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The Short Dark Triad across 14 cultures: A novel network-based invariance approach

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ABSTRACT

The aim of this study was to implement and extend exploratory graph analysis to examine the network-based invariance of the Short Dark Triad (SD3) across 14 nations/cultures worldwide. The sample included 15,690 (42.8% male) participants. First, the data were split into two halves: the first half was used for exploratory graph analysis to establish the three-dimensional configural measurement model, while the second half was analyzed using confirmatory factor analysis to test this configuration. Second, metric invariance was assessed within each culture based on community memberships established during configural invariance testing. Finally, network loadings were compared across cultures. The results showed that the network structure achieved both approximate and partial metric invariance, with 13 out of 27 items consistently demonstrating this invariance. The central and invariant item for Machiavellianism involved strategic information tracking, for narcissism–external validation of specialness, and for psychopathy–lack of control, reflecting their unique characteristics. Items related to a revengeful mindset and the demand for deserved respect exhibited the largest absolute differences in network loadings across cultures. The findings support the cross-cultural metric invariance of the SD3, highlighting both culturally universal and culture-specific indicators for each dark trait.

1. Introduction

The Dark Triad comprises three socially aversive traits: Machiavellianism, characterized by manipulation and a cynical worldview; narcissism, marked by entitlement, superiority, and a grandiose self-image; and psychopathy, defined by a lack of empathy, guilt, and

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remorse, along with impulsivity and disinhibition (Paulhus & Williams, 2002). These traits share a common core of manipulativeness and affective detachment or callousness (e.g., Dinić et al., 2020) while maintaining distinct characteristics. The popularity of Dark Triad research grew significantly with the development of its measurement methods (Dinić & Jevremov, 2021). Shortly after the concept was introduced, two short measures were developed: the Dark Triad Dirty Dozen (DTDD; Jonason & Webster, 2010) and the Short Dark Triad (SD3; Jones & Paulhus, 2014). Both assess each dark trait as a unidimensional construct and demonstrate adequate psychometric properties in terms of reliability and validity (Jonason & Webster, 2010; Jones & Paulhus, 2014). However, some researchers favor the SD3 due to its stronger convergent and incremental validity (Maples et al., 2014).

While the introduction of measures assessing all Dark Triad traits together has facilitated global research, most studies remain concentrated in Western countries. This raises concerns about the validity of these measures across different cultural contexts. Previous research on the cross-cultural invariance of the DTDD and SD3 has highlighted some challenges. For instance, in a study across 49 countries, Jonason et al. (2020) found only metric invariance for DTDD scores. However, using a less conservative alignment approach, they achieved some scalar invariance, with 19% of non-invariant intercepts—an acceptable threshold. Similarly, in a subsequent study comparing WEIRD. and non-WEIRD. regions, only metric invariance was confirmed (Rogoza et al., 2021). The SD3 presents even greater cross-cultural invariance issues. Across 18 cultural and national contexts, it failed to achieve even configural invariance (Aluja et al., 2022). Only after using item parcels (combining multiple items into a single score) was metric invariance attained (Aluja et al., 2022). A recent study by Denovan et al. (2024) further identified differential item functioning across three countries (the UK, Canada, and Russia), suggesting that specific items—narcissism items 17R (average person) and 18 (entitlement-demand respect), and psychopathy items 19 (revenge on authorities), 21 (swift revenge), 23 (meanness), and 24 (vengeful mindset)—may require revision.

However, the aforementioned research relied on a traditional approach—testing at least three levels of measurement invariance across groups (i.e., samples from different cultures, nations, or linguistic backgrounds): configural, metric, and scalar invariance. While this method is useful for comparing two or a few groups, it becomes increasingly difficult to apply in large-scale cross-cultural studies, where multiple groups are involved (Funder & Gardiner, 2024). In addition, recent literature has questioned the necessity of strict measurement invariance in latent variable approaches to multi-group comparisons (e.g., Robitzsch & Lüdtke, 2023). Therefore, a promising alternative is a network analysis approach which offers several distinct advantages compared to traditional latent variable approach. Network approaches provide a more flexible and exploratory framework for understanding how questionnaires function across different cultural or linguistic settings, allowing researchers to examine both universal and culture-specific patterns of item relationships.

1.1. Network-based invariance testing framework

Network approaches to psychological measurement conceptualize constructs as systems of mutually reinforcing elements rather than manifestations of latent variables. In this framework, items (nodes) are directly connected through regularized partial correlations (edges) that remain after controlling for all other nodes in the network. Exploratory graph analysis (EGA; Golino & Epskamp, 2017) extends this approach by applying community detection algorithms to identify clusters of densely interconnected items that often correspond to theoretical dimensions. Unlike traditional latent variable models that impose strict assumptions about local independence between items and unidirectional causality from latent variables to indicators, network models explicitly represent the complex interdependencies among items. Moreover, unlike latent variable models that attribute covariation to unobserved factors, network models explicitly models direct item relationships.

A critical innovation that enables invariance testing in networks is the development of network loadings (Christensen & Golino, 2021), which quantify how strongly each item connects to its community. While factor loadings represent the relationship between observed variables and unobserved latent factors, network loadings measure the strength of an item's direct connections to other items within its detected community. This parallel makes network loadings particularly useful for assessing measurement equivalence across groups without requiring the restrictive assumptions of traditional measurement invariance testing.

The network-based invariance testing approaches differ from traditional approaches in several key aspects. First, it only requires testing for configural invariance (same community structure) and metric invariance (similar connection strengths), as scalar invariance cannot be tested in the absence of latent variables and intercepts. Second, network approaches provide more granular information about which specific item relationships may vary across groups rather than testing the entire measurement model as a unified entity. Third, by using permutation testing rather than model comparison statistics, this approach avoids making distributional assumptions and can better accommodate smaller or uneven sample sizes across groups. These advantages make network-based invariance particularly well-suited for large-scale cross-cultural investigations where the practical limitations of traditional invariance testing are most evident (Jamison et al., 2024).

Saintila (2023) applied the network approach to cross-cultural analysis, examining SD3 structures across 10 countries using centrality metrics and clique-percolation algorithms. Their bootstrap-stability analyses revealed culturally stable core manipulative tendencies, particularly item 2 (clever manipulation) and item 6 (revenge) from Machiavellianism and item 14 (acquaintance with important people) from narcissism, despite structural variations between specific regions (e.g., the US vs. Spain). Notably, item 27 (manipulative talk) from psychopathy demonstrated the highest cross-cultural centrality. However, methodological constraints emerged due to the exclusion of all five reverse-coded items and reliance solely on conventional network comparison tests, which assess global network similarity rather than item-level invariance. Ramos-Vera et al. (2024) advanced this line of research on the same dataset using spinglass community detection and $k = 7$ clique percolation after excluding problematic items (item 1 – guard secrets, and all five reverse-coded indicators). Their analysis confirmed the previously identified centrality of certain items, while also highlighting item 5 (using information against others) from Machiavellianism and item 21 (swift revenge) from psychopathy. They further revealed critical overlaps in manipulative behaviors between the psychopathy-narcissism domains via item 27 (manipulative talk) and between the Machiavellianism-psychopathy domains via item 2 (clever manipulation). Nevertheless, their approach retained key limitations, including item exclusion and dependence on standard network comparison methods. Subsequent analyses of joint dark-light trait networks (Ramos-Vera et al., 2023) found significant cross-country differences in most comparisons, except for the Colombia-Nigeria and Peru-Nigeria dyads.

1.2. Current study

While the SD3 is a widely used instrument for assessing Dark Triad traits, previous research has shown that it lacks cross-cultural invariance when tested using both traditional multi-group confirmatory analysis (e.g., Aluja et al., 2022) and network analysis (e.g., Ramos-Vera et al., 2024). Although previous network analysis studies have applied state-of-the-art psychometric techniques to Dark Triad research, they share common limitations in their approach to measurement invariance testing. Specifically, they have relied primarily on traditional network comparison tests with basic correction procedures, lacking a comprehensive framework for assessing measurement equivalence across cultures.

The main goal of our study is to further examine the cross-cultural invariance of the SD3 using a novel network-based invariance testing procedure based on Jamison et al.'s (2024) framework. Our approach introduces three key innovations: 1) integrating Jamison et al.'s (2024) permutation testing framework with parametric bootstrap validation, 2) analyzing all 27 SD3 items simultaneously, including reverse-coded items through regularization-sensitive loadings, and 3) implementing multi-algorithm community detection (Louvain/Leiden/Walktrap) to establish dimensionally stable configural models. This method combines the granularity of network loadings with the structural rigor of traditional metric invariance testing, operationalizing approximate invariance through empirically derived difference thresholds rather than binary pass/fail criteria for the entire instrument. Crucially, our permutation protocol preserves cultural group interdependencies—a critical limitation in conventional network comparison tests. Moreover, this approach allows us to identify central items both across the entire item pool and within detected communities. Detecting these highly influential items will help determine whether they correspond to theoretically shared or unique features of Dark Triad traits and whether they are cross-culturally invariant. These insights will enhance our understanding of cross-cultural variability and the robustness of Dark Triad manifestations, contributing to the development of a non-biased assessment of dark traits.

2. Method

2.1. Sample

The total sample included 15,690 participants (42.8% male, 0.2% with missing gender information) from 13 countries and 12 languages, aged 16–88 ($M = 31.09$, $SD = 13.21$). Sample characteristics for the 14 nations/cultures are provided in Table 1 and details are provided in Table A in the Supplement. All samples were drawn from existing studies of authors or open data, except for the Indian and Polish samples, which were collected as part of larger, unpublished projects. When selecting open datasets, we ensured that each group/culture had a sufficient number of participants for meaningful group comparisons (Jamison et al., 2024). There was no missing data and all participants were included in the analysis.

2.2. Instrument

The Short Dark Triad (SD3; Jones & Paulhus, 2014) measures Machiavellianism, narcissism, and psychopathy, each per 9 items with a 5-point Likert response scale (1 = *disagree strongly* to 5 = *agree strongly*). The references to validation studies of the measure in each language can be found in Table A in the Supplement and descriptives and alphas in Table B in Supplement.

Table 1
Sample characteristics ($N = 15,690$).

Culture	Total (% males)	*M*age	*SD*age	Age range
Brazilian	2056 (37.2%)	28.24	10.22	18–73
Chinese	800 (20.4%)	20.17	1.11	18–24
Croatian	977 (22.4%)	23.61	6.34	18–88
German	463 (20.3%)	25.78	7.61	18–66
Greek	1247 (69.4%)	35.34	13.11	16–86
Hungarian	1200 (43.8%)	25.41	10.49	16–72
Indian	453 (64.5%)	23.65	1.91	20–31
Italian	431 (29.9%)	27.47	10.71	16–69
Japanese	1947 (49.7%)	44.81	12.74	20–69
Polish	548 (49.1%)	47.92	16.22	18–82
Russian	1350 (24.9%)	21.29	4.48	17–60
Serbian	2348 (49.4%)	31.18	11.54	17–76
UK	616 (70.3%)	27.88	11.18	16–71
USA	1254 (40.9%)	38.99	11.83	18–78

2.3. Data analysis

Our analytical approach follows a comprehensive framework that combines exploratory and confirmatory techniques to validate the dimensional structure of the SD3 and test its invariance across cultures. First, we employed a train-test validation strategy, and then proceeded with invariance testing on the full dataset using the validated structure (see Fig. 1). The dataset ($N = 15,690$) was split into two stratified halves, with exactly 50% of participants from each culture allocated to each half to ensure balanced representation. The first half (training sample) was used for Exploratory Graph Analysis (EGA) to establish the measurement model, while the second half (validation sample) was reserved for validation of this structure through Confirmatory Factor Analysis (CFA).

In the training phase, we implemented EGA using Gaussian graphical models (GGM) with graphical LASSO regularization (Costantini et al., 2015; Epskamp & Fried, 2018) and automatic correlation method selection. Three community detection algorithms were applied: Louvain, Leiden, and Walktrap. We chose Louvain and Walktrap, because recent research has found their performance to be significantly better in psychological networks than other popular approaches (Christensen et al., 2024), including clique percolation (Santiago et al., 2024). Leiden is a recent, improved version of the Louvain algorithm and it is reasonable to expect it to perform better compared to the aforementioned algorithms (Traag et al., 2019). To determine the optimal algorithm, we used the Total Entropy Fit Index (TEFI; Golino et al., 2021), an information-theoretic measure that evaluates structural organization through von Neumann entropy of correlation matrices. Unlike factor-analytic fit indices that assess model-data discrepancy, TEFI quantifies the reduction in systemic disorder when items are clustered into communities, with lower values indicating a clearer separation between communities.

The EGA-derived structure from the training sample was then validated using CFA on the validation sample. The CFA was conducted using the diagonally weighted least squares (DWLS) estimator. Model fit was evaluated via comparative fit index (CFI) and Tucker-Lewis index (TLI), which should be $\geq$0.90 for acceptable fit and $\geq$0.95 for good fit and the standardized root-mean-square residual (SRMR) and the root-mean-square error of approximation (RMSEA), which should be $\leq$0.08 for an acceptable fit (Hooper et al., 2008).

Following confirmation that the EGA-derived structure showed good fit in the validation sample, we applied the same EGA approach with the best-performing algorithm (Leiden) to the full dataset. This ensures that the structure used for invariance testing represents the optimal community structure across all 14 cultures. Importantly, the community structure obtained from the full dataset was consistent with that derived from the training sample, further supporting the robustness of the identified dimensions.

With the established structure, we proceeded to test two levels of invariance - configural and metric (Fig. 1). Configural invariance was assessed by examining whether the same community structure held across all cultures. Simulation studies demonstrate EGA's robustness to sample size variations typical in cross-cultural research (500–1500 participants per group), with minimal bias in network loading estimates when $N \geq 500$ (Jamison et al., 2024). This makes it particularly suitable for our multi-country design containing groups approximately within this range, but not less than 400 individuals per group.

Metric invariance was tested by estimating networks for each culture using the community memberships established during configural invariance testing, then comparing network loadings between cultures. Network loadings (Christensen & Golino, 2021) are computed and compared between cultures to generate empirical difference values. These empirical differences are then evaluated against null distributions created through permutation testing (1000 iterations), where culture memberships are randomly shuffled, and network loadings recomputed. Statistical significance is assessed using a two-tailed false discovery rate (FDR), and corrected *p*-values (Benjamini & Hochberg, 1995) are computed, with significance flagged at $\alpha = 0.05$.

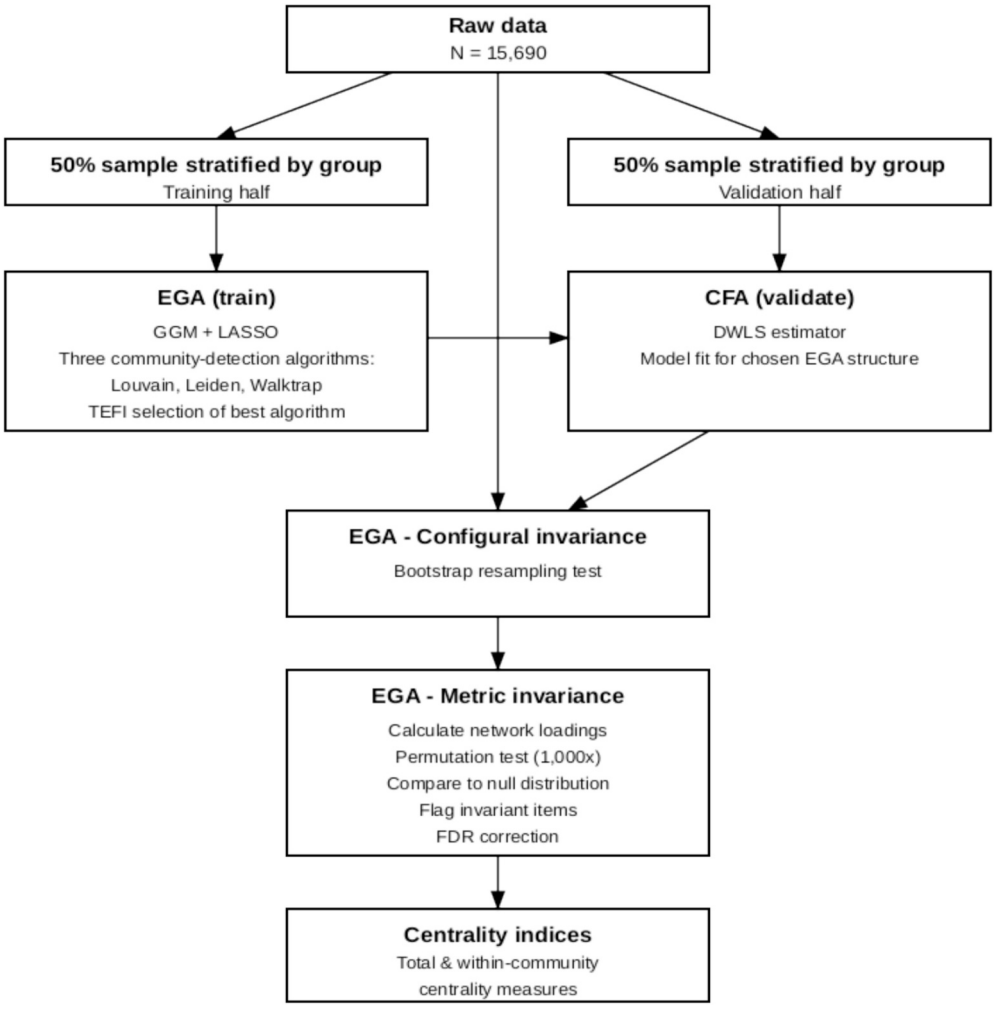

Fig. 1. Data analysis flowchart.

Given our multi-group design, the metric invariance testing involves all possible pairwise comparisons between cultures (91 total comparisons, see the Online Supplement for details). For each pair, the procedure maintains the same community structure derived from configural invariance, while examining loading differences. Following the similar logic of the alignment approach (Muthén & Asparouhov, 2014), the support for approximate metric invariance is demonstrated when less than 25% of loadings show significant differences after FDR correction. Thus, the simulation study by Muthén and Asparouhov (2014), with IRT and alignment methods, shows that when non-invariant parameters remain at or below 25%, the estimated group factor means closely match population values, with correlations of at least 0.98. This supports the practical use of the 25% threshold for evaluating approximate invariance in large-scale, multi-group studies. The partial metric invariance analysis then examines specific patterns of non-invariant items, requiring at least two invariant items per theoretical dimension to support partial invariance (Cieciuch & Davidov, 2015). This comprehensive approach allows us to identify both global patterns of invariance and specific items that may function differently across cultures.

Finally, two centrality indices were calculated - a total and within-community centrality. A total item centrality represents its overall importance in the network, reflecting both the strength and number of its connections with other items across all Dark Triad communities. It is a sum of all item's absolute loadings and cross-loadings within the network. Items with higher total centrality have stronger and more numerous connections throughout the network, suggesting they are key items that bridge multiple indicators of dark personality. A within-community centrality represents network loading of items within a community, revealing the most central items within that community. Although high centrality values suggest strong connectivity, they reflect statistical prominence rather than definitive indicators of theoretical importance (Christensen & Golino, 2021).

All analyses were conducted in R4.4.2 (R Core Team, 2024) using the *EGAnet* package for network estimation and invariance testing (Golino & Christensen, 2025) and *lavaan* for confirmatory factor analysis (Rossel, 2012). Data and code are available at https://osf.io/t5wgm/.

3. Results

In the training sample ($n = 7842$) on which EGA was conducted, the Leiden algorithm with three communities emerged as the optimal solution based on multiple criteria, showing the best fit with a VN.Entropy. Fit of −21.51, compared to Walktrap (−21.18) and Louvain (−20.53). The CFA results on the validation sample ($n = 7,848$) supported the network structure with acceptable model fit indices: $\chi^2(321) = 14{,}069.13$, $p < .001$, CFI = 0.933, TLI = 0.927, RMSEA = 0.074, 90%CI 0.073–0.075, SRMR = 0.065. These fit indices suggest that the three-dimensional structure identified through EGA demonstrates an appropriate fit to the holdout data, providing strong cross-validation evidence for the structural validity of the SD3 across 14 cultures.

The EGA with Leiden algorithm applied to the full sample yielded identical community membership assignments to those found in the training sample, demonstrating the stability of the three-dimensional structure across different subsets of the data (Table 2).

Table 2
Results obtained from EGA with different community detection methods (N = 15,690).

	Louvain	Leiden	Walktrap
Dimensions	3	3	3
Configural invariance	Yes	Yes	Yes
Approx. invariance (% sig.)	14 %	16 %	22 %
No. of invariant items - Machiavellianism	4	4	3
No. of invariant items - narcissism	6	5	2
No. of invariant items - psychopathy	0	4	4

Then, the same EGA with Leiden algorithm for community detection was conducted on the total sample. The network structure shown on Fig. 2 is very robust as bootstrap re-estimation shows that 21 items (from 27) are always assigned in their respective community, while the other six (items 1, 7, 8, 9, 20R, and 25R) having a replication proportion ≥0.99.

While all the methods achieved configural invariance, the Leiden solution showed a balanced distribution of invariant items across all three theoretical dimensions (four, five, and four items of nine, respectively, see Table 2 for results and Table 3 for items), unlike Louvain, which had no invariant items in the community of psychopathy items, or Walktrap, which showed relatively few invariant items in the community of narcissism items. In sum, 13 items (from 27) consistently showed metric invariance. The percentage of significant differences in approximate invariance testing (16%) also fell well within our acceptable threshold of 25%.

Based on total centrality across all SD3 items, items 5, 6, 19, and 27 showed the highest centrality (Table 3). Among them, all except item 27 showed metric invariance across 14 cultures. In contrast, items 5, 13, and 22 showed the highest within-community centrality and all of them are invariant across comparisons (Table 3). In addition, we can see that either the item with the highest network loading within a community or with the second highest network loading is invariant across all comparisons (Table 3).

When we examine the differences across 14 cultures in network loadings, items 24 (vengeful mindset) and 18 (entitlement-demand respect) have shown the biggest absolute difference in network loadings, which occur dominantly in the Japanese sample vs. others (Table 4). When we examine the average differences in standardized network loadings, the largest are found in the case of Japan vs. USA, Germany, China, Greece, and Brazil (Table 5).

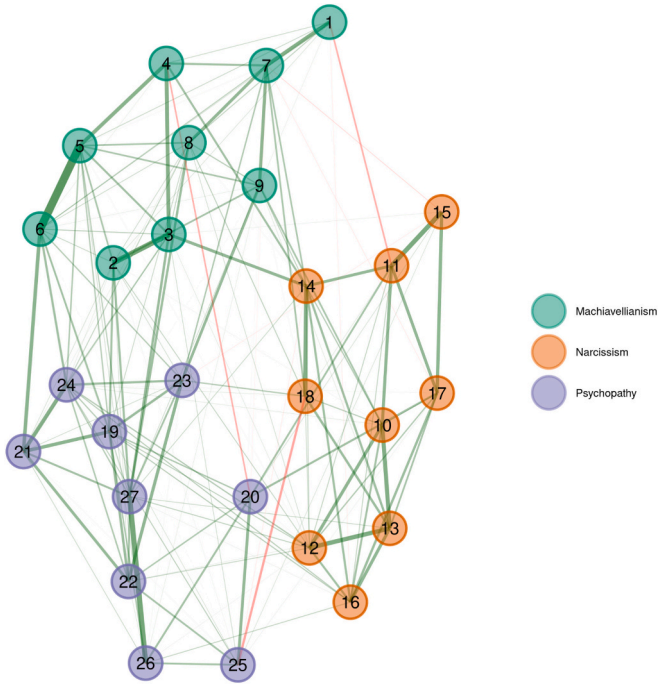

Fig. 2. The network structure obtained with EGA with the Leiden algorithm (N = 15,690).

4. Discussion

The present study provides evidence for the cross-cultural validity of the Short Dark Triad (SD3) across 14 national-cultural contexts using a novel network-based invariance testing approach based on exploratory graph analysis. Our findings demonstrate that the SD3 maintains a robust three-dimensional structure across cultures, supported by both configural and approximate metric invariance. First, the network structure is remarkably stable in the bootstrap analysis of the total sample, with 21 items consistently assigned to their theoretical dimensions and the remaining six items showing very high replication proportions (≥0.99). This stability is further validated by acceptable CFA fit indices in our cross-validation analysis, suggesting that the three-dimensional structure of the SD3 is well-preserved across cultures. Second, 13 items showed metric invariance, which is considered adequate for achieving approximate metric invariance. While previous research using traditional methods and stricter criteria did not achieve configural invariance (Aluja et al., 2022), this study contributes to a better approximation of cross-cultural invariance at the item-level network structure.

When examining the relative strength centrality of the SD3 items, our findings suggest balanced average centrality across psychopathy (0.346), Machiavellianism (0.346), and narcissism items (0.372), pointed out to the coherence of dark traits indicators. This aligns with previous network analysis on dark traits showing that all traits contribute to the network structure organization (Dinić et al., 2020). Our approach uniquely captures two complementary aspects of item centrality: total item centrality and within-community centrality. Based on total centrality values, the highest scoring items are items 5 (strategic information tracking) and 6 (strategic revenge) from Machiavellianism, reflecting caution and strategic revenge, as well as items 19 (revenge on authorities) and 27 (manipulative talk) from psychopathy, reflecting revenge and verbal manipulation. These results are partially in line with previous research on a selected item pool, in which items reflecting manipulation, revenge, and social influence tactics were identified as the most central (i.e., items 2-clever manipulation, 6-revenge, 14-getting acquainted with important people, 27-manipulative talk, see Ramos-Vera et al., 2024). The results of our study indicate that cross-culturally central items refer to explicitly maladaptive features. In contrast, narcissism has been seen as "brighter" among the dark traits (Rauthmann & Kolar, 2012), and it appears that the SD3 narcissism scale lacks indicators of the explicitly antagonistic aspect of narcissism (like narcissistic rivalry), which constitutes the Dark Core (Dinić et al., 2023).

However, within-community centrality provides more valuable insight into the core aspects of each Dark Triad trait across cultures. Additionally, items with the highest within-community centrality in this study represent the unique features of each Dark Triad trait. For Machiavellianism, item 5 (strategic information tracking) showed the highest within-community centrality, capturing the aspect of strategic information tracking. This item reflects subtle manipulation, mirroring today's reality where possession of information equates to power. It also showed the highest total centrality, representing the only case of overlapping centrality values in terms of intensity. While previous research has identified item 5 as central in some countries, other Machiavellianism items reflecting revenge also showed high total centrality (Ramos-Vera et al., 2024), as seen in our total centrality findings. However, the revenge aspect is also present in psychopathy items, blurring the distinction between these traits (Knitter et al., 2025). Therefore, our study reveals that the central item within Machiavellianism involves strategic manipulation, a characteristic recognized as

Table 3
Network loadings obtained with EGA with Leiden algorithm ($N = 15{,}690$).

Item	Machiavellianism	Narcissism	Psychopathy	Total centrality	Invariance
1 It's not wise to tell your secrets.	**0.226**	−0.051	0.000	0.277	No
2 I like to use clever manipulation to get my way.	**0.318**	0.026	0.161	0.504	No
3 Whatever it takes, you must get the important people on your side.	**0.386**	0.092	0.124	0.602	Yes
4 Avoid direct conflict with others because they may be useful in the future.	**0.314**	0.052	−0.042	0.408	No
5 It's wise to keep track of information that you can use against people later.	**0.586**	0.002	0.122	0.710	Yes
6 You should wait for the right time to get back at people.	**0.376**	0.000	0.241	0.618	Yes
7 There are things you should hide from other people to preserve your reputation.	**0.398**	0.062	0.029	0.489	No
8 Make sure your plans benefit yourself, not others.	**0.265**	0.042	0.112	0.418	Yes
9 Most people can be manipulated.	**0.247**	0.080	0.096	0.423	No
10 People see me as a natural leader.	0.051	**0.438**	0.010	0.499	Yes
11R I hate being the center of attention.	−0.046	**0.446**	0.049	0.540	Yes
12 Many group activities tend to be dull without me.	0.048	**0.379**	0.115	0.543	No
13 I know that I am special because everyone keeps telling me so.	0.010	**0.513**	0.027	0.549	No
14 I like to get acquainted with important people.	0.204	**0.380**	0.010	0.595	No
15R I feel embarrassed if someone compliments me.	−0.008	**0.227**	0.018	0.253	Yes
16 I have been compared to famous people.	−0.008	**0.359**	0.087	0.454	Yes
17R I am an average person.	−0.009	**0.360**	0.065	0.434	Yes
18 I insist on getting the respect I deserve.	0.073	**0.247**	−0.017	0.337	No
19 I like to get revenge on authorities.	0.157	0.052	**0.410**	0.619	Yes
20R I avoid dangerous situations.	−0.048	0.118	**0.229**	0.395	Yes
21 Payback needs to be quick and nasty.	0.123	0.000	**0.403**	0.526	Yes
22 People often say I'm out of control.	0.013	0.029	**0.460**	0.501	No
23 It's true that I can be mean to others.	0.158	0.025	**0.308**	0.491	No
24 People who mess with me always regret it.	0.164	0.082	**0.329**	0.575	No
25R I have never gotten into trouble with the law.	0.019	−0.048	**0.242**	0.309	Yes
26 I enjoy having sex with people I hardly know.	0.023	0.027	**0.348**	0.398	No
27 I'll say anything to get what I want.	0.235	0.065	**0.388**	0.688	No
Average loadings per community	0.346	0.372	0.346		

Note. Reversely formulated items were recoded before analysis. The highest network loadings per item across communities is bolded and the items with the highest network loading within the community and with the highest total centrality are underlined.

Table 4
Top 10 largest differences in absolute network loadings across 14 cultures ($N = 15{,}690$).

Culture comparison	Item	Difference	Adjusted p-value	Direction
Croatian-Japanese	24	0.484	0.011	Croatian > Japanese
Chinese-Japanese	24	0.436	0.011	Chinese > Japanese
Japanese-Greek	18	0.415	0.006	Japanese > Greek
Chinese-Japanese	18	−0.401	0.011	Chinese < Japanese
Japanese-German	18	0.399	0.009	Japanese > German
Brazilian-Japanese	24	0.391	0.008	Brazilian > Japanese
Japanese-Italian	18	0.388	0.014	Japanese > Italian
Japanese-UK	24	−0.377	0.018	Japanese < UK
Japanese-Greek	24	−0.366	0.006	Japanese < Greek
Brazilian-Greek	14	0.365	0.011	Brazilian > Greek

Table 5
Top 5 largest differences in average network loadings across 14 cultures ($N = 15{,}690$).

Culture comparison	Average absolute difference
USA-Japanese	0.116
Japanese-German	0.116
Chinese-Japanese	0.113
Japanese-Greek	0.111
Brazilian-Japanese	0.110

unique to this trait compared to the other dark traits (Jones, 2016).

In narcissism, item 13 (externally validated specialness) emerged as the most central in terms of within-community centrality. The content of this item highlights the importance of externally validated sense of specialness and uniqueness as a key aspect of a grandiose self-view and superiority. It is worth noting that in Ramos-Vera et al. (2024), among the overall central items is narcissism item 14, which refers to getting acquainted with important people. However, the content of item 14 seems closer to Machiavellianism, as it pertains to alliance-seeking for instrumental goals, and is not a unique characteristic of narcissism. In a study of French-speaking participants in Belgium, a network analysis of items from the Narcissistic Personality Inventory (NPI) found that the item reflecting a self-view as an extraordinary person was among the three most central items, alongside items related to entitlement and authority (Briganti & Linkowski, 2020). Similarly, in a network analysis of a broader set of narcissism facets in a Serbian sample (Dinić et al., 2022), features of superiority formed a community with grandiose aspects of narcissistic antagonism, including entitlement, exploitativeness, and lack of empathy, which are recognized as the core characteristics of narcissism (e.g., Weiss et al., 2019). Furthermore, grandiose exhibitionism and leadership/authority, which encompass aspects of viewing the self as extraordinary, showed the highest centrality in the network. However, entitlement also played a central role in connecting various narcissism dimensions (Dinić et al., 2022). In a large-scale cross-cultural comparison using a traditional approach, leadership/authority and grandiose exhibitionism (which includes a similarly formulated item to our central item) were identified as the cross-culturally invariant facets of narcissism, while entitlement/exploitativeness was found to be culturally specific (Fatfouta et al., 2021). Thus, seeking social validation to maintain a superior self-image appears to be a universal, unique, and central indicator of grandiose narcissism across culturally diverse samples.

For psychopathy, item 22 (out of control) exhibited the highest within-community centrality, reflecting impulsivity and disinhibition. This aspect of psychopathy is characteristic of secondary psychopathy, which occupies a peripheral position in the network of dark trait facets (Dinić et al., 2020). In contrast, primary psychopathy, characterized by callousness or a lack of affective empathy and a manipulative interpersonal style, serves as the central or core feature in a broader set of dark traits (Dinić et al., 2020, 2023). However, across a broader set of psychopathy items measured in students from the USA, manipulation

and irresponsibility/impulsivity were found to have the strongest centrality (Tsang & Salekin, 2019). Thus, although primary psychopathy represents a shared characteristic of dark traits (Dinić et al., 2020), on an item level, features of secondary psychopathy are central, reflecting unique and culturally invariant elements of psychopathy.

The study also identified specific items that show notable cross-cultural variation, particularly in comparisons involving the Japanese sample. Items 24, reflecting a vengeful mindset, and 18, reflecting entitlement, demonstrated the largest differences in network loadings across cultures. These differences were most pronounced in comparisons between the Japanese sample and several other cultures, including Croatian, Chinese, Greek, and German. Furthermore, the Japanese sample consistently showed the largest average differences in network loadings when compared to other contexts, particularly with the USA, Germany, China, Greece, and Brazil. This pattern suggests that these items might be interpreted differently in Japanese culture, possibly due to varying cultural norms regarding the expression of revenge and demands for respect. Previous research has also highlighted cross-cultural variation in the entitlement aspect of narcissism, captured by item 18 (Fatfouta et al., 2021). Moreover, previous studies have noted that Japanese individuals tend to score lower on dark traits compared to other cultures, likely due to strong normative pressure to suppress maladaptive traits (Rogoza et al., 2021). Taken together, these results suggest that cultural adaptation of certain items may be necessary for more accurate assessment in East Asian contexts.

Previous research suggested cross-cultural differences in expression of dark traits. In more collectivistic cultures, overt expressions of vengeance and other dark traits features may be socially discouraged in favor of harmony and group cohesion, whereas in more individualistic cultures, such expressions may be more tolerated (e.g., Ma et al., 2021). Similarly, in high power-distance cultures, entitlement and other dark traits features might be normalized among individuals in positions of authority, whereas in egalitarian societies, it could be viewed more negatively. Furthermore, differences across countries can reflect differences in regime and not only cultural differences, although they can be connected. In a large-scale research (Neumann et al., 2025), results showed that as governments shifted from autocracy to full democracy, citizens showed lower dark traits and higher light traits, although this association can be bidirectional. Therefore, the socio-economic environment linked to authoritarian regimes may contribute to the expression of aversive traits, as such traits can more effectively aid in acquiring resources in competitive and unstable conditions or serve as adaptive responses in a system that does not reward fairness or cooperation.

There are several limitations to this research. First, while our sample size was substantial, there are imbalances across cultures, with some cultures represented by relatively smaller samples compared to others. This imbalance may affect the stability of network estimates in these samples. Second, there is a gender and age imbalance between the samples, which may influence the results. Additionally, the sample characteristics are not necessarily representative of each culture or country, limiting the generalizability of the findings. Third, in the absence of established recommendations for cut-off values for non-invariant parameters in a network-based approach, we relied on the alignment approach (Muthén & Asparouhov, 2014). However, this cut-off remains subject to further empirical validation. Future research on the cross-cultural application of the SD3 could focus solely on items identified as invariant. Additionally, future studies could explore the invariance of the newly developed Short Dark Tetrad (SD4; Paulhus et al., 2021), which, in addition to including sadism, also incorporates changes in the operationalization of Machiavellianism. These changes could affect the centrality of certain items.

The practical implications of the results concerning cross-cultural comparisons can be approached in two directions. First, non-invariant items can be revised. However, the current findings do not allow us to determine whether the lack of invariance stems from translating issues or reflects a genuinely emic or culturally specific conceptualization of the traits. Second, a more certain option is a tailored interpretation, in which culturally invariant items are prioritized and assigned greater weight in the total score. This allows researchers and practitioners to make more accurate and fair comparisons across cultures without discarding potential culturally meaningful information. We should note that we do not suggest omitting the non-invariant items since SD3 is already short scale and omitting items would violate construct validity of the instrument.

Overall, we can conclude that compared to traditional invariance testing, this novel network-based invariance testing procedure proves to be an adequate method for assessing measurement invariance in large-scale cross-cultural contexts. This approach provides a more nuanced understanding of how personality measures function across different cultural settings and which specific features of traits are universally measurable and which require cultural contextualization. Compared to previous network analysis approaches, our methodology allowed for the examination of all items, including reverse-coded ones, offering a more comprehensive understanding of the SD3's cross-cultural properties.

CRediT authorship contribution statement

Bojana M. Dinić: Writing – review & editing, Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **Giulio Costantini:** Writing – review & editing, Methodology, Investigation. **Kostas A. Papageorgiou:** Writing – review & editing, Investigation. **Bruno Bonfá-Araujo:** Writing – review & editing, Investigation. **Beata Grabovac:** Writing – review & editing, Investigation. **Magdalena Żemojtel-Piotrowska:** Writing – review & editing, Investigation. **Ankit:** Writing – review & editing, Investigation. **Anja Wertag:** Writing – review & editing, Investigation. **Dmitriy Kornienko:** Writing – review & editing, Investigation. **Padma Tripathi:** Writing – review & editing, Investigation. **Theodoros Kyriazos:** Writing – review & editing, Investigation. **Jing Zhang:** Writing – review & editing, Investigation. **Mary Poga:** Writing – review & editing, Investigation. **Aleksandar Tomašević:** Writing – original draft, Visualization, Methodology, Formal analysis, Data curation.

Ethics approval statement

The secondary dataset used here are from Open Science Framework or from authors of the study. No additional ethics approvals were required.

Declaration of competing interest

The author declares no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2025.113321.

Data availability

The data that support the findings of this research are publicly available at https://osf.io/t5wgm/. This was not a preregistered study.

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