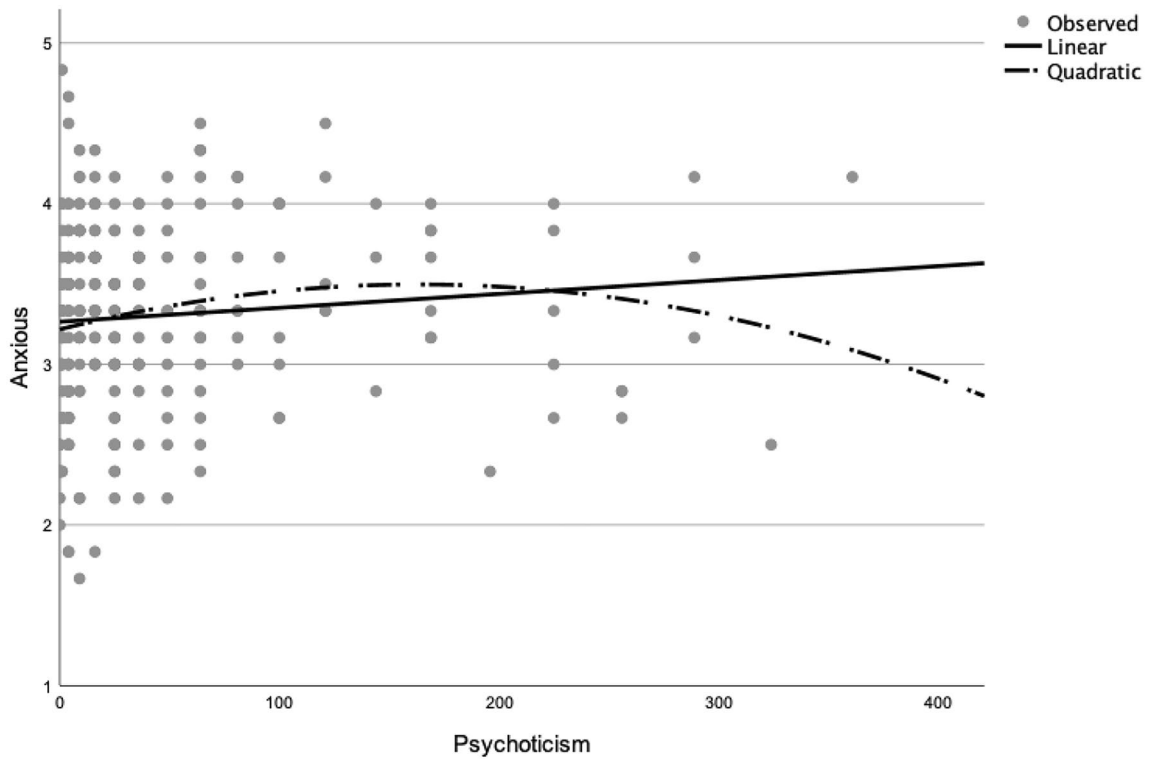
Fig. 1 Curve Estimation Graph of Psychoticism in reference to Anxious. *Note*: Psychoticism (MMPI-2-RF; PSYC-r) reflects the raw and squared raw scale score. Anxious (PDF) reflects the full scale score
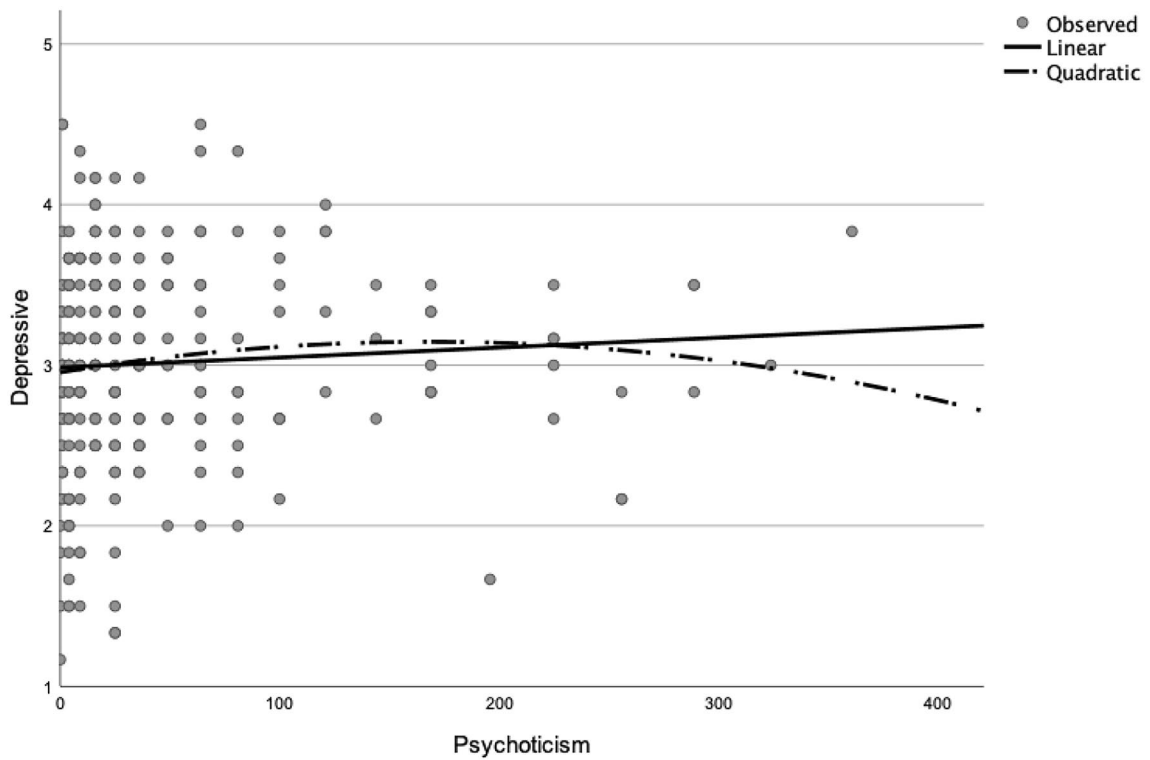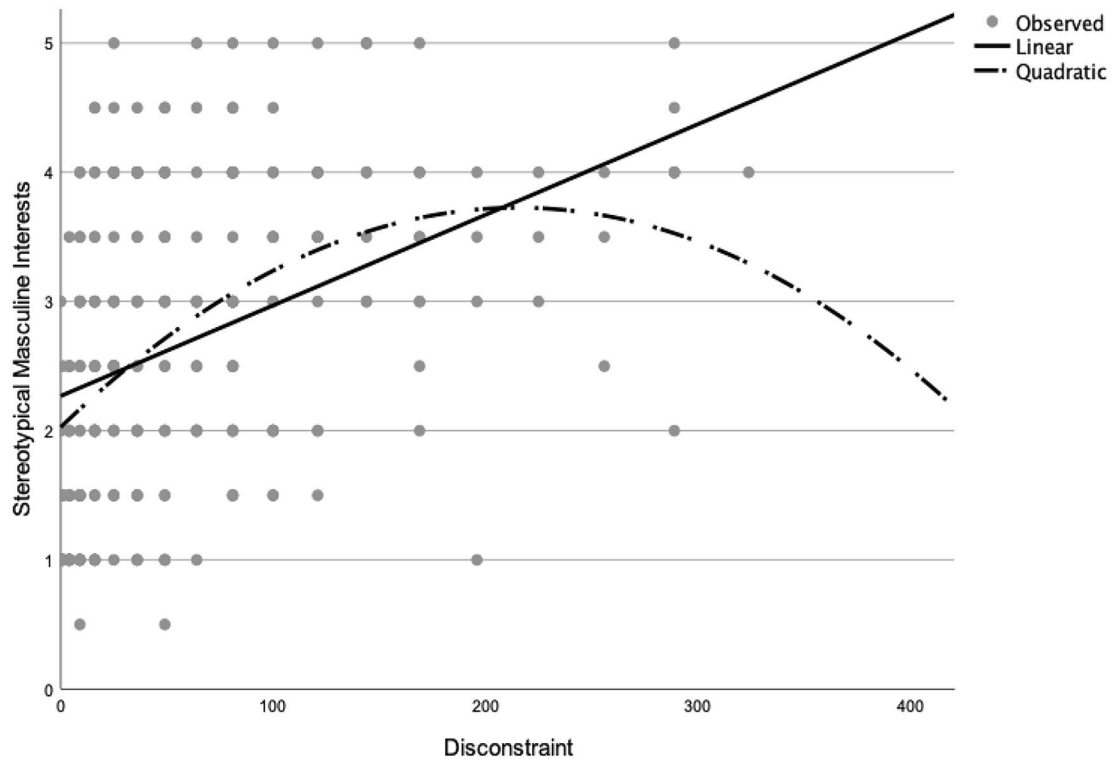

Fig. 2 Curve Estimation Graph of Psychoticism in reference to Depressive. *Note*: Psychoticism (MMPI-2-RF; PSYC-r) reflects the raw and squared raw scale score. Depressive (PDF) reflects the full scale score
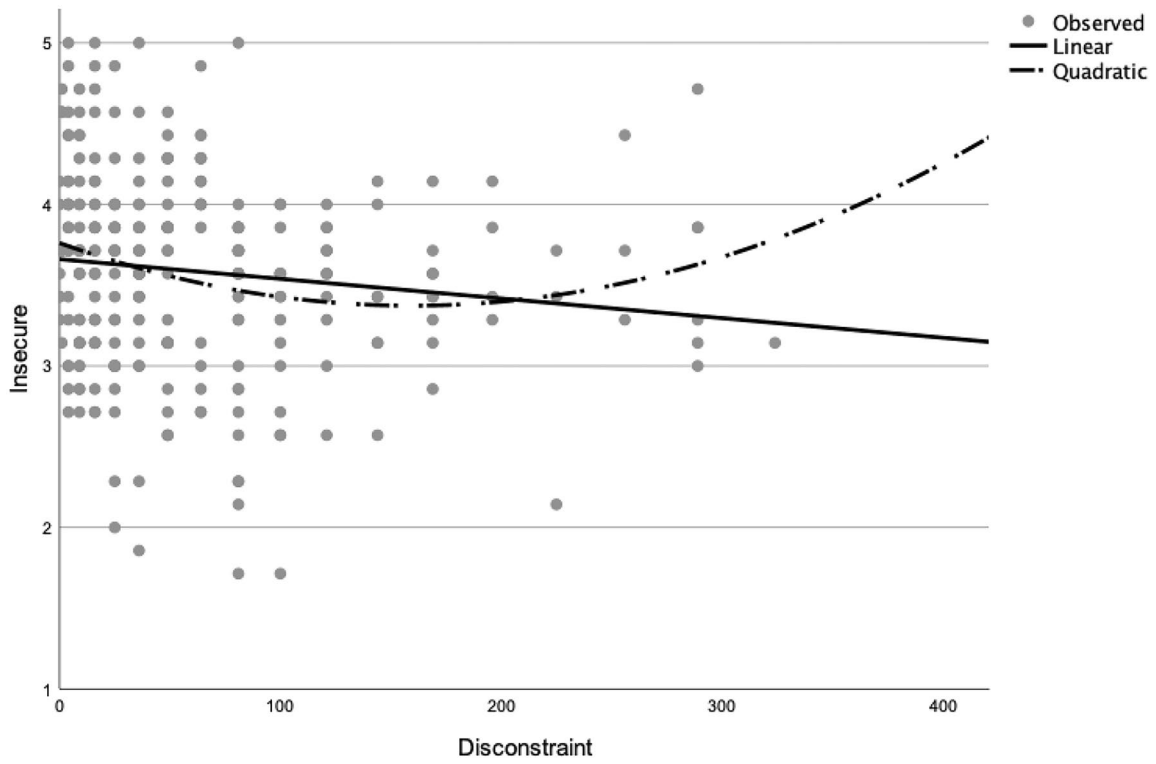
Fig. 3 Curve Estimation Graph of Disconstraint in reference to Insecure. *Note*: Disconstraint (MMPI-2-RF; DISC-r) reflects the raw and squared raw scale score. Insecure (PDF) reflects the full scale score
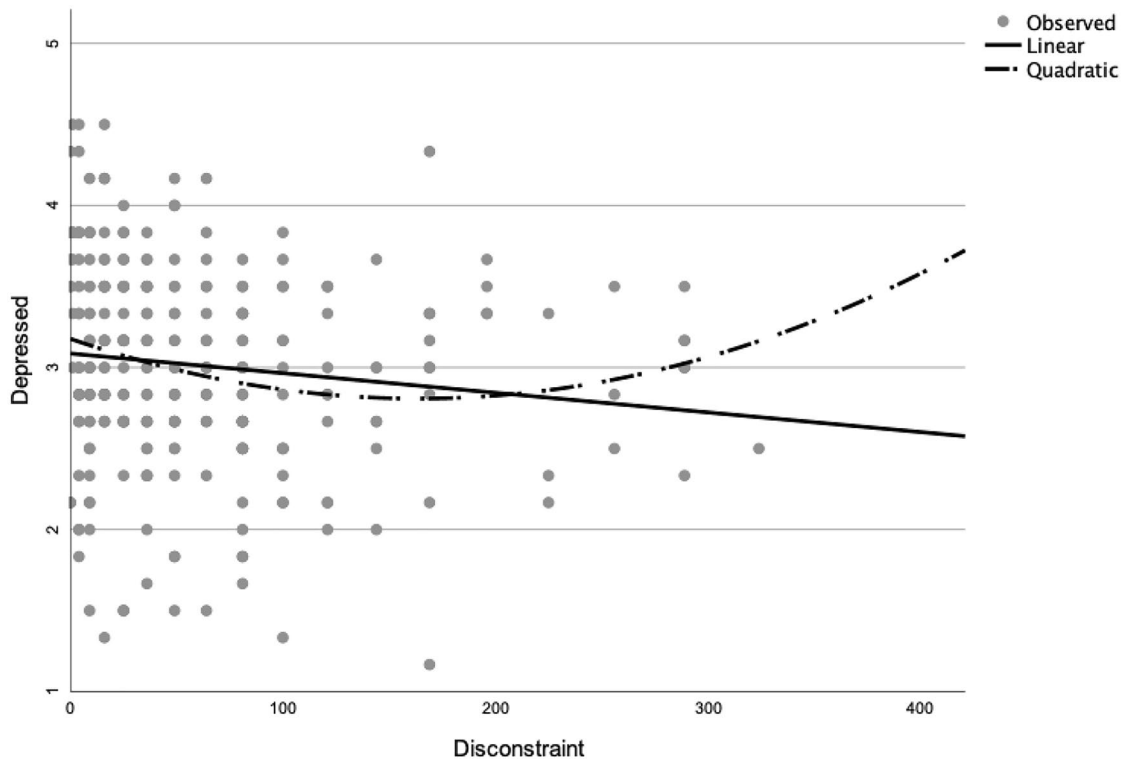
Fig. 4 Curve Estimation Graph of Disconstraint in reference to Depressed. *Note*: Disconstraint (MMPI-2-RF; DISC-r) reflects the raw and squared raw scale score. Depressed (PDF) reflects the full scale score

Fig. 5 Curve Estimation Graph of Disconstraint in reference to Stereotypical Masculine Interests. *Note*: Disconstraint (MMPI-2-RF; DISC-r) reflects the raw and squared raw scale score. Stereotypical Masculine Interests (PDF) reflects the full scale score
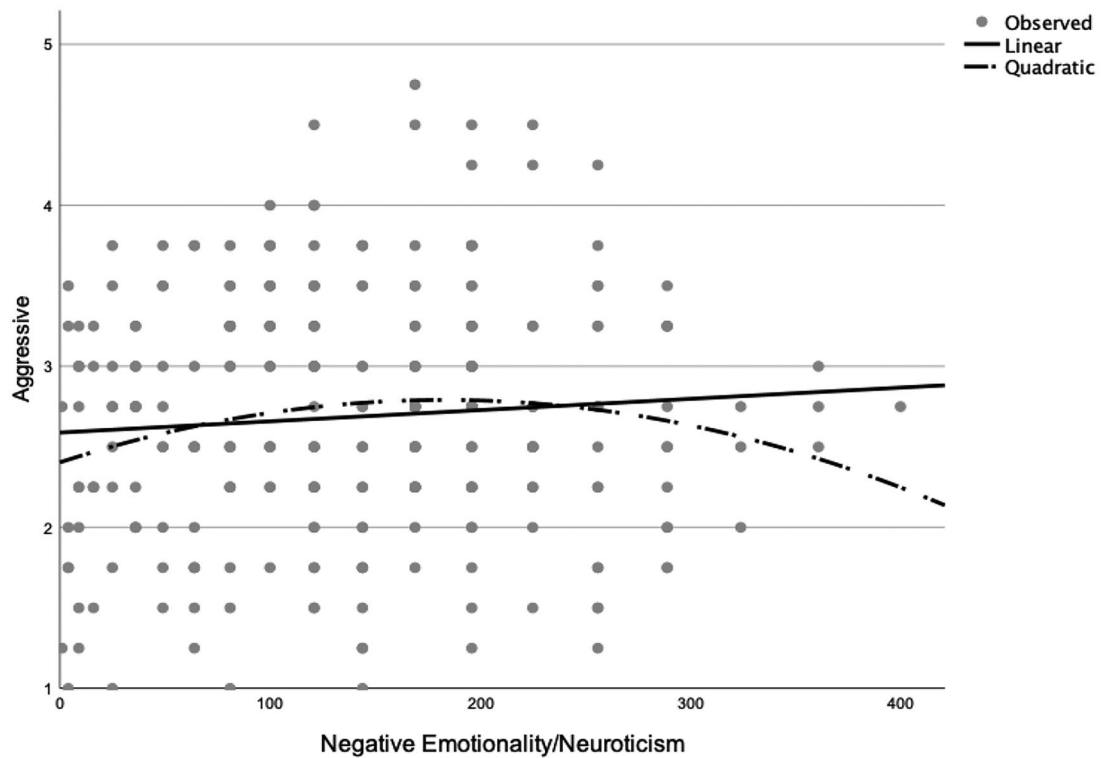
Fig. 6 Curve Estimation Graph of Negative Emotionality/Neuroticism in reference to Aggressive. *Note*: Negative Emotionality/Neuroticism (MMPI-2-RF; NEGE-r) reflects the raw and squared raw scale score. Aggressive (PDF) reflects the full scale score

Declarations

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