PYSCHOMETRIC MODELING OF THE LATENT STRUCTURE OF DARK PERSONALITY TRAITS

A Thesis

by

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Submitted to the College of Graduate Studies of
Tarleton State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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August 2021

Major Subject: Applied Psychology

ABSTRACT

Lenoir, Annie, Psychometric Modeling of the Latent Structure of Dark Personality Traits, MASTER OF SCIENCE (Applied Psychology), August, 2021, LVII pp., VI tables, IX figures, bibliography, XIX titles.

The Short Dark Triad Questionnaire (SD3; Jones and Paulhus 2014) is a likert-type, self-reported measure primarily developed to evaluate three socially undesired traits of personality. The “Dark Triad" refers to three socially aversive personality attributes. These include narcissism, psychopathy, and Machiavellianism. Since the SD3s creation the questionnaire has gained substantial popularity among researchers (e.g., Somma et al., 2019; Maleza et al., 2017; Bonfá-Araujo et al., 2021; Schneider, McLarnon, & Carswell, 2017; Vaughan et al., 2019). Jones and Paulhus (2014) provided preliminary evidence that a three-factor model reflecting the Dark Triad supplied a good fit for the data. However, additional study has not always replicated this original structural model (eg., Persson, Kajonius, & Garcia, 2017; Zhang, Ziegler, & Paulhus, 2019; Rogoza & Cieciuch, 2018). The present study aimed to further investigate the reliability, validity, and structure of the Short Dark Triad (Paulhus & Jones, 2014) and its content to identify the best model fit using Confirmatory Factor Analysis and Structural Equation Modeling. Past study has already indicated that a bifactor model has yielded a promising model fit. However, there is still debate about the exact structure of this bifactor model. The current study compared the fits of the original three factor structure of the SD3 to a group of bifactor models. The bifactor models both fit the given data better than the three-factor model. The model with the best fit was the bifactor model with three specific factors. This model was then used to create the new Model four, which had the best overall fit.

Keywords: Dark Triad, SD3, confirmatory factor analysis, model fit, structure

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Psychometric Modeling of the Latent Structure of Dark Personality Traits

Personality assessments have been used in psychology settings for a little over a century. However, over the last decade they have been more readily available to the general public via the internet, resulting in an influx of new data. Interest in understanding our own nature and qualities has grown so substantially that there are now thousands of personality tests and quizzes available with the click of a search button. Many people pursue these assessments to gain better knowledge of themselves and how their personality traits help them. However, there has also been developing concern for the personality traits that hurt us. Dark personality traits have always captured curiosity. For example, serial killers and their psychopathy and Wall Street Hedge Fund brokers and their narcissism. The majority of people would never consider themselves anything like these evil doers. However, with a further look and a few personality tests we can see we are not as different as we may hope. Everyone has dark personality traits.

The Short Dark Triad (SD3) by Paulhus and Jones (2014) has allowed it's test takers to see what dark personality traits (psychopathy, Machiavellianism, and narcissism) they harbor within their own personality. Through the use of confirmatory factor analysis and structural equation modeling I will investigate the reliability, validity, and structure of this assessment and its content.

Measurement of the Dark Triad

The Short Dark Triad Questionnaire (SD3; Jones & Paulhus 2014) is a likert-type, self-reported measure primarily developed to evaluate three socially undesired traits of personality. The measure includes narcissism (9 items), psychopathy (9 items) and Machiavellianism (9 items). Each item is assessed on a 5-point ordinal scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The aim is to measure the three components of the Dark Triad Personality

Model by Paulhus and Jones (2002). The "Dark Triad" refers to three socially aversive personality attributes. These include narcissism, psychopathy, and Machiavellianism. The narcissistic trait is characterized by manipulativeness, callousness, lack of empathy, impulsivity, and risk-taking. The psychopathic trait is characterized by callous-unemotional traits, deceitfulness, impulsivity, and risk-taking. Finally, the Machiavellian traits characterized by strategic exploitation. (Somma et al., 2019). Classically, each of these personality traits has been subjected to their own assessments and measures. For example, narcissism can be measured by the Narcissistic Personality Inventory (NPI; Raskin & Hall, 1979); psychopathy can be measured by the Self-Report Psychopathy Scale (Paulhus, Neumann, & Hare, 2016); and Machiavellianism can be measured by the Mach IV (Christie & Geis, 1970). However, in their construction of the Short Dark Triad, Paulhus and Jones (2011) argued that these three personality dimensions share similar characteristics. For example, all three of the Dark Triad traits shared "low agreeableness" in the five-factor space of personality (The Big Five inventory (BFI); John & Srivastava, 1999). Narcissism and Psychopathy were also positively correlated with extraversion and openness. The sharing of characteristics among the differing traits lead Paulhus and Jones (2011) to measure the Dark Triad together in an intercorrelated fashion.

Paulhus and Jones (2014) also argued that other assessments of dark personalities were too lengthy. The only shorter option available was the Dirty Dozen questionnaire (DD; Jonason & Webster, 2010) which measured all three constructs in a shorter format (only four items per subscale). Adequate reliabilities were reported for the three DD subscales, however, upon further investigation the DD showed some limitations (Jones & Paulhus, 2014; Jonason et al., 2011; Rauthmann, 2013). For example, the Machiavellianism subscale of the DD showed it could not discriminate among different levels of psychopathy (Somma et al., 2019). Finally, the

Machiavellian subscale indicated significant correlations with short-term orientation measures (Jonason & Tost, 2010). Short term orientation values include freedom, rights, achievement, and thinking for oneself. Conversely, the observation that the Machiavellians are impetuous is inconsistent with the initial concept of their cleverness (Jones & Paulhus, 2009). Due to these limitations with the DD shorter assessment, Paulhus and Jones created the 27-item Short Dark Triad questionnaire.

Paulhus and Jones (2011) constructed the Short Dark Triad questionnaire with the goal of having as few items as possible while still retaining the theoretical nature of each triad construct. They first selected a large pool of items that would circumscribe the known characteristics of the Dark Triad constructs. The selection of the items was motivated by three theoretical principles. First, Ego-identity goals drive narcissistic tendencies, while instrumental goals drive Machiavellian and psychopathic tendencies. Second, with respect to temporal focus, Machiavellianism differs from psychopathy. Third, all three of the dark traits have a callous base that incentivizes interpersonal manipulation. The chosen items accurately represented and drew forth the essence of the Dark Triad constructs. Psychopathy items derived from impulsivity, callous manipulation, and antisocial behavior. An example of an item used for this trait was "People who mess with me always regret it." Machiavellian attribute items were composed of cynicism and manipulation tactics. An item used for this trait was, "I like to use clever manipulation to get my way." Narcissism items derived from self-centeredness and grandiosity. An item used for this trait was, "I insist on getting the respect I deserve." The refining and structural evaluations of the item pool reduced the original item set to the remaining 27 items measuring the Dark Triad constructs (see appendix).

Initial psychometric assessment of the proposed 27-item scale was done with four experiments involving a total of 1,063 participants (Paulhus & Jones, 2014). Three correlated latent factors that clarified the recognized correlations among the 27 SD3 items were found through exploratory factor analysis and exploratory structural equation modeling. Paulhus and Jones (2014) administered their own SD3 along with the Dirty Dozen (DD; Jonason & Webster, 2010) and the standard measures used to test the Dark Traits -- e.g., the Narcissistic Personality Inventory, NPI (Raskin & Hall, 1979), the Self-Report Psychopathy Scale (Paulhus, Neumann, & Hare, 2016), and the Mach IV (Christie & Geis, 1970). In comparison to the DD, the SD3 subscales appeared to have adequate convergent and discriminant validity. Convergent validity was first seen when all SD3 subscales correlated .68 or better with each of their standard measure counterparts. In order to determine if the SD3 subscales were accurately capturing each dark trait, Paulhus and Jones (2014) broke the traditional Dark Triad assessments into their respective facets. For example, The Mach-IV (Christie & Geis, 1970) was portioned into its two major facets (manipulative tactics and cynical worldview). Each SD3 subscale correlated firmly and correspondingly with all of the scales facets it was intended to parallel. For example, derived from nonsignificant Z-scores for correlation differences, the correlation between the two Mach-IV facets and the Machiavellianism subscale did not vary. In this regard, the SD3 fared better than the DD subscales, which demonstrated smaller correlations with the facets of its corresponding factor. Discriminant validity can also be seen with the reported concurrent validities of the SD3 and the DD measured against the standard measures. The highest correlation between a SD3 subscale and a standard assessment that was not its counterpart was .49 (SD3-Psychopathy with both Mach-IV and NPI). However, Psychopathy correlated .78 with its own counterpart. The lowest correlation was .15 between SD3-Narcissism and Mach-IV.

Overall, discriminant validity was adequately demonstrated through the lack of correlation between the SD3 subscales and the standard measures that are not recognized as their counterparts.

Literature Review

Applied Research with SD3

Since its creation the questionnaire has gained substantial popularity among researchers (e.g., Somma et al., 2019; Maleza et al., 2017; Bonfá-Araujo et al., 2021; Schneider, McLarnon, & Carswell, 2017; Vaughan et al., 2019). It has been used in a variety of studies all over the world. For example, it has been translated from English to German, Spanish, and Chinese. It has been used with all age groups and genders. It has even been used to help determine the best career fit for participants, and to study individual and team athletes.

Maleza and colleagues (2017) aimed to ascertain whether the existing structure of the SD3 could be recreated into the German version by Confirmatory Factor Analysis (CFA), and to evaluate the construct validity of the adaptation of this measure. The CFA results indicated that the three-factor model best fit the data. Concurrent validity of the SD3 was verified by linking its sub-scales to the Big Five concept (The Big Five inventory, or BFI; John & Srivastava, 1999), aggression and self-esteem measures. They deduced that the Short Dark Triad measure had a high cross-language replication capability and recommended its use in the German language.

Schneider, McLarnon, and Carswell (2017) investigated whether the five-factor model (BFI; John & Srivastava, 1999) of personality and the SD3 traits can serve as suitable constructs to illustrate significant variance between career and personal interests. Overall, their findings argued that the Dark Triad features do have meaningful relationships with career interest variables (enterprising, assertive, socialized, conventional, and logical). In addition, the Dark

Triad and its factors contribute to a unique variance in career goals beyond the five-factor model. With this new perspective, researchers and practitioners may care to discuss the use of the Dark Triad and other personality traits outside the standard five-factor model structure to assess the congruency between personalities and career interests.

Somma and colleagues (2019) used the SD3 with Italian adult and adolescent participants. They measured the two participant groups separately in order to see if the Dark Triad scores diminished with age. Aligned with Jones and Paulhus (2014), the observations of the Confirmatory Factor Analysis implied the adequacy of the three-factor SD3 model. Indeed, all fit indices advocated the preservation of the three-correlated-factor model as the best suitable model for both adults and adolescents. The results showed that adolescents did have higher Dark Triad scores, and that the SD3 sufficiently translated to Italian.

Vaughan et al. (2019) adopted the SD3 in a sport psychology setting and evaluated its psychometric properties with an emphasis on assessing invariance across gender, athletic skill sets, and sport. Their analysis revealed that the three-factor model provided an adequate fit, but the bifactor-ESEM models, which included three main factors and a general factor, supported a superior fit to the data. In addition, the invariance testing suggested some discrepancy between groups in the observed factor structures. Overall, the results revealed group distinctions between men and women where men scored higher than women on the SD3, athletes with greater skills scored higher than those with less skills, and individual athletes scored higher than team athletes across all factors.

Bonfá-Araujo and colleagues (2021) combined a confirmatory factor analysis and a unidimensional scale model to evaluate the significance of a general factor in the Short Dark Triad (SD3; Jones & Paulhus, 2014). The analysis indicated that the true score variance in the

SD3 scales was attributed to a common dark triad characteristic, while the coverage of the material that is distinctive to each factor was relatively small. The true score score variance can be calculated as the result of the observed score variance and reliability of the questionnaire, which is regarded to be an estimate of the variance of the reliable scores measured by the questionnaire. Overall, Bonfá-Araujo and colleagues's CFA and unidimensional scale model revealed that SD3 items tend to emphasize the common characteristics of the dark traits rather than the distinctive qualities of each of them. It has been made evidently clear from the wide array of applied studies using the SD3, that there is still mystery surrounding the psychometric structure of the dark personality traits.

Previous Psychometric Testing of SD3

The SD3 was originally created by Jones and Paulhus (2011), who provided preliminary evidence that a three-factor model reflecting the Dark Triad supplied a good fit for the data. However, additional study has not always replicated this original structural model (eg., Persson, Kajonius, & Garcia, 2017; Zhang, Ziegler, & Paulhus, 2019; Rogoza & Cieciuch, 2018). The SD3 has been evaluated in many ways, however, since its availability on OpenPsychometrics.org it has gained over 18,000 new participants via online test takers. The data is open to the public and has allowed for further investigation of the SD3 psychometric properties to be carried out worldwide.

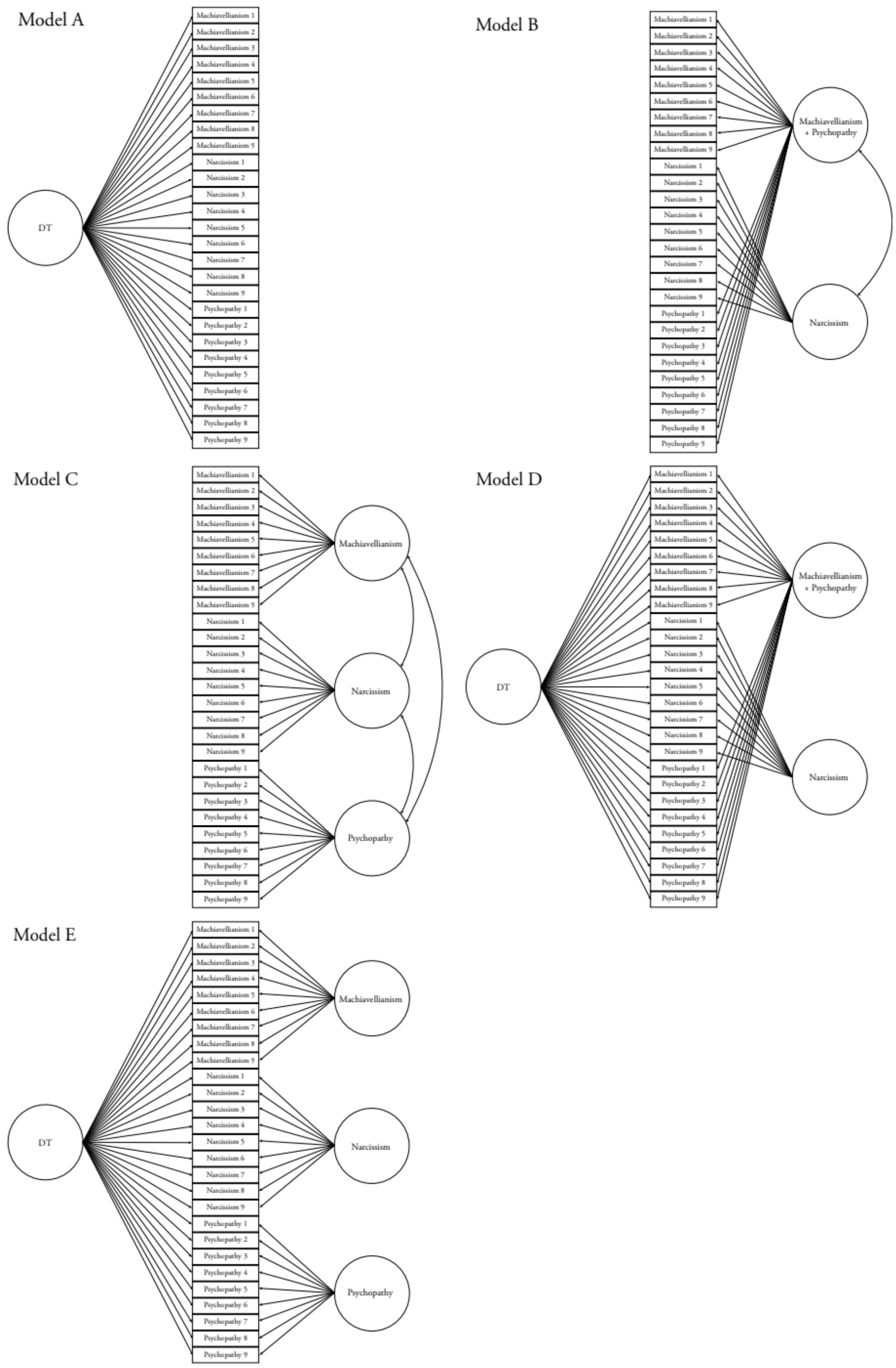
Persson, Kajonius, and Garcia (2017) investigated the structure and extended the validation process of the SD3 through three different large samples (total N = 19,723). In three studies with three independent samples, the psychometric properties of SD3 were investigated using exploratory and confirmatory factor analysis (N_1 = 1,487; N_2 = 17,740; N_3 = 496). They mainly concentrated on the relationship between Machiavellianism and Psychopathy and definitively tested if these two constructs can be seen as a single construct. Persson, Kajonius, and Garcia (2017) engineered their studies to contribute acumen into the character of the latent factors underlying SD3.

In the first study, exploratory factor analysis (EFA) was used as a first stage in characterizing the dimensionality of SD3, which involved recreating the initial factor structure (Jones & Paulhus, 2014) and exploring a bifactor structure used in prior Dark Triad research (Jonason & Luévano, 2013; Kajonius et al., 2016). The results were similar to those presented by Jones and Paulhus (2014), but they also protracted them considerably. In an exploratory bifactor analysis, Persson, Kajonius, and Garcia (2017) observed that psychopathy items were loaded onto the factor of Machiavellianism, but not contrariwise, while narcissism was steadily loaded on one factor. Psychopathy items had the highest load on the general factor, which was shown by the percentage of variance accounted for by the general factor on the psychopathy items.

In the second study, CFA was used to test five distinct models. These models included a unidimensional model that included all 27 items loaded on to a single factor (Model A), a correlated two-factor model with psychopathy and Machiavellianism assimilated under one factor (Model B), a correlated three-factor model (Model C), a bifactor model with two specific factors (Model D), and a bifactor model with three specific factors (Model E). See Figure 1 for the path diagrams created by Persson, Kajonius, and Garcia (2017). The best-fitting model of the five tested was a bifactor model with two specific factors, where Machiavellianism and psychopathy were amalgamated under one factor, with narcissism as a second factor. The best-fitting model was at the threshold of normal standards for adequate model fit.

Figure 1

Persson, Kajonius, and Garcia (2017) illustration of Models (A-E)



Note. Path diagrams for each of the previously described models are illustrated to show the factors, factor groups, factor loadings, and cross loadings of the respective models.

In the third study, Persson, Kajonius, and Garcia (2017) duplicated and compared the two best fitting CFA models (Models D and E) in reference to stand-alone Dark Triad measurements. The factor structure of the second study was recreated in a smaller MTurk sample. The factor scores of Models D and E were also analyzed. This evaluation showed that the general factor yielded large convergent validity estimates opposed to stand-alone Dark Triad measures. The various specific factors correlated less with stand-alone measures in both Models D and E than the general factor, excluding the correlation between the specific narcissism factor and the Narcissistic Personality Inventory (NPI; Raskin & Hall, 1979).

The general consensus was that divergent correlations demonstrated that a subscale is measuring something distinct, but if subscales are not absolutely correlated, divergent correlations must be anticipated. The data was slightly enigmatic regarding the presence of a general factor. The ECV (explained common variance) values were not substantial enough to say that the SD3 was unidimensional. Persson, Kajonius, and Garcia (2017) felt the reason for this was the I-ECV (the proportion of common variance for each item that is ascribable to the general factor) values indicated that narcissism offered some reliable variance beyond the general factor. This conclusion has implications for future utilizations of latent variable models, as narcissism feasibly infringes the assumption of unidimensionality (Persson, Kajonius, & Garcia, 2017).

Zhang, Ziegler, and Paulhus (2019) translated the Dark Triad (SD3) into Chinese (SD3-C). Their data was acquired from two large samples (total N = 950), and they analyzed its psychometric properties, including the factorial structure, reliability estimates, and the interrelationship of the three subscales. Zhang, Ziegler, and Paulhus (2019) tested several alternative models, a correlated three-factor CFA (Model A), an orthogonal three-factor ESEM (Model B), and a three-factor bifactor ESEM B-ESEM (Model C). The data was inadequately fit with the three-factor CFA3 and the orthogonal three-factor ESEM. Factor analysis results indicated that the SD3-C instrument exhibited an instructive and credible B-ESEM model where all SD3 items were markers of their specific constructs Machiavellianism, Narcissism and Psychopathy, as well as markers of a general factor named “DT”. This finding was in accordance with previous research, verifying that the B-ESEM model is the best fitting model (McLarnon & Tarraf, 2017). Most of the items loaded appropriately on their respective constructs and on the general factor. Numerous exceptions demonstrated comparatively low factor loadings on their respective constructs. Specifically, the lower factor loadings of two narcissism items (“feel embarrassed if someone compliments me” and “insist on getting the respect I deserve”) may have been due to the collectivistic nature of the Chinese participants (Zhang, Ziegler, & Paulhus, 2019).

Rogoza and Cieciuch (2018) examined the structure of the Dark Triad using as wide array of dark personality items originating from the most diverse and regularly utilized measures (i.e., NPI, MACH-IV and LSRP) available, in order to circumvent the shortcomings of existing single measurement models (e.g., SD3; Jones & Paulhus, 2014) and allow for intricate analysis of the development. The scale-level analysis demonstrates how the various dark traits measured by the distinct instruments are correlated to each other, while the item-level analysis allows the coinciding of the scales to be taken into account and started a step before the measurement of the established Dark Triad constructs. Rogoza and Cieciuch (2018) hypothesized that the three-factor composition of the SD3 at the scale level would not be verified given the high theoretical correlation between Machiavellianism and Psychopathy, that a group of relevant dark traits (factors) could be differentiated within the SD3 item pool, and that such traits could be formatted within a significant hierarchical structure. The first hypothesis was tested with the confirmatory version of the Exploratory Structural Equation Modeling (ESEM; Asparouhov & Muthén 2009) in which three models were analyzed. These included a model (1) wherein all SD3 measurements were theorized to be loaded onto a single latent factor, a model (2) wherein scales characterizing narcissism were intended to be loaded on to one factor, and scales characterizing Machiavellianism and Psychopathy loading onto another factor, and a model (3) where each respective scale was anticipated to be loaded onto the parallel factor. The second hypothesis was tested employing the exploratory version of ESEM, Rogoza and Cieciuch (2018) investigated the structure by evaluating which of the challenging models was best fitted to the data and clarified most of the information. The third hypothesis was tested utilizing Goldberg's (2006) top-down proposal. Rogoza and Cieciuch (2018) retrieved the factor scores from ESEM analyzes with a growing number of factors and compared them by level (eg., the single factor model factor score was correlated with the two factor model factor scores, and so on). From these tests, Rogoza and Cieciuch (2018) found evidence that the composition of the SD3, as currently evaluated by existing instruments, is not necessarily a three-factor structure, but rather a two factor structure, both at scale and item level. A total of twelve facets, which were coordinated in a hierarchical structure, were identified. Distinguishable facets exhibited distinct relationships with personality characteristics and basic values, and similarly dark traits did with personality traits and higher order values (Rogoza & Cieciuch, 2018).

In summary, despite its popularity, there is an abundance of controversy surrounding the Short Dark Triad (Paulhus and Jones, 2014). Traditionally, research pertaining to dark personality traits has measured each trait individually. Paulhus and Jones (2014) sought to make this research more efficient when they created the SD3, however, Jonason & Luévano (2013) argued that there is a fine line between effectiveness and exactness. The above studies demonstrate the continuation of the SD3 validation process, all with the goal to make the structure as accurate as possible. Based on these past results (e.g., Persson, Kajonius, & Garcia, 2017; Zhang, Ziegler, & Paulhus, 2019; Rogoza & Cieciuch, 2018), a bifactor structure seems to provide a better model fit when compared to the original three factor structure. Thus, there continues to be debate on whether a bifactor model or a three-factor model is best.

Present Study

The present study aims to further investigate the reliability, validity, and structure of the Short Dark Triad, Paulhus and Jones (2014) and its content in order to identify the best model fit using Confirmatory Factor Analysis and Structural Equation Modeling. Past study has already indicated that a bifactor model has yielded a promising model fit. However, there is still debate about the exact structure of this bifactor model. The current study will compare the fits of the original three factor structure of the SD3 to a group of bifactor models.

Method

The data used in this study is publicly available at http://www.openpsychometrics.org/_rawdata. All statistical analysis and psychometric modeling will be done using JASP version 0.14.1 (JASP Team, 2020). Specific JASP modules utilized for this study will include the Confirmatory Factor Analysis module and the Structural Equation Modeling module.

Participants

The Short Dark Triad (SD3) was completed online at https://openpsychometrics.org/tests/SD3/ by a total of 18,192 participants. Each participant gave informed consent for the further use of their data before they took the SD3. The only descriptive data available is the participant's country of origin (based on the IP address) and how they accessed the webpage. Participants originated from all over the world, however, there were a substantial number of respondents from the United States (n=8,679), Great Britain (n=2,688), Canada (n=1,126) and Australia (n=720).

Measures

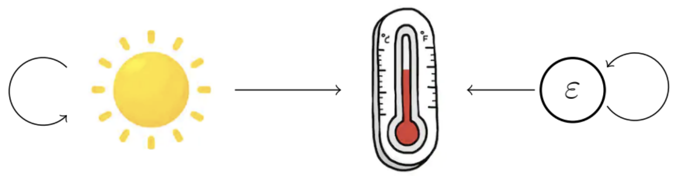
The Short Dark Triad (SD3; Jones & Paulhus, 2014) consists of 27 items (see appendix) that are rated on a 5-point Likert-type scale (1 = Strongly disagree and 5 = Strongly agree). The SD3 appraises the capacity of Machiavellianism, narcissism, and psychopathy with nine items each. The items consist of statements such as “Make sure your plans benefit you, not others” (i.e., Machiavellianism) and “I like to get acquainted with important people” (i.e., narcissism). Higher scores reflect higher levels of the dark triad traits.

Proposed Psychometric Modeling

Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) was used to compare the fits of several competing latent factor models of the SD3. These techniques are used to verify the factor structure of a set of observed variables. It allows the researcher to explicitly model the relationship between a set of observed (indicator) variables and their underlying latent constructs. To see how CFA works, consider the example of temperature as measured by a thermometer (see Figure 2). Here, the reading on the thermometer reflects our ability to observe temperature. There are two quantities that lead to changes in this observable temperature. First, heat (depicted by the sun) causes changes in the observed temperature. Because heat cannot directly be observed, it is called a latent variable. Second, some changes in the observed temperature will be due to measurement error from the thermometer.

Figure 2

Illustration of temperature path diagram

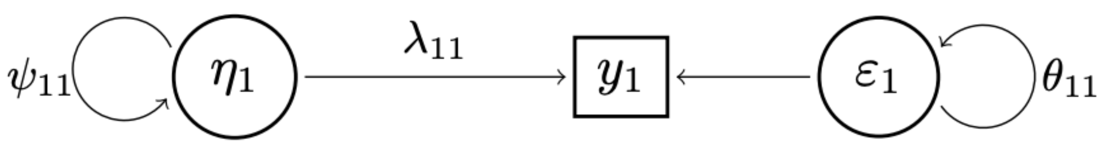


Note. The illustration demonstrates the relationship between the sun (latent variable) and the temperature (observed variable).

More formally, we can model the relationship seen in Figure 2 as a *path diagram*, which can be seen in Figure 3.

Figure 3

Formal Path Diagram



Note. The path diagram gives a visual of the relationship between factor η_1 and observation y_1.

The circles in Figure 3 represent the latent (unobserved) variables. The square is the observed variable, and y_1 is indicated by factor η_1. Within the path diagram is a lot of encoded information about the relationship between factor η_1 and observation y_1. For reference, λ_{11} is the loading of factor η_1 onto observation y_1, and ε_1 is the measurement error. η_1 is assumed to be normally distributed with a mean of 0 and a variance of ψ_{11} (this is called the factor variance). Finally, ε_1

is assumed to be normally distributed with a mean of 0 and a variance of θ_{11} (this is called the residual variance). Given observed data y_1, estimations of the unknown parameters of the model (i.e., the factor loadings, the factor variances, and the residual variances) can be determined.

Phase One

Description of Methods

For the current study, the three dark traits measured by the SD3 (psychopathy, Machiavellianism, and narcissism) are the latent factors. The observed variables or indicators are the nine items that correlate with each of the three factors. The indicators used for psychopathy, Machiavellianism, and narcissism are statements that are intended to bring forth responses ranging from 1 (strongly disagree) to 5 (strongly agree). These statements include markers for each of the SD3 factors. These markers include leadership, exhibitionism, grandiosity, and entitlement for the narcissism indicators, antisocial behavior, erratic lifestyle, callous affect, and short-term manipulation for psychopathy indicators, and reputation, planning, cynicism, and coalition building for Machiavellianism indicators (Paulhus & Jones, 2014). The goal of the confirmatory factor analysis is to determine if the three-factor structure of the Short Dark Triad, Paulhus and Jones (2014) determines a relationship between the three factors and their corresponding indicators.

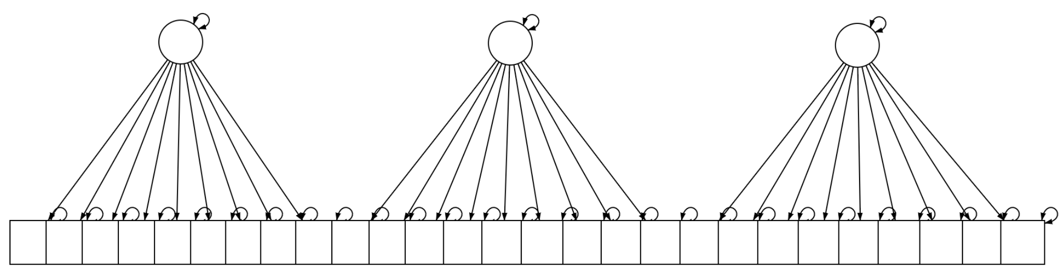
Structural Equation Modeling is a very general statistical modeling technique that is commonly utilized in behavioral sciences. It can be seen as a combination of factor analysis and regression or path analysis. The concentration in SEM is often on theoretical constructs, which are portrayed by the latent factors. Relations between theoretical constructs are identified by regressions or path coefficients between factors. The structural equation model indicates a structure for the covariances between the indicators. Structural equation modeling arranges a very conventional and accessible outline for statistical analysis.

Definition of Models

Along with the original SD3 three factor model (Paulhus and Jones, 2014) two new models were created: a bifactor model with a general factor (model 2) and a two-factor model (model 3). The path diagrams for these models can be seen in Figure 4, Figure 5, and Figure 6.

Figure 4

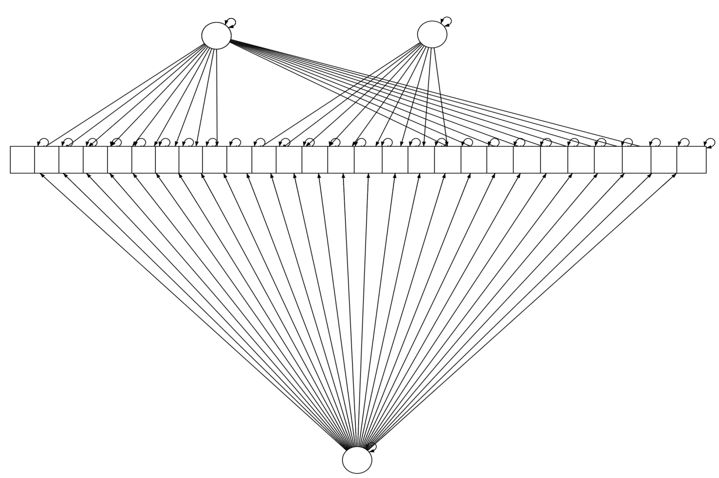
Model One (M1)



Note. A three-factor structure model.

Figure 5

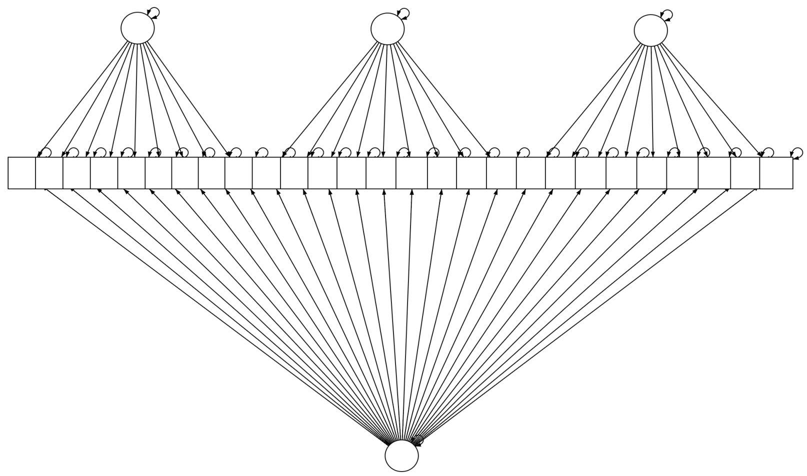
Model Two (M2)



Note. A bifactor model with two specific factors.

Figure 6

Model Three (M3)



Note. A bifactor model with three specific factors.

A large subset of participants (N=1000) will be randomly selected from the original sample. Then the three models will be fit to the observations. These model fits were then compared.

Model Comparison

During model comparison, absolute model fit was computed for each of the models using Root Mean Square Error of Approximation (RMSEA). RMSEA is mostly used to determine the model fit of scales with large data samples. It analyzes the inconsistencies between the hypothesized model, with optimally chosen parameter estimates, and the population covariance matrix. Then a relative model fit will be computed between the models. First, model BIC (Bayesian information criterion; Schwarz, 1980) must be computed. BIC is a criterion for selecting a model from a limited set of models; the model with the smallest BIC is preferred. The BIC balances the likelihood of data under a model with the number of parameters in the model, thus naturally penalizing models which are too complex (i.e., the BIC promotes model parsimony). Compared to other model "information criteria" (e.g., AIC), BIC is often preferred because it can be used to compute a Bayes factor (Kass and Raftery, 1995; Faulkenberry, 2018), which shows the factor by which observed data are more likely under the better model compared to the worse model. The BIC Bayes factor is computed as follows:

$$BF = exp\left(\frac{BIC_1 - BIC_2}{2}\right).$$

Phase Two

Goals

The aim for phase two was to verify the fit of the winning model against new data. In order to do this structural equation modeling (SEM) was performed on a new set of randomly selected participants (N=1000) using the winning model structure. This also allowed for an opportunity to improve the model using incremental modification.

Report absolute model fit

As before, I reported absolute model fit using RMSEA along with BIC. During this process a table of modification indices (MI) were reported. A modification index is an indicator of the amount by which the chi-square statistic would be decreased if a single parameter constraint had been removed from the model. There are therefore as many MIs as the constraints placed on the model. Most frequently, the MI exemplifies an improvement in model fit which would result if an initially excluded parameter were added and openly estimated. This may be an additional factor loading, a regression coefficient, or a correlated residual. A "post-hoc model modification" is when a parameter is incorporated based on a large MI and reflects a data-driven alteration of the original hypothesized model.

Construct New Model

Finally, a new model was constructed using one or two (at most) of the largest MIs. The minimal threshold for including a MI is 3.84. This is because the modification index can be theorized as a χ^2 statistic with 1 *df*, indices of 3.84 or higher (which represents the critical value of χ^2 at $p < .05$, 1 *df*) imply that the all-around fit of the model could be considerably improved if the fixed or restricted parameter was freely estimated (Brown, 2006). Once the new model was built including the modifications, absolute model fit, and BIC was computed and reported a final time. Then a Bayes factor was computed against the previous model using the two BIC values, indicating the extent to which the new model better predicts the observed data.

Results

Model Comparison

Before model construction a random sample was created in Excel. A sample of 1000 participants was selected through the use of the =RAND() formula. This formula assigns a random decimal number between 0 and 1 to each row of data. Once the random number has been generated, I then sorted the data rows in order of smallest to greatest random number size. From here I selected the first 1000 random participants' data by copying the first 1000 listed on the Excel document. This sample was then used to test the models. After the recreation of the original three-factor model and the creation of the two bifactor models, it was immediately apparent that the original model was not a sufficient fit when tested against the new random sample (N=1000). The RMSEA value for the original model (M1) was 0.093, while the RMSEA value for the bifactor model with two specific factors (M2) was 0.060 and the bifactor model with three specific factors (M3) was 0.055. The model estimates by JASP for the three models can be seen in Table 1, Table 2, and Table 3.

Table 1

Model One (M1) Parameter estimates

Factor Loadings

						95% Confidence Interval	
Factor	**Indicator**	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
Mach	M1	0.457	0.030	15.450	< .001	0.399	0.515
	M2	0.894	0.036	24.775	< .001	0.823	0.964
	M3	0.692	0.037	18.876	< .001	0.620	0.764
	M4	0.503	0.037	13.680	< .001	0.431	0.575
	M5	1.024	0.036	28.275	< .001	0.953	1.095
	M6	0.890	0.036	24.606	< .001	0.819	0.961
	M7	0.445	0.027	16.500	< .001	0.392	0.498
	M8	0.831	0.038	22.128	< .001	0.758	0.905
	M9	0.633	0.029	21.635	< .001	0.576	0.690
Narc	N1	0.709	0.037	19.063	< .001	0.637	0.782
	N2	-0.626	0.045	-14.054	< .001	-0.714	-0.539
	N3	0.727	0.036	19.948	< .001	0.656	0.799
	N4	0.710	0.040	17.847	< .001	0.632	0.788
	N5	0.605	0.038	15.920	< .001	0.531	0.680
	N6	-0.663	0.043	-15.299	< .001	-0.748	-0.578
	N7	0.728	0.041	17.641	< .001	0.647	0.809
	N8	-0.582	0.043	-13.484	< .001	-0.667	-0.497
	N9	0.678	0.039	17.294	< .001	0.601	0.755
Psyc	P1	0.877	0.039	22.758	< .001	0.801	0.952
	P2	-0.515	0.041	-12.531	< .001	-0.595	-0.434
	P3	0.705	0.042	16.814	< .001	0.623	0.787
	P4	0.618	0.041	15.054	< .001	0.537	0.698
	P5	0.666	0.036	18.648	< .001	0.596	0.736
	P6	0.852	0.037	22.760	< .001	0.778	0.925
	P7	-0.471	0.048	-9.770	< .001	-0.566	-0.377
	P8	0.667	0.048	13.898	< .001	0.573	0.761
	P9	0.948	0.042	22.326	< .001	0.865	1.031

Residual Variances

					95% Confidence Interval	
Indicator	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
M1	0.664	0.031	21.299	< .001	0.603	0.725
M2	0.752	0.040	18.743	< .001	0.673	0.831
M3	0.943	0.046	20.646	< .001	0.854	1.033
M4	1.058	0.049	21.555	< .001	0.962	1.155
M5	0.636	0.038	16.735	< .001	0.562	0.711
M6	0.761	0.040	18.818	< .001	0.682	0.841
M7	0.539	0.026	21.124	< .001	0.489	0.589
M8	0.901	0.046	19.758	< .001	0.812	0.990
M9	0.555	0.028	19.914	< .001	0.500	0.610
N1	0.854	0.045	18.992	< .001	0.766	0.942
N2	1.393	0.067	20.760	< .001	1.262	1.525
N3	0.795	0.043	18.555	< .001	0.711	0.879
N4	1.014	0.052	19.520	< .001	0.912	1.116
N5	0.973	0.048	20.217	< .001	0.879	1.067
N6	1.283	0.063	20.411	< .001	1.159	1.406
N7	1.097	0.056	19.602	< .001	0.987	1.207
N8	1.322	0.063	20.904	< .001	1.198	1.445
N9	1.000	0.051	19.736	< .001	0.901	1.099
P1	0.836	0.047	17.783	< .001	0.743	0.928
P2	1.258	0.059	21.326	< .001	1.142	1.373
P3	1.204	0.059	20.322	< .001	1.088	1.320
P4	1.199	0.058	20.793	< .001	1.086	1.312
P5	0.830	0.042	19.721	< .001	0.748	0.913
P6	0.789	0.044	17.781	< .001	0.702	0.876
P7	1.802	0.083	21.757	< .001	1.640	1.964
P8	1.676	0.080	21.056	< .001	1.520	1.832
P9	1.034	0.057	18.037	< .001	0.921	1.146

Table 2

Model Two (M2) *Parameter estimates*

Factor Loadings

						95% Confidence Interval	
Factor	**Indicator**	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
Machpsyc	M1	-0.191	0.039	-4.850	< .001	-0.268	-0.114
	M2	0.032	0.053	0.605	0.545	-0.071	0.135
	M3	-0.195	0.050	-3.870	< .001	-0.294	-0.096
	M4	-0.425	0.048	-8.777	< .001	-0.520	-0.330
	M5	-0.164	0.055	-2.970	0.003	-0.272	-0.056
	M6	-0.079	0.053	-1.489	0.136	-0.182	0.025
	M7	-0.171	0.036	-4.730	< .001	-0.242	-0.100
	M8	-0.099	0.053	-1.859	0.063	-0.204	0.005
	M9	-0.068	0.041	-1.642	0.101	-0.149	0.013
	P1	0.244	0.053	4.574	< .001	0.140	0.349
	P2	-0.539	0.052	-10.365	< .001	-0.641	-0.437
	P3	0.118	0.055	2.149	0.032	0.010	0.226
	P4	0.439	0.053	8.331	< .001	0.336	0.543
	P5	0.138	0.048	2.905	0.004	0.045	0.232
	P6	0.162	0.052	3.116	0.002	0.060	0.264
	P7	-0.566	0.060	-9.483	< .001	-0.683	-0.449
	P8	0.399	0.061	6.528	< .001	0.279	0.519
	P9	0.096	0.059	1.638	0.101	-0.019	0.212
Narc	N1	0.612	0.040	15.350	< .001	0.534	0.690
	N2	-0.718	0.048	-14.961	< .001	-0.812	-0.624
	N3	0.503	0.037	13.581	< .001	0.431	0.576
	N4	0.563	0.042	13.301	< .001	0.480	0.646
	N5	0.320	0.038	8.387	< .001	0.245	0.395
	N6	-0.596	0.046	-12.854	< .001	-0.687	-0.505
	N7	0.564	0.044	12.885	< .001	0.478	0.650
	N8	-0.420	0.046	-9.199	< .001	-0.509	-0.330
	N9	0.307	0.038	8.171	< .001	0.234	0.381
General	M1	0.412	0.030	13.637	< .001	0.353	0.471
	M2	0.930	0.034	26.962	< .001	0.862	0.997
	M3	0.718	0.036	19.821	< .001	0.647	0.789
	M4	0.429	0.040	10.660	< .001	0.350	0.508
	M5	0.978	0.036	26.841	< .001	0.907	1.049
						95% Confidence Interval	

Factor	Indicator	Estimate	Std. Error	z-value	p	Lower	Upper
	M6	0.890	0.035	25.258	< .001	0.821	0.959
	M7	0.412	0.027	15.035	< .001	0.358	0.466
	M8	0.839	0.037	22.907	< .001	0.767	0.911
	M9	0.620	0.029	21.613	< .001	0.564	0.677
	N1	0.366	0.037	9.778	< .001	0.293	0.439
	N2	-0.160	0.044	-3.642	< .001	-0.246	-0.074
	N3	0.545	0.036	15.313	< .001	0.476	0.615
	N4	0.416	0.039	10.546	< .001	0.338	0.493
	N5	0.567	0.036	15.909	< .001	0.497	0.637
	N6	-0.335	0.043	-7.877	< .001	-0.419	-0.252
	N7	0.445	0.041	10.917	< .001	0.365	0.524
	N8	-0.414	0.041	-10.028	< .001	-0.495	-0.333
	N9	0.698	0.036	19.298	< .001	0.627	0.769
	P1	0.830	0.038	21.840	< .001	0.756	0.904
	P2	-0.411	0.045	-9.106	< .001	-0.500	-0.323
	P3	0.659	0.040	16.382	< .001	0.580	0.738
	P4	0.487	0.044	11.180	< .001	0.402	0.573
	P5	0.655	0.034	19.180	< .001	0.588	0.722
	P6	0.847	0.036	23.733	< .001	0.777	0.917
	P7	-0.327	0.052	-6.323	< .001	-0.428	-0.225
	P8	0.604	0.049	12.449	< .001	0.509	0.699
	P9	0.998	0.039	25.437	< .001	0.921	1.075

Residual Variances

Indicator	Estimate	Std. Error	z-value	p	95% Confidence Interval	
					Lower	Upper
M1	0.667	0.032	20.821	< .001	0.604	0.730
M2	0.685	0.034	19.964	< .001	0.618	0.752
M3	0.868	0.043	20.322	< .001	0.785	0.952
M4	0.947	0.051	18.487	< .001	0.847	1.048
M5	0.702	0.037	18.889	< .001	0.629	0.775
M6	0.754	0.037	20.130	< .001	0.681	0.828
M7	0.538	0.026	20.693	< .001	0.487	0.589
M8	0.878	0.043	20.553	< .001	0.795	0.962
M9	0.566	0.027	20.856	< .001	0.513	0.619
N1	0.855	0.043	19.819	< .001	0.771	0.940
N2	1.062	0.061	17.442	< .001	0.943	1.182
N3	1.252	0.058	21.562	< .001	1.139	1.366
N4	1.150	0.060	19.197	< .001	1.033	1.268
N5	0.825	0.039	21.065	< .001	0.748	0.902
N6	0.770	0.038	20.148	< .001	0.695	0.845
N7	1.597	0.085	18.829	< .001	1.431	1.764
N8	1.597	0.079	20.324	< .001	1.443	1.751
N9	0.926	0.046	20.225	< .001	0.836	1.015
P1	0.849	0.047	18.190	< .001	0.757	0.940
P2	1.244	0.068	18.209	< .001	1.110	1.378
P3	0.773	0.040	19.238	< .001	0.694	0.852
P4	1.029	0.053	19.474	< .001	0.925	1.132
P5	0.915	0.043	21.106	< .001	0.830	1.000
P6	1.254	0.064	19.680	< .001	1.129	1.379
P7	1.112	0.056	19.687	< .001	1.001	1.223
P8	1.312	0.062	21.101	< .001	1.190	1.434
P9	0.879	0.042	20.895	< .001	0.796	0.961

Table 3

Model Three (M3) Parameter estimates

Factor Loadings

						95% Confidence Interval	
Factor	**Indicator**	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
Mach	M1	0.570	0.045	12.711	< .001	0.482	0.658
	M2	0.048	0.039	1.233	0.217	-0.028	0.125
	M3	0.044	0.042	1.055	0.291	-0.038	0.127
	M4	0.300	0.045	6.693	< .001	0.212	0.388
	M5	0.211	0.040	5.214	< .001	0.132	0.291
	M6	0.179	0.040	4.442	< .001	0.100	0.259
	M7	0.504	0.040	12.618	< .001	0.426	0.582
	M8	0.237	0.043	5.574	< .001	0.154	0.321
	M9	0.162	0.034	4.789	< .001	0.095	0.228
Narc	N1	0.612	0.040	15.197	< .001	0.533	0.691
	N2	-0.716	0.049	-14.746	< .001	-0.811	-0.620
	N3	0.491	0.037	13.178	< .001	0.418	0.565
	N4	0.555	0.043	13.007	< .001	0.472	0.639
	N5	0.313	0.039	8.102	< .001	0.237	0.388
	N6	-0.592	0.047	-12.638	< .001	-0.683	-0.500
	N7	0.566	0.044	12.789	< .001	0.479	0.652
	N8	-0.424	0.046	-9.198	< .001	-0.515	-0.334
	N9	0.288	0.038	7.622	< .001	0.214	0.362
Psyc	P1	0.237	0.044	5.421	< .001	0.151	0.323
	P2	-0.599	0.053	-11.250	< .001	-0.703	-0.495
	P3	0.153	0.050	3.055	0.002	0.055	0.251
	P4	0.469	0.051	9.156	< .001	0.368	0.569
	P5	0.122	0.042	2.950	0.003	0.041	0.204
	P6	0.107	0.041	2.616	0.009	0.027	0.188
	P7	-0.779	0.066	-11.896	< .001	-0.908	-0.651
	P8	0.559	0.059	9.489	< .001	0.443	0.674
	P9	0.109	0.045	2.415	0.016	0.021	0.197
General	M1	0.333	0.031	10.641	< .001	0.271	0.394
	M2	0.939	0.035	26.970	< .001	0.871	1.007
	M3	0.729	0.036	20.422	< .001	0.659	0.799
	M4	0.387	0.037	10.385	< .001	0.314	0.461
	M5	0.957	0.037	26.101	< .001	0.885	1.029
	M6	0.873	0.036	24.341	< .001	0.803	0.943
	M7	0.343	0.028	12.087	< .001	0.288	0.399

						95% Confidence Interval	
Factor	**Indicator**	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
	M8	0.812	0.037	21.758	< .001	0.739	0.885
	M9	0.602	0.029	20.576	< .001	0.544	0.659
	N1	0.367	0.038	9.703	< .001	0.293	0.442
	N2	-0.169	0.044	-3.798	< .001	-0.256	-0.082
	N3	0.559	0.036	15.582	< .001	0.489	0.629
	N4	0.426	0.040	0.040	< .001	0.348	0.504
	N5	0.572	0.036	0.036	< .001	0.501	0.642
	N6	-0.343	0.043	0.043	< .001	-0.427	-0.258
	N7	0.443	0.041	0.041	< .001	0.362	0.523
	N8	-0.408	0.042	0.042	< .001	-0.490	-0.326
	N9	0.717	0.036	0.036	< .001	0.646	0.788
	P1	0.821	0.037	0.037	< .001	0.748	0.894
	P2	-0.367	0.041	0.041	< .001	-0.447	-0.287
	P3	0.654	0.041	0.041	< .001	0.574	0.733
	P4	0.457	0.041	0.041	< .001	0.377	0.537
	P5	0.648	0.034	0.034	< .001	0.581	0.715
	P6	0.862	0.035	0.035	< .001	0.793	0.931
	P7	-0.249	0.048	0.048	< .001	-0.343	-0.155
	P8	0.560	0.047	0.047	< .001	0.467	0.652
	P9	1.013	0.039	0.039	< .001	0.936	1.090

Residual Variances

					95% Confidence Interval	
Indicator	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
M1	0.438	0.045	9.826	< .001	0.350	0.525
M2	0.667	0.035	19.201	< .001	0.599	0.735
M3	0.889	0.042	20.967	< .001	0.806	0.972
M4	1.072	0.050	21.260	< .001	0.973	1.170
M5	0.725	0.037	19.700	< .001	0.653	0.797
M6	0.759	0.037	20.263	< .001	0.686	0.833
M7	0.365	0.035	10.498	< .001	0.297	0.433
M8	0.876	0.042	20.653	< .001	0.793	0.959
M9	0.567	0.027	20.961	< .001	0.514	0.620
N1	0.848	0.047	18.093	< .001	0.756	0.939
N2	1.245	0.069	18.100	< .001	1.110	1.380
N3	0.769	0.040	19.283	< .001	0.691	0.848
N4	1.029	0.053	19.507	< .001	0.926	1.133
N5	0.915	0.043	21.067	< .001	0.830	1.000
N6	1.255	0.064	19.671	< .001	1.130	1.380
N7	1.112	0.057	19.622	< .001	1.001	1.223
N8	1.314	0.062	21.055	< .001	1.191	1.436
N9	0.863	0.042	20.758	< .001	0.781	0.944
P1	0.874	0.043	20.305	< .001	0.790	0.958
P2	1.029	0.065	15.909	< .001	0.902	1.156
P3	1.250	0.058	21.545	< .001	1.137	1.364
P4	1.152	0.061	19.043	< .001	1.034	1.271
P5	0.838	0.039	21.227	< .001	0.761	0.916
P6	0.759	0.038	20.180	< .001	0.686	0.833
P7	1.354	0.098	13.759	< .001	1.162	1.547
P8	1.496	0.080	18.714	< .001	1.339	1.652
P9	0.894	0.045	19.779	< .001	0.806	0.983

Relative model fit

Following the parameter estimation of each model, relative model fit was computed using BIC (Bayesian information criterion; Schwarz, 1980). BIC is a criterion for selecting a model from a limited set of models; the model with the smallest BIC is preferred. The BIC for the models was as follows:

- original three factor model (M1): BIC = 81301.044
- bifactor model with two specific factors (M2): BIC = 79745.894
- bifactor model with three specific factors (M3): BIC = 79595.410.

Once the BIC values for each of the models was computed, approximate BIC Bayes factors were computed to further verify the best fitting model. The BIC approximation is reported using log(BF) instead of BF because log(BF) is a standard way to report BF in Bayesian statistics, as it compresses the multiplicative comparisons into a linear scale. The BIC Bayes factor approximation for M1 versus M2 was $\log(BF_{21}) = 777.575$, M2 versus M3 was $\log(BF_{32}) = 75.24$, and for M1 and M3 it was $\log(BF_{31}) = 852.817$. This confirms that the data are much more likely under the bifactor model with three specific factors (M3) than the original three factor model.

New Model Construction

After M3 was deemed the best fitting model it was tested once again against a new set of random participants (N=1000), selected using the method described above. The RMSEA value for the bifactor model with three specific factors was 0.055, and the BIC was 78731.455. These figures further supported that M3 was the best fitting model. Once the model fit was verified, the Modification Indices were consulted to determine if any of the MIs could potentially make the model an even better fit. The Modification Indices can be seen in Table 4.

Table 4

Modification Indices

Cross-loadings

			Mod. Ind.	**EPC**
Narc	→	P2	47.022	-0.306
Narc	→	M3	43.401	0.247
Psyc	→	N2	39.481	-0.341
Mach	→	N5	37.172	0.260
Mach	→	P4	34.854	-0.305
Mach	→	N2	13.963	0.194
Narc	→	M6	13.174	-0.130
Psyc	→	M4	13.024	-0.180
Narc	→	P5	11.415	-0.128
Narc	→	P1	11.308	-0.134
Psyc	→	N9	10.524	-0.142
Mach	→	N3	10.417	-0.131
Narc	→	P8	9.861	0.162
Mach	→	P1	7.251	0.126
Psyc	→	N3	6.764	0.111
Psyc	→	N4	6.063	-0.121
Psyc	→	N7	5.473	0.124
Psyc	→	N8	5.436	-0.125
Mach	→	P5	4.974	0.098
Narc	→	M7	4.788	-0.063
Narc	→	P3	4.222	-0.091

The two highest MIs were Narcissism cross loading with item “P2” with the Mod. Ind. = 47.022 and Narcissism cross loading with item “M3” with the Mod. Ind. = 43.401. The “P2” item reads “I avoid dangerous situations”, and the “M3” item reads “Whatever it takes, you must get the important people on your side.” Both items embody Narcissism characteristics previously described. These items were then added to the Narcissism items that load onto the Narcissism factor as well as their own respective factors. This new model (M4) is a bifactor model with three specific factors, however the Narcissism factor has two additional items loaded onto it.

Model 4 was then tested against another new set of randomly selected participants (N=1000). The RMSEA value for M4 was 0.051 and the BIC value was 79054.546. The BIC Bayes factor for M3 and M4 was $\log(BF_{43}) = 270.432$. The model plot created by JASP for Model Four can be seen in Figure 7. The results for each of the models can be seen in Table 5. Table 6 shows the model estimates for Model four provided by JASP.

Table 5

Model Results

Model	RMSEA	BIC
Model One	0.093	81301.044
Model Two	0.060	79745.894
Model Three	0.055	79595.410
Model Four	0.051	79054.546

Figure 7

Model Four (M4)

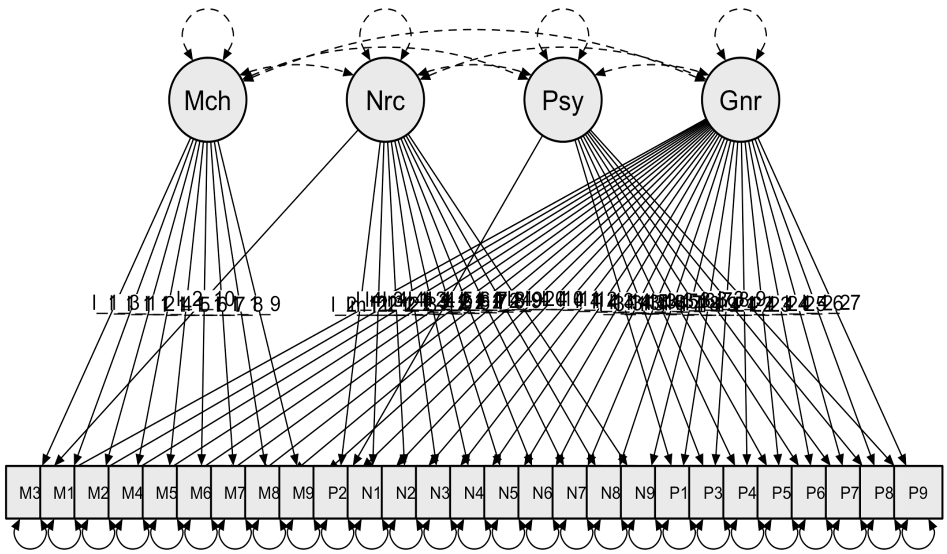


Table 6

Parameter estimates Model Four

Factor Loadings

						95% Confidence Interval	
Factor	**Indicator**	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
Mach	M1	0.465	0.041	11.453	< .001	0.386	0.545
	M2	0.109	0.041	2.646	0.008	0.028	0.189
	M3	0.070	0.042	1.659	0.097	-0.013	0.152
	M4	0.273	0.048	5.716	< .001	0.179	0.367
	M5	0.296	0.039	7.692	< .001	0.221	0.372
	M6	0.360	0.041	8.723	< .001	0.279	0.441
	M7	0.551	0.041	13.427	< .001	0.471	0.632
	M8	0.043	0.044	0.964	0.335	-0.044	0.129
	M9	0.201	0.034	5.851	< .001	0.133	0.268
Narc	N1	0.523	0.041	12.747	< .001	0.442	0.603
	N2	-0.654	0.048	-13.576	< .001	-0.749	-0.560
	N3	0.469	0.036	12.985	< .001	0.398	0.540
	N4	0.472	0.042	11.125	< .001	0.389	0.555
	N5	0.345	0.039	8.814	< .001	0.268	0.422
	N6	-0.525	0.048	-10.903	< .001	-0.620	-0.431
	N7	0.499	0.045	11.066	< .001	0.411	0.588
	N8	-0.525	0.046	-11.516	< .001	-0.614	-0.436
	N9	0.226	0.038	5.992	< .001	0.152	0.300
	M3	0.138	0.038	3.602	< .001	0.063	0.213
	P2	-0.216	0.042	-5.196	< .001	-0.297	-0.135
Psyc	P1	0.251	0.045	5.626	< .001	0.164	0.339
	P2	-0.641	0.054	-11.884	< .001	-0.747	-0.535
	P3	0.124	0.048	2.583	0.010	0.030	0.218
	P4	0.426	0.048	8.867	< .001	0.332	0.520
	P5	0.121	0.044	2.781	0.005	0.036	0.207
	P6	0.112	0.041	2.719	0.007	0.031	0.193
	P7	-0.805	0.068	-11.844	< .001	-0.938	-0.672
	P8	0.395	0.055	7.158	< .001	0.287	0.503
	P9	0.106	0.044	2.429	0.015	0.020	0.192
General	M1	0.360	0.032	11.372	< .001	0.298	0.422

Factor	Indicator	Estimate	Std. Error	z-value	p	95% Confidence Interval Lower	Upper
	M2	0.897	0.036	25.200	< .001	0.827	0.967
	M3	0.720	0.036	20.147	< .001	0.650	0.791
	M4	0.388	0.039	10.013	< .001	0.312	0.464
	M5	0.991	0.035	28.025	< .001	0.922	1.060
	M6	0.872	0.037	23.830	< .001	0.800	0.944
	M7	0.312	0.029	10.609	< .001	0.254	0.370
	M8	0.777	0.037	21.009	< .001	0.705	0.850
	M9	0.561	0.029	19.308	< .001	0.504	0.618
	N1	0.332	0.037	8.969	< .001	0.259	0.404
	N2	-0.210	0.043	-4.893	< .001	-0.294	-0.126
	N3	0.562	0.034	16.430	< .001	0.495	0.629
	N4	0.502	0.039	12.954	< .001	0.426	0.578
	N5	0.605	0.036	16.750	< .001	0.534	0.676
	N6	-0.285	0.043	-6.677	< .001	-0.369	-0.201
	N7	0.442	0.041	10.846	< .001	0.362	0.521
	N8	-0.467	0.041	-11.301	< .001	-0.548	-0.386
	N9	0.668	0.035	19.144	< .001	0.600	0.737
	P1	0.729	0.038	19.351	< .001	0.655	0.802
	P2	-0.378	0.040	-9.487	< .001	-0.456	-0.300
	P3	0.712	0.040	17.982	< .001	0.635	0.790
	P4	0.557	0.039	14.134	< .001	0.480	0.634
	P5	0.651	0.036	18.072	< .001	0.581	0.722
	P6	0.841	0.036	23.646	< .001	0.771	0.911
	P7	-0.236	0.049	-4.861	< .001	-0.331	-0.141
	P8	0.633	0.045	14.029	< .001	0.545	0.722
	P9	0.968	0.038	25.352	< .001	0.893	1.043

Residual Variances

					95% Confidence Interval	
Indicator	**Estimate**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
M1	0.570	0.036	15.903	< .001	0.500	0.640
M2	0.735	0.037	19.913	< .001	0.662	0.807
M3	0.861	0.041	21.151	< .001	0.782	0.941
M4	1.175	0.055	21.514	< .001	1.068	1.282
M5	0.553	0.030	18.377	< .001	0.494	0.612
M6	0.687	0.036	19.159	< .001	0.617	0.758
M7	0.367	0.039	9.444	< .001	0.291	0.443
M8	0.929	0.045	20.722	< .001	0.841	1.017
M9	0.558	0.027	20.957	< .001	0.506	0.610
N1	0.893	0.047	19.082	< .001	0.801	0.984
N2	1.187	0.065	18.219	< .001	1.060	1.315
N3	0.674	0.036	18.867	< .001	0.604	0.744
N4	0.998	0.050	20.011	< .001	0.900	1.096
N5	0.875	0.042	20.690	< .001	0.792	0.958
N6	1.306	0.065	20.065	< .001	1.178	1.433
N7	1.136	0.057	20.063	< .001	1.025	1.247
N8	1.145	0.058	19.837	< .001	1.031	1.258
N9	0.829	0.039	21.030	< .001	0.752	0.907
P1	0.832	0.066	12.615	< .001	0.703	0.962
P2	0.950	0.046	20.596	< .001	0.860	1.041
P3	1.148	0.054	21.318	< .001	1.043	1.254
P4	1.043	0.054	19.377	< .001	0.938	1.149
P5	0.946	0.044	21.294	< .001	0.859	1.033
P6	0.784	0.039	20.237	< .001	0.708	0.860
P7	1.354	0.104	12.993	< .001	1.150	1.558
P8	1.462	0.071	20.475	< .001	1.322	1.602
P9	0.849	0.043	19.731	< .001	0.765	0.934

Discussion

The purpose of the present study was to further investigate the reliability, validity, and structure of the Short Dark Triad, Paulhus and Jones (2014) and its content in order to identify the model that best fit the given data using Confirmatory Factor Analysis and Structural Equation Modeling. The Short Dark Triad by Paulhus and Jones (2014) measures dark personality traits and has been used in a variety of ways. Its model structure and the items are responsible for measuring Machiavellianism, narcissism, and psychopathy have been thoroughly investigated. Given the questionnaire's widespread popularity and numerous translations (e.g., Somma et al., 2019; Maleza et al., 2017; Bonfá-Araujo et al., 2021; Schneider, McLarnon, & Carswell, 2017; Vaughan et al., 2019), the interest in its structure and the desire to make sure it properly measures what it claims to measure is understandable and necessary.

Model Structure

Persson, Kajonius, and Garcia (2017) aimed to analyze the structure of the SD3 in a similar way to the current study. The models chosen for this investigation were the models that achieved the best results in previous psychometric studies that analyzed the model structure of the SD3 (eg., Persson, Kajonius, & Garcia, 2017; Zhang, Ziegler, & Paulhus, 2019; Rogoza & Cieciuch, 2018). Many of the results achieved in this study support the results of the previous psychometric studies. Similar to Persson, Kajonius, and Garcia (2017) the introduction of a general factor (a factor with all 27 items loaded onto it) improved the model fit substantially. Before the general factor was integrated into the model structure the original three factor model had an RMSEA of 0.093. Once the general factor was added to the structure of both bifactor models (M2 and M3), the RMESA improved significantly. The RMSEA for M2 was 0.060 and the RMSEA for M3 was 0.055.

Bayesian Model Selection

Unlike previous studies, this study further confirmed the goodness of model fit by using BIC (Bayesian information criterion; Schwarz, 1980). As stated previously, BIC is a criterion for selecting a model from a limited set of models; the model with the smallest BIC is preferred. The BIC got smaller with each model structure change, which showed the steps taken to improve the model fit were on the right track. BIC can also be used to compute a Bayes factor (Kass and Raftery, 1995; Faulkenberry, 2018), which shows the factor by which observed data are more likely under the better model compared to the worse model. The BIC values were then taken to compute approximate BIC Bayes factors to further verify the best fitting model. The BIC Bayes factor approximation for M2 and M3 was $\log(BF_{32}) = 75.24$, and for M1 and M3 it was $\log(BF_{31}) = 852.817$. This computation demonstrated how the data was more likely under Model Three compared to Model One and Two. Model Three (bifactor model with three specific factors) was analyzed against a new sample of data (N=1000) and the RMSEA and BIC were both less than the previously tested models RMESA and BIC values. The model was tested with completely new data and still maintained its previous integrity. This further supported the model's claim to a good fit. However, the goal of this study was to find the best fitting model for the data. The winning model three was then used to create an entirely new model that fit the given data even better.

New Model Construction

Modification Indices

The Modification Indices were then consulted to identify where the model could be changed. As previously stated, the modification index can be theorized as a χ^2 statistic with 1 *df*, indices of 3.84 or higher (which represents the critical value of χ^2 at $p < .05$, 1 *df*) imply that the all-around fit of the model could be considerably improved if the fixed or restricted parameter was freely estimated (Brown, 2006). The two highest MIs were used in the construction of the new model (M4). Previous research (Rogoza & Cieciuch, 2018) has already confirmed that the items associated with the three factors (Machiavellianism, narcissism, and psychopathy) accurately measure the dark trait factors that they are intended to measure. However, some of the items have the potential to measure more than one of the factors. Persson, Kajonius, and Garcia (2017) found similar results when they discovered that Machiavellian and psychopathy items measured very similar characteristics. During the analysis of the current study, it was discovered from the Modification Indices that the narcissism factor had a significant correlation with a psychopathy item (P2) and a Machiavellian item (M3). The two highest MIs were Narcissism cross loading with item "P2" with the Mod. Ind. = 47.022 and Narcissism cross loading with item "M3" with the Mod. Ind. = 43.401. The item structure for both of the separate items (P2 & M3) brought forth the characteristics commonly seen in their corresponding dark trait factor, however, they also encouraged narcissistic characteristics. Therefore, it is understandable that both would correlate with the narcissism factor. Based on this evidence, during the construction of the new model the items "P2" and "M3" were loaded onto the narcissism factor as well as their own respective factors.

New Model

With the two highest MIs added the new model was then tested against another new set of random participants (N=1000). The RMSEA and BIC values for M4 was the lowest out of all of the previously reported values. The BIC bayes factor for M3 and M4 was log(BF_43) = 270.432 and log(BF_42) = 345.674 for M2 and M4. The results found confirmed that the new model was the best fitting model for the given data.

Dark Personality Traits Structure

The SD3 was created using three well known personality assessments that measured each of the dark traits individually. Measuring narcissism, psychopathy, and Machiavellianism successfully and in a correlated fashion is necessary, but it is also problematic because the assessment of all three of these dark traits has been met with many complications. Psychopathy in the past has been measured with the most success in a clinical setting, however it has been less successfully measured outside of the clinical environment. Despite the strong previous evidence in support of Machiavellianism and psychopathy being very similar constructs, the winning model measured the two separately. This may imply that despite their similar characteristics (e.g., manipulativeness, social callousness, and lack of emotion) the two traits still harbor their own unique qualities and are different enough to be measured respectively. With the addition of the general factor, the traits can be measured harmoniously and individually. Considering all of the traits have a callous base that incentivizes interpersonal manipulation, their similarities do not take away from their distinct differences. The general factor embraces their similarities and allows for better measurement of the differing characteristics that each dark trait demonstrates.

Limitations

The data used through this study does not give deep insight into the participants themselves. However, the focus is more so directed at how the "given" data fits into specific models. The chosen sample size was also rather large (N=1000), which makes finding the best model fit more difficult and it is less concise compared to when the sample size is smaller. The study was also conducted in the midst of a global pandemic, so there was limited access to data. Therefore, the data that has been used was not personally acquired. The data used was from OpenPsychometrics.org and each participant gave informed consent for the further use of their data before they took the SD3.

Conclusion

The aim of this study was to find the best model fit for the Short Dark Triad, Paulhus and Jones (2014) data given by OpenPsychometics.org. Through the use of Structural Equation Modeling and Confirmatory factor analysis, three models were compared and analyzed. Model three (bifactor model with three specific factors) yielded the best RMSEA and BIC values. BIC Bayes factor comparison confirmed that model three was the best fit for the given data. This model was then used to create the new model (Model four) which contained two of the highest MIs. Once model four was tested with a new random sample (N=1000) the RMSEA and BIC values confirmed that the newly created model was the best fit for the given data. This study has supported past research into the model structure and psychometric properties of the SD3. The original three factor model was subpar compared to all of the bifactor models, the addition of a general factor improved the model fit overall, and the independent factors correlated with items that were not originally meant to measure them. These findings are consistent with previous studies (eg., Persson, Kajonius, & Garcia, 2017; Zhang, Ziegler, & Paulhus, 2019; Rogoza & Cieciuch, 2018). Future studies could further investigate the model structure of the SD3 by continuing to use the bifactor structure model comparison. The residual modification indices could also be used to better the fit of the model instead of just the factor loading modification indices.

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Appendix A

Short Dark Triad (Paulhus and Jones, 2014) 27 items

Machiavellianism	Narcissism	Psychopathy
1. It's not wise to tell your secrets.	1. People see me as a natural leader.	1. I like to get revenge on authorities.
2. I like to use clever manipulation to get my way.	2. I hate being the center of attention. (R)	2. I avoid dangerous situations. (R)
3. Whatever it takes, you must get the important people on your side.	3. Many group activities tend to be dull without me.	3. Payback needs to be quick and nasty.
4. Avoid direct conflict with others because they may be useful in the future.	4. I know that I am special because everyone keeps telling me so.	4. People often say I'm out of control.
5. It's wise to keep track of information that you can use against people later.	5. I like to get acquainted with important people.	5. It's true that I can be mean to others.
6. You should wait for the right time to get back at people.	6. I feel embarrassed if someone compliments me. (R)	6. People who mess with me always regret it.
7. There are things you should hide from other people to preserve your reputation.	7. I have been compared to famous people.	7. I have never gotten into trouble with the law. (R)
8. Make sure your plans benefit yourself, not others.	8. I am an average person. (R)	8. I enjoy having sex with people I hardly know
9. Most people can be manipulated.	9. I insist on getting the respect I deserve.	9. I'll say anything to get what I want.