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Locating the Dark Triad in a Multidimensional Personality Space

Revital Naor-Ziv[1], **Joseph Glicksohn**[1] **and Anton Aluja**[2,3]

[1] *Bar-Ilan University (Israel)*
[2] *Universitat de Lleida (Spain)*
[3] *Institut de Recerca Biomédica Fundació Dr. Pifarré (Spain)*

Abstract. The Dark Triad traits of Psychopathy, Machiavellianism, and Narcissism should be clearly recognizable within a multidimensional personality space. Two such personality spaces were investigated in this study: HEXACO (Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to Experience); and the Zuckerman-Kuhlman-Aluja Personality Questionnaire (ZKA-PQ) space (Extraversion, Neuroticism, Activity, Sensation Seeking, and Aggressiveness). Our sample comprised 289 participants (137 males, 145 females, 7 unspecified) who completed these three questionnaires: HEXACO–60, ZKA-PQ/SF, and the SD3, assessing the Dark Triad. We reduced the dimensionality of each space to that of a 2D representation using Smallest Space Analysis (SSA). Three research questions guided the data analysis: (a) Do the HEXACO and ZKA-PQ SSA spaces conform to the structure of a radex? (b) Will these spaces remain invariant following the entry of the Dark Triad traits into the analyses? (c) Where will the Dark Triad traits be located in each SSA space? For ZKA-PQ space, the structure was clearly indicative of a radex, both prior to entering the Dark Triad traits into the analysis, and subsequent to this. Psychopathy and Machiavellianism were in close proximity in the Aggressiveness region; Narcissism was positioned at the common origin. In contrast, HEXACO space did not conform to a radex; furthermore, the presence of the Dark Triad traits distorts this 2D SSA space.

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Psychopathy might well be the major trait of the Dark Triad (Muris et al., 2017, p. 189); its locus within Eysenckian personality space (the Big Three) being in the octant of high Extraversion, high Neuroticism, and high Psychoticism (Eysenck, 1995). Its sister dark trait of Machiavellianism lies in the high Psychoticism, high Extraversion quadrant (Allsopp et al., 1991). Narcissism completes the Dark Triad, and is aligned with Neuroticism (Jang et al., 1998). The Big Three, however, is not the dominant paradigm for personality research at the present, and various models have been proposed suggesting more than three central dimensions of personality. Given this, where would one locate the Dark Triad in a space of higher dimensionality? To answer this, we first have to address these candidate multidimensional personality spaces.

On making the transition from a focus on the Big Three (Eysenck & Eysenck, 1985) to the Big Five (McCrae & Costa, 1997), a consensus was prescribed indicating that this was *the* working paradigm for personality research. Indeed, Ozer and Reise (1994, p. 361) could proclaim that "Personality psychologists who continue to employ their preferred measure without locating it within the five-factor model can only be likened to geographers who issue reports of new lands but refuse to locate them on a map for others to find ….". The Big Five (Neuroticism,

Correspondence concerning this article should be addressed to Joseph Glicksohn. Bar-Ilan University. Faculty of Social Sciences. Department of Criminology. 52900 Ramat Gan (Israel).
E-mail: gliksoj@biu.ac.il

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Extraversion, Agreeableness, Conscientiousness, and Openness to Experience) not only describes normative personality, but also embeds personality disorders within the same personality space (Costa & McCrae, 1992).Nevertheless, within the space of ten years (from 1994), the paradigmatic status of the Big Five was beginning to be challenged, on three fronts.

First, an 'alternative' Big Five (Zuckerman, 2005) was promoted, one in which the Big Three could be embedded (Zuckerman & Glicksohn, 2016). While this 'alternative' Big Five has not succeeded in generating a large literature, it nevertheless presents an alternative framework within which one can conduct personality research, as in the present paper. Second, a Big Six was advanced, namely that of HEXACO (Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to Experience; Lee & Ashton, 2004). While the important addition here is the dimension of Hostility-Humility (Saucier, 2019), it is not the case that this is a simple addition to the existing Big Five. In particular, HEXACO Emotionality is not comparable with Big Five Neuroticism (Howard & van Zandt, 2020); and Honesty-Humility has no clear projection on Big Five Agreeableness and Conscientiousness (Ashton & Lee, 2020). Again, while this HEXACO framework has generated quite a large literature, this is still not as extensive as that generated by the Big Five. Nevertheless, this is also an alternative framework within which one can conduct personality research. Third, the Dark Triad made its appearance in the literature (Paulhus & Williams, 2002). While this did not pose a challenge to the Big Five, it certainly suggested that the Big Five could be complemented by looking at other personality dimensions. Thus, what Lee and Ashton (2014, p. 3) refer to as the "Big-Five plus-Dark-Triad" (B5–plus–D3 model; see, e.g., Kowalski et al., 2019, for a recent example of this) can now be contrasted with HEXACO as two competing theories (Ashton & Lee, 2020; Howard & van Zandt, 2020) whose predictive value are under scrutiny at the present.

Turning now to HEXACO space, where would the Dark Triad be located? One finds two prominent patterns in the literature. The first identifies the Dark Triad with Honesty-Humility (Ashton & Lee, 2009, 2020; Hodson et al., 2018; Paulhus, 2014); the second places the Dark Triad within a subspace marked by Honesty-Humility, Agreeableness, and Conscientiousness (Watts et al., 2017). There is an ongoing debate regarding the degree of convergence of Honesty-Humility and the Dark Triad. While the two constructs do converge (Ashton & Lee, 2009, p. 344; Kowalski et al., 2021), one line of thought is that the 'dark core' of the Dark Triad (and of all such dark traits of personality) is much wider than the content expressed by Honesty-Humility (Moshagen et al., 2018). A second line of thought is that the two constructs, in fact, have maximal overlap (Hodson et al., 2018, p. 128). The most recent argument is that the two constructs are, in fact, functionally distinct, while still bearing a great degree of overlap (Horsten et al., 2021). Hence, it is important to continue investigating where exactly the Dark Triad is located in HEXACO space, and our use of Smallest Space Analysis (see below) will comprise an important contribution here.

A second major goal is to study the space of the 'alternative' Big Five, the ZKA-PQ space (Extraversion, Neuroticism, Activity, Sensation Seeking, and Aggressiveness; Glicksohn et al., 2018; Rossier et al., 2016). Note that this 'alternative' Big Five model also enables one to place both 'normal' and pathological traits within the same personality space (Aluja et al., 2021). Given that Psychoticism converges with Sensation Seeking, Aggressiveness and Activity (Zuckerman & Glicksohn, 2016, p. 50), one option is for the Dark Triad to be embedded in ZKA-PQ space within the zone corresponding to the high end of these dimensions. Another would be to consider a subspace such as that of Sensation Seeking and Aggressiveness (Glicksohn et al., 2018, p. 21). We are particularly interested in seeing whether Machiavellianism and Psychopathy can be clearly differentiated in ZKA-PQ space. For as Kowalski et al. (2019, p. 3) have recently suggested, in contrast to the Big Five framework, a personality space that emphasizes such a dimension as impulsivity might be better suited to differentiate between Psychopathy and Machiavellianism. ZKA-PQ space would be a good candidate here.

In order to investigate the location of the Dark Triad within each of these multidimensional personality spaces, we employ multidimensional scaling (specifically, Smallest Space Analysis), to reduce the dimensionality of each space (for HEXACO, this is 6; for the ZKA-PQ, this is 5) to that of a 2D representation. Given that the reader may be unfamiliar with this technique, we outline below the rationale of the analysis, exemplify its use, and then present a working hypothesis for the structure of personality space that should be uncovered using Smallest Space Analysis (SSA).

SSA is a technique of data reduction, whereby a correlation matrix (or matrix of any suitable measure of similarity) is translated into a matrix of distances.[1]

[1]Note that the same matrix of correlations is used to explore the factorial structure of each personality space and its corresponding questionnaire (see Appendix). What both factor analysis and SSA do is to go beyond these surface, pairwise, Pearson correlations, to look for underlying structure that would result in the pattern of intercorrelation observed in the correlation matrix. In particular, SSA presents a 2D geometric representation of the personality space, and it is within this space that one can embed the Dark Triad. What the structure of this space is (e.g., a radex, as explored here), where the Dark Triad traits are positioned in this space, and to what degree their positions overlap, all contribute to the added value of employing SSA, as opposed to looking just at the size and sign of the various Pearson correlations.

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Consider, for example, the 3 × 3 correlation matrix for the Dark Triad: the 3 above-diagonal correlations are that between Psychopathy (P) and Narcissism (N; r_{PN}), that between Psychopathy and Machiavellianism (M; r_{PM}), and that between Narcissism and Machiavellianism (r_{NM}). In the study reported here, these were found to be as follows: r_{PN} = .31; r_{PM} = .51; r_{NM} = .35 (see Table 1). The correlation between P and M is translated into a distance between a point in a plane representing P and a point in the same plane representing M; this distance is $d_{PM.}$ In the same manner, r_{NM} is translated into d_{NM} and r_{PN} into d_{PN}. The three points P, N, and M must be situated such that inequalities between correlations (e.g., $r_{PM} > r_{NM}$) are reflected in the corresponding inequalities between distances (i.e., $d_{PM} < d_{NM}$); in addition, given that the three points form a triangle, these distances must preserve the triangle inequality, namely that the sum of any two sides must be greater than the third side. In a larger $k \times k$ correlation matrix, there are multiple constraints on these calculated distances. SSA preserves the order among the correlations in the smallest possible Euclidean space (Schlesinger & Guttman, 1969, p. 95). In practice, the 2D space is the most useful one for exploring the structure of that space.

SSA has been employed in the past to examine the 2D space representing structural brain asymmetry (Glicksohn & Myslobodsky, 1993; Myslobodsky et al., 1991), mood (Glicksohn & Boikova, 2018; Glicksohn et al., 1996), personality disorders (Kumar et al., 2012; Pukrop et al., 1998; Turkheimer et al., 2008), parenting styles (Alt, 2016), and other varied topics. Of present interest is the use of SSA to study the structure of personality space, be this the Eysenckian Big Three (Hammond, 1987), the Big Five (Maraun, 1997), and as shown in this paper, to study the personality space underlying HEXACO in comparision with that underlying the ZKA-PQ. As opposed to studying the factor space underlying a personality inventory, with its inherent focus on the number of factors entailed (e.g., the Big Three, the Big Five, etc.), SSA is concerned with the *structure* of that personality space, how the space can be partitioned into regions, and what those regions represent.

Furthermore, as a nonlinear and nonmetric technique of data analysis, SSA comprises a major alternative to the linear type of data reduction incorporated in factor analysis (see the Appendix). Another approach to the depiction of the structure of personality space, which also presents an alternative to such linear data reduction, is that of a *network* representation of personality space (Cramer et al., 2012; Epskamp et al., 2018). A benefit of a network analysis is to indicate the centrality of particular traits within the network, and to present their spatial interdependencies (for recent use of this with respect to the Dark Triad and the Big Five, see Jordan et al., 2021; Wehner et al., 2021), and this is also apparent in SSA. In addition to this, however, SSA also enables one to look for a particular *structure* in the data—and in the present context, a particular structure of the personality space, as we detail below.

Using SSA, Maraun (1997) has uncovered a radex (Shepard, 1978, p. 57) for the Big Five, which entails the partitioning of the 2D SSA space into conical regions corresponding to each of the Big Five dimensions, with rays emanating from a common point of origin delineating these regions. The ordering of regions in a radex is circular, and Maraun (1997) reported the following circular ordering, moving in a clockwise direction: Neuroticism—Agreeableness—Conscientiousness—Extraversion—Openness to Experience. Both Alt and Boniel-Nissim (2018) and de Souza et al. (2015) also reported a radex structure for the Big Five—and in each study there was a slightly different circular ordering of the regions. We note, however, that in each of these studies, a different measure of the Big Five was used; hence, while the radex structure seems to be common, its particular version is dependent on the questionnaire employed to assess the Big Five.

Will we also find that both the HEXACO and the ZKA-PQ spaces conform to this structure of a radex? We know of no previous study that has addressed this question. Based on the radex structure that has been reported for the Big Five, this is a plausible hypothesis to be examined for these other personality spaces. Further, where will the Dark Triad traits be located in this space? Finally, on embedding the Dark Triad traits within these 2D SSA spaces, will there be a *distortion* of the space? This is an interesting possibility, and we can demonstrate this when looking at how SSA was used by Hammond (1987) to examine the Eysenckian Big Three. In order to do so, we first reflect on the fourth factor proposed by Eysenck. For Eysenck incorporated a Lie Scale (L) in his personality questionnaires (Eysenck & Eysenck, 1985), so as to assess the degree to which subjects attempt to 'fake good.' The negative correlation between P and L (Glicksohn & Abulafia, 1998) was the basis for profiling the antisocial risk taker (Glicksohn et al., 2004), and for mapping psychiatric patients onto a P-L plane (Glicksohn & Bar-El, 2004).

When excluding L from his analysis, Hammond (1987) presented a clear partitioning of the 2D SSA space into three regions, one comprising items of the Extraversion scale, a second comprising items of the Neuroticism scale, and the third items of the Psychoticism scale, in support of the Big Three. A potential problem arises when L items are included in the analysis, because of the negative correlation between P and L (Hammond, 1987, p. 546). Thus, L could well distort the 2D SSA space for the Big Three. In fact,

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Table 1. *Pearson Correlations* and Descriptive Statistics for the Five Dimensions of the 'Alternative' Big Five, Assessed Using the ZKA-PQ, the Six Dimensions of HEXACO, and the Three Dimensions of the Dark Triad, Assessed Using the SD3*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sensation Seeking (SS)														
2. Aggressiveness (Ag)	.20													
3. Activity (Act)	.24*	.02												
4. Neuroticism (NE)	–.02	.45*	.03											
5. Extraversion (EX)	.20	–.22	.27*	–.23										
6. Honesty-Humility (H)	–.23	–.40*	–.01	–.20	–.02									
7. Emotionality (E)	–.29*	.10	.07	.54*	.18	.01								
8. Extraversion (X)	.21	–.16	.27*	–.47*	.68*	–.06	–.08							
9. Agreeableness (A)	–.12	–.65*	–.04	–.18	.19	.25*	.05	.13						
10. Conscientiousness (C)	–.12	–.14	.26*	–.30*	.03	.13	–.07	.15	–.08					
11. Openness to Experience (O)	.23	–.13	–.11	–.15	.05	.14	–.13	.08	.13	.09				
12. Machiavellianism	.16	.37*	.08	.20	–.15	–.53*	–.06	–.07	–.24*	–.11	–.22			
13. Narcissism	.25*	.26*	.26*	–.03	.29*	–.52*	–.01	.46*	–.17	–.02	–.07	.35*		
14. Psychopathy	.35*	.60*	.03	.29*	–.19	–.51*	–.13	–.13	–.40*	–.27*	–.17	.51*	.31*	
α reliability	.79	.88	.83	.87	.82	.78	.76	.77	.68	.70	.76	.78	.72	.75
Min	17	16	21	17	26	1.5	1.5	1.5	1.7	1.4	1.4	1.2	1.0	1.0
M	37.9	31.7	44.9	33.7	49.7	3.5	3.2	3.6	3.2	3.8	3.3	2.9	2.8	1.9
SD	7.7	8.6	7.7	8.8	7.0	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.6	0.6
Max	55	62	64	60	63	4.9	4.9	5.0	4.8	5.0	5.0	4.9	4.6	4.7
n	272	276	284	271	275	282	279	280	280	283	283	287	285	281

Note. *significant at $p < .0001$.

however, this was not the case, and when the L items were entered into his analysis, Hammond (1987) reported a clear partitioning of the 2D SSA space into four regions, with the P and L regions extending successively and in separate along one diagonal of the plane. Note that in an SSA plot, when two regions such as those of P and L lie at 180 degrees to each other, this reflects the negative correlation between the two domains.

In the present study, a distortion of the 2D SSA space might occur for the HEXACO space, in comparison to the radex found for the Big Five, because of the very presence of the sixth dimension of Honesty-Humility in the matrix. In addition, for both the HEXACO and ZKA-PQ spaces, a distortion of the respective 2D SSA spaces might occur on entering the Dark Triad items into the analysis. Note that the surface pattern of intercorrelation is quite predictive of the 2D SSA structure. For example, the positive correlations between the Dark Triad and Aggressiveness (see Table 1) would ensure that the Dark Triad should appear in the subspace of the SSA structure for the ZKA-PQ pertaining to Aggressiveness, while the negative correlations between the Dark Triad and Honesty-Humility (see Table 1) would ensure that the Dark Triad should be diametrically opposite Honesty-Humility in the SSA structure for HEXACO. Nevertheless, given that these are not the only correlations observed between the Dark Triad and the various traits under investigation here, one has to take into consideration the whole pattern of intercorrelation—and that is exactly what the 2D SSA solution will do. The answers to these three questions should, therefore, be of interest for both the study of personality structure and that of personality assessment: (a) Do the HEXACO and the ZKA-PQ 2D SSA spaces conform to the structure of a radex, as does that 2D SSA space pertaining to the Big Five? (b) On embedding the Dark Triad traits within these 2D SSA spaces, will there be a *distortion* of the space, or will the space remain essentially unchanged in structure?[2] (c) Where will the Dark Triad traits be located in each of these 2D SSA spaces?

To conclude this section, what will be gained from embedding the Dark Triad within these two

[2]Note that if the 2D SSA space remains essentially unchanged on entering the Dark Triad traits into the analysis, then one can deduce that the Dark Triad traits comprise *parts* of this invariant structure—parts of this *gestalt*. In contrast, if the space is distorted, then one can deduce that the Dark Triad traits comprise an external factor that, in conjunction with the traits of the original personality space (HEXACO or ZKA-PQ), generate a new structure. This follows from the Gestalt concept of Prägnanz, namely that "psychological organization will always be as 'good' as the prevailing conditions allow" (Koffka, 1935, p. 110). We thank an anonymous reviewer for asking us to clarify what the meaning of a distortion (or, lack of) in the 2D SSA space would indicate.

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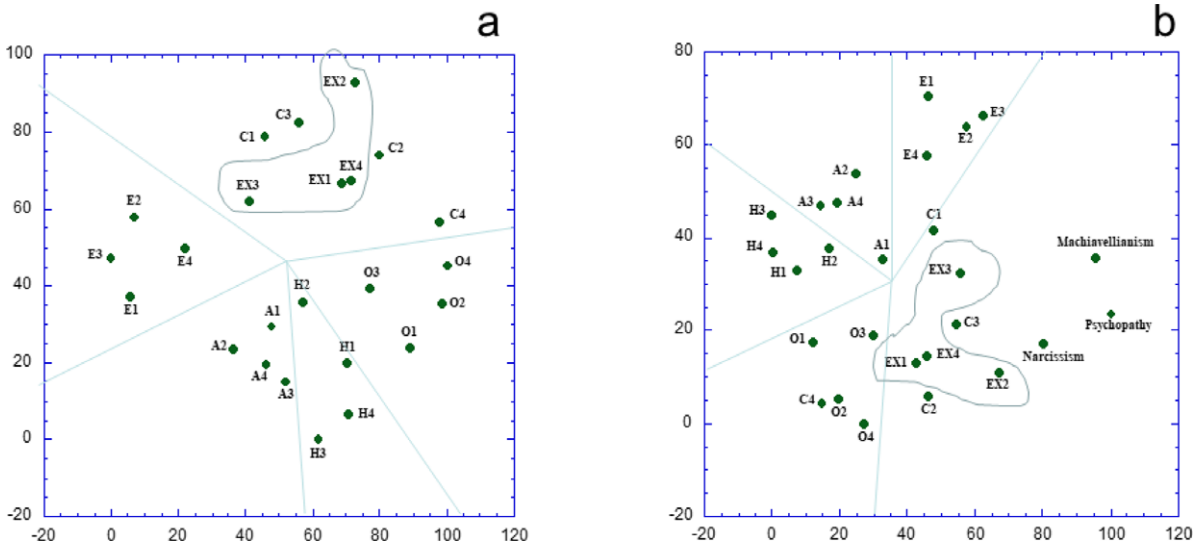

Figure 1. The 2D Personality Space Obtained Via Smallest Space Analysis for HEXACO (a), and when Entering the Dark Triad into the Analysis (b)

personality spaces? First, it should be clear from the results that we report whether the Dark Triad is, as Moshagen et al. (2018, p. 27) put it, "well suited for inclusion in a more general model of personality dimensions akin to the … HEXACO model." Second, whether the Dark Triad has, as Hodson et al. (2018, p. 128) put it, any "incremental value … at least as a latent 'constellation' " will surely be of interest to the literature. Thus, if the Dark Triad traits are clearly, and unambiguously, aligned only with Hostility-Humility in HEXACO space (Ashton & Lee, 2009, p. 344), then the "Big-Five plus-Dark-Triad" option can be safely exchanged with that of HEXACO (Ashton & Lee, 2020). Furthermore, if this is the case, then this alignment of the Dark Triad with Hostility-Humility, and not with Agreeableness in HEXACO space, will surely support the distinction of these two dimensions, in spite of their similarities (Howard & van Zandt, 2020).

In turn, if the Dark Triad traits do lie in the quadrant of a higher-order circumplex, spanning Disharmony, Disinhibition, and Sensation Seeking (Rogoza et al., 2022, Figure 1), then this would suggest that they should be easily embedded within a lower-order ZKA-PQ space. This is because Sensation Seeking in this circumplex is defined, using HEXACO, as High Emotionality, High Extraversion, High Openness to Experience, Low Agreeableness, Low Conscientiousness, and Low Hostility-Humility (Rogoza et al., 2022, Figure 1), while in ZKA-PQ space, Sensation Seeking is itself one of the five dimensions defining this space. Thus, it is important to embed the Dark Triad within ZKA-PQ space, in order to further our understanding of these personality spaces, and their degree of compatibility.

Method

Participants

Two hundred and eighty-nine individuals (137 males, 145 females, 7 unspecified) participated in this study on a voluntary basis. Their age ranged between 18 and 87 (M = 43.3, SD = 17.47 years). We had hoped to achieve a sample size closer to 400, but given constraints (especially a deadline by which time we had to complete collecting our data, as part of a larger study—see Aluja et al., 2020), we remained with the n reported here.[3]

The study was approved by the university ethics board; all participants provided written informed consent. They completed the following measures in the same order as below.

Measures

Three questionnaires were employed, and each underwent a process of back-translation into Hebrew. The first author translated the items into Hebrew, and the

[3]This sample size would be adequate (at the .80 power level): (a) To uncover a correlation of a moderate size (r = .3); (b) to enable the implementation of a factor analysis (see Appendix), presenting "good" agreement between sample and population solutions (given a high degree of communality), one having a variables-to-factor ratio of 4 (for HEXACO, this pertains to 6 factors, each of which comprises 4 facets; for the ZKA-PQ, this pertains to 5 factors, each of which comprises 4 facets), following Mundfrom et al. (2005, p. 164); and (c) to enable the implementation of Smallest Space Analysis (SSA), given 24 facets for HEXACO and 20 facets for the ZKA-PQ, on comparing our data set to those of others (Kumar & Farley, 2009, employed SSA for 22 questionnaire items in a sample of 203 participants; Maraun, 1997, employed SSA for 40 items in a sample of 215 participants).

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second author translated the Hebrew version back into English, staying as closely as possible to the idiomatic language of the Hebrew. Both authors then reviewed these versions and jointly decided on the final Hebrew version. For the ZKA-PQ/SF, we could rely on our Hebrew version of the ZKA-PQ (Glicksohn et al., 2018) and only had to add a few items for this shortened form. At the time, we were unaware of the fact that a Hebrew version of both the HEXACO–60 and the SD3 had been prepared, independently of our own versions (Zeigler-Hill et al., 2017). The alpha reliabilities that we report here (see Table 1) closely match those reported by these colleagues.

The Hebrew version of the Zuckerman-Kuhlman-Aluja Personality Questionnaire, shortened form (ZKA-PQ/SF) comprises 80 items (Aluja et al., 2018; Aluja et al., 2020), from which we derived scores for the five dimensions of the Alternative 5 (Zuckerman, 2005): Extraversion (EX), Neuroticism (NE), Sensation Seeking (SS), Aggressiveness (Ag) and Activity (Act). Participants selected their response to each item on a 4-point scale, ranging from *strongly disagree* (1) to *strongly agree* (4).

The Hebrew version of HEXACO–60 comprises 60 items (Ashton & Lee, 2009), from which we derived scores for the six dimensions of Honesty-Humility (H), Emotionality (E), Extraversion (X), Agreeableness (A), Conscientiousness (C), and Openness to Experience (O). Participants selected their response to each item on a 5-point scale, ranging from *strongly disagree* (1) to *strongly agree* (5).

The Hebrew version of the Short Dark Triad (SD3) comprises 27 items (Jones & Paulhus, 2014), from which we derived scores for the three dimensions of Machiavellianism, Psychopathy, and Narcissism. Participants selected their response to each item on a 5-point scale, ranging from *strongly disagree* (1) to *strongly agree* (5).

Alpha reliabilities for the five dimensions of the Alternative 5 (ZKA-PQ), the six dimensions of HEXACO (HEXACO–60), and the three dimensions of the Dark Triad (SD3) are reported in Table 1. They range between .79 and .88 for the ZKA-PQ, between .68 and .78 for HEXACO, and between .72 and .78 for the SD3.

Procedure

This study was conducted as part of a large, cross-cultural project (Aluja et al., 2020), and followed the same protocol. The three questionnaires were presented in one standard order to students studying with either the first author or the second author, who volunteered to participate in the study. These students were then invited to administer the questionnaires to family members, friends, associates and neighbors, with the following constraints: An equal number of men and women, within the following age ranges: (a) 18 to 30 years, (b) 31 to 45 years, (c) 46 to 60 years, and (d) more than 60 years old.

Data Analysis

The Smallest Space Analysis (SSA) in the present report is conducted on a $k \times k$ correlation matrix (here k is either 20 [ZKA-PQ] or 24 [HEXACO], increasing with the addition of the 3 Dark Triad traits to either 23 or 27), and our n-to-k ratio is roughly 10. This seems to be quite plausible.[4] The analysis is provided by the SSA module of HUDAP (Guttman & Greenbaum, 1998).[5] The coefficient of alienation (a measure of 'lack-of-fit') for the 2D SSA space for HEXACO was found to be 0.272, and while this would not be considered to be adequate (for the 3D space, the coefficient was 0.165, which would be considered to be adequate), we follow the guidelines advanced by Borg and Groenen (2005, p. 73) who, in discussing an example, stress that the interpretability of the space is more important than is the actual value of such a goodness-of-fit criterion. Furthermore, a rotation of this space is allowed, because the 2D SSA space can be rotated along any axis. This was reported by Tiliopoulos et al. (2010, pp. 36–37) for the Big Five, and by Glicksohn et al. (1996) for mood space (see also Glicksohn & Boikova, 2018).

Results

Table 1 presents Pearson correlations and descriptive statistics for all the personality dimensions studied here. Note the following: (a) The positive correlation of .45 between Aggressiveness and Neuroticism; (b) the positive correlation between Psychopathy and

[4]Up till about 20 years ago, claims were made such as that a ratio of sample size to variable size exceeding 2:1 is recommended (Livneh, 1983, p. 407), and that while a large sample size can make the SSA more robust, this is not necessary (Maslovaty et al., 2001, p. 75). More recently, it has been argued (without reference to SSA), that if correlations are used, then sample size should be in excess of n = 150, in order for the correlations to become stable (Schönbrodt & Perugini, 2013; see also Klimstra et al., 2014, p. 84, who rely on this criterion in discussing the literature on the Dark Triad). This criterion, however, would seem to ignore the constraints placed on the SSA space by the very structure of the matrix of distances derived from the correlation matrix. That is to say, there should clearly be a trade-off between the n required for estimating a single correlation, and the n required for mapping a $k \times k$ correlation matrix into a space of low dimensionality.

[5]HUDAP is the Hebrew University Data Analysis Package. SSA is one of the modules incorporated in the software. We employed Weighted Smallest Space Analysis (WSSA1), using Guttman weak monotonicity coefficients (instead of Pearson correlations, hence not requiring underlying linearity), as recommended in the version released in 2001. The goodness-of-fit measure provided is the coefficient of alienation, and it is generally accepted (or suggested) that a value < .15 would be 'good', though this is a general 'rule of thumb', as discussed below.

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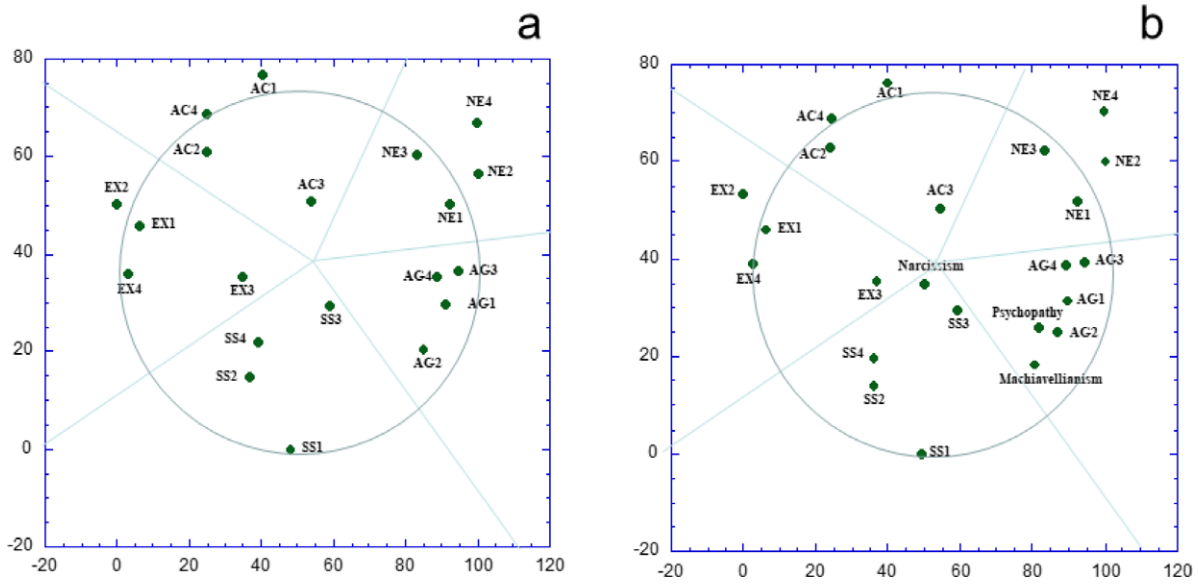

Figure 2. The 2D Personality Space Obtained Via Smallest Space Analysis for the ZKA-PQ (a), and when Entering the Dark Triad into the Analysis (b)

Machiavellianism of .51; (c) the negative correlation between Aggressiveness and Agreeableness; (d) the positive correlation between Neuroticism and Emotionality, and that between the two dimensions of Extraversion, these tapping essentially the same personality dimensions; (e) the negative correlation between Aggressiveness and Honesty-Humility; (f) for Psychopathy, its positive correlation with Aggressiveness and its negative correlation with Agreeableness; (g) the negative correlations between each measure of the Dark Triad and Honesty-Humility; and (h) the positive correlations between each measure of the Dark Triad and Aggressiveness.

Embedding the Dark Triad in HEXACO Space

The 2D SSA space depicted in Figure 1a can be partitioned into five regions, four of which demark the HEXACO dimensions of Emotionality, Agreeableness, Honesty-Humility, and Openness to Experience, in that counterclockwise order. In the fifth region, a cluster indicative of Extraversion is embedded within a region that also spans the Conscientiousness dimension. Hence, these two dimensions are not differentiated in the 2D SSA space. On entering the Dark Triad scales into the analysis (Figure 1b), one notes the following: (a) The same circular ordering of dimensions (regions) is preserved; (b) the Dark Triad lie in the same region of Extraversion + Conscientiousness; and (c) the presence of the Dark Triad in this space impacts on the space, the other 4 regions being more squished together.

Embedding the Dark Triad in ZKA-PQ Space

Figure 2a presents the 2D SSA space (coefficient of alienation = 0.148), for the 20 facets of the ZKA-PQ, with the structure being clearly indicative of a radex: The space is evenly partitioned into regions corresponding to each of the dimensions, the circular counterclockwise ordering being Activity, Extraversion, Sensation Seeking, Aggressiveness, and Neuroticism. On entering the Dark Triad scales into the analysis (Figure 2b), one notes the following: (a) There is no major change in this space, hence this space retains the structure of a radex and, moreover, of an invariant *gestalt*; (b) the Dark Triad lie within this space, with Psychopathy and Machiavellianism being in closer proximity, in the Aggressiveness region, than either is with Narcissism; and (c) the common origin of the radex is also the locus for Narcissism.

Discussion

Turning first to the Pearson correlations, note the following. First, the positive correlation of .45 between Aggressiveness and Neuroticism is higher than the .34 correlation reported for these by Aluja et al. (2018). Second, for HEXACO all intercorrelations were quite low, as one would expect given the orthogonality of these dimensions (Lee & Ashton, 2014); for the Dark Triad, the correlation between Psychopathy and Machiavellianism of .51 is comparable to the value of .47 reported by Jones and Paulhus (2014, Study 3). Third, the negative correlation between Aggressiveness and Agreeableness is expected (Aluja et al., 2002; Dinić & Smederevac, 2018; Zuckerman et al., 1993). Fourth,

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the positive correlation of Psychopathy with Aggressiveness, and its negative correlation with Agreeableness, is internally consistent, given the negative correlation between Aggressiveness and Agreeableness, and places Psychopathy in both personality spaces. Fifth, the negative correlations between each measure of the Dark Triad and Honesty-Humility, clearly aligns the Dark Triad with this dimension of the HEXACO space. Sixth, the positive correlations between each measure of the Dark Triad and Aggressiveness, clearly aligns the Dark Triad with this dimension of the ZKA-PQ space; furthermore, this is internally consistent, given the negative correlation between Aggressiveness and Honesty-Humility.

Turning now to the 2D SSA spaces, why is it important to know where to locate the Dark Triad here? There are two considerations here. The first is that of redundancy (O'Boyle et al., 2015), especially given the notion that in the HEXACO space, the dimension of Honesty-Humility might very well cover the same ground as that of the Dark Triad (e.g., Lee & Ashton, 2014; Schreiber & Marcus, 2020). The second is that of the internal structure of the Dark Triad, especially given the debate in the literature regarding the distinction (or lack of) between Psychopathy and Machiavellianism (e.g., Jones & Figueredo, 2013; Rogoza & Cieciuch, 2020).

Embedding the Dark Triad in HEXACO Space

SSA space for HEXACO does not conform to a radex as has been reported for the Big Five (Maraun, 1997, p. 638). Why might this be so? The problem seems to lie in the extensive overlap between Conscientiousness and Extraversion. While partial overlap of these two dimensions has been reported recently (Schwaba et al., 2020, p. 17; Strus & Cieciuch, 2021, p. 3; Woods & Anderson, 2016, pp. 589–590), it is only when the data are analyzed using SSA that one can appreciate the problematic nature of this. Note that the second largest correlation in the HEXACO intercorrelation matrix (see appropriate submatrix in Table 1) is that between Conscientiousness and Extraversion, with a value of .15 which, while being modest at best, is still of the same size as that reported recently by both García et al. (2021) and Thielmann et al. (2020). This is not, however, the result, as an anonymous reviewer has suggested, of "metric partial non-invariance of the Hebrew version" of HEXACO–60, because García et al. (2021) reported metric invariance of the HEXACO–60 across eighteen cultures/languages, including that of our sample. Such cross-cultural metric invariance has also been reported by Thielmann et al. (2020). Furthermore, the presence of the Dark Triad within this 2D space distorts the space, while the presence of the Dark Triad in the 6D factorial space preserves that space (see the Appendix). What this means is that on entering the Dark Triad into the analysis, the same 6D factorial space defined by HEXACO remains invariant, with the Dark Triad loading (with negative sign) on the factor of Honesty-Humility, as expected (Paulhus, 2014, p. 422), on the one hand, and with Narcissism loading in addition on Extraversion, and Psychopathy loading in addition on Agreeableness. Thus, the Dark Triad differentially load on a subspace of Honesty-Humility × Extraversion × Agreeableness, which is a subspace worthy of further investigation (Schreiber & Marcus, 2020, pp. 1036–1037); and further, all six HEXACO factors are not compromised by the presence of the Dark Triad traits in the factor analysis. It is when the 6D HEXACO space is reduced to a 2D space that the impact of the Dark Triad is realized. This ties in with some recent comments in the literature that, because the underlying D factor of the Dark Triad represents a blend of basic traits, it would be difficult to preserve orthogonality with other dimensions of the personality space (Moshagen et al., 2018, p. 27), and that the Dark Triad comprises a heterogeneous constellation (Watts et al., 2017, p. 952). We wonder whether a different type of geometric space is required for making a smooth transition to a space of lower dimensionality, one that would enable a better embedding of the Dark Triad in that space (Townsend et al., 2001; Townsend et al., 2012).

We were interested in seeing whether Machiavellianism and Psychopathy are coincident in HEXACO space (Muris et al., 2017, p. 188; Vize et al., 2018, p. 109). Note that the Dark Triad and Honesty-Humility lie at 180 degrees to each other in the 2D SSA space, and this is an interesting finding, given the discussions in the literature as to whether there is much overlap between Honesty-Humility and the Dark Triad (Ashton & Lee, 2020; Hodson et al., 2018; Moshagen et al., 2018). This finding reflects the fact that these measures are negatively correlated. Furthermore, in the 2D SSA space for HEXACO, Machiavellianism and Psychopathy lie in the same region, while being quite distinct. This is important to stress, given that their differentiation is still being debated in the literature (Kowalski et al., 2019; Rogoza et al., 2022).

Embedding the Dark Triad in ZKA-PQ Space

We report a major finding: SSA space for the ZKA-PQ conforms to a radex; furthermore, this radex is preserved when embedding the Dark Triad in this space, and thus this is indicative of the fact that the ZKA-PQ radex is a *gestalt* (Glicksohn et al., 2018). In this radex, Machiavellianism and Psychopathy are close in proximity, as would be expected (Rogoza & Cieciuch, 2020), hence might well reflect the very similar personality constructs (Glenn & Sellbom, 2015, p. 363) in the SD3

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instantiation of these traits (Jones & Paulhus, 2014). The differential placement of the Dark Triad traits within the radex comes in support of the argument that Machiavellianism and Psychopathy might be combined into one factor, which is differentiated from Narcissism (Koehn et al., 2019). Furthermore, given the fact that both Psychopathy and Machiavellianism lie in close proximity in the Aggressiveness region of the radex, together with the fact that Aggressiveness and Agreeableness are negatively correlated (Aluja, 2019, p. 187), we find support for the argument that it is not only Hostility-Humility which is related to the Dark Triad traits, but also Agreeableness (Vize et al., 2019, p. 97).

While Machiavellianism and Psychopathy are in close proximity in the radex, they are not coincident. The literature has stressed that these two measures from the SD3 poorly reflect the richness of Psychopathy (Muris et al., 2017, p. 195); that the Psychopathy measure may not assess both primary and secondary Psychopathy (Koehn et al., 2019); that there is a need to clarify the difference between Psychopathy and Machiavellianism (Rogoza et al., 2019, p. 174); and that the SD3 does not adequately assess the subdimensions of Psychopathy, which might be related differentially to external criteria (Lilienfeld, 2018, p. 81). If what 'binds' the Dark Triad is primary psychopathy (Neumann et al., 2015, p. 679), then what might distinguish Machiavellianism from Psychopathy in the radex? The primary-secondary distinction within Psychopathy might not be the key to differentiating Machiavellianism and Psychopathy, because while one group of researchers has suggested that Machiavellianism may reflect secondary Psychopathy (Vize et al., 2018), a second group has suggested that this might reflect primary Psychopathy (Kavish et al., 2019, p. 205).

Consider, therefore, a second distinction. If Lilienfeld's (2018) Impulsive Antisociality (IA) subdimension of Psychopathy is more closely associated with the SD3 measure of Psychopathy (Dowgwillo & Pincus, 2017, p. 25), then Machiavellianism, which should be unrelated to impulsivity (Watts et al., 2017, p. 108) might, instead, be related to Lilienfeld's Fearless Dominance (FD) subdimension of Psychopathy. In addition, psychopathy and antisocial personality have a strong biological component (García et al., 2010) and have been associated with Aggressiveness and Sensation Seeking (Dickey, 2014; Wilson & Scarpa, 2011). If so, then one intercorrelated factor of IA, Impulsivity and Neuroticism (Ben-Yaacov & Glicksohn, 2020) might characterize Psychopathy, while a second intercorrelated factor of FD, Sensation Seeking and Extraversion (Ben-Yaacov & Glicksohn, 2020) might characterize Machiavellianism. Note that in the radex, Machiavellianism is located somewhat closer to the Sensation Seeking region, while Psychopathy is located somewhat closer to the Neuroticism region. Conceivably, more refined measures of Psychopathy and Machiavellianism (and here we support this call for such measures, raised by Miller et al., 2017, p. 450) might further stretch apart these two dimensions (both of which would still be located in the region of Aggressiveness), pulling Psychopathy more in the direction of the Neuroticism region. That is a hypothesis worthy of future investigation.

Two limitations of the present study should be stressed. First, our participants completed the three questionnaires in the same order (ZKA-PQ/SF, HEXACO–60, SD3)—following the prescribed protocol of the larger, cross-cultural study (Aluja et al., 2020; García et al., 2021). Whether this impacted on our results is an unknown. Second, the SD3, as noted above, does not lend itself to a refined analysis of the subcomponents of Psychopathy. The same point can be made with respect to Narcissism, which has a grandiose form, and a vulnerable form (Egan et al., 2014; Lilienfeld et al., 2019; Watts et al., 2017). As suggested above, the use of more refined measures of the Dark Triad, coupled with SSA, should provide a better understanding of the location of these traits, and their subcomponents, in a multidimensional personality space.

In conclusion, we address the implications of the results reported here. In both HEXACO and ZKA-PQ 2D spaces, the Dark Triad traits form a triangular structure, indicating a specific constellation. The traits do not overlap in location, hence are differentiated. Of particular importance, while Machiavellianism and Psychopathy are located in close proximity, their differentiation is clearly captured using SSA. Their location in HEXACO 2D space is diametrically opposite that of Honesty-Humility, and had they been inversely coded, they would have been located within this Honesty-Humility section of the space. They lie in the conjoint section of Extraversion and Conscientiousness, and that is an interesting finding, worthy of further exploration. Furthermore, this 2D SSA space for HEXACO is not as well organized as is that for the ZKA-PQ. This is the case irrespective of whether or not the Dark Triad traits are entered into the analyses. Indeed, the 2D SSA space for HEXACO has captured a fair degree of overlap between Extraversion and Conscientiousness, that is not widely discussed in the literature, and which requires attention. This overlap impinges on the radex structure that is expected to be found for HEXACO. In contrast, ZKA-PQ space exhibits this radex, and the Dark Triad is embedded in this radex without altering its basic organization. Their location in ZKA-PQ 2D space is such that Narcissism is found at the very center of the radex, while Psychopathy and Machiavellianism lie in the Aggressiveness section of the radex. Their presence in this radex does not distort this structure (hence the *gestalt*-like nature

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of the radex), which further suggests that the Dark Triad fit very well into ZKA-PQ personality space.

The data reported here will be made available, following such a request to the corresponding author.

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Appendix: Factor Analyses

Embedding the Dark Triad in HEXACO Space

Summary scores for each of the four facets for each of the six scales of the HEXACO–60 constituted the twenty-four variables for exploratory factor analysis (inspection of the scree plot, subsequent factor extraction and rotation, a criterial loading of 0.4, and 'good structure' being elements here). A total of 270 participants had complete data for these, hence the ratio of participants to variables is well in excess of 10. Table A1 provides the correlations of each of the Dark Triad scales with each of these 24 HEXACO facets, to aid in interpreting this factor analysis. The scree plot indicated a break in support of a six-factor solution, the eigenvalues being 3.08, 2.61, 2.37, 2.14, 1.90, 1.43, 1.02, 0.93, 0.87, and 0.75 for the first 10 factors. We then ran a parallel analysis (PA) test as a converging operation, employing FACTOR, version 10.10.02 (Lorenzo-Seva & Ferrando, 2006). PA (using 500 random data matrices) indicated between 5 and 6 factors (depending on criterion: 95th percentile or mean). We therefore retained the 6-factor solution reported here. The correlations among the six extracted factors ranged between –0.20 and +0.33, hence an orthogonal rotation was adopted. On entering the Dark Triad scales into the analysis, the same six-factor space was preserved. We stress that exploratory factor analysis (EFA), as opposed to confirmatory factor analysis (CFA), is the more appropriate analysis here, given that we explore where the Dark Triad lie in each personality space. Furthermore, the use of CFA to 'confirm' a given factorial structure of a personality model—be this that of the Big Five or that of the 'alternative' Big Five—has not found much support in the literature (Aluja et al., 2005, p. 1884; Ginns et al., 2014, p. 183; Hopwood & Donnellan, 2010, pp. 341–342; Surányi & Aluja, 2014, p. 5).

One factor was indicative of Emotionality; a second was indicative of Honesty-Humility, and on this factor, the three Dark Triad scales loaded with negative sign (as expected); a third factor was identified as Extraversion, and on this factor, Narcissism also loaded with positive sign; a fourth factor was identified with Conscientiousness; a fifth factor was indicative of Openness to Experience; the sixth factor was indicative of Agreeableness, and on this factor, Psychopathy also loaded with negative sign. We compared this factor solution to that provided by an oblique rotation, and can report that a highly similar pattern matrix was found—both prior to and after entering the Dark Triad scales into the analysis. Specifically, for the orthogonal solution the loadings on Honesty-Humility of Machiavellianism (–.70), Narcissism (–.65), and Psychopathy (–.52) were similar to those for the oblique rotation: –.69, –.63, and –.44, respectively.

Table A1. *Pearson Correlations* of the Three Dimensions of the Dark Triad, Assessed Using the SD3, with the 24 Facets of HEXACO*

Trait Facet	Machiavellianism	Narcissism	Psychopathy
Honesty-Humility			
sincerity	–.311*	–.386*	–.308*
fairness	–.372*	–.304*	–.472*
greed-avoidance	–.435*	–.412*	–.321*
modesty	–.449*	–.546*	–.310*
Emotionality			
fearlessness	–.056	–.060	–.199
anxiety	.026	–.040	–.008
dependence	.043	.011	.029
sentimentality	–.193	.002	–.179
Extraversion			
social self-esteem	–.170	.220	–.219
social boldness	.100	.544*	.036
sociability	–.070	.213	–.105
liveliness	–.131	.270*	–.168
Agreeableness			
forgiveness	–.079	.032	–.066
gentleness	–.208	–.156	–.317*
flexibility	–.246*	–.201	–.311*
patience	–.145	–.146	–.391*
Conscientiousness			
organization	–.014	–.079	–.259*
diligence	–.147	.165	–.049
perfectionism	.087	.028	–.078
prudence	–.172	–.178	–.310*
Openness to Experience			
aesthetic appreciation	–.151	–.166	–.189
inquisitiveness	–.142	–.072	–.074
creativity	–.129	.052	–.118
unconventionality	–.174	–.014	–.105

Note. *significant at $p < .0001$.

Embedding the Dark Triad in ZKA-PQ Space

Summary scores for each of the four facets of the five scales of the ZKA-PQ-SF constituted the twenty variables for exploratory factor analysis. A total of 249 participants had complete data for these, and rather than imputing scores to replace missing data, we preferred to work with the smaller sample, which still preserved a ratio of participants-to-variables in excess of 10. Table A2 provides the correlations of each of the Dark Triad scales with each of these 20 ZKA-PQ facets, to aid in interpreting this factor analysis. The scree plot indicated a five-factor solution, the eigenvalues being 4.66, 3.43, 1.96, 1.71, 1.38, 0.76, 0.74, 0.68, 0.60, and 0.59 for the first 10 factors. While PA indicated a 4-factor solution, this solution provided by FACTOR had no

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Table A2. *Pearson Correlations* of the Three Dimensions of the Dark Triad, Assessed Using the SD3, with the 20 Facets of the ZKA–PQ*

Trait Facet	Machiavellianism	Narcissism	Psychopathy
Aggressiveness			
Physical Aggression	.445*	.198	.577*
Verbal Aggression	.236	.232	.520*
Anger	.262*	.160	.418*
Hostility	.345*	.196	.457*
Sensation Seeking			
Thrill and Adventure Seeking	.133	.108	.261*
Experience Seeking	.052	.162	.183
Disinhibition	.279*	.372*	.381*
Boredom Susceptibility/ Impulsivity	.010	.106	.210
Activity			
Work Compulsion	.024	.167	–.016
General Activity	–.025	.167	–.087
Restlessness	.243*	.358*	.297*
Work Energy	–.078	.087	–.110
Extraversion			
Positive Emotions	–.121	.147	–.228
Social Warmth	–.266*	.124	–.224
Exhibitionism	.227	.419*	.180
Sociability	–.261*	.145	–.224
Neuroticism			
Anxiety	.305*	.109	.410
Depression	.153	–.026	.205
Dependency	.197	.078	.201
Low self–esteem	.020	–.225	.123

Note. *significant at $p < .0001$.

'simple structure'; in addition, one factor was comprised of Aggressiveness and Sensation Seeking. In contrast, in the 5-factor solution, these two dimensions were clearly separated. We therefore retained the 5-factor solution reported here. The correlations among the five extracted factors ranged between –0.22 and +0.45, hence an oblique rotation was adopted. On entering the Dark Triad scales into the analysis, the same five-factor space was preserved. One factor was identified as Neuroticism; a second was indicative of Activity; a third factor was identified as Sensation Seeking; the fourth factor was that of Extraversion, and on this factor, Narcissism also loaded with positive sign; the fifth factor was identified as Aggressiveness, and on this factor, the three Dark Triad scales loaded with positive sign.

Appendix References

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