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Abstract

Pathological personality traits are an important inhibitor of social functioning and well-being. Individual human values also possess important connections to both personality and well-being, but the links between human values and pathological personality traits have not been directly examined. Across two studies ($N = 478$), we provide the first direct examination of these relations by employing linear and sinusoidal methodologies assessing relations between Schwartz's circular model of human values (Schwartz, 1992) and a series of personality measures, including the Personality Inventory for the DSM-5 (e.g., Callousness, Intimacy avoidance, Rigid perfectionism). Data for Study 1 was collected in Germany and data for Study 2 in the UK. Self-transcendence values buffer against several pathological personality traits that constrain psychological well-being (e.g., callousness). Conversely, self-enhancement values (which are motivationally opposite to self-transcendence values in Schwartz's circular model of human values) were positively associated with these personality traits. Several pathological personality traits were related to the 10 value types in a sinusoidal waveform that was consistent with Schwartz's circular model of human values. Findings were overall consistent across samples from both countries. The results help us move closer to distinguishing between different processes underpinning the associations between personality traits and human values.

Keywords: Human Values, Personality, Psychopathology, Linear associations, Sinusoidal associations

1. Introduction

Human values are abstract ideals that people consider to be important guiding principles in their lives, such as achievement, freedom, power, and equality (Rokeach, 1973; Schwartz, 1992). As such, these ideals play an important role in diverse attitudes and behaviour (Boer & Fischer, 2013; Roccas & Sagiv, 2017), which makes them highly relevant for understanding personality functioning and psychological well-being (Maio, 2016). Yet, the links between values and relevant personality traits that can impact psychological well-being have not been examined directly. Here, we provide a new and rigorous examination of this question across two countries.

1.1 Background

It is frequently suggested that some values support psychological well-being and others act against it (for reviews see Boer, 2017; Sagiv et al., 2004; Schwartz & Sortheix, 2018). This account is related to a common distinction between intrinsic and extrinsic values. Intrinsic values are inherently satisfying to pursue, as they are directly relevant to important psychological needs, such as autonomy, competence, and relatedness (Ryan & Deci, 2000). In contrast, extrinsic values are less directly satisfying of psychological needs, because they are more likely to involve contingent or unstable self-esteem, non-enjoyable or even demeaning activities, and external pressures (Kasser, 2002). Psychological well-being is positively related to achievement values (Oishi et al., 2009), intrinsic values (Sheldon, 2005), and benevolence values (Kasser & Ryan, 1993) while being negatively associated with extrinsic values (Kasser & Ryan, 1993).

This distinction between intrinsic and extrinsic values conceptually overlaps with Schwartz's circular model of values (Schwartz, 1992) (Fig. 1A). Unlike other human values models, this model has been extensively studied in the context of psychological well-being in general and has been supported by diverse types of correlational and experimental evidence

(Maio, 2016). The model enables specific predictions regarding different values. For example, psychological well-being is likely to be promoted by values that promote growth needs (hedonism, stimulation, self-direction, universalism, benevolence, achievement, Fig. 1A) and undermined by values that address deficiency needs (conformity, tradition, security, power, Fig. 1A) (Bilsky & Schwartz, 1994). Several studies (cited in Boer, 2017; Haslam et al., 2009) support this prediction. For instance, the affective component of psychological well-being is positively related to people's endorsement of self-direction, achievement, and stimulation values, while being negatively associated with people's endorsement of security, conformity, and tradition values (Sagiv & Schwartz, 2000). Similarly, positive affect is positively related to endorsement of self-direction, stimulation, and universalism values, while being negatively associated with endorsement of power and conformity (Roccas et al., 2002).

Furthermore, people who value self-direction, universalism, and benevolence are more likely to perceive others to value those values (Hanel et al., 2018), which can increase people's well-being (Sagiv & Schwartz, 2000). However, it is also possible that happy people have more cognitive resources to care about others (benevolence and universalism) or be independent (self-direction; see also Schwartz & Sortheix, 2018).

However, little attention has been given to associations between values and pathological personality traits and other clinically relevant constructs that undermine psychological well-being. For example, pathological traits such as antagonism (e.g., manipulateness, deceitfulness), disinhibition (e.g., irresponsibility, impulsivity), and detachment (e.g., withdrawal, anhedonia) are negatively associated with various measures of well-being (Góngora & Castro Solano, 2017). Only a few studies investigated the associations between values, psychopathology (e.g., schizotypy; Hanel & Wolfradt, 2016), and prominent antisocial traits, especially the so-called Dark Triad (i.e., machiavellianism,

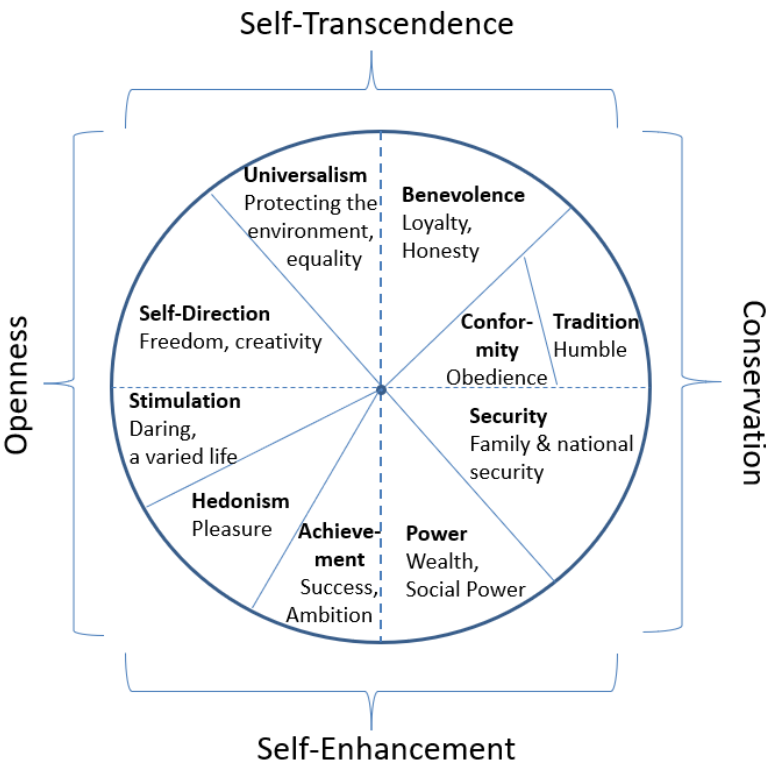
narcissism, and psychopathy Paulhus & Williams, 2002). For example, several studies overall found that the three dimensions of the Dark Triad and sadism were positively correlated with achievement and power values but negatively associated with universalism and benevolence (Balakrishnan et al., 2017; Jonason et al., 2015; Kajonius et al., 2015). The underlying motives for the Dark Triad are self-serving, typically at the expense of other people (Furnham et al., 2013), which might explain why the Dark Triad is negatively associated with values that are self-transcending and positively associated with values which are self-enhancing.

In the present research, we are going significantly beyond past research by investigating the associations between values with a wide range of personality traits to better understand the underlying associations. Specifically, we hypothesize that particular human values as assessed from Schwartz' model (Schwartz, 1992) will be associated with personality traits that undermine psychological well-being in healthy participants, such as the 25 traits assessed in the Personality Inventory for the DSM-5 (PID-5). Other relevant traits are assessed by (i) the Schizotypal Personality questionnaire assessing schizotypy, the motivation scales (ii) BIS/BAS examining behavioural inhibition and behavioural activation, (iii) Temps-A assessing temperament, (iv) Vancouver Obsessional Compulsive Inventory, the (v) UPPS-P Impulsive Behaviour Scale examining impulsivity and compulsivity respectively, and (vi) the six HEXACO personality traits (humility, emotional stability or neuroticism, extraversion, agreeableness, conscientiousness, and openness). High levels of honesty-humility and extraversion putatively relate to high psychological well-being while compulsivity, impulsivity, neuroticism, and schizotypy correlate with lower psychological well-being (Aghababaei & Arji, 2014; Carter et al., 2016; Emmons & Diener, 1986; Fumero et al., 2018; Gale et al., 2013; Pavot et al., 1990). Moreover, these relations should reveal a sinusoidal waveform when plotted with value types arrayed along an x-axis in their order of placement along the value circle's circumference. Three examples of putative waveforms are

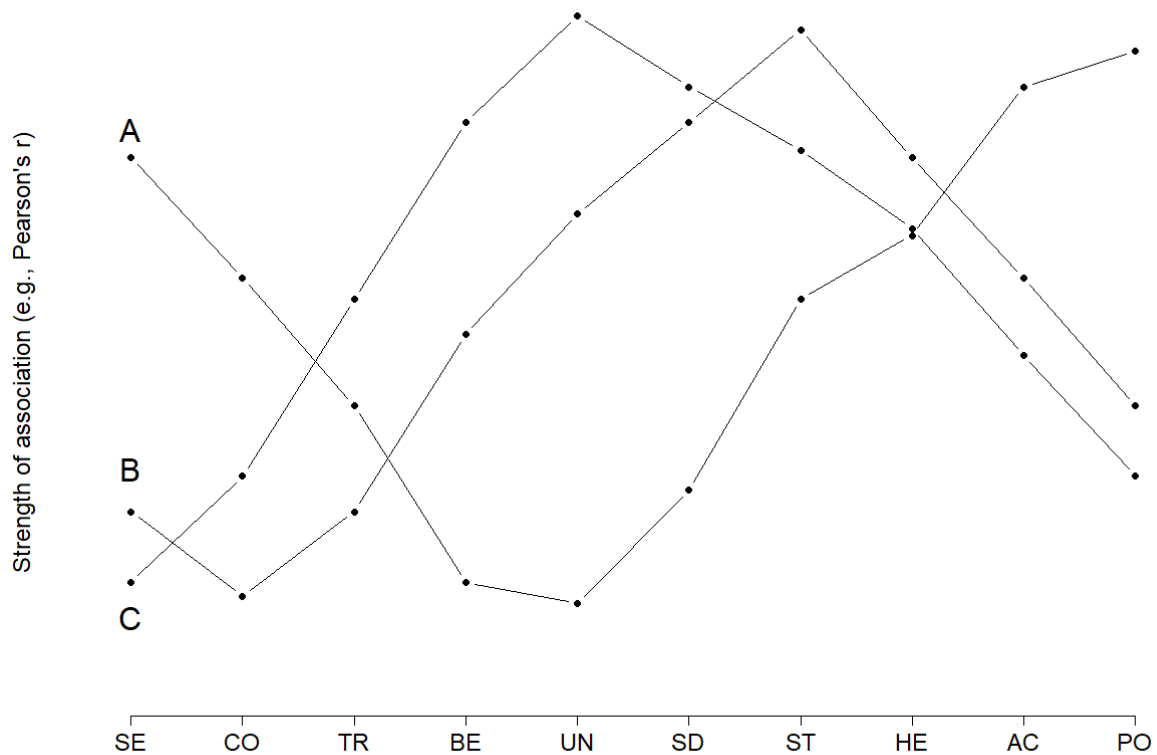
shown in Fig.1B. For example, pathological traits (hostility, grandiosity) might be positively correlated with achievement and power, uncorrelated with orthogonal values such as stimulation and conformity, and negatively correlated with benevolence and universalism (Fig.1B, line A). The resulting waveform resembles a sine wave. But this waveform has not yet been tested for its reliability in the context of wide range of traits related to personality.

Fig. 1. A: The circumplex structure of personal values. B: Plot of hypothesized relationships between three external variables (line graphs A, B and C) and the 10 values from the circumplex structure.

A



B



Note. PO: power; AC: achievement; HE: hedonism; ST: stimulation; SD: self-direction; UN: universalism; BE: benevolence; TR: tradition; CO: conformity; SE: security. Each dot/point could represent a correlation coefficient (Fig. 1A: Copied under a CC BY licence from Hanel, 2016; Fig. 1B: Redrawn based on the concept proposed by Schwartz, 1992).

The prediction of a sinusoidal waveform is a powerful aspect of Schwartz's model, but another important aspect is the support obtained across samples from over 80 nations (Schwartz et al., 2012). Such extensive cross-cultural support may imply that values express evolutionarily conserved motives. Indeed, using a twin-study methodology, previous research demonstrated that the shared variance between human values and personality traits has a significant heritable component (Schermer et al., 2008; Schermer et al., 2011), paving the way for testing whether human values are related to specific personality genetic components (for an overview see Fischer, 2017). There is now evidence showing a direct link between the

values assessed in Schwartz's model and several neurobiological markers including cortical (Zacharopoulos et al., 2017), subcortical (Zacharopoulos, Lancaster, Bracht, et al., 2016) and genetic data (Zacharopoulos, Lancaster, Maio, et al., 2016). Zacharopoulos and colleagues (Zacharopoulos, Lancaster, Maio, et al., 2016) found that human values are related in a sinusoidal manner to the polygenic score for neuroticism (which is itself linked to psychopathology Van Os et al., 2001). Nonetheless, there are various indicators of personality psychopathology that have not yet been linked to values in past research.

1.2 The Present Research

The present research provides a comprehensive examination of the link between measures assessing pathological personality traits and human values. Based on the research described above, we postulate that intrinsic values (e.g., hedonism, stimulation, and self-direction) will be negatively associated, whereas extrinsic values (e.g., achievement and power) will be positively associated with pathological personality traits. Specifically, Study 1 (conducted in Germany) tested these proposed relations between personality psychopathology and values using the PID-5, and in Study 2 (conducted in Wales), we replicated and extended the findings using various other measures, including schizotypy, compulsivity, and impulsivity.

2. Study 1

2.1 Method

2.1.1 Participants

Three-hundred ninety-one individuals studying various academic subjects at the Martin-Luther University Halle-Wittenberg (Germany) who were between 18 and 39 (304 women; mean age=21.51 \pm 3.73 SD) participated in the study. The study was in line with the ethical requirements of the Institute of Psychology at Martin-Luther University Halle-Wittenberg. Participants were verbally informed that the study was about personality and values, that their

participation was voluntary, and their responses would be anonymous. Data collection took place during class hours in one large lecture hall. In line with the local common practice, the researchers implied consent when the participants remained in the lecture hall and started completing the survey (a few students decided not to participate and left). After completion, which took 30-40 minutes, participants were debriefed. The data were collected in Halle/Saale (Germany).

2.1.2 Procedure

First, participants completed the short version of the Schwartz Value Survey (SSVS) (Lindeman & Verkasalo, 2005) in its German translation (Boer, 2014). The SSVS consists of ten items, one for each value type in Schwartz's circular model of values (Schwartz, 1992). For example, power was measured with "*Power*. (Social status and prestige, control or dominance over people and resources)." Participants rated the importance of their values on a 6-point scale, ranging from 1 (completely unimportant) to 6 (very important). The reliability and validity of the SSVS were found to be good (Lindeman & Verkasalo, 2005). For example, a multidimensional scaling analysis using Torgerson revealed that the ten items replicated Schwartz's model (Schwartz, 1992) (cf. Fig. 1A), thus indicating that the correlations among the value type items were as proposed. Supplementary Material 1 .1 shows only two minor deviations: The position of achievement and power was reversed, as was the position of security and tradition/conformity. Deviations within one higher order value type (e.g., conservation) are considered as unproblematic and in line with the model prediction (Bilsky et al., 2011). In scoring the responses, we followed the recommendation to center the values on an individual basis (Schwartz, 1992, 2003).

Next, participants completed the full Personality Inventory for DSM-5 (PID-5) with 220 items (Association, 2013). The PID-5 assesses 25 personality trait facets: anhedonia, anxiousness, attention-seeking, callousness, deceitfulness, depressivity, distractibility,

eccentricity, emotional lability, grandiosity, hostility, impulsivity, intimacy avoidance, irresponsibility, manipulativeness, perceptual dysregulation, perseveration, restricted affectivity, rigid perfectionism, risk-taking, separation insecurity, submissiveness, suspiciousness, unusual beliefs and experiences, and withdrawal. Example items included "I'm good at making people do what I want them to do" (manipulativeness), "I can be mean when I need to be" (hostility), and "I usually do what others think I should do" (submissiveness). Responses were given on a 4-point scale, ranging from 0 (very false or often false) to 3 (very true or often true). The internal consistency of the PID-5 was acceptable to very good (see Table 1). Since several variables were not normally distributed when statistically assessed for normality, we additionally report the results based on Spearman correlations, which produced similar results as can be seen in Supplementary Material 2.1.

2.2 Sinusoidal Relationship Analyses

To test the sinusoidal prediction of Schwartz's model (Schwartz, 1992), we utilized a recently developed sinusoidal test (Hanel et al., 2017; Zacharopoulos et al., 2017; Zacharopoulos, Lancaster, Maio, et al., 2016). For the full description of the sinusoidal relationship analyses, please see Supplementary Material 3. In short, it tests how well the 10 correlation coefficient can be described by a sine wave. The test returns the *Sinusoidal Fit Index* (SFI) which ranges between 0 (perfect fit) and 1 (very poor fit).

2.3 Results

A summary of the results can be found in Table 1. The focus of the present analysis is the correlation pattern. This pattern allows us to differentiate which value types are associated with pathological personality traits. The correlations' magnitude was mostly small, consistent with previous research (Hanel & Wolfradt, 2016), but in line with the predicted pattern. For example, power tended to correlate more positively with callousness, deceitfulness, and

grandiosity, whereas benevolence correlated mostly negatively with these traits. We computed 10 one-sample t-tests to ascertain whether the correlation coefficients are significantly above or below 0. The 25 PID-facets were, on average, positively associated with power ($p < .001$) and hedonism ($p = .002$), but negatively with benevolence and tradition (both $ps < .001$). The remaining six value types were often unrelated to the PID-facets.

To further investigate whether different values types are differentially associated with the PID-5 facets, we investigated whether the correlation coefficients of the value type power and each PID-5 facet are significantly different from the correlations between the value type benevolence and each PID-5 facet, using Fisher's r-to-z transformation (two-tailed p-values in Table 1, last column). We focused on power and benevolence because they were on average most strongly correlated with the PID-5 facets. The differences between the correlation coefficients (power vs benevolence) across PID-5 facets were often large. Overall, the 25 PID-5 facet correlations with power were significantly different from the corresponding correlations with benevolence, $t(24) = 6.54$, $p < .001$, $d = 2.44$), because the sign of the correlation coefficients was often in the opposite direction.

After investigating the linear associations, we tested the sinusoidal patterns of association between the human values and each of the 25 PID-5 facets. We placed the 10 human values types on the x-axis in an order that follows the circular structure (Fig. 1) and plotted the ten correlation coefficients between each of the 10 human value types (x-axis, power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity, security) and the 25 PID-5 facets (y-axis). We then applied the Sinusoidal Fit Index to test whether the 10 points (i.e., correlation coefficients) followed a sine-wave. Results indicated a robust sinusoidal pattern of association between the 10 human value types and separation insecurity ($SFI=.07$), but not for any other variables obtained from

Study 1. The results were very similar when we computed Spearman's rank correlation coefficients (see Supplementary Materials 2.1).

Table 1

Statistical results summary from Study 1

	PO	AC	HE	ST	SD	UN	BE	TR	CO	SE	SFI	R ²	α	P>B
Anhedonia	.17***	.11*	-.09	-.22***	-.03	.11*	-.12*	-.09	.10*	.05	.68	.19	.85	<.001
Anxiousness	.09	.11*	.03	-.20***	-.15**	0	-.09	-.07	.09	.15**	.30	.10	.90	.029
Attention seeking	.18***	.06	.18***	.02	.08	-.06	-.07	-.13**	-.13**	-.16**	.34	.11	.87	.002
Callousness	.40***	.15**	.12	-.09	.05	-.16**	-.23***	-.09	-.19***	-.08	.40	.27	.85	<.001
Deceitfulness	.31***	.12*	.14**	-.10*	.04	-.12*	-.15**	-.17***	-.10*	-.01	.33	.16	.88	<.001
Depressivity	.13**	.01	.02	-.14**	-.04	.11*	-.09	-.12*	.09	.03	.78	.12	.93	.008
Distractibility	.04	-.17***	.17***	0	.03	.10*	0	-.14**	.06	-.05	.87	.11	.85	NS
Eccentricity	.12*	.03	.10*	.05	.12*	.07	-.11*	-.15**	-.07	-.16**	.34	.08	.94	.005
Emotional lability	-.04	-.01	.06	-.08	-.08	.10*	.09	-.06	-.04	.13**	.95	.05	.85	NS
Grandiosity	.27***	.15**	.09	-.14**	.05	-.09	-.16**	-.06	-.14**	-.03	.44	.12	.78	<.001
Hostility	.26***	.10*	.19***	-.10*	.02	-.03	-.14**	-.18***	-.11*	-.05	.38	.15	.84	<.001
Impulsivity	.05	-.07	.04	.14**	.05	.02	-.02	0	-.09	-.16**	.44	.05	.83	NS
Intimacy avoidance	.12*	-.07	-.05	.04	.12*	.07	-.17***	-.03	.05	-.11*	.92	.12	.84	<.001
Irresponsibility	.07	-.03	.09	.06	.14**	.11*	.01	-.20***	-.12*	-.05	.38	.11	.71	NS
Manipulativeness	.26***	.14**	.19***	-.04	.04	-.13**	-.12*	-.13**	-.17***	-.12*	.32	.14	.80	<.001
Perceptual dysregulation	.10*	0	.05	.06	.07	.08	-.02	-.15**	-.09	-.07	.39	.06	.83	NS
Perseveration	.14**	.03	.12*	-.13**	-.04	.06	-.09	-.10*	.04	-.07	.76	.09	.80	.005
Restricted affectivity	.20***	.03	.02	-.04	.04	-.04	-.19***	-.04	.04	-.12*	.70	.12	.81	<.001
Rigid perfectionism	.18***	.16**	-.04	-.14**	-.11*	-.05	-.12*	-.04	.06	.04	.24	.08	.87	<.001
Risk taking	-.07	-.12*	.01	.41***	.17***	.04	.02	-.03	-.11*	-.30***	.32	.23	.91	NS
Separation insecurity	.13**	.02	-.02	-.18***	-.18***	-.07	-.06	.01	.15**	.13**	.07 ⁺	.08	.84	.021
Submissiveness	.04	.02	0	-.26***	-.17***	-.03	-.07	.02	.29***	.10*	.29	.14	.80	NS
Suspiciousness	.18***	.15**	-.01	-.18***	-.12*	.01	-.13**	-.10*	.07	.10*	.30	.12	.68	<.001
Unusual belief experiences	.03	-.06	.03	.05	.09	.06	-.03	-.02	-.05	-.09	.33	.02	.79	NS
Withdrawal	.11*	.04	-.02	-.16**	.03	.11*	-.22***	-.01	.08	-.01	.86	.20	.89	<.001
Mean <i>r</i>	.14	.04	.06	-.05	.01	.01	-.09	-.08	-.01	-.04				.005
R ²	.27	.18	.16	.28	.14	.15	.16	.12	.19	.19				

Notes. All R^2 s of the bottom row are significant at $p < .001$, all R^2 s of column $\geq .04$ are significant at $p < .05$. All $rs \geq .10$ are significant at $p < .05$, all $\geq .13$ at $p < .01$, and all $rs \geq .17$ at $p < .001$ (all two-tailed). Significant values are in bold. PO: Power, AC:

Achievement, HE: Hedonism, ST: Stimulation, SD: Self-direction, UN: Universalism, BE: Benevolence, TR: Tradition, CO: Conformity, SE: Security.

* $p < .05$, ** $p < .01$, *** $p < .001$

2.4 Discussion

The results indicated that individuals who attached more importance to power, achievement, and hedonism values exhibited higher pathological traits, whereas individuals who attached more importance to benevolence, tradition, and conformity exhibited lower pathological traits as assessed by the PID-5 facets. Power, achievement, and hedonism values focus on self-promotion, whereas benevolence and tradition promote getting along well with others. Thus, this pattern of associations is consistent with prior theory and evidence indicating that positive connectedness to others is a critical aspect buffering against pathological personality traits.

3. Study 2

Study 1 showed that some value types are systematically related to pathological personality traits. In Study 2, we tested whether these findings of Study 1 could be replicated using a different set of personality measures and self-assessment tools focusing on specific syndromes, such as impulsivity, obsessive-compulsiveness, and schizotypy.

3.1 Method

3.1.1 Participants and Procedure

Eighty-seven university students between 19 and 42 (56 females; mean age=23.97 \pm 3.92 *SD*) participated in the study. Respondents were informed that the study examined value-morality judgments. They completed a measure of human values and several measures of personality and personality psychopathology. The study was approved by the ethics committee of the School of Psychology at Cardiff University (EC.12.01.10.3071). Participants provided written informed consent. Since several variables were not normally

distributed when statistically assessed for normality, we additionally report the results based on Spearman correction, which produced similar results as can be seen in Supplementary Material 2.2. The study was conducted in Cardiff, Wales (United Kingdom).

3.1.2 Measures

Participants completed the Schwartz Value Survey (SVS; Schwartz, 1992). This 56-item scale can be used to measure the value types shown in Fig. 1. Participants were asked to rate the importance of each of the 56 values as a guiding principle in their lives, using a quasi-bipolar 9-point scale ranging from -1 (opposed to my values), 0 (not important), 4 (important), to 7 (of supreme importance). Examples of SVS items are as follows: "Equality: Equal opportunity for all" (Universalism); "Pleasure: Gratification of desires" (Hedonism); "Obedient: Dutiful meeting obligations" (Conformity). The average score across the 56 items was calculated and subtracted from each of the 56 initial raw scores before calculating the average of the value scores within each of the 10 value types. Schwartz recommends this procedure to help control superfluous individual variations in rating styles (Schwartz, 1992). The internal consistencies of the values scales as assessed with Cronbach's alpha were low to good (>.6 for all ten value types).

A set of questionnaires was administered to assess personality and psychopathological traits: the HEXACO Personality Inventory-Revised (HEXACO-PI-R; Lee & Ashton, 2004) measured six major dimensions of personality, UPPS-P Impulsive Behaviour Scale (Whiteside & Lynam, 2001) measured impulsivity, the Vancouver Obsessional Compulsive Inventory (VOCI; Thordarson et al., 2004) assessed compulsivity, the Behavioural Inhibition and Activation Scales (BIS/BAS; Carver & White, 1994) assessed motivation, the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) assessed schizotypy, and the TEMPS-A-short version assessed affective temperament (Akiskal et al., 2005).

3.2 Results

As in Study 1, we again assessed the relations between the 10 human value types and the trait measures (Table 2) while also calculating the corresponding sinusoidal fit indices.

Consistent with the previous findings, participants who attached higher importance to benevolence values exhibited lower scores on the pathological personality traits in several measures (including constricted affect, state anxiety, positive urgency, lack of premeditation, obsessions), although the negative correlations did not consistently reach significance.

As in Study 1, we then investigated the extent to which the personality traits were associated with the 10 human value types in a sinusoidal manner as predicted by Schwartz's circular model of values (Schwartz, 1992). We consider any sinusoidal associations with an SFI score of less than .20 to be significant. Results indicated a robust sinusoidal pattern of association between the 10 human value types and Reward Responsiveness (SFI=.16) from BAS, Agreeableness (SFI=.16) from HEXACO, and Checking (SFI=.12) from VOI.

304 **Table 2**
 305 Statistical results summary from Study 2.

	PO	AC	HE	ST	SD	UN	BE	TR	CO	SE	SFI	R ²	P>B
BIS/BAS													
Drive	.109	.201	.147	.283**	.07	-.192	-.294**	-.065	-.115	-.008	.20	.233*	<.05
Fun-seeking	-.095	-.172	.145	.353**	-.007	.058	-.06	.025	.081	-.079	.74	.214*	NS
Reward responsiveness	.208	.129	.192	.212*	-.085	-.248*	-.218*	-.072	-.069	.146	.16	.161	<.05
BIS	.12	.186	-.096	-.220*	-.127	-.196	.059	.172	-.077	-.023	.60	.232*	NS
SPQ													
Ideas of reference	.082	-.083	-.052	-.133	-.061	-.007	-.203	.053	.024	.135	.53	.127	NS
Odd beliefs or magical thinking	-.032	-.106	-.196	-.031	.039	.101	-.044	-.025	.045	.068	.62	.079	NS
Unusual Perceptual Experiences	-.104	-.036	-.039	.029	.129	.106	-.11	-.065	.015	-.016	.64	.056	NS
Odd or Eccentric Behaviour	-.279**	-.028	-.143	.13	.330**	.333**	-.074	-.102	-.116	-.151	.27	.243*	NS
Excessive social anxiety	-.018	-.005	.024	-.077	.124	.096	-.16	.042	-.174	.089	.91	.124	NS
No close friends	-.006	-.058	-.081	-.026	.176	.124	-.16	.071	-.116	-.024	.79	.157	NS
Odd speech	-.208	-.243*	-.039	.024	.184	.221*	-.065	.045	-.055	-.02	.35	.182	NS
Constricted affect	-.049	-.068	.003	.085	.211	.195	-.247*	.068	-.063	-.105	.63	.215*	NS
Suspiciousness	.086	-.075	-.071	-.113	-.099	-.036	-.21	.161	-.007	.247*	.49	.142	NS
TEMPS-A													
Cyclothymic	-.177	-.001	-.077	.094	.164	.156	-.106	-.006	-.142	-.12	.29	.124	NS
Dysthymic	.067	.017	-.081	-.034	.204	.212	-.158	-.116	-.088	-.101	.73	.156	NS
Irritable	-.075	.01	.079	.099	.059	.003	-.248*	.027	-.026	.033	.72	.114	NS
Hyperthymic	-.011	.081	-.125	.282**	.028	-.048	-.021	-.118	.144	-.12	.89	.174	NS
Anxious	.059	.08	.017	-.125	-.204	-.107	-.132	.074	-.075	.240*	.33	.174	NS
UPPS-P													
(Negative) Urgency	.097	-.016	.214*	.042	-.11	-.007	-.245*	.015	-.1	.087	.53	.144	NS
(lack of) Premeditation	.009	.052	.254*	.305**	.066	.101	-.355**	-.113	-.203	.133	.38	.252*	<.05
(lack of) Perseverance	.032	-.138	.201	.023	-.06	.057	-.159	.202	-.032	.019	1.0	.163	NS
Sensation seeking	-.232*	-.094	.006	.349**	.091	.053	-.171	.002	.274*	-.002	.90	.314**	NS
(Positive) Urgency	.058	-.078	.117	.088	-.016	.091	-.295**	.036	-.071	-.015	.78	.151	<.05
VOCI													
Contamination	.118	-.073	.068	-.098	-.127	.063	-.18	.051	-.041	.246*	.65	.184	NS
Checking	.118	.107	-.005	-.094	-.197	-.186	-.107	.04	.041	.309**	.12	.153	NS
Obsessions	.11	-.041	-.029	.052	.006	.045	-.214*	-.017	-.015	.118	.77	.080	NS
Hoarding	-.001	-.007	.035	.047	-.005	.146	-.185	.022	-.207	.142	.87	.164	NS
Just Right	.054	-.049	-.177	-.065	.062	.078	-.17	-.043	.087	.112	.85	.141	NS
Indecisiveness	.171	.06	-.012	-.061	-.007	-.093	-.056	-.028	-.029	.067	.30	.051	NS
VOCI Total	.128	-.006	-.047	-.05	-.048	.01	-.191	.002	-.019	.2	.52	.108	NS
HEXACO													
Honesty-Humility	-.481***	-.229*	-.274*	-.184	.165	.327**	.398***	-.052	.109	-.181	.18	.348***	<.001

Emotionality	.211*	.13	-.094	-.250*	-.303**	-.247*	.182	-.013	.027	.098	.35	.337***	NS
Extraversion	-.011	-.029	.012	.076	-.03	.014	.048	.056	-.026	-.102	.66	.032	NS
Agreeableness	-.228*	-.125	-.111	-.144	-.057	.126	.288**	.137	.078	-.127	.16	.144	<.01
Conscientiousness	-.047	.037	-.257*	-.113	.012	-.137	.161	-.122	.267*	.077	.65	.216*	NS
Openness	-.328**	.019	-.149	.162	.511***	.407***	.059	-.331**	-.272*	-.195	.24	.356***	<.05
Altruism	-.269*	-.143	-.191	-.229*	-.116	.123	.434***	-.012	-.004	-.107	.33	.317***	<.001
STATE ANXIETY	.078	.086	.002	.055	.167	.083	-.238*	-.088	-.038	-.113	.56	.132	NS

Notes. * $p < .05$, ** $p < .01$, *** $p < .001$, SFI= sinusoidal fit index, R^2 : the amount of explained variance with the value types as predictors and the variable in the first column as the dependent variable, P>B: p-value when investigated whether the correlation coefficients of the value type power and each variable in the first column facet are significantly different from the correlations between the value type benevolence and that variable, using Fisher's r-to-z transformation.

3.3 Discussion

The results indicated that individuals who attached more importance to power and achievement values exhibited on average higher scores on obsessional compulsiveness (VOCI) and drive, whereas individuals who attached more importance to benevolence and universalism exhibited lower scores on these measures. Consistent with the aforementioned link between benevolence values and connectedness to others (Study 1 Discussion), it is also noteworthy that participants who attached more importance to self-transcendence values (e.g., benevolence) or less importance to self-enhancement values (e.g., power, achievement) scored higher on several personality traits that promote good relations with others, including honesty-humility and agreeableness.

4. General Discussion

The present research provides a novel investigation of the linear and sinusoidal associations between values and a wide range of measures assessing pathological personality traits as well as non-clinical personality traits. Two main results emerged from this research.

First, we demonstrated across two studies conducted in Germany and the United Kingdom, that benevolence and some conservation values (but only in the German sample) buffer against several pathological personality traits that constrain psychological well-being. Conversely, self-enhancement values (especially power) were positively associated with these psychological tendencies.

Interestingly, benevolence was more strongly negatively associated with many psychopathological traits than universalism. We believe this is because people higher in benevolence care more for “people with whom one is in frequent personal contact” whereas people higher in universalism care more for humanity in general (Schwartz, 1992). Many of the psychopathological traits we investigated have negative consequences for people with whom one is in close contact (e.g., callousness, hostility, obsessions).

It is worth noting that tradition was negatively associated with a range of pathological traits including deceitfulness, hostility, or irresponsibility in the German sample but not in the British sample (i.e., Study 1 but not Study 2). This suggests that valuing tradition can buffer against pathological traits that might have direct negative consequences for other people. Indeed, the goal of tradition values is “respect, commitment, and acceptance of the customs and ideas that one's culture or religion impose on the self” (Schwartz, 1992). In contrast, hostility, deceitfulness, and irresponsibility are strong indicators of disrespecting others. However, we can only speculate why these associations appeared only in the German sample but not the British sample. In terms of cultural values, average income, life expectancy, or education levels, the UK and Germany are very similar (Hofstede, 2001; UNDP, 2015).

However, one noticeable difference is the number of young people who identify themselves as religious. Among 16 to 29-year-olds, 45% of Germans but 70% of British participants identified themselves as non-religious (Bullivant, 2018). This difference can

contribute to explaining the different patterns of correlations we obtained, assuming that higher levels of religiosity increase the likelihood of being in a religious community. For example, Hanel et al. (Hanel et al., 2019) sampled students studying the same subject at the same institution as our Study 1 participants, albeit from a different cohort. The authors found that religiosity, which is strongly associated with tradition values (Saroglou et al., 2004), tended to be negatively associated with schizotypy, another pathological trait, but only among those students who were members of a religious community. That is, a higher percentage of German participants might have been a religious community member than the British participants, which could potentially explain this difference. Moreover, PID-5 and HEXACO are trait-based measures. Such measures usually rely on factor analyses of the results which are not always replicable as they can vary between samples and depend on several factors, including the variables inserted in the analysis (Goldberg, 1992). Moreover, it was previously argued that only certain traits (extraversion, agreeableness, and conscientiousness) were replicated across cultures, and other studies found inconsistent results regarding the sixth-factor dimensions (Becker, 1999; De Raad et al., 2010; Thalmayer et al., 2011). Nevertheless, future research is needed to shed more light onto this cross-country difference in these correlations.

Second, by employing a recently developed methodology to detect sinusoidal patterns specifically, we were able to capture all of the available information in the relations between human values and pathological personality traits. In particular, we detected robust sinusoidal relationships with a range of traits (including Reward Responsiveness from BAS, Agreeableness from HEXACO and Checking from VOCI, Separation Insecurity from 25 PID-5 facets). Of additional interest, the individual correlations between the pathological personality traits and human values were often below conventional levels of significance when viewed individually. Still, the pattern was highly reliable when viewed together using

the sinusoidal test. The sinusoidal approach has two important advantages. First, a single SFI, as opposed to a single correlation, is calculated by taking into account the association between an external variable and all 10 human values at a time; the number of comparisons when using this approach is reduced 10 times. Second, this approach allows researchers to detect sinusoidal links that are undetectable at the linear level. The findings extend our previous demonstrations of the utility of the sinusoidal methodology for testing theoretical predictions from Schwartz's circular model of values (Schwartz, 1992), and we recommend its use in future research using the model.

In both studies, we used different measures for values and psychopathological constructs in samples from two countries. This was done to test whether our findings are independent of specific measurements and are robust across countries (Boer et al., 2011). Further, since our results are cross-sectional, we do not know whether values impact psychopathological traits or vice versa. Recent evidence suggests that the link between values and well-being is bi-directional (Grosz et al., 2021), but it is unclear whether this generalises to personality traits.

5. Conclusion

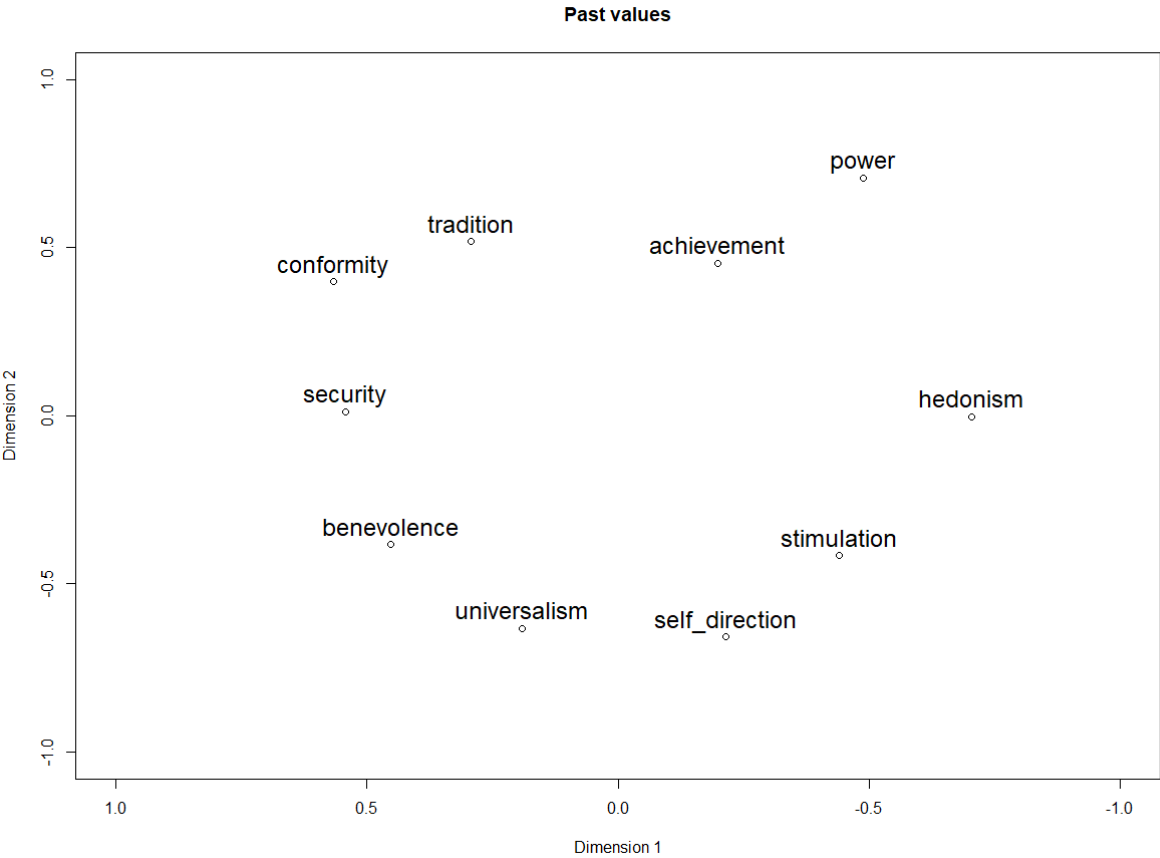
In sum, our results are consistent with the hypothesis that some values (i.e., self-transcendence) support personality traits underpinning well-being, while other values (i.e., self-enhancement) oppose these traits. These findings might pave the way for developing human value change interventions to cultivate dispositions that support well-being. Indeed, several studies have found that human values are malleable (Çileli, 2000; Inglehart, 1997; Klages, 2005; Sheldon, 2005; Verkasalo et al., 2006), and some interventions have been successful at changing values (Bardi & Goodwin, 2011; but see Manfredi et al., 2017 for an opposing view). These include interventions that ask participants to generate reasons for values (Bernard et al., 2003), or deliver feedback that challenges individuals to consider the

fit between their values and self-concept (Maio et al., 2009; Rokeach, 1975). The use of these methods may also lead to additional insights into the mechanisms through which values and personality psychopathology are interlinked. Lastly, our findings will motivate future studies examining the predictive role of human values in developing personality psychopathology in clinical populations.

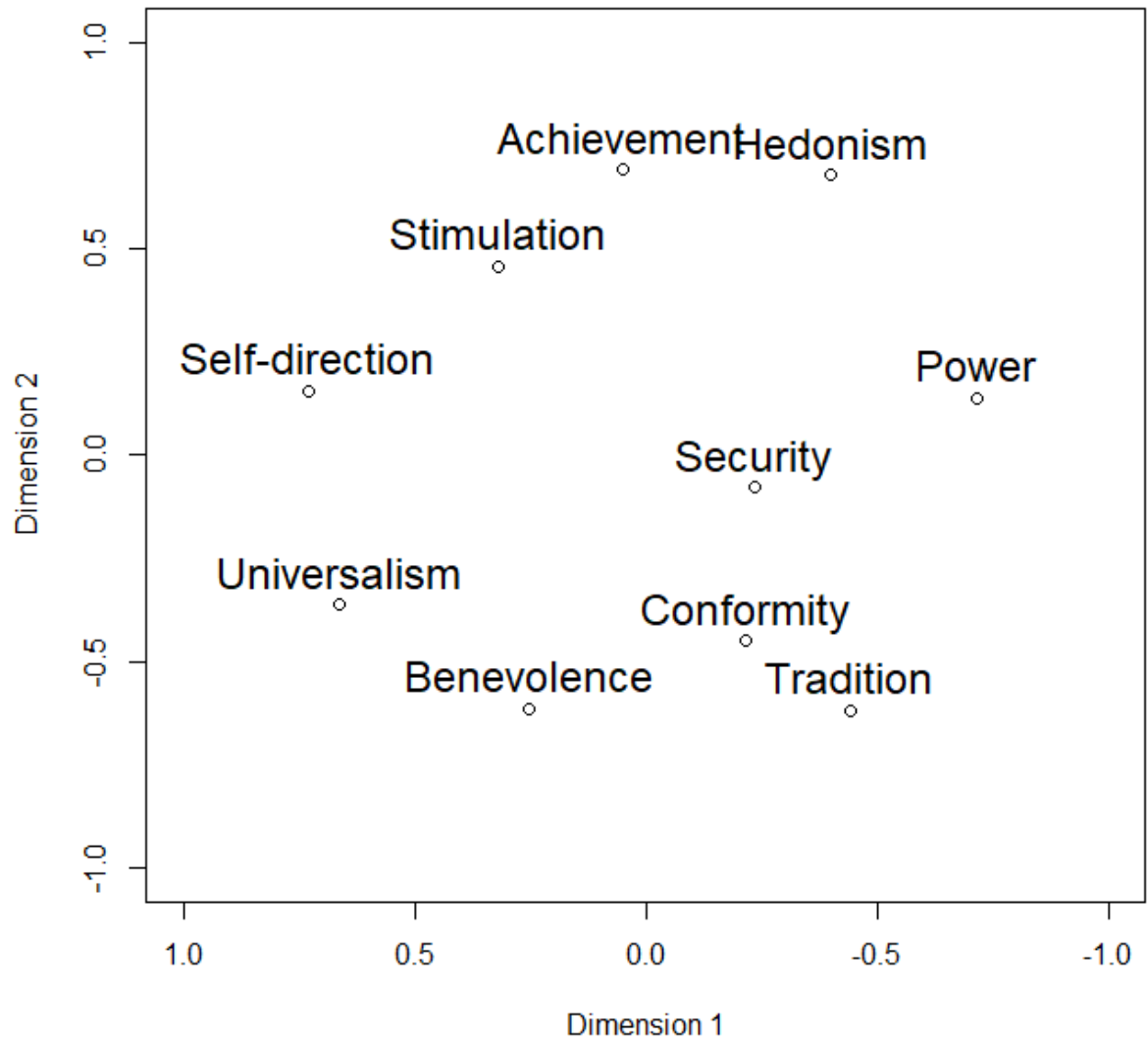
Supplementary Material

Supplementary Material 1.

1.1. Result of a multidimensional scaling analysis from our Study 1 with the Short Schwartz's Value Scale.



1.2. Result of a multidimensional scaling analysis from our Study 2 with the Schwartz's Value Scale.



Supplementary Material 2

2.1. Replication of the main analyses when using Spearman correlations in Study 1.

	PO	AC	HE	ST	SD	UN	BE	TR	CO	SE	SFI	R ²	α	P>B
Anhedonia	0.15	0.14	-0.09	-0.21	-0.05	0.11	-0.07	-0.08	0.10	0.06	0.66	.19	.85	<.001
Anxiousness	0.07	0.12	0.02	-0.21	-0.14	0.03	-0.04	-0.07	0.10	0.17	0.40	.10	.90	.029
Attention seeking	0.17	0.06	0.18	0.05	0.08	-0.06	-0.05	-0.11	-0.10	-0.16	0.34	.11	.87	.002
Callousness	0.33	0.13	0.14	-0.01	0.05	-0.13	-0.17	-0.11	-0.14	-0.15	0.38	.27	.85	<.001
Deceitfulness	0.27	0.06	0.18	-0.09	0.04	-0.09	-0.10	-0.15	-0.03	-0.09	0.47	.16	.88	<.001
Depressivity	0.10	0.01	0.03	-0.16	-0.07	0.13	-0.01	-0.09	0.13	0.04	0.78	.12	.93	.008
Distractibility	0.06	-0.15	0.17	-0.02	0.02	0.09	-0.01	-0.14	0.07	-0.06	0.91	.11	.85	NS
Eccentricity	0.11	0.03	0.11	0.05	0.10	0.09	-0.05	-0.13	-0.03	-0.15	0.40	.08	.94	.005

Emotional lability	-0.05	-0.02	0.08	-0.12	-0.08	0.12	0.09	-0.05	-0.03	0.15	0.92	.05	.85	NS
Grandiosity	0.21	0.15	0.07	-0.13	0.05	-0.10	-0.08	-0.04	-0.12	-0.06	0.53	.12	.78	<.001
Hostility	0.25	0.07	0.21	-0.11	0.00	-0.05	-0.12	-0.17	-0.08	-0.08	0.43	.15	.84	<.001
Impulsivity	0.04	-0.09	0.05	0.14	0.05	-0.01	-0.04	0.03	-0.05	-0.18	0.58	.05	.83	NS
Intimacy avoidance	0.12	-0.07	-0.04	0.07	0.10	0.12	-0.11	-0.03	0.05	-0.15	0.84	.12	.84	<.001
Irresponsibility	0.07	-0.06	0.13	0.04	0.11	0.13	0.01	-0.17	-0.05	-0.09	0.47	.11	.71	NS
Manipulativeness	0.23	0.10	0.22	-0.02	0.03	-0.11	-0.06	-0.10	-0.13	-0.16	0.41	.14	.80	<.001
Perceptual dysregulation	0.06	-0.03	0.06	0.04	0.04	0.10	0.03	-0.11	-0.03	-0.08	0.53	.06	.83	NS
Perseveration	0.12	0.03	0.14	-0.12	-0.05	0.06	-0.08	-0.10	0.04	-0.08	0.77	.09	.80	.005
Restricted affectivity	0.18	0.05	0.03	-0.01	0.03	-0.02	-0.08	-0.06	0.05	-0.14	0.74	.12	.81	<.001
Rigid perfectionism	0.16	0.17	-0.07	-0.15	-0.13	-0.03	-0.08	-0.05	0.05	0.05	0.31	.08	.87	<.001
Risk taking	-0.08	-0.14	0.02	0.41	0.15	0.02	0.00	-0.01	-0.07	-0.29	0.38	.23	.91	NS
Separation insecurity	0.10	0.02	0.00	-0.17	-0.20	-0.06	-0.04	0.04	0.15	0.12	0.10	.08	.84	.021
Submissiveness	0.05	0.05	-0.02	-0.23	-0.17	0.00	-0.06	0.01	0.26	0.09	0.29	.14	.80	NS
Suspiciousness	0.19	0.14	-0.02	-0.19	-0.11	-0.01	-0.11	-0.08	0.08	0.07	0.31	.12	.68	<.001
Unusual belief experiences	0.01	-0.05	0.03	0.04	0.07	0.08	0.03	-0.02	0.01	-0.10	0.34	.02	.79	NS
Withdrawal	0.08	0.08	0.00	-0.15	0.03	0.09	-0.09	-0.04	0.08	-0.04	0.91	.20	.89	<.001
Mean <i>r</i>	0.12	0.03	0.07	-0.05	0.00	0.02	-0.05	-0.07	0.01	-0.05	0.53			.005
<i>R</i> ²	.27	.18	.16	.28	.14	.15	.16	.12	.19	.19				

Note. All *R*²s of the bottom row are significant at *p* < .001, all *R*²s of column ≥ .04 are

significant at *p* < .05. All *rs* ≥ .10 are significant at *p* < .05, all ≥ .13 at *p* < .01, and all *rs*

≥ .17 at *p* < .001 (all two-tailed). Significant values are in bold. PO: Power, AC:

Achievement, HE: Hedonism, ST: Stimulation, SD: Self-direction, UN: Universalism, BE:

Benevolence, TR: Tradition, CO: Conformity, SE: Security.

2.2. Replication of the main analyses when using Spearman correlations in Study 2.

	PO	AC	HE	ST	SD	UN	BE	TR	CO	SE	SFI	<i>R</i> ²	P>B
BIS/BAS													
Drive	.13	.229*	.094	.284**	.046	-.222*	-.310**	-.039	-.008	.058	.28	.233*	<.05
Fun-seeking	-.133	-.188	.157	.396***	.022	.103	-.075	.048	.07	-.091	.68	.214*	NS
Reward responsiveness	.201	.127	.230*	.183	-.036	-.272*	-.217*	-.021	-.035	.203	.19	.161	<.05
BIS	.167	.230*	-.148	-.208	-.044	-.240*	.034	.091	-.05	-.018	.62	.232*	NS
SPQ													
Ideas of reference	.079	-.04	.031	-.098	.034	.015	-.221*	-.015	.065	.068	.74	.127	NS
Odd beliefs or magical thinking	-.026	-.093	-.054	.015	-.023	-.055	-.017	-.04	-.002	.13	.83	.079	NS

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Unusual Perceptual Experiences	-.108	-.008	-.002	-.004	.068	.07	-.104	-.042	.069	.016	.91	.056	NS
Odd or Eccentric Behaviour	-.255*	.033	-.151	.044	.328**	.303**	-.093	-.076	-.089	-.083	.44	.243*	NS
Excessive social anxiety	-.004	.032	.04	-.073	.093	.024	-.141	.055	-.162	.094	.90	.124	NS
No close friends	.014	-.101	-.073	-.055	.152	.105	-.181	.089	-.163	.011	.89	.157	NS
Odd speech	-.181	-.197	.03	.016	.133	.188	-.094	.043	.011	-.032	.48	.182	NS
Constricted affect	-.04	-.12	-.008	.044	.213*	.197	-.235*	.1	0	-.142	.70	.215*	NS
Suspiciousness	.028	-.108	-.004	-.055	-.098	-.042	-.257*	.173	-.006	.144	.71	.142	NS
TEMPS-A													
Cyclothymic	-.17	-.02	.003	.082	.161	.122	-.064	-.027	-.111	-.101	.16	.124	NS
Dysthymic	.054	.026	.087	-.012	.189	.209	-.147	-.108	-.183	-.05	.49	.156	NS
Irritable	-.106	.03	.082	.124	.088	.022	-.198	.043	.012	.021	.74	.114	NS
Hyperthymic	-.028	.114	-.075	.282**	.029	-.063	-.024	-.146	.182	-.131	.86	.174	NS
Anxious	.145	.045	.021	-.17	-.276*	-.154	-.139	.117	.023	.254*	.16	.174	NS
UPPS-P													
(Negative) Urgency	.138	.019	.242*	-.026	-.064	-.057	-.193	-.036	-.029	.17	.36	.144	NS
(lack of) Premeditation	.031	.001	.193	.255*	.067	.139	-.357**	-.037	-.198	.12	.53	.252*	<.05
(lack of) Perseverance	.018	-.16	.225*	.001	-.063	.067	-.191	.2	-.055	.006	.99	.163	NS
Sensation seeking	-.193	-.119	.06	.410***	.07	.087	-.175	.022	.243*	-.038	.85	.314**	NS
(Positive) Urgency	.103	-.086	.129	.051	-.006	.049	-.237*	.053	-.039	.039	.81	.151	NS
VOCI													
Contamination	.112	-.055	.109	-.088	-.18	.023	-.189	.139	-.049	.279**	.60	.184	NS
Checking	.151	.139	.019	.034	-.124	-.230*	-.268*	.012	.055	.308**	.18	.153	<.05
Obsessions	.071	.073	.065	.08	.073	.018	-.268*	-.04	-.119	.181	.52	.080	NS
Hoarding	.073	-.068	.14	.075	.006	.098	-.253*	.07	-.094	.16	.84	.164	NS
Just Right	.063	-.049	-.082	-.072	.013	-.003	-.128	.029	.131	.155	.48	.141	NS
Indecisiveness	.152	.046	.043	-.1	-.004	-.105	-.044	-.011	-.057	.126	.36	.051	NS
VOCI Total	.129	.011	.025	-.051	-.084	-.098	-.179	.078	.09	.239*	.23	.108	NS
HEXACO													
Honesty-Humility	-.443***	-.222*	-.250*	-.144	.172	.308**	.365**	-.12	.097	-.207	.21	.348***	<.001
Emotionality	.233*	.153	-.1	-.275**	-.230*	-.267*	.158	-.05	.016	.127	.36	.337***	NS
Extraversion	-.031	-.009	-.037	.18	-.163	-.122	.169	-.052	.026	-.029	1.0	.032	NS
Agreeableness	-.279**	-.15	-.139	-.15	-.006	.183	.251*	.023	.113	-.189	.19	.144	<.01
Conscientiousness	.003	.037	-.243*	-.142	.007	-.21	.181	-.114	.204	.072	.65	.216*	NS
Openness	-.388***	-.016	-.191	.155	.590***	.435***	.098	-.348**	-.212*	-.221*	.26	.356***	<.01
Altruism	-.283**	-.17	-.178	-.208	-.051	.076	.444***	-.042	-.046	-.147	.34	.317***	<.001
STATE ANXIETY													
	.082	.065	.107	.04	.163	.055	-.261*	-.068	-.05	-.089	.46	.132	<NS

Notes. * $p < .05$, ** $p < .01$, *** $p < .001$, SFI= sinusoidal fit index, R^2 : the amount of explained variance with the value types as predictors and the variable in the first column as the dependent variable, $P>B$: p-value when investigated whether the correlation coefficients of the value type power and each variable in the first column facet are significantly different from the correlations between the value type benevolence and that variable, using Fisher's r-to-z transformation.

Supplementary Material 3

Sinusoidal Relationship Analyses

This test examines whether values are systematically related to an external variable (e.g., anxiety). This test is important because other statistics, such as the amount of explained variance R^2 , cannot fully test the model's circular distribution. For example, a high R^2 can occur when one value type is highly correlated with an external variable, whereas the other value types are unrelated. Conversely, a low R^2 still can occur even when the value types are systematically related to the external variables in the predicted sinusoidal manner.

To test the sinusoidal pattern, the correlation coefficients with the 10 value types were calculated. The fit of the sinusoidal function presented below (1) was calculated using the programming language R.

$$(1) \hat{y} = f(x) = a + b \cdot \sin(c \cdot x + d)$$

In equation 1, \hat{y} is the estimated numerical value (e.g., estimated correlation coefficients), x is a vector containing the numbers 1 to 10, parameter a is the y-offset that moves the function up and down along the ordinate (y-axis), parameter b determines the amplitude of the sinus wave on the y-axis, parameter c is the period of the sine wave, and parameter d (x-offset) moves the sinusoidal function along the x-axis (Hanel et al., 2017).

The script used to calculate the sinusoidal fit index is composed of mathematical functions available in R. Here, we describe the main functions used in the Sinusoidal Fit Index. To optimize the four parameters (a , b , c , d) of the sine function (equation 1) we used the ‘brute force method’, an exploratory approach used to determine the starting points for the actual optimization function. This determination was achieved using the R command `optim` (general-purpose optimization function, <https://stat.ethz.ch/R-manual/R-devel/library/stats/html/optim.html>; R version 3.6.3). The R command `optim` is often used for optimizations and only searches for local minima (i.e., stabilizes to the closest local minima) – as do all optimization algorithms. The `optim` function takes 4 arguments-inputs (the a , b , c , and d of the eq1) and produces 4 outputs through Nelder–Mead, quasi-Newton and conjugate-gradient algorithms (Nash, 1990; Nelder & Mead, 1965). For all four parameters, 50 numerical values were selected, resulting in $50 \times 50 \times 50 \times 50 = 6,250,000$ combinations (selection procedure further explained below). Specifically, we tested which of 6,250,000 combinations of the four parameters in the sinusoidal function result in a sine function with the smallest deviation from the empirical data. The selection of numerical values (i.e., the 6,250,000 combinations) was employed to achieve a range that is as large as necessary – more combinations can increase the fit slightly – but still manageable in computational terms.

For each parameter, the numerical values were selected from a specific range according to Schwartz's theoretical predictions (Schwartz, 1992). The 50 numerical values selected for the parameter a were -1, -.96, -.92, ..., .96, 1. In other words, parameter a was restricted between -1 to 1 because this is the possible range for a correlation coefficient. The same restrictions were applied to parameter b , which determines the amplitude of the sinus wave on the y-axis (i.e., the distance between the turning points of the sinusoidal function). The parameter c , the period of the sine wave, was allowed to range between 85-95% of a full

sine wave. This restriction was based on the circular model's assumption that "the distances between the values around the circle may not be equal" (Schwartz et al., 2012). Given that the first value type was plotted at $x = 1$, the parameter d (x -offset), which moves the sinusoidal function along the x -axis, was set to the interval $[1 + 10/2, 1 - 10/2]$. The parameter d was restricted to 10, which is the number of correlation coefficients between the external variable and the 10 value types. This restriction is useful because there was no hypothesis regarding the exact starting point of the sine wave for each parameter. To be able to define a lower and upper bound given these constraints, a method developed by Byrd, Lu, Nocedal, and Zhu (Byrd et al., 1995) was used. This is a "limited memory quasi-Newton algorithm for solving large nonlinear optimization problems with simple bounds on the variables" (p. 1).

To estimate the model fit indices for the sinusoidal function, we calculated the sum of the squared residuals divided by the variance. This Sinusoidal Fit Index (SFI, Hanel et al., 2017) and is presented below (equation 2).

$$(2) SFI = \frac{\frac{1}{K-1} \sum_{k=1}^K (y_k - \hat{y}_k)^2}{\frac{1}{K-1} \sum_{k=1}^K (y_k - \bar{y}_k)^2}$$

In this equation (2), K represents the number of correlation coefficients, y_k represents the correlation coefficients, \hat{y}_k represents the estimated correlation coefficient through the optimization function, and \bar{y}_k represents the mean of the correlation coefficients. The denominator is the formula for the variance.

To obtain the number of false-positive results for the SFI, three simulations of $m = 100,000$ samples each were conducted with the programming language R. To simulate a random pattern of correlation coefficients, we tested the following two assumptions regarding the distribution of the correlation coefficients. (1) We sampled 10 numbers (i.e., number of human values) between $-.5$ and $.5$, assuming a uniform distribution. The range from $-.5$ to $.5$ represents the interval in which most correlations between values and external variables

usually fall (the pattern of results remained the same when we extended the range to $-.7$ to $.7$).

(2) We sampled k numbers from a normal distribution with $\sim N(0, .1)$, and (3) $\sim N(0, .3)$.

Numbers $>|1|$ were restricted to -1 or 1 , respectively.

The proportion of false positives was well below 1% for all three simulations for $SFI < .20$. The percentage of false positives was slightly larger if a uniform distribution was assumed. The percentage of false positives for an $SFI < .20$ was 0.49 (i.e., less than 5 false-positive results per one thousand comparisons), assuming a normal distribution. This means that 200 SFI tests will yield merely one false-positive result. Therefore, our statistical threshold is considerably more conservative than typical statistical thresholds (i.e., $p < .05$). The percentage of false positives are 0.20%, 0.05% and 0.005% for $SFI < .15$, $SFI < .10$ and $SFI < .05$, respectively. Please note that the main reason for our cut-off values ($SFI < .20$) was the careful examination of many plots and not the simulations' results. An SFI of $> .20$ can still be considered as following a sine wave, but it is harder to recognize an SFI of $.30$ as following a sine wave. We note that this cut-off is somewhat subjective and therefore report the exact SFI-values in case readers prefer a different threshold.

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