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Bridging the Gap: A Network Approach to Dark Triad, Mental Toughness, the Big Five and

Perceived Stress

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Abstract

Objective: We employed the network methodology to explore the connections between the Dark Triad (DT) traits with Mental Toughness (MT) and the degree to which they account for perceived stress beyond the Big Five (B5). **Method:** Network analyses were undertaken to explore connections between the DT, MT and perceived stress, independently in two samples, and in the combined dataset; and whether B5 factors are responsible for the connections that emerged in the original network. **Results:** DT and MT traits improved the prediction of perceived stress above the B5. Furthermore, narcissism occupied a strategic position in the network acting as a bridge between prosocial and "dark" sides of personality. The pattern of network connections could not be explained by B5 traits alone. **Conclusions**: The results suggest that there is more to personality than what can be captured by the B5 and that broadening the domain of personality beyond the B5 can improve the prediction of important outcomes, such as perceived stress. Narcissism is a unique trait and studying its connection with MT may be the key to moving forward from a dichotomous way of perceiving personality traits, as beneficial or malevolent, to focusing on a dynamic continuum of personality.

Keywords: Dark Triad, Mental Toughness, Big Five, Perceived Stress, Network Analysis.

Introduction

Various personality factors have been associated with symptoms of psychopathology (e.g.

Kotov, Gamez, Schmidt, & Watson, 2010). These associations can be bidirectional: symptoms of

psychopathology can vary depending upon an individual's personality traits, and personality may be

influenced by symptoms of psychopathology, such as stress (Widiger, 2011). Stress is a multifaceted

construct and may be defined as a state of imbalance, a disruption of homeostasis, between internal

or external demands and personal or social resources available to cope with such demands (Cohen,

Kamarck, & Mermelstein, 1983). Stress has become a major threat to public health, for instance, by

putting college students at risk for a range of health conditions such as depression or anxiety

(Nguyen-Michel, Unger, Hamilton, & Spruijt-Metz, 2006) and cardiovascular disease (Steptoe &

Kivimäki, 2012). However, it is often not the level of stress per se that negatively affects individuals'

health but rather their appraisal of it (Tugade & Fredrickson, 2004). Perceived stress indicates the

degree to which an individual appraises his or her own life as stressful, when what is demanded

exceeds the ability to cope with it (Cohen, et al., 1983). Research has shown that high levels of

perceived stress is linked to psychopathology with a study reporting that perceived stress mediates

the relationship between environmental stressors and individuals' risk for depression (Lee, Joo, &

Choi, 2013). Exploring factors that may guard against symptoms of perceived stress, such as

personality traits, is of paramount importance considering that the negative consequences of stress-

related illness are large contributors to the global burden of disease (Walker, McGee, & Druss,

2015).

Using network analysis (Costantini et al., 2015), we explored the complex pattern of

connections between socially undesirable traits, namely the Dark Triad (DT) traits, with resilience

factors as encapsulated in the multifaceted construct of Mental Toughness (MT; Clough, Earle,

Sewell, 2002). Furthermore, we investigated and the degree to which the aforementioned traits

account for perceived stress after controlling for what could be explained by the Big Five (B5) alone.

The B5 model of personality asserts that individual differences in normal behaviour could be classified in terms of five independent dimensions, namely Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (Furnham, Monsen, & Ahmetoglu, 2009). It has been argued that – while the B5 is the most widespread description of personality (e.g., McCrae & Costa, 2008; Saucier & Srivastava, 2015) – it does not capture sufficiently variation across the whole spectrum of normal personality and that its heterogeneous broad traits may be too few in number to contribute significantly to the prediction of various phenomena, such as symptoms of psychopathology (Boyle, 2008).

The DT is a personality cluster that is defined at the subclinical level and is composed of three distinct but overlapping personality traits: subclinical narcissism, subclinical psychopathy and Machiavellianism (Paulhus &Williams, 2002). Of these traits, narcissism is typically regarded as the most complex construct, including both self-enhancing tendencies (narcissist grandiosity) and a proneness to experience psychological distress (narcissist vulnerability; Miller et al., 2011; Miller, Lynam, Hyatt, & Campbell, 2017). The vulnerable side of narcissism is characterised by negative affect, distrust, selfishness, and a need for attention and recognition (Ackerman et al., 2018; Dickinson & Pincus, 2003). The grandiose side of narcissism is instead characterised by exhibitionism, lack of humility/modesty, and interpersonal dominance (Vize, Lynam, Collison & Miller, 2016). A recent investigation that explored the structure of narcissism using network analysis concluded that both grandiose and vulnerable narcissistic manifestations play a central role for the dynamics taking place within this trait (Di Pierro, Costantini, Benzi, Madeddu, & Preti, 2018).

Of the other two DT traits, psychopathy is typically perceived as the most impactful construct as it has close links with most extreme and frequent antisocial behavior (Paulhus & Williams, 2002). The adaptation of psychopathy to the subclinical sphere happened recently (Lilienfeld & Andrews, 1996). Psychopathy involves antagonistic personality traits (e.g. meanness), high impulsivity and thrill-seeking, low empathy and anxiety (Paulhus & Williams, 2002). Unlike

narcissism, psychopathy is characterised by disinhibition, which is prominent in nearly all conceptions of this trait (e.g. Hare, 1980). Psychopathy is conventionally perceived as socially malevolent. However, some of its facets (for example boldness) predict positive outcomes, such as creative achievement and better divergent thinking (e.g. Galang et al., 2016).

Individuals who score high on Machiavellianism show characteristics not seen in psychopathy, including a long-term strategic focus, the ability to delay gratification, and average or good impulse control. Furthermore, they tend to be skilled manipulators and callous pragmatists, who strive for success (Miller, Hyatt, Maples-Keller, Carter, & Lynam, 2017). Like the other two dark traits, Machiavellianism is thought to include positive as well as toxic characteristics. For example, individuals who scored high on Machiavellianism were popular and liked by peers, socially skilled, and well adjusted (Hawley, 2003). Unlike psychopathy and narcissism, typical conceptualizations of Machiavellianism do not associate the construct with any type of clinical impairment (Vize et al., 2016).

Previous findings have shown that the DT traits share a common core of callous-manipulation (see Furnham, Richards, & Paulhus, 2013 for a review). This has led some researchers questioning whether the DT traits are sufficiently distinct (e.g. Muris, Merckelbach, Otgaar, & Meijer, 2017). However, other researchers have argued that grouping DT traits together may not be particularly informative (e.g. Papageorgiou et al., 2017). In particular, several studies examining the association among narcissism and other traits, performance measures, and psychopathology symptoms (e.g. Ng et al., 2014; Onley et al., 2013; Papageorgiou et al., 2017; Papageorgiou et al., 2018; Papageorgiou, Denovan, & Dagnall, 2019; Papageorgiou et al., 2019; Petrides et al., 2011; Sabouri et al., 2016; Sedikides et al., 2004; Veselka, Schermer, & Vernon et al., 2012; Zeigler-Hill & Besser, 2011) suggested that the inclusion of narcissism in the malevolent side of human personality may need to be reconsidered.

MT reflects an effective coping mechanism for dealing with stressors (Mutz, Clough, & Papageorgiou, 2017). MT allows individuals to proactively seek out opportunities for personal growth (Lin, Clough, Welch, & Papageorgiou, 2017). MT has been linked with several positive outcomes across achievement contexts (Lin, Mutz, Clough, & Papageorgiou, 2017). Individuals who score high on MT are able to control their emotions effectively in the face of setbacks and challenges; they believe that they are truly worthwhile people; they are confident about successfully completing the task and are assertive in social situations (Papageorgiou, Mutz, Lin, & Clough, 2018). Clough et al., (2002) characterised MT as a composite of four interrelated but independent components (the 4Cs): (1) *Control* (life and emotion): the tendency to feel and act as if one is influential and keep anxieties in check; (2) *Commitment*: the tendency to be deeply involved in pursuing goals despite difficulties that arise; (3) *Challenge*: the tendency to see potential threats as opportunities for self-development and to continue to strive in changing environments; and (4) *Confidence* (in abilities and interpersonal): the belief that one is a truly worthwhile person in spite of setbacks, and the ability to push oneself forward in social settings.

Studies that explored the association between MT and the DT reported mixed findings. Whereas some found positive associations among all 4Cs and narcissism, psychopathy and Machiavellianism (Sabouri et al., 2016), others reported a positive correlation between MT and narcissism, but negative correlations among MT, psychopathy and Machiavellianism (Onley, Veselka, Schermer, & Vernon, 2013). Similar associations (in terms of size and direction)n emerged in another study, which reported that confidence is the strongest (out of the 4Cs) correlate of narcissism; and a mediation effect such that narcissism reduces psychopathy and Machiavellianism (Papageorgiou, Wong, & Clough, 2017); symptoms of depression (Papageorgiou, Denovan, & Dagnall, 2019); and perceived stress (Papageorgiou et al., 2019), through MT. This mediation model has also been tested using longitudinal data and showed that narcissism may increase MT resulting in higher school grades in an adolescent sample (Papageorgiou et al., 2018).

DT, perceived stress and MT have been explored in relation to the B5. Veselka and colleagues (2012) reported that psychopathy and Machiavellianism exhibited a pattern of correlations that is to be expected with measures of social malevolence: Specifically, both Machiavellianism and psychopathy were correlated negatively with agreeableness and conscientiousness. Machiavellianism was correlated positively with neuroticism. On the other hand, narcissism correlated positively with extraversion and negatively with agreeableness. Perceived stress is known to be positively correlated with neuroticism and to be negatively correlated with extraversion (Ebstrup, Eplov, Pisinger, & Jørgensen, 2011). MT and its facets correlate with several B5 traits, with overall MT being negatively correlated with neuroticism and positively with the remaining traits (Horsburgh, Schermer, Veselka, & Vernon, 2009).

Since all traits that constitute the main focus of our study entertain relationships with B5 factors, we considered fundamental to inspect whether the connections among those traits could be simply understood within the B5 model, or whether they involved personality features that could not be completely encompassed within the B5. We employed network analysis, in the form of Gaussian Graphical Models (GGM; Epskamp, Waldorp, Mõttus, & Borsboom, 2018), to investigate how traits belonging to the positive (MT) and the negative (DT) side of the spectrum of personality interact with each other and with perceived stress, after accounting for what could be explained by the B5 alone. Unlike other techniques such as Structural Equation Models (SEM), GGM networks allow examining all possible pairwise relationships among a large number of variables through a model that is both parsimonious and exploratory (Costantini et al., 2015, 2019; Epskamp & Fried, 2018). Like SEM, GGM result in sparse models including a limited number of parameters: In GGM networks, if two variables are not connected by an edge, this means that they are linearly independent conditioning on the others (Lauritzen, 1996). This makes GGM more informative than, for instance, a simple correlational model (Costantini et al., 2015). However, unlike SEM, conditional independence relationships are determined using data-driven methods. Crucially, GGMs models are undirected and do not assume acyclic relationships (Epskamp, Rhemtulla, & Borsboom, 2017), an

assumption that is untenable for most processes in personality psychology (Costantini et al., 2015; Schmittmann et al., 2013). Furthermore, whereas each GGM is uniquely determined (Epskamp et al., 2017), each SEM model is characterized by many equivalent models that fit the data equally well making edge directions often undetermined (MacCallum, Wegener, Uchino, & Fabrigar, 1993). In the case of B5, MT, DT and stress, we had no reason to exclude the presence of cycles or of bidirectional relationships. GGM networks do not assume direct causal associations among personality traits; this offers a model that is closer to data-generating processes in personality, which are characterized by mutual causal paths (Cramer et al., 2012), without loss in parsimony and without requiring a priori specifications of the model (Costantini et al., 2015).

Overview of the studies

We performed two independent studies to inspect how traits belonging to the positive (MT) and the negative (DT) sides of the spectrum of personality interact with each other and with perceived stress. By assessing DT, MT, and perceived stress across two independent studies, we could evaluate the general stability of the results. Additionally, in the second study, we assessed the B5 personality traits, both to inspect their role as factors within the network, and to rule out the B5 as a potential simpler explanation of the pattern of relationships recovered among the other traits of interest. We expected that, if there is no personality beyond B5, the relationships among MT and DT should wane traits after controlling for the B5. Finally, of particular interest within the tested networks was the role of narcissism in respect to the aforementioned traits considering its unique role within the DT.

Since the two studies are largely similar, save for the inclusion of the B5 and some procedural details, we present their methods and results together.

Method

Participants

Study 1. Participants (N = 364, mean age = 24.30 years, SD = 9.16, $range$ = 18-79; 56.90% females) were recruited online through advertisements on social networks (e.g. Facebook), as well as through word of mouth. Participants received detailed information regarding the aims of the studies and the voluntary basis of their participation and they signed informed consent forms.

Study 2. Participants (N = 384, mean age = 24.30, SD = 6.87, $range$ = 18-59, 72.7% females) were recruited online through advertisements on social networks, around the university and through the university's SONA system, an online system that facilitates recording students' participation in research studies and assigning credits for their participation. Participants received detailed information regarding the aims of the study and the voluntary basis of their participation and they signed informed consent forms. Participants recruited via SONA system were compensated via course credits, whereas the others took part in the study on a purely voluntary basis.

Measures

The Dark Triad. The Short Dark Triad questionnaire (SD3; Jones & Paulhus, 2014) assesses the DT of personality, as conceptualized by Paulhus and Williams (2002): subclinical narcissism, subclinical psychopathy and Machiavellianism. The SD3 includes 27 items, 9 by scale. Responses are given on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Example items include: "*I like to use clever manipulation to get my way*" (Machiavellianism), "*People see me as a natural leader*" (narcissism) and "*It's true that I can be mean to others*" (psychopathy).

Mental Toughness. The Mental Toughness Questionnaire 48 (MTQ48) is the most frequently used measure of MT and the 4Cs, as conceptualized by Clough et al. (2002) and has shown good psychometric properties in several studies (Crust & Swann, 2011; Horsburgh et al., 2009; Perry, Clough, Crust, Earle, & Nicholls, 2013). Participants are asked to respond to 48 items on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Example items include "*I can usually adapt myself to challenges that come my way*" and "*I don't usually give up under pressure*". Each of the 4Cs (Control, Commitment, Challenge, and Confidence) is assessed by 12 items and an overall MT score can be calculated by averaging all 48 items.

Perceived Stress. The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983; see also Leung, Lam, & Chan, 2010) was used to measure the degree to which respondents perceived their life as unpredictable, uncontrollable, and overloading during the past month. Participants responded to 10 items on a Likert scale ranging from 0 (*never*) to 4 (*very often*). Example items include "*In the last month, how often have you been upset because of something that happened unexpectedly?*" and "*In the last month, how often have you felt nervous and stressed?*".

The Big Five. The Big Five Inventory (BFI; John & Srivastava, 1999) is a 44-item questionnaire measuring the B5. These correspond to openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. This measure consists of short statements rated by participants on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Ten items assess openness to experience (e.g., "I see myself as someone who is original, comes up with new ideas"), nine assess conscientiousness (e.g., *"I see myself as someone who is a reliable worker"*); eight assess extraversion (e.g., "I see myself as someone who is talkative"), nine assess agreeableness (e.g., "I see

myself as someone who is helpful and unselfish with others"), eight assess neuroticism (e.g., "I see myself as someone who is depressed, blue").

Procedure

Study 1. A battery of questionnaires was administered online via SurveyMonkey (www.surveymonkey.com). The battery included the SD3, the MTQ48 and the PSS scales. Each participant received a message containing a link to the online questionnaire and password access as well as a unique participant code. Questionnaire completion was self-paced, and participants could proceed to the subsequent page only once they had answered all items. Upon completion of the study the participants were given an online written debrief.

Study 2. The procedure of Study 2 was the same followed in Study 1, the only difference being the inclusion of the BFI to assess the B5. Furthermore, participants recruited via the SONA system completed the questionnaires at the University instead of online.

Network Analyses

Networks are models that include nodes interconnected by edges. Nodes represent variables, such as traits or symptoms, whereas edges represent pairwise relationships among nodes and are typically estimated through GGM (Epskamp, Waldorp, et al., 2018). Within GGM, edges encode conditional dependence/independence relations among nodes in the form of partial correlations. In GGM networks, nodes represent variables and an edge is drawn between two nodes if the corresponding variables correlate after controlling for all others. A missing edge indicates that two nodes are conditionally independent given the others. Partial correlation networks are typically

estimated using a *lasso* regularization via the graphical lasso algorithm, which reduces overfitting and results in more parsimonious and replicable network models (Epskamp & Fried, 2018; Friedman, Hastie, & Tibshirani, 2008).

Once a network is computed, centrality indices allow obtaining useful summaries of the complex patterns of relationships that each node entertains within the network (Costantini et al., 2015). We will consider three main centrality indices: A node has a large *strength centrality* if it has strong connections with many nodes (Barrat, Barthélemy, Pastor-Satorras, & Vespignani, 2004). A node has a large *closeness centrality* if it is well connected to other nodes either by direct paths or by short indirect paths. A node has large *betweenness centrality* if it frequently lies on the shortest path between other nodes and thus the node is important for them to influence each other. The informative value of centrality indices in psychological networks is currently debated: Some studies have shown that central elements of psychopathology networks have high clinical relevance (Boschloo, van Borkulo, Borsboom, & Schoevers, 2016; Christensen, Kenett, Aste, Silvia, & Kwapil, 2018; Rodebaugh et al., 2018). However, centrality indices have been originally developed for social networks and might not be adequate to capture the type of relationships encoded by psychological networks (Bringmann et al., 2018). Therefore, in addition to centrality, we estimated also the predictability of each node, an index that has been developed specifically for psychological networks (Haslbeck & Waldorp, 2017). Node predictability quantifies the proportion of variance of each node that is explained within the network model (Haslbeck & Waldorp, 2017). Nodes with zero predictability value are those that cannot be predicted by the model, whereas nodes with a predictability value of 1 can be perfectly predicted by the model. Predictability can also be seen as the upper bound estimate of the controllability of a node. If all GGM edges incident to a node indicated causal connections directed to that node, the predictability would be equal to the amount

of variance of that node that could be controlled by acting on other nodes in the network (Haslbeck & Fried, 2017).

Recently, the replicability of psychological networks has been at the center of a debate (Borsboom et al., 2017; Forbes, Wright, Markon, & Krueger, 2017a, 2017b; Fried et al., 2018). For this reason, it is important to ascertain whether each of the results obtained in the network is sufficiently stable. There are two main ways to ensure replicability of the results: Firstly, to replicate the results in an independent sample. The networks obtained in independent samples can then be compared using several methods. For instance, one could simply compute the correlation between the edge weights in the two samples (Borsboom et al., 2017). The *Network Comparison Test* has been recently proposed as a more formal test of the equivalence of two networks based on permutation. It can be used to test the invariance of *network structure*, which is operationalized by the largest difference between two corresponding edges in the two networks (index *M*), and the invariance of global strength (index *S*), the absolute sum of all edge weights in a network (van Borkulo et al., 2017). Secondly, one can use bootstrap techniques to ensure that network estimates are sufficiently stable. The *correlation stability coefficient* (*CS*-coefficient) is defined as the proportion of cases that can be dropped such that the resulting centrality estimate correlates more than .7 with the original centrality estimate with 95% probability in case-dropping bootstrap resamples. Cutoff values of .25 and .50 have been suggested to indicate sufficient stability and good stability, respectively (Epskamp, Borsboom, & Fried, 2018).

Networks were estimated using the packages *bootnet* (Epskamp, Borsboom, et al., 2018) and *qgraph* (Epskamp, Costantini, et al., 2018; Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012) in the *R* statistical software package (R Core Team, 2017). The network comparison test was performed using package *NetworkComparisonTest* (van Borkulo, 2016).

Results and discussion

Network of DT, Mental Toughness and Perceived Stress

Descriptive statistics and reliabilities for all scales are presented in Table 1. Skewness and Kurtosis indicated that none of the variables considered showed substantial deviations from normality. Samples from Study 1 and 2 included partially overlapping sets of measures. In particular, both samples completed the SD3, MTQ48 and PSS, whereas participants in Study 2 completed also the BFI. We first computed networks of the DT, the 4Cs of MT and perceived stress independently in the two samples, to check for the overall stability of the results. The networks are reported in Supplementary Material Figure S1 and the exact values of the edges are reported in Supplementary Tables S1 and S2. Edge weights in the two networks showed a remarkably large correlation of $r = .92$ ($p < .001$) and the network comparison test revealed that the two networks were not significantly different in structure ($M = .162$, $p = .188$) or in global strength ($S = .053$, $p = .804$). These results indicate that the network structure replicated very well across the two studies. Subsequently, we combined the samples from both datasets and estimated a single network that benefited of a much larger sample size ($N = 748$), which is reported in Figure 1A (exact values of the edges are reported in Table 2). Of 28 possible edges, 6 (21%) were estimated as zeros by the graphical lasso regularization. Network indices are reported in Figure 1B. The *CS-Coefficient* were equal to .84 for strength centrality, .86 for closeness centrality, .78 for betweenness centrality, and .92 for predictability, and therefore largely exceed the proposed cutoff value of .50 (Epskamp, Borsboom, et al., 2018), indicating very good stability for all indices.

Nodes representing the DT traits of narcissism, psychopathy and Machiavellianism were all connected to each other by positive edges, in line with previous findings (Furnham et al., 2013). Similarly, nodes representing the 4Cs of MT were positively connected to each other in all networks confirming that mental toughness is a multidimensional construct comprised of four interrelated but independent components (e.g. Clough et al., 2002, Lin et al., 2017 and Papageorgiou, Mutz, Lin, &

Clough, 2018). Narcissism was not directly connected to perceived stress, whereas psychopathy and Machiavellianism, showed only very weak positive connections. Conversely, perceived stress was negatively connected to all mental toughness nodes with the strongest connections being with control and confidence. All else being equal, individuals who feel in control and are confident tend to feel also less stressed (see also Gerber, Brand, et al., 2013; Gerber, Kalak et al., 2013), confirming that MT may act as a protective factor against perceived stress.

Interestingly, there were two main connections between MT and the DT traits: a negative connection between Machiavellianism and confidence and a positive connection between narcissism and confidence. In fact, confidence was the most central node according to all centrality indices, as well as the most predictable one. Narcissism was the second most central node according to betweenness and closeness centrality. Narcissism's strength centrality was around average, indicating that although narcissism did not have particularly strong direct connections to other nodes, it occupied a strategic position connecting MT and DT traits, as shown by its high betweenness and closeness centralities. These findings suggest that the link between narcissism and confidence may constitute a "bridge" between the prosocial and the socially malevolent side of human personality. As such, studying this connection (between confidence and narcissism) may prove useful in moving away from a dichotomous way of perceiving personality traits (i.e. prosocial versus socially toxic traits) to focusing on a more dynamic continuum of human personality (i.e. contextually adaptive or maladaptive traits). This idea is further supported by the lack of a direct connection between narcissism and perceived stress, meaning that these two nodes are not related to each other after controlling for the role played by the other nodes in the network.

Recent research has shown that connections at the level of broader constructs might mask more complex patterns of relationships at the level of specific items (e.g., Mõttus, 2016; Mõttus et al. 2018; Seeboth & Mõttus, 2018; see also Christensen, Cotter & Silva, 2018). In our case, a trait-level analysis does not allow excluding that the connection between narcissism and confidence could involve only a very specific subset of items, for instance due to specific aspects of narcissism (Ackerman et al., 2018). Therefore, to further inspect this pattern of connections, we estimated a GGM network in which nodes represented specific items[1]. The resulting network is reported in Figure S2. In this network, there were 30 positive connections and no negative connection between narcissism items and confidence items. The largest connection was between nodes NAR1 ("People see me as a natural leader") and CONF5 ("I am comfortable telling people what to do"). However, all narcissism items but one (NAR8, "I have been compared to famous people") were positively connected to at least one confidence item and all confidence items but one (CONF3, "If something can go wrong, it usually will", reverse scored) were positively connected to at least one narcissism items. This confirmed that connections between the two traits were not item-specific, but pertained narcissism and confidence as traits.

Examining the role of the B5

We used the data from Study 2 to explore the degree to which the B5 were responsible for the connections emerged in the network of DT, MT, and perceived stress. Figure 2A represents the network computed using data from Study 2, whereas Figure 2B represents the same network after removing the variance due to the B5 factors from all nodes. In particular, we regressed each node on

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[1] We thank an anonymous reviewer for suggesting to this analysis.

the B5 factors and estimated a network on the residuals (for a similar approach, see Costantini &

Perugini, 2016). Exact values of the edges are provided in Tables S2 and S3 and the corresponding

network indices are presented in Figure 2C. The resulting network structure was remarkably similar

to the original one (Figure 1A) and most network indices were relatively stable even after partialling

out all the B5 variance, indicating that the relationships among the mental toughness facets and the

DT traits cannot be simply attributed to the confounding effect of B5 traits. Interestingly, after

controlling for the B5, Narcissism remained the second most betweenness-central node after

Confidence. This indicates that narcissism's role in bridging the DT nodes with other traits could not

be fully accounted for by B5 factors.

Furthermore, after partialling out B5 traits, the relative predictability of perceived stress,

compared to other nodes in the network, decreased, suggesting that the B5 might explain a

substantial portion of variance for this node. We followed-up this result by performing a hierarchical

multiple regression in which the B5, DT and MT traits were sequentially entered as predictors of

perceived stress in three subsequent steps (Table 3). B5 were entered in the first step and, as

expected, they explained a large portion of the variation in perceived stress, $R^2 = .44$, $F(5, 378) =$

60.47, $p < .001$. Perceived stress was mostly predicted by the B5 trait of neuroticism, with a

significant contribution of conscientiousness. Adding the DT traits allowed explaining an additional

2% of the variation in perceived stress, $F(3, 375) = 3.47$, $p = .010$, with an overall $R^2 = .46$, albeit each

individual DT traits had a non-significant contributions to the prediction of perceived stress.

Including the 4Cs of MT allowed explaining an additional 5% of the variation in perceived stress, $F (4,$

$371) = 9.75$, $p < .001$, the strongest contributions being from MT components of control and

confidence.

To further inspect the role of the B5 within the network, we estimated networks including also nodes representing the B5 (Figure 3; the exact values of the edges are reported in the Supplementary Material Table S3). When B5 factors were included in the network, they showed strong connections with several other traits. Neuroticism was strongly negatively connected to control, and confidence, and positively connected to perceived stress. These connections suggest that neuroticism could be particularly responsible for the reduction in the links involving perceived stress in the network of Figure 2B. Openness was particularly connected to narcissism and challenge. All else being equal, individuals with high openness were also more likely to have higher narcissism and to be able to see opportunities in challenging situations. Low agreeableness was strongly connected to psychopathy and weakly connected to Machiavellianism. This is in line with previous studies showing moderate in size negative correlations between the DT traits (especially psychopathy and Machiavellianism) and agreeableness (Muris, Merckelbach, Otgaar, & Meijer, 2017; Paulhus & Williams, 2002). On one hand, this finding indicates the toxic elements of psychopathy and Machiavellianism considering that agreeableness has been linked with various positive outcomes, including prosocial behavior and mental health (Graziano & Eisenberg, 1997). On the other hand, this is an interesting pattern of connections because it hints to the idea that psychopathy and Machiavellianism may not be toxic in contexts, where high agreeableness does not predict positive outcomes. For example, a study reported that agreeableness was associated negatively to career satisfaction (Seibert & Kraimer, 2001). Commitment was strongly connected to conscientiousness, indicating a partial overlap between these constructs. Extraversion was strongly connected to both confidence and narcissism, thus explaining part of their connection (see also Veselka et al., 2012). Nonetheless, the connection between these two nodes remained strong and positive even after controlling for extraversion. This finding further indicates that the role played by narcissism and confidence in bridging adaptive and malevolent traits goes beyond what can be accounted by B5 traits.

Conclusions

In two studies, we employed the network methodology to elucidate the complex web of connections between well-established socially undesirable traits, such as the DT traits, with potential resilience factors as encapsulated in the multifaceted construct of MT; and the degree to which they account for perceived stress after controlling for what could be explained by the B5 alone. Additionally, of particular interest in the present investigation was exploring the role of narcissism in respect to the aforementioned traits considering its unique role within the DT. The current investigation provides novel insights into the underlying mechanisms that connect a broad spectrum of personality traits and how they predict an example of symptoms of psychopathology, namely perceived stress.

The results highlighted several pathways through which MT and perceived stress are interrelated. Furthermore, the findings establish the role of narcissism as a trait that is unique among the DT suggesting that it may act as bridge between the prosocial and the "dark" side of human personality. This finding hints to the idea that simply clustering the three DT traits together may not be particularly informative (Papageorgiou et al., 2017). We also examined whether MT and the DT personality traits were informative in describing personality, or if B5 factors alone could be responsible for the pattern we obtained in our network. Crucially, our results indicate that the relationships between DT and MT cannot be fully explained by the B5 personality traits. However, it should be noted here that the present investigation has used the BFI (John & Srivastava, 1999) to assess B5. While the BFI is an established and valid measure of the B5 traits, it is also relatively limited in its specification of personality characteristics and it has not been designed to assess different facets of the B5 traits (Soto & John, 2017). Future studies may employ the revised version of the scale (BFI-2; Soto & John, 2017) in an attempt to shed additional light into the role of the B5 in accounting for the connection between the DT and MT. Furthermore, although the B5 constitute a parsimonious model that includes several necessary components to the description of personality,

they may not encompass some personality manifestations (Saucier & Srivastava, 2015), which constitute nonetheless important elements to fully describe personality structure and dynamics (e.g., Clough et al., 2002; Furnham et al., 2013). In fact, several researchers have argued that the B5 model is limited as it does not account for the full range of personality traits (Ashton & Lee, 2007; Paunonen & Jackson, 2000) and it is based upon an overreliance on factor analytic methodology in deriving and replicating its structure (Boyle, 2008; Veselka et al., 2012).

In our study, narcissism and perceived stress were not directly connected to each other. It should be noted here however that the SD3 scale of narcissism is biased towards assessing the grandiose rather than vulnerable aspects of this trait (Maples, Lamkin, & Miller, 2014). Future research may want extent the current investigation by incorporating a broader range of measures of narcissism, including a more comprehensive assessment of the different aspects of this trait.

To conclude, in terms of the theoretical implications, the current findings indicate that, whereas the B5 traits (mainly neuroticism) seem to explain most of the variation in perceived stress, adding DT and MT to the model allowed capturing an additional sizeable portion of variation in perceived stress. This finding, in combination with the fact that the connections among the DT and MT did not wane traits after controlling for the B5, suggests that there is much more to personality than what can be captured by the B5 alone. Furthermore, despite personality research has traditionally focused on a dichotomy between toxic and prosocial traits, the consistent emergence of a link between narcissism and the MT facet of confidence might be the key to moving forward from a dichotomous way of perceiving personality traits to focusing on a dynamic continuum of human personality.

Albeit network analysis alone is not itself sufficient to prove the presence of causal paths, it constitutes an important guide for future experimental research (Epskamp, Waldorp, et al., 2018). Whereas personality traits such as the B5 have been traditionally considered immutable, a large body of evidence has shown that personality traits can change because of interventions (Roberts et

al., 2017) and experimental studies in personality, based on network results, are currently being developed (Costantini & Perugini, 2018). Our results suggest that joint and specialized intervention programs could be developed in order to inspect whether boosting certain traits (e.g. the mental toughness), while weakening other traits (e.g. neuroticism) in individuals willing to do so might result in a reduction of symptoms of psychopathology, such as perceived stress. The possibility of intervening on the personal determinants of stress would be important not only from a theoretical standpoint, but also from an applied perspective, as it could provide invaluable guidance for preventing the insurgence of psychopathology.

Conflict of interest

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References

Ackerman, R. A., Donnellan, M. B., & Wright, A. G. (2018). Current conceptualizations of
narcissism. *Current Opinion in*
Psychiatry. https://doi.org/10.1097/YCO.0000000000000463

Ashton, M. C., & Lee, K. (2007). Empirical, theoretical, and practical advantages of the HEXACO
model of personality structure. *Personality and social psychology review*, *11*, 150-166.
https://doi.org/10.1177/1088868306294907

Barrat, A., Barthélemy, M., Pastor-Satorras, R., & Vespignani, A. (2004). The architecture of
complex weighted networks. *PNAS*, *101*, 3747–3752.
https://doi.org/10.1073/pnas.0400087101

Baumert, A., Schmitt, M., Perugini, M., Johnson, W., Blum, G., Borkenau, P., ... & Jayawickreme,
E. (2017). Integrating personality structure, personality process, and personality
development. *European Journal of Personality*, *31*, 503-528.
https://doi.org/10.1002/per.2115

Borsboom, D., Robinaugh, D. J., The Psychosystems Group, Rhemtulla, M., & Cramer, A. O. J.
(2018). Robustness and replicability of psychopathology networks. *World Psychiatry, 17*,
143–144. https://doi.org/10.1002/wps.20515

Borsboom, D. (2017). A network theory of mental disorders. *World psychiatry*, *16*, 5-13.
https://doi.org/10.1002/wps.20375

Borsboom, D., & Cramer, A. O. (2013). Network analysis: an integrative approach to the
structure of psychopathology. *Annual review of clinical psychology*, *9*, 91-121.
https://doi.org/10.1146/annurev-clinpsy-050212-185608

Borsboom, D., Fried, E. I., Epskamp, S., Waldorp, L. J., van Borkulo, C. D., van der Maas, H. L. J., &
Cramer, A. O. J. (2017). False alarm? A comprehensive reanalysis of "evidence that
psychopathology symptom networks have limited replicability" by Forbes, Wright,
Markon, and Krueger (2017). *Journal of Abnormal Psychology*, *126*, 989–999.
https://doi.org/10.1037/abn0000306

Boyle, G. J. (2008). Critique of the five-factor model of personality. *The SAGE handbook of
personality theory and assessment*, *1*, 295-312.
http://dx.doi.org/10.4135/9781849200462

Clough, P., Earle, K., & Sewell, D. (2002). Mental toughness: The concept and its
measurement. *Solutions in sport psychology*, 32-43.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal
of health and social behavior*, 385-396. http://dx.doi.org/10.2307/2136404.

Costa, P. T., & McCrae, R. R. (2008). The revised neo personality inventory (neo-pi-r). *The SAGE
handbook of personality theory and assessment*, *2*, 179-198. http://dx.doi.org/10.4135/
9781849200479.

Costantini, G., Epskamp, S., Borsboom, D., Perugini, M., Mõttus, R., Waldorp, L. J., & Cramer,   A.
O. J. (2015). State of the aRt personality research: A tutorial on network analysis of
personality data in R. *Journal of Research in Personality*, *54*, 13–29.
https://doi.org/10.1016/j.jrp.2014.07.003

Costantini, G., & Perugini, M. (2016). The network of conscientiousness. *Journal of Research in
Personality*, *65*, 68–88. https://doi.org/10.1016/j.jrp.2016.10.003

Costantini, G., & Perugini, M. (2018). A framework for testing causality in personality research.

European Journal of Personality, *32*(3), 254–268. https://doi.org/10.1002/per.2150

Costantini, G., Richetin, J., Borsboom, D., Fried, E. I., Rhemtulla, M., & Perugini, M. (2015). Development of indirect measures of conscientiousness: Combining a facets approach and network analysis. *European Journal of Personality*, *29*, 548-567. https://doi.org/10.1002/per.2014

Cramer, A. O., Van der Sluis, S., Noordhof, A., Wichers, M., Geschwind, N., Aggen, S. H., ... & Borsboom, D. (2012). Dimensions of normal personality as networks in search of equilibrium: You can't like parties if you don't like people. *European Journal of Personality*, *26*, 414-431. https://doi.org/10.1002/per.1866

Christensen, A. P., Cotter, K. N., & Silvia, P. J. (2018b). Reopening openness to experience: A network analysis of four openness to experience inventories. *Journal of Personality Assessment,* 1-15.https://doi.org/10.1080/00223891.2018.1467428

Christensen, A. P., Kenett, Y. N., Aste, T., Silvia, P. J., & Kwapil, T. R. (2018a). Network structure of the Wisconsin Schizotypy Scales–Short Forms: Examining psychometric network filtering approaches. *Behavior Research Methods*, 1-20. https://doi.org/10.3758/s13428-018-1032-9

Crust, L., & Swann, C. (2011). Comparing two measures of mental toughness. *Personality and Individual Differences*, *50*, 217-221. http://dx.doi.org/10.1016/j.paid.2010.09.032.

Dickinson, K. A., & Pincus, A. L. (2003). Interpersonal analysis of grandiose and vulnerable narcissism. *Journal of personality disorders*, *17*, 188-207. https://doi.org/10.1521/pedi.17.3.188.22146

Di Pierro, R., Costantini, G., Benzi, I. M. A., Madeddu, F., & Preti, E. (2018). Grandiose and entitled, but still fragile: A network analysis of pathological narcissistic traits. *Personality and Individual Differences.* https://doi.org/10.1016/j.paid.2018.04.003

Ebstrup, J. F., Eplov, L. F., Pisinger, C., & Jørgensen, T. (2011). Association between the five factor personality traits and perceived stress: Is the effect mediated by general self-efficacy? *Anxiety, Stress and Coping, 24*, 407–419. https://doi.org/10.1080/10615806.2010.540012

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, *50*, 195–212. https://doi.org/10.3758/s13428-017-0862-1

Epskamp, S., Costantini, G., Haslbeck, J. M. B., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2017). qgraph: Graph plotting methods, psychometric data visualization and graphical model estimation. R package version 1.4.4.

Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software*, *48*, 1–18. https://doi.org/10.18637/jss.v048.i04

Epskamp, S., & Fried, E. I. (2018). A tutorial on regularized partial correlation networks. *Psychological Methods*. https://doi.org/10.1037/met0000167

Epskamp, S., Waldorp, L. J., Mõttus, R., & Borsboom, D. (2018). The Gaussian Graphical Model in Cross-Sectional and Time-Series Data. *Multivariate Behavioral Research*. https://doi.org/10.1080/00273171.2018.1454823

Forbes, M. K., Wright, A. G. C., Markon, K. E., & Krueger, R. F. (2017a). Evidence that
Psychopathology Symptom Networks have Limited Replicability. *Journal of Abnormal
Psychology*, 1–37. http://dx.doi.org/10.1037/abn0000276.

Forbes, M. K., Wright, A. G. C., Markon, K. E., & Krueger, R. F. (2017b). Further evidence that
psychopathology networks have limited replicability and utility: Response to Borsboom et
al. (2017) and Steinley et al. (2017). *Journal of Abnormal Psychology*, *126*, 1011–1016.
https://doi.org/10.1037/abn0000313

Fossati, A., Borroni, S., Marchione, D., & Maffei, C. (2011). The big five inventory
(BFI). *European Journal of Psychological Assessment*. 50-58.
https://doi.org/10.1027/1015-5759/a000043

Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social networks*, *1*,
215-239.

Fried, E. I., Eidhof, M. B., Palic, S., Costantini, G., Huisman-van Dijk, H. M., Bockting, C. L. H., …
Karstoft, K.-I. (2018). Replicability and generalizability of Posttraumatic Stress Disorder
(PTSD) networks: A cross cultural multisite study of PTSD symptoms in four trauma patient
samples. *Clinical Psychological Science*. https://doi.org/10.1177/2167702617745092

Friedman, J., Hastie, T., & Tibshirani, R. (2008). Sparse inverse covariance estimation with the
graphical lasso. *Biostatistics*, *9*, 432–441. https://doi.org/10.1093/biostatistics/kxm045

Fruchterman, T. M., & Reingold, E. M. (1991). Graph drawing by force-directed
placement. *Software: Practice and experience*, *21*, 1129-1164.
https://doi.org/10.1002/spe.4380211102

Furnham, A., Monsen, J., & Ahmetoglu, G. (2009). Typical intellectual engagement, Big Five personality traits, approaches to learning and cognitive ability predictors of academic performance. *British Journal of Educational Psychology*, *79*, 769-782. https://doi.org/10.1348/978185409X412147

Furnham, A., Richards, S. C., & Paulhus, D. L. (2013). The Dark Triad of personality: A 10 year review. *Social and Personality Psychology Compass*, *7*, 199-216. https://doi.org/10.1111/spc3.12018

Galang, A. J. R., Castelo, V. L. C., Santos III, L. C., Perlas, C. M. C., & Angeles, M. A. B. (2016). Investigating the prosocial psychopath model of the creative personality: Evidence from traits and psychophysiology. *Personality and Individual Differences*, *100*, 28-36. https://doi.org/10.1016/j.paid.2016.03.081

Gerber, M., Brand, S., Feldmeth, A. K., Lang, C., Elliot, C., Holsboer-Trachsler, E., & Pühse, U. (2013). Adolescents with high mental toughness adapt better to perceived stress: A longitudinal study with Swiss vocational students. *Personality and Individual Differences*, *54*, 808-814. https://doi.org/10.1016/j.paid.2012.12.003

Gerber, M., Kalak, N., Lemola, S., Clough, P. J., Perry, J. L., Pühse, U., ... & Brand, S. (2013). Are adolescents with high mental toughness levels more resilient against stress?. *Stress and Health*, *29*, 164-171. https://doi.org/10.1002/smi.2447

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American psychologist*, *48*, 26-34. http://dx.doi.org/10.1037/0003-066X.48.1.26.

Hare, R. D. (1980). A research scale for the assessment of psychopathy in criminal populations. *Personality and individual differences*, *1*, 111-119. https://doi.org/10.1016/0191-8869(80)90028-8

Haslbeck, J. M. B., & Fried, E. I. (2017). How predictable are symptoms in psychopathological

   networks? A reanalysis of 18 published datasets. *Psychological Medicine*, *47*, 2767–2776.

   https://doi.org/10.1017/S0033291717001258

Haslbeck, J. M. B., & Waldorp, L. (2017). How well do network models predict future

   observations? On the importance of predictability in network models. *Behavioral Research*

   Methods, 1–9. https://doi.org/10.3758/s13428-017-0910-x

Hawley, P. H. (2003). Prosocial and coercive configurations of resource control in early

   adolescence: A case for the well-adapted Machiavellian. *Merrill-Palmer Quarterly (1982)*,

   279-309.

Horsburgh, V. A., Schermer, J. A., Veselka, L., & Vernon, P. A. (2009). A behavioural genetic study

   of mental toughness and personality. *Personality and individual differences*, *46*, 100-105.

   https://doi.org/10.1016/j.paid.2008.09.009

John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and

   theoretical perspectives. *Handbook of personality: Theory and research*, *2*(1999), 102-138.

Jones, D. N., & Paulhus, D. L. (2014). Introducing the short dark triad (SD3) a brief measure of

   dark personality traits. *Assessment*, *21*, 28-41.

   https://doi.org/10.1177/1073191113514105.

Kajonius, P. J., & Björkman, T. (2018). Dark malevolent traits and everyday perceived stress.

   Current Psychology. https://doi.org/10.1007/s12144-018-9948-x

Kotov, R., Gamez, W., Schmidt, F., & Watson, D. (2010). Linking "big" personality traits to

   anxiety, depressive, and substance use disorders: a meta-analysis. *Psychological*

   bulletin, *136*, 768.

Lee, J. S., Joo, E. J., & Choi, K. S. (2013). Perceived stress and self-esteem mediate the effects of work-related stress on depression. *Stress and Health*, *29*, 75-81. https://doi.org/10.1002/smi.2428

Leung, D. Y., Lam, T. H., & Chan, S. S. (2010). Three versions of Perceived Stress Scale: validation in a sample of Chinese cardiac patients who smoke. *BMC public health*, *10*, 513. https://doi.org/10.1186/1471-2458-10-513.

Lilienfeld, S. O., & Andrews, B. P. (1996). Development and preliminary validation of a self-report measure of psychopathic personality traits in noncriminal population. *Journal of personality assessment*, *66*, 488-524. https://doi.org/10.1207/s15327752jpa6603_3

Lin, Y., Clough, P. J., Welch, J., & Papageorgiou, K. A. (2017). Individual differences in mental toughness associate with academic performance and income. *Personality and Individual Differences*, *113*, 178-183. ttps://doi.org/10.1016/j.paid.2017.03.039

Lin, Y., Mutz, J., Clough, P. J., & Papageorgiou, K. A. (2017). Mental toughness and individual differences in learning, educational and work performance, psychological well-being, and personality: A systematic review. *Frontiers in psychology*, *8*, 1345. https://doi.org/10.3389/fpsyg.2017.01345

Loh, P. L., & Wainwright, M. J. (2012). Structure estimation for discrete graphical models: Generalized covariance matrices and their inverses. In Advances in Neural Information Processing Systems (pp. 2087-2095). Retrieved from: http://papers.nips.cc/paper/4584-structure-estimation-for-discrete-graphical-models-generalized-covariance-matrices-and-their-inverses.pdf

Maples, J. L., Lamkin, J., & Miller, J. D. (2014). A test of two brief measures of the dark triad: The dirty dozen and short dark triad. *Psychological assessment*, *26*, 326. http://dx.doi.org/10.1037/a0035084

McCrae, R. R., & Costa, P. T. (2008). Empirical and theoretical status of the five-factor model of personality traits. *The SAGE handbook of personality theory and assessment, 1,* 273-294.

McCrae, R. R., & Costa, P. T. (1987). Validation of the five-factor model of personality across instruments and observers. *Journal of personality and social psychology*, *52*, 81.

Miller, J. D., Hoffman, B. J., Gaughan, E. T., Gentile, B., Maples, J., & Keith Campbell, W. (2011). Grandiose and vulnerable narcissism: A nomological network analysis. *Journal of personality*, *79*, 1013-1042. https://doi.org/10.1111/j.1467-6494.2010.00711.x

Miller, J. D., Hyatt, C. S., Maples-Keller, J. L., Carter, N. T., & Lynam, D. R. (2017). Psychopathy and Machiavellianism: A distinction without a difference? *Journal of personality*, *85*, 439-453. https://doi.org/10.1111/jopy.12251

Miller, J. D., Lynam, D. R., Hyatt, C. S., & Campbell, W. K. (2017). Controversies in narcissism. *Annual Review of Clinical Psychology, 13*, 291–315. http://dx.doi.org/ 10.1146/annurev-clinpsy-032816-045244.

Mõttus, R., Sinick, J., Terracciano, A., Hřebíčková, M., Kandler, C., Ando, J., . . . Jang, K. L. (2018). Personality characteristics below facets: A replication and meta-analysis of cross-rater agreement, rank-order stability, heritability, and utility of personality nuances*. Journal of Personality and Social Psychology.* http://dx.doi.org/10.1037/pspp0000202

Muris, P., Merckelbach, H., Otgaar, H., & Meijer, E. (2017). The malevolent side of human nature: A meta-analysis and critical review of the literature on the dark triad (narcissism,

Machiavellianism, and psychopathy). *Perspectives on Psychological Science*, *12*, 183-204.

https://doi.org/10.1177/1745691616666070

Mutz, J., Clough, P., & Papageorgiou, K. A. (2017). Do individual differences in emotion

regulation mediate the relationship between mental toughness and symptoms of

depression? *Journal of Individual Differences*. https://doi.org/10.1027/1614-

0001/a000224

Ng, H. K., Cheung, R. Y. H., & Tam, K. P. (2014). Unraveling the link between narcissism and

psychological health: new evidence from coping flexibility. *Personality and Individual*

Differences, *70*, 7-10. https://doi.org/10.1016/j.paid.2014.06.006

Nguyen-Michel, S. T., Unger, J. B., Hamilton, J., & Spruijt-Metz, D. (2006). Associations between

physical activity and perceived stress/hassles in college students. *Stress and Health:*

Journal of the International Society for the Investigation of Stress, *22*, 179-188.

https://doi.org/10.1002/smi.1094

Noser, A. E., Zeigler-Hill, V., & Besser, A. (2014). Stress and affective experiences: The

importance of dark personality features. *Journal of Research in Personality, 53,* 158–164.

https://doi.org/10.1016/j.jrp.2014.10.007

Onley, M., Veselka, L., Schermer, J. A., & Vernon, P. A. (2013). Survival of the scheming: a

genetically informed link between the dark triad and mental toughness. *Twin Research*

and Human Genetics, *16*, 1087-1095. https://doi.org/10.1017/thg.2013.66

Papageorgiou, K. A., Gianniou, F. M., Wilson, P., Moneta, G. B., Bilello, D., & Clough, P. J. (2019).

The bright side of dark: Exploring the positive effect of narcissism on perceived stress

through mental toughness. *Personality and Individual Differences, 139,* 116-124.

Papageorgiou, K. A., Denovan, A., & Dagnall, N. (2019). The positive effect of narcissism on depressive symptoms through mental toughness: Narcissism may be a dark trait but it does help with seeing the world less grey. *European Psychiatry, 55,* 74-79.

Papageorgiou, K. A., Malanchini, M., Denovan, A., Clough, P. J., Shakeshaft, N., Schofield, K., & Kovas, Y. (2018). Longitudinal associations between narcissism, mental toughness and school achievement. *Personality and Individual Differences, 131,* 105-110.

Papageorgiou, K.A., Mutz, J., Lin, Y., & Clough, P.J. (2018). Mental Toughness: A Personality Trait That Is Relevant across Achievement Contexts and Mental Health Outcomes In Zeigler-Hill, V., & Shackelford, T.K., *The SAGE Handbook of Personality and Individual Differences* (pp. 587-604). Los Angeles, LA: Sage

Papageorgiou, K. A., Wong, B., & Clough, P. J. (2017). Beyond good and evil: Exploring the mediating role of mental toughness on the Dark Triad of personality traits. *Personality and Individual Differences*, *119*, 19-23. https://doi.org/10.1016/j.paid.2017.06.031

Paulhus, D. L., & Williams, K. M. (2002). The dark triad of personality: Narcissism, Machiavellianism, and psychopathy. *Journal of research in personality*, *36*, 556-563. https://doi.org/10.1016/S0092-6566(02)00505-6

Paunonen, S. V., & Jackson, D. N. (2000). What is beyond the big five? Plenty! *Journal of personality*, *68*, 821-835. ttps://doi.org/10.1111/1467-6494.00117

Perry, J. L., Clough, P. J., Crust, L., Earle, K., & Nicholls, A. R. (2013). Factorial validity of the mental toughness questionnaire-48. *Personality and individual differences*, *54*, 587-592. http://dx.doi.org/10.1016/j.paid.2012.11.020

Petrides, K. V., Vernon, P. A., Schermer, J. A., & Veselka, L. (2011). Trait emotional intelligence

and the dark triad traits of personality. *Twin Research and Human Genetics*, *14*(1), 35-41.

https://doi.org/10.1375/twin.14.1.35

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases

in behavioral research: A critical review of the literature and recommended

remedies. *Journal of applied psychology*, *88*, 879.

R Core Team. (2017). *R: a language and environment for statistical computing. Version 3.3.3.*

Vienna: R Foundation for Statistical Computing.

Roberts, B. W., Luo, J., Briley, D. A., Chow, P. I., Su, R., & Hill, P. L. (2017). A systematic review of

personality trait change through intervention. *Psychological Bulletin*, *143*(2), 117–141.

https://doi.org/10.1037/bul0000088

Rodebaugh, T. L., Tonge, N. A., Piccirillo, M. L., Fried, E., Horenstein, A., Morrison, A. S., . . .

Heimberg, R. G. (2018). Does centrality in a cross-sectional network suggest intervention

targets for social anxiety disorder? *Journal of Consulting and Clinical Psychology, 86*, 831-

844. http://dx.doi.org/10.1037/ccp0000336

Sabouri, S., Gerber, M., Bahmani, D. S., Lemola, S., Clough, P. J., Kalak, N., ... & Brand, S. (2016).

Examining Dark Triad traits in relation to mental toughness and physical activity in young

adults. *Neuropsychiatric disease and treatment*, *12*, 229. doi: 10.2147/NDT.S97267

Saucier, G., & Srivastava, S. (2015). What makes a good structural model of personality?

Evaluating the Big Five and alternatives. In M. Mikulincer, P. R. Shaver, M. L. Cooper, & R.

J. Larsen (Eds.), APA handbook of personality and social psychology, Volume 4: Personality

processes and individual differences. (pp. 283–305). Washington: American Psychological

Association. https://doi.org/10.1037/14343-013

Schmittmann, V. D., Cramer, A. O. J., Waldorp, L. J., Epskamp, S., Kievit, R. A., & Borsboom, D.

 (2013). Deconstructing the construct: A network perspective on psychological

 phenomena. *New Ideas in Psychology, 31*, 43–53.

 https://doi.org/10.1016/j.newideapsych.2011.02.007

Sedikides, C., Rudich, E. A., Gregg, A. P., Kumashiro, M., & Rusbult, C. (2004). Are normal

 narcissists psychologically healthy?: Self-esteem matters. *Journal of personality and social*

 psychology, *87*, 400.

Seeboth, A., & Mõttus, R. (2018). Successful explanations start with accurate descriptions:

 Questionnaire items as personality markers for more accurate predictions. *European*

 Journal of Personality, 32, 186-201.https://doi.org/10.1002/per.2147

Soto, C. J., & John, O. P. (2017). The next Big Five Inventory (BFI-2): Developing and assessing a

 hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive

 power. *Journal of personality and social psychology*, *113*(1), 117.

Srivastava, S., John, O. P., Gosling, S. D., & Potter, J. (2003). Development of personality in early

 and middle adulthood: Set like plaster or persistent change?. *Journal of personality and*

 social psychology, *84*, 1041-1053. http://dx.doi.org/10.1037/0022-3514.84.5.1041

Steptoe, A., & Kivimäki, M. (2012). Stress and cardiovascular disease. *Nature Reviews*

 Cardiology, *9*, 360. http://dx.doi.org/10.1038/nrcardio.2012.45

Tugade, M. M., & Fredrickson, B. L. (2004). Resilient individuals use positive emotions to bounce

 back from negative emotional experiences. *Journal of personality and social*

 psychology, *86*, 320.

van Borkulo, C. D., Boschloo, L., Kossakowski, J. J., Tio, P., Schoevers, R. A., Borsboom, D., …

Boschloo, L. (2017). Comparing network structures on three aspects.

https://doi.org/10.13140/RG.2.2.29455.38569

Veselka, L., Schermer, J. A., & Vernon, P. A. (2012). The Dark Triad and an expanded framework

of personality. *Personality and Individual Differences*, *53*, 417-425.

https://doi.org/10.1016/j.paid.2012.01.002

Veselka, L., Schermer, J. A., Petrides, K. V., & Vernon, P. A. (2009). Evidence for a heritable

general factor of personality in two studies. *Twin Research and Human Genetics*, *12*, 254-

260. https://doi.org/10.1375/twin.12.3.254

Vize, C. E., Lynam, D. R., Collison, K. L., & Miller, J. D. (2016). Differences among dark triad

components: A meta-analytic investigation. http://dx.doi.org/10.1037/per0000222

Walker, E. R., McGee, R. E., & Druss, B. G. (2015). Mortality in mental disorders and global

disease burden implications: a systematic review and meta-analysis. *JAMA psychiatry*, *72*,

334-341. doi:10.1001/jamapsychiatry.2014.2502

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

https://doi.org/10.1002/j.2051-5545.2011.tb00024.x

Zeigler-Hill, V., & Besser, A. (2011). Humor style mediates the association between pathological

narcissism and self-esteem. *Personality and Individual Differences*, *50*, 1196-1201.

https://doi.org/10.1016/j.paid.2011.02.006

Tables

Table 1: Descriptive Statistics and Omega reliabilities for the DT, the 4Cs of MT, Stress and the B5 across Study 1, Study 2 and the Combined Dataset

| | Omega Ω | | | | | | |
	Study 1	Study 2	Combined Dataset	*M*	*SD*	*Skew*	*Kurt*
Commitment (MTQ)	.83	.83	.83	3.52	0.54	-0.16	0.20
Control (MTQ)	.78	.82	.81	3.18	0.45	-0.23	0.47
Confidence (MTQ)	.85	.87	.86	3.36	0.54	-0.29	0.25
Challenge (MTQ)	.78	.83	.81	3.56	0.55	-0.23	0.25
Narcissism (SD3)	.76	.79	.78	2.85	0.59	0.03	-0.23
Psychopathy (SD3)	.78	.83	.81	2.10	0.59	0.46	-0.24
Machiavellianism (SD3)	.84	.80	.82	3.04	0.66	-0.05	-0.04
Perceived Stress (PSS)	.88	.91	.90	1.69	0.70	0.29	0.01
Agreeableness (BFI)		.79	.79	3.80	0.57	-0.43	0.29
Conscientiousness (BFI)		.84		3.50	0.60	-0.10	-0.27
Extraversion (BFI)		.89		3.20	0.75	-0.01	-0.38
Neuroticism (BFI)		.89		3.04	0.79	0.16	-0.51
Openness (BFI)		.82		3.50	0.55	-0.12	0.14
N	364	384	748				

Note. Reliability presented using Omega Values. *N* represents the sample size for study 1 and study 2 as well as the combined dataset containing data from both Study 1 and Study 2 (for DT, 4Cs and Stress).

Table 2. Network edges of the DT, the 4Cs of MT and Stress in samples in Studies 1 and 2 (*N* = 748;

Figure 1A).

	1	2	3	4	5	6	7	8
1. Challenge		.53***	.60***	.61***	-.48***	.31***	.00	-.09*
2. Committment	.20		.60***	.56***	-.48***	.24***	-.12**	-.13***
3. Control	.21	.24		.67***	-.61***	.28***	-.11**	-.14***
4. Confidence	.25	.15	.28		-.56***	.52***	.01	-.13***
5. Stress	-.08	-.1	-.29	-.18		-.22***	.12**	.16***
6. Narcissism	.00	.00	.00	.41	.01		.34***	.19***
7. Psychopathy	.04	-.07	-.07	.00	.06	.29		.41***
8. Machiavellianism	.00	-.01	.00	-.13	.04	.15	.32	

Note. Values of network edges are reported below the main diagonal, whereas Pearson's correlations

are reported above the main diagonal.

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

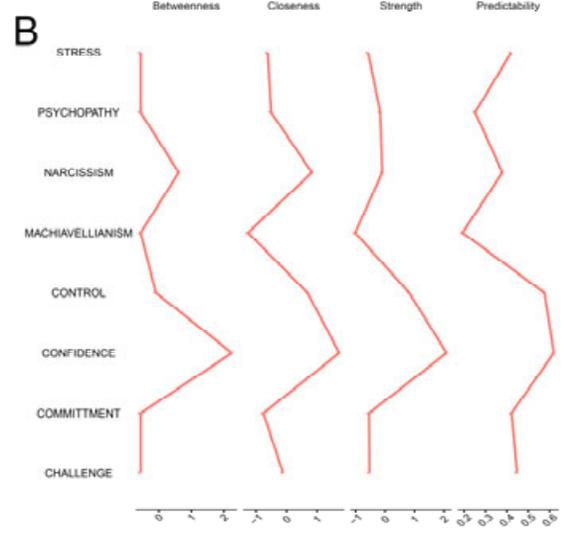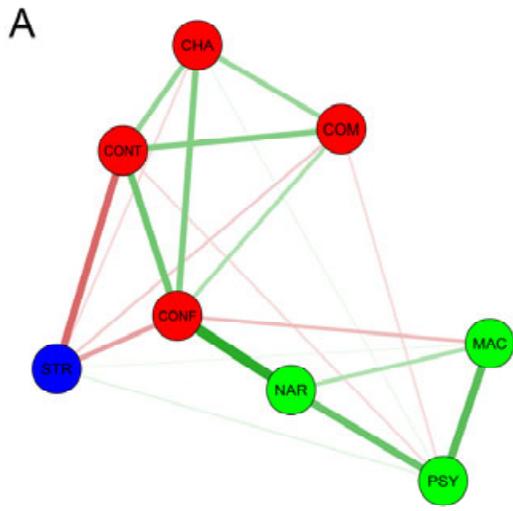*Table 3. Hierarchical Multiple Regression Model Predicting Perceived Stress from Personality*

	R^2	ΔR^2	β	*p-values*
Step 1	.44			< .001
Extraversion			.03	.485
Agreeableness			.04	.361
Conscientiousness			-.11	.009
Neuroticism			.65	< .001
Openness			-.03	.483
Step 2	.46	.02		.010
Narcissism			-.08	.087
¤ Psychopathy			.09	.070
Machiavellianism			.09	.054
Step 3	.51	.05		< .001
Challenge			.00	.995
Commitment			-.06	.307
Control			-.21	.002
Confidence			-.22	.002

Figure 1. **A.** Network of the DT, the 4Cs of MT, and Stress (*N* =748). **B.** Node indices for the network in Panel A All indices were standardized to improve interpretability. CHA = Challenge, CONT = Control, COM = Commitment, CONF = Confidence, NAR = Narcissism, MAC = Machiavellianism, PSY = Psychopathy, STR = Perceived Stress. Thickness represents edge weight, green lines represent positive edges and red lines represent negative edges. The network layout is kept constant across figures to facilitate comparison.

Figure 2. **A.** Network of the DT, the 4Cs of MT, and Stress on Sample 2 (*N* =384). **B.** Network of DT, the 4Cs of MT, and Stress after partialling out the B5 (*N* = 384). **C.** Node indices for the Networks in Panels A (full line) and B (dashed line). All indices were standardized to improve interpretability. CHA = Challenge, CONT = Control, COM = Commitment, CONF = Confidence, NAR = Narcissism, MAC = Machiavellianism, PSY = Psychopathy, STR = Perceived Stress. Thickness represents edge weight, green lines represent positive edges and red lines represent negative edges. The network layout is kept constant to facilitate comparison.

Figure 3. Graphical Lasso Network of the DT, the 4Cs of MT, Stress and the B5 (*N* =384). CHA = Challenge, CONT = Control, COM = Commitment, CONF = Confidence, NAR = Narcissism, MAC = Machiavellianism, PSY = Psychopathy, STR = Perceived Stress, OPE = Openness, CONS = Conscientiousness, EXT = Extraversion, AGR = Agreeableness, NEU = Neuroticism. Thickness represents edge weight, green lines represent positive edges and red lines represent negative edges.
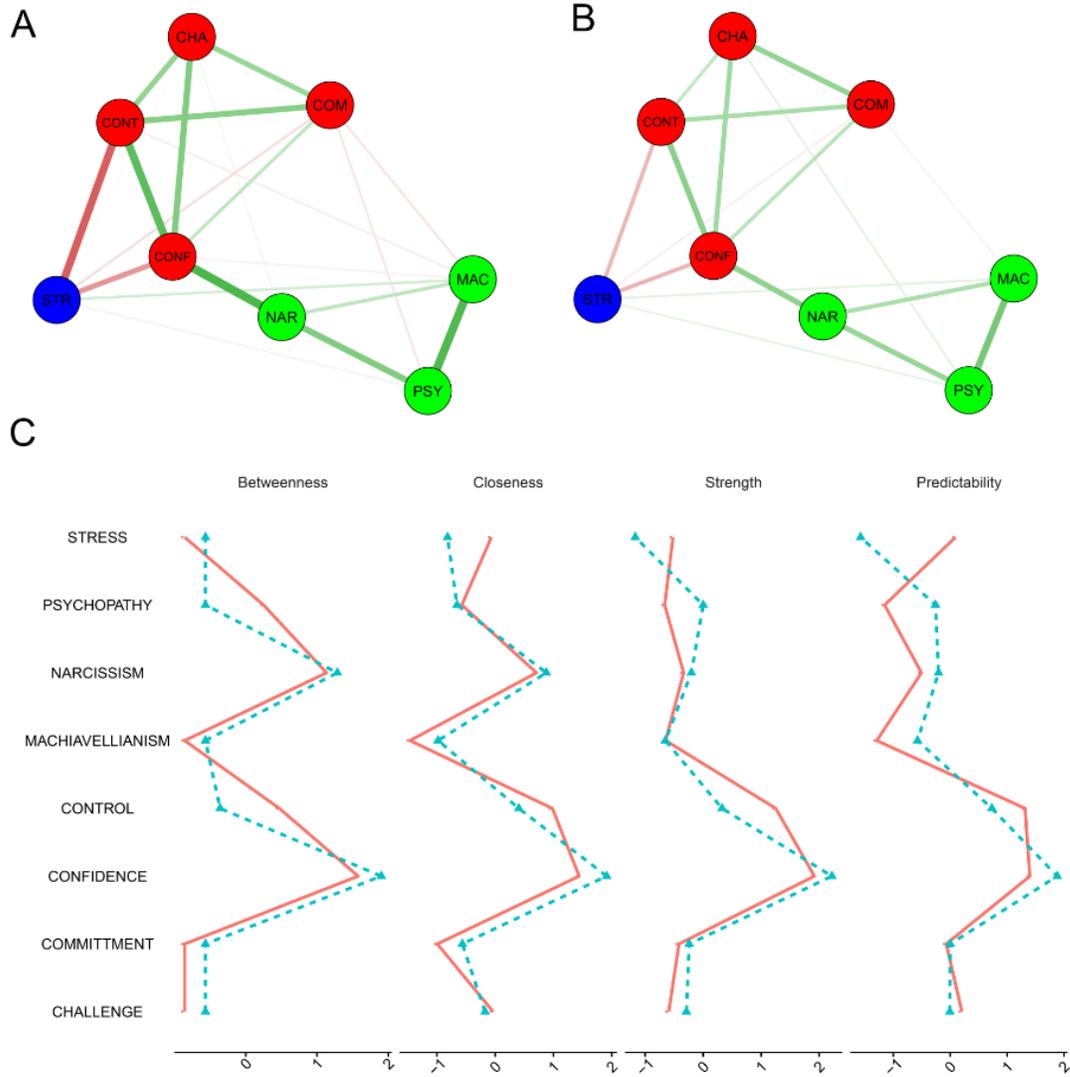
Figure 2. **A.** Network of the DT, the 4Cs of MT, and Stress on Sample 2 (*N* =384). **B.** Network of DT, the 4Cs of MT, and Stress after partialling out the B5 (*N* = 384). **C.** Node indices for the Networks in Panels A (full line) and B (dashed line). All indices were standardized to improve interpretability. CHA = Challenge, CONT = Control, COM = Commitment, CONF = Confidence, NAR = Narcissism, MAC = Machiavellianism, PSY = Psychopathy, STR = Perceived Stress. Thickness represents edge weight, green lines represent positive edges and red lines represent negative edges. The network layout is kept constant to facilitate comparison.