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Optimizing Efficiency of Psychopathology Assessment through Quantitative Modeling: Development of a Brief Form of the Externalizing Spectrum Inventory

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Abstract

The Externalizing Spectrum Inventory (ESI; Krueger, Markon, Patrick, Benning, & Kramer, 2007) provides for integrated, hierarchical assessment of a broad range of problem behaviors and traits in the domain of deficient impulse control. The ESI assesses traits and problems in this domain through 23 lower-order facet scales organized around three higher-order dimensions, reflecting general disinhibition, callous-aggression, and substance abuse. The full-form ESI contains 415 items, and a shorter form would be useful for questionnaire screening studies or multi-domain research protocols. The current work employed item response theory and structural modeling methods to create a 160-item brief form (ESI-bf) that provides for efficient measurement of the ESI's lower-order facets and quantification of its higher-order dimensions either as scale-based factors or as item-based composites. The ESI-bf is recommended for use in research on psychological or neurobiological correlates of problems such as risk-taking, delinquency, aggression, and substance abuse, and studies of general and specific mechanisms that give rise to problems of these kinds.

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Footnote

Keywords

externalizing; disinhibition; impulse control; aggression; substance abuse; item response theory; structural equation modeling; factor analysis; short form

Dimensional models of psychopathology offer a promising alternative to traditional discrete-category approaches to defining mental disorders in research and clinical contexts (Cuthbert, 2005; Widiger & Sankis, 2000). As an example, impulse-related problems such as conduct disorder, adult antisocial behavior, and drug and alcohol dependence covary systematically with one another, and with traits reflecting impulsivity, aggression, and absence of inhibitory control (Krueger et al., 2002; Sher & Trull, 1994)—suggesting that phenomena of these types might profitably be organized into a common assessment framework. An integrative measurement model of this domain of problems and traits has been operationalized in the form of the Externalizing Spectrum Inventory (ESI; Krueger, Markon, Patrick, Benning, & Kramer, 2007), a self-report instrument for use with clinical and non-clinical samples. Structural analyses of the lower-order facet scales of the ESI revealed the presence of an overarching higher-order factor reflecting disinhibitory traits and general proneness to impulse control problems, along with two distinct subfactors (residual factors), one reflecting callous-aggressive tendencies and the other excessive use of substances (Krueger et al., 2007).

As a counterpart to measurement models of the internalizing domain of psychopathology (e.g., Brown, Chorpita, & Barlow, 1998; Clark & Watson, 1991; Mineka, Watson, & Clark, 1998; Watson et al., 1995; Watson, 2005; Watson et al., 2007), the model articulated through formulation of the ESI has become a key point of reference in the literature, as evidenced by a strong and steady rate of citations to the original development paper (Krueger et al., 2007). However, the full-form ESI is too long (415 items) for use in extensive protocols (e.g., administrations involving multiple inventories; studies entailing interview, behavioral, and/or physiological assessment along with self-report assessment) or time-limited surveys, and a briefer version is needed as a basis for systematic research on the validity of the ESI measurement model. As an indication of the need for an abbreviated version of the ESI, validation studies to date have relied exclusively on shorter-length forms, designed either to approximate scores on the ESI as whole (Blonigen et al., 2011; Hall, Bernat, & Patrick, 2007; Nelson, Patrick, & Bernat, 2011) or to index its three higher-order factors (Venables & Patrick, 2012). However, the shortened versions used in prior studies do not provide for measurement at the finer-grained, lower-order facet level. The current work was undertaken to establish a comprehensive brief form that provides for efficient assessment of the externalizing domain at both lower- (individual facet) and higher-order (broad factor) levels.

Externalizing Spectrum Inventory: Content, Structure, and Correlates

Externalizing disorders represent one coherent domain of psychopathology identified by factor analytic studies of psychiatric conditions described within current and earlier versions of the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 2000) (Kendler et al., 2003; Krueger 1999a; Krueger et al., 1998). Research on

the etiologic basis of the broad factor that differing impulse-related disorders share indicates that this factor is highly (>80%) heritable (Kendler et al., 2003; Krueger et al., 2002; Young, Stallings, Corley, Krauter, & Hewitt, 2000) and that personality traits known to be related to these disorders—in particular, disinhibitory traits such as impulsivity, sensation seeking, and unconventionality function as indicators of this broad common factor (Krueger, 1999b; Krueger et al, 2002).

Krueger et al. (2007) developed the ESI to provide for measurement of externalizing problems and affiliated traits within an integrative, hierarchical framework. The full-form ESI contains 415 items that populate 23 unidimensional facet scales, covering domains of impulsiveness/sensation-seeking, irresponsibility and externalization of blame, aggression, deceitfulness, and substance use/problems of differing types. The 23 facet scales of the ESI exhibit a hierarchical (bifactor) structure in which all scales load appreciably on a general factor (labeled *Externalizing*, or *Disinhibition*), and residual variance in certain scales (i.e., variance not accounted for by the general factor) loads separately on one of two subsidiary factors (subfactors). The first of these subfactors, *Callous-Aggression*, is marked by residual variance in scales reflecting deficient empathy, relational aggression, destructiveness, excitement seeking, rebelliousness, and dishonesty. The second, *Substance Abuse*, is marked by residual variance in scales indexing recreational and problematic use of marijuana, other drugs, and alcohol.

As noted earlier, ESI validation studies to date have relied exclusively on shortened versions of the inventory rather than the full-length version. For example, in a study that included brain response measures along with questionnaire-based assessment, Hall et al. (2007) reported that high overall scores on a 100-item screening form of the ESI were associated with: lower levels of socialization (Gough, 1960); higher and lower scores, respectively, on broad Negative Emotionality and Constraint trait dimensions of the Multidimensional Personality Questionnaire (MPQ; Patrick, Curtin, & Tellegen, 2002; Tellegen & Waller, 2008); higher reported incidence of rule-breaking behaviors in childhood and adulthood; heightened levels of alcohol dependence and drug abuse; and reduced amplitude of the error-related negativity, a brain response that normally occurs following behavioral errors. Relatedly, Blonigen et al. (2011) reported that scores on this 100-item ESI strongly predicted scores on a widely-used test of integrity, the Personnel Research Blank (Gough, Arvey, & Bradley, 2004), designed to screen for tendencies toward counterproductive behaviors in employment settings (i.e., higher ESI scores predicted lower integrity scores).

Extending this work, Venables and Patrick (2012) administered a somewhat lengthier (159-item) screening version that provided for estimation of scores on the three higher-order ESI factors (disinhibition, callous-aggression, substance abuse) to an incarcerated offender sample, and examined relations of these factors with criterion variables including interview-based assessments of DSM-IV antisocial and substance-related disorders, personality traits as assessed by self-report, and psychopathic features as assessed by the interview-based Psychopathy Checklist-Revised (PCL-R; Hare, 2003) and the self-report based Psychopathic Personality Inventory (PPI; Lilienfeld & Andrews, 1996). Convergent and discriminant relations for scores on the three ESI factors coincided largely with a priori prediction. Scores on the ESI general disinhibition factor were predictive of child and adult symptoms of

DSM-IV antisocial personality disorder (*r*s = .42 and .54, respectively) and symptoms of alcohol and drug dependence (*r*s = .30 and .57) as assessed by diagnostic interview, antisocial deviance but not affective-interpersonal features of psychopathy as assessed by either the PCL-R or the PPI, and scores on Constraint and Negative Emotionality dimensions of personality (-.31 and .43, respectively) from the self-report based MPQ. The ESI substance abuse subfactor predicted appreciable variance in alcohol and drug dependence symptoms over and above that accounted for by the ESI disinhibition factor, and the ESI callous-aggression subfactor contributed distinctively to prediction of aggressive symptoms of antisocial personality disorder, affective-interpersonal features of psychopathy as assessed by either the PCL-R or the PPI, and traits of aggression, dominance, and aggression as assessed by self-report.

Current Study: Creation of a Brief Form of the ESI

Results of validation studies to date provide compelling support for the validity of scores on the ESI and its factors in relation to criteria in the domains of clinical interview, self-report, and physiological response. However, abbreviated versions of the ESI used in these prior studies are limited in that they do not provide for fine-grained assessment of facets of externalizing in terms of scores on the 23 lower-order ESI scales. Measurement at the lower-order facet level is likely to be valuable for characterizing patterns of disinhibitory problems/traits for individuals in research studies or for clinical purposes. With this in mind, we sought to develop a brief form of the ESI that would provide for effective measurement at both lower-order facet and higher-order factor levels.

Our main objective in the current work was to establish abbreviated versions of the 23 ESI content scales that provide for effective measurement at the lower-order facet level, and that exhibit a bifactor structure (one general factor, two subfactors) comparable to that for the full-form ESI. To achieve this, we relied heavily on item response theory (IRT) and confirmatory factor analysis (CFA) methods. Specifically, we evaluated items within each full-form ESI scale for their information value using IRT criteria and selected items from each scale that, as a set, faithfully reflected the content of the full-length scale and that: (1) demonstrated effective measurement of the construct underlying the full scale, and (2) functioned in a manner similar to the full-length scale within the higher-order ESI structural model. A further aim was to develop item-based scales for indexing the higher-order factors of the ESI (general disinhibition, callous-aggression, substance abuse) directly and efficiently. We sought to accomplish this by selecting subsets of items that: (1) exhibited preferential relations with scores on one or another of the ESI factors from the higher-order model, (2) were as distinct from one another as possible (i.e., given that all of the full-length ESI scales load together on a broad common factor), and (3) effectively captured the higher-order structure of the full-form ESI.

Method

Participant Sample

The current work utilized data for the participant sample of Krueger et al (2007), which included male and female undergraduates together with male and female prisoners (overall

N = 1,787). The mean age of the sample was 26.8 years (*SD* = 9.4, range = 18 – 63), 51% were female, and 68.8% identified themselves as Caucasian. (For additional information regarding sample characteristics, see Table 1 in Krueger et al. [2007].)

Measures

ESI full form—The 415 items of the full-form ESI served as the pool of candidate items for development of the ESI-bf. As described by Krueger et al. (2007), the ESI was developed using an approach in which items formulated to index distinct but presumably related constructs targeted on the basis of a detailed review of relevant literatures were progressively refined across multiple waves of item administration and analysis.[1] Classical psychometric (item-total *r*s, exploratory factor analysis) and modern item-analytic techniques (IRT) were applied to item data from each wave to establish unidimensional scales for measuring lower-order facets (specific problems and traits) within the externalizing domain. The development sample for the ESI (overall *N* = 1,787) consisted of male and female undergraduates (*n*s = 289, 299, and 283 in development waves 1, 2, 3), included to represent the normative range of the continuum of externalizing tendencies, and incarcerated male and female offenders (*n*s = 286, 314, and 316 in waves 1-3), to represent the higher end of the continuum.

The resultant full-form ESI contains 415 items organized into 23 unidimensional facet scales. The items of the ESI are completed using a 4-point response format (i.e., 0 = *false*, 1 = *somewhat false*, 2 = *somewhat true*, 3 = *true*). Scores for items within each facet scale are summed together (after reversing scores on false-keyed items) to yield scale scores, and these scale scores are then summed (after reversing scores for negative scale indicators of externalizing proneness—i.e., Planful Control, Dependability, Honesty, and Empathy) to yield a total ESI score. While intercorrelated, the various facet scales are thematically distinct (i.e., each captures a different expression of externalizing proneness). The names of the 23 facet scales, reflecting their item content, are listed in Table 1 along with the number of items comprising each scale (range = 9 to 31 items). Table 1 also presents (for the Wave 3 subset of the ESI development sample, in which data were collected for the final full item set) item endorsement statistics (Ms, SDs) for each ESI scale along with internal consistency reliability coefficients (α) for each. Table 2 shows descriptive statistics for maximum likelihood IRT-based estimates of facet scale scores for the full-form ESI, by participant subgroup (students, prisoners), within the overall sample (N = 1,787).

The structure of the 23 ESI facet scales was evaluated by Krueger et al. (2007) in two steps, entailing initial exploratory analyses (factor analysis, hierarchical cluster analysis) to identify candidate structural models, followed by CFAs to identify a best-fitting model. The

[1]As reported in the original ESI paper (Krueger et al., 2007), facet scales included at the outset of the development effort changed over the course of the three waves of data collection, as refinement occurred through item- and scale-level analyses (e.g., some initial scales were parsed into separate facets; other scales were pared down to focus their content). Additionally, the item composition of scales retained from one wave to the next also changed, with some items dropped due to weak measurement properties and others added as candidates for inclusion. In analyses for each wave, all available item data were used (i.e., data from prior waves were included along with data from the current wave), to maximize the amount of information relevant to each item. As new items were introduced in each wave, responses of individuals from prior waves were treated as missing on the new items, and the missing data were then treated with full information missing data analytic methods, as has been recommended for modeling of data that are missing by design (e.g., Graham, Hofer, & MacKinnon, 1996).

candidate models evaluated consisted of one factor, two-subfactor higher order, and two-subfactor hierarchical (bifactor) models. The one-factor model specified all facet scales as loading on a broad, overarching general factor. The higher order model (depicted schematically in Figure 3 of Krueger et al. [2007]) conceptualized the domain as the bifurcation of one general factor into two distinct factors that were further parsed into scale measures, with the correlation between factors accounted for by the general factor. By contrast, the bifactor model (depicted in Figure 4 of Krueger et al.) parameterized all ESI facet scales as being saturated by a broad general factor, with particular facet scales saturated additionally by subfactors separate from the general factor.

Modeling analyses performed by Krueger et al. (2007) revealed the best fit for the bifactor model, in which all scales were parameterized to load on a general factor labeled *Externalizing* (or *Disinhibition*), and residual variances for certain scales (i.e., variance not accounted for by the general factor) were specified as loading separately on one or the other of two subsidiary factors (subfactors). The first of these subfactors, *Callous-Aggression*, was marked by residual variance in scales reflecting deficient empathy, relational aggression, destructiveness, excitement seeking, rebelliousness, and dishonesty. The second, *Substance Abuse*, was marked by residual variance in scales indexing recreational and problematic use of marijuana, other drugs, and alcohol.

Multidimensional Personality Questionnaire (MPQ)—The MPQ (Tellegen & Waller, 2008) was used as a criterion measure for evaluating the predictive validity of scores on the ESI-bf relative to those for the full-form ESI. The MPQ assesses personality in terms of 11 primary traits subsumed under higher-order factors of positive emotionality (PEM), negative emotionality (NEM), and constraint (CON). The PEM factor of the MPQ can be subdivided further into agentic and communal subfactors, reflecting orientations toward achievement/status-seeking versus social affiliation (Tellegen & Waller, 2008). Items from the 155-item brief form of the MPQ (Patrick et al., 2002) were interspersed with ESI candidate items and administered in Wave 2 of data collection (n = 613) as reported by Krueger et al. (2007). To keep the overall item set for this wave within manageable limits, the 12-item Absorption trait scale of the MPQ and its 14-item Unlikely Virtues scale (which indexes social desirability) were omitted.

Development of Facet Scales for the ESI-bf

Given the progressive, wave-by-wave approach used to develop the original ESI, specific items and items comprising constructs added in latter waves were missing by design in the collapsed sample (N = 1,787), and were thus treated using full-information maximum likelihood missing data methods in IRT analyses of all available item responses. Items comprising the facet scales of the ESI-bf were selected based on their parameter estimates from IRT analyses of their counterpart full-form scales. The scale-level measurement properties of the resultant brief-form scales were then compared to those of the full-length ESI scales using descriptive and correlational approaches along with IRT methods (i.e., comparison of test information functions).

Item response modeling—Item parameters from IRT analyses of the final full-ESI scales (paralleling those reported by Krueger et al., 2007) were used to select items for the ESI-bf facet scales. IRT analyses employed the graded response model (GRM; Samejima, 1969), as implemented in *Mplus* (Muthén & Muthén, 1998-2010). For each of the 23 facet scales, parameters from the GRM were estimated in the overall development sample (N = 1,787) using all items from the finalized inventory, as described by Krueger et al. (2007). To fulfill the aim of establishing a reduced item set for each brief scale that would provide for effective measurement of the facet trait, comparable to that for the full-scale item set, we selected items for the ESI-bf facet scales based on their parameter estimates from the full scale IRTs.[1] Specifically, items were chosen that exhibited the highest discrimination parameters at particular levels of difficulty, so as to effectively represent information across the range of the trait continuum captured by the items of the full-form scale. Accordingly, in some instances, items with lower discrimination values were selected in place of ones with higher discrimination values if they provided information at underrepresented levels of difficulty. In cases where more than one item was available with effective discrimination at a particular level of difficulty, the thematic content of the item was considered in relation to other candidate items—in order to maximize content coverage and limit redundancy within brief-form scales.

Scale level comparisons—Analyses were undertaken to compare the measurement properties of the resultant brief-form scales with those of the full-form scales. One approach entailed comparing descriptive statistics and correlations between ESI and ESI–bf facet scale scores computed both as mean item endorsements and as IRT-based estimates. Additionally, we examined test information functions (TIFs) for brief and full length scales as another approach to evaluating comparability. The TIF provides a means of graphically representing the precision of measurement of a particular set of test items across varying levels of an underlying trait dimension. For purposes of comparison, we plotted a TIF for each full-length ESI scale (as reported by Krueger, 2007) along with the TIF for its corresponding brief-form scale on a common axis. Given the reduced number of items for the ESI–bf facet scales, the full and brief form facet scale TIFs were compared based on both their morphology and the location of maximum information (i.e., the TIFs were not expected to overlap upon each other given the reduced number of items in the brief scales). We also compared the efficiency of measurement of the full and brief facet scales by

[1]A key assumption in item-response theory (IRT) is the assumption of local independence—that is, items within a scale are assumed to be interrelated only as a function of the underlying trait that the scale as a whole measures. (We are grateful to an anonymous reviewer for highlighting the importance of this issue.) The local independence assumption relates to the assumption of scale undimensionality in IRT, insofar as items that are locally dependent will tend to demarcate a separate factor in a factor analysis. The question of unidimensonality of the facet scales of the ESI was examined extensively in their original development through use of factor and cluster analysis as described in Krueger et al (2007). Nonetheless, to address the question of local independence of items comprising the facet scales of the ESI-bf, we ran and evaluated one-factor confirmatory models for each scale using weighted least squares to obtain estimates of absolute and incremental model fit. The values of the comparative fit index (CFI) for these models ranged from .96–.999 (*M* = .99, SD = .01), the Tucker-Lewis index (TLI) ranged from .95–.999 (*M* = .984, SD = .01), and the root mean square error of approximation (RMSEA) ranged from .028–.114 (*M* = .064, SD =.022). RMSEA was <=.05 for eight scales, . 05-.07 for seven scales, and <=.08 for all but three scales (boredom proneness [4 items], impatient urgency [5 items], and honesty [5 items]), for which values of RMSEA were .087, .099, and .114. However, inspection of modification indices for item pairs within each of these scales revealed that none met the minimum required value of 10 chi-square units. These results indicate that interrelations among items with facet scales of the ESI-bf were attributable predominantly to the common trait factor indexed by each (i.e., that the local independence assumption was not violated).

computing the ratio of information provided by the two versions of the scale across trait levels θ.

Structural Modeling of ESI Facet Scales

Since a key aim of the current work was to establish brief-form scales that exhibit the same higher-order structure as the full-form ESI scales, we undertook CFAs to establish the best fit of a comparable structural model to the facet scales of the ESI-bf, and then performed follow-up analyses to confirm similarity of the factors of the brief-form model with those of the full-form model. CFAs were conducted in *Mplus* using IRT-based maximum likelihood (ML) estimates of facet scale scores for the overall ESI development sample (N = 1,787) based on ML estimation with standard errors robust to non-normality of their distributions (MLR; version 5; Muthén & Muthén, 1998-2009). The 23 ESI facet scales were utilized as indicators in the structural analyses, following the approach of Krueger et al. (2007) for the full-form ESI, because the facet scales were developed to index distinct, unidimensional facets of externalizing proneness. Three sets of confirmatory models were fitted for ESI full-length facet scales, ESI–bf facet scales, and subsets of items from the factor scales of the ESI-bf representing differing facets. In the case of the latter, facet scores were estimated based on 1 to 10 available items per facet scale (median = 3), with Blame Externalization and Rebelliousness omitted given that no items from these facet scales appear in the item-based factor scales. Confirmatory models were specified in accordance with those fitted in Krueger et al (2007), though MLR estimation was utilized in favor of semi-parametric ML estimation. Specifically, one factor, two-subfactor higher order, and two-subfactor hierarchical (bifactor) models were tested using facet scores for the full-form ESI, the ESI–bf, and the factor scales of the ESI–bf as indicators.

The relative fit of models for each array of facet scores was compared on the basis of two information-theoretic criteria: Akaike's information criterion (AIC) and the Bayesian information criterion (BIC). These criteria take into account complexity of the model while indexing the efficiency of model parameters in accounting for observed data. Values of AIC and BIC are lower for models superior in terms of both fit and parsimony. For BIC, differences in values of 10 reflect odds of 150:1 that the model with the lower value fits better (Raftery, 1995). Absolute model fit was indexed using the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR), with lower values of both reflecting better fit. For SRMR and RMSEA, values less than .05 or .06 indicate good fit, values from .06 to .08 indicate adequate fit, values from .08 to .10 marginal fit, and values above .10 less than adequate fit. Additionally, the comparative fit index (CFI) and the Tucker-Lewis index (TLI) were included as indices of incremental fit; for these indices, values above .95 indicate good fit and values above .90 indicate adequate fit. Following selection of the best-fitting model in each set, we compared parameters of models specifying full-length ESI facet scales as indicators with facet scales of the ESI–bf and facet score estimates based on relevant items of the ESI-bf factor scales.

Development of Item-based Factor Scales for the ESI-bf

A secondary aim in developing the ESI–bf was to construct scales of modest length (~20 items each) to index the general externalizing or disinhibition factor (ESI_{DIS}) of the ESI, and

the callous-aggression (ESI_{AGG}) and substance abuse (ESI_{SUB}) subfactors. Two main goals guided the development of the item-based factor scales. First, items comprising the factor scales would be 'nested' in the item set for the ESI–bf, such that administration of the ESI–bf would yield scores on these scales. Second, the factor scales would show fidelity in indexing factor scores estimated from either the full-form ESI or ESI–bf models, and could thus be used as proxies for model-estimated factor scores. This would enable researchers interested mainly in scores on the ESI factors to administer the item-based factor scales in place of the lengthier ESI or ESI–bf protocols.

Candidate items for the ESI_{DIS}, ESI_{AGG}, and ESI_{SUB} factor scales consisted of items from the ESI-bf facet scales that showed robust loadings on target factors of the full-form ESI model and weaker loadings on other factors. Candidate items for the ESI_{DIS} scale were from the *Irresponsibility*, *Problematic Impulsivity*, *Impatient Urgency*, *Planful Control* (−), *Dependability* (−), *Theft*, and *Alienation* scales; those for the ESI_{AGG} scale were from the *Relational Aggression*, *Empathy* (−), *Destructive Aggression*, *Excitement Seeking*, *Physical Aggression*, *Rebelliousness*, and *Honesty* (−) scales; and those for the ESI_{SUB} scale were from the *Marijuana Use*, *Marijuana Problems*, *Drug Use*, *Drug Problems*, *Alcohol Use*, and *Alcohol Problems* scales. From among the candidates for each, items were selected that exhibited robust, selective associations with scores on the target factor (computed via ML estimation from the model of the full-length ESI scales as specified in *Mplus*) and effective IRT parameters in conjunction with other items fulfilling this inclusion criterion.

The properties of scores on these resultant factor scales (computed as item-sums) were evaluated by examining their correlations with one another and with model-estimated scores for the full-form ESI factors; in the case of ESI_{AGG} and ESI_{SUB} item sets, correlations with corresponding model-estimated factor scores were examined after partialling out variance in common with $ESI_{DIS.}$

Criterion-Related Validity of ESI–bf Scores

As a means of evaluating the criterion-related validity of scores on the ESI–bf, factor scores estimated from models of the facet scales and item-based factor scales of the ESI–bf were compared with model-estimated factor scores for the full-form ESI in terms of their relations with scores on the brief form of the MPQ (Patrick et al., 2002). These analyses were performed using data for the Wave 2 subset of the ESI development sample (n = 613), which included administration of the MPQ. ML estimated factor scores for the general disinhibition factor and callous-aggression and substance abuse subfactors based on parameters of the best-fitting confirmatory models for the full and brief ESI facet scales were correlated with primary trait and higher-order factor scores of the MPQ. In addition, correlations with the MPQ were examined for IRT-based ML estimates of scores on the general disinhibition factor computed using the facet indicators of the ESI_{DIS} scale, and for IRT-based estimates of scores on the two ESI subfactors derived from facet indicators of the ESI_{AGG} and ESI_{SUB} scales; scores for the subfactors were rendered independent of the general disinhibition factor by removing variance in common with this factor.

Results

Properties of Facet Scales of the ESI-bf

The ESI–bf contains 160 items, completed using the same 4-point response format as the full-form ESI. Table 1 (right side) lists the number of items comprising each facet scale of the ESI-bf. The median length of the facet scales for this form is 7 items (range: 3 – 11), as compared to 17 items for those of the full-form ESI (range: 9 – 31). The factor scales (18-20 items each) are composed of items from the ESI-bf facet scales, chosen to index the general disinhibition factor and callous-aggression and substance abuse subfactors of the ESI structural model (Krueger et al., 2007). A listing of the items of the ESI–bf, denoting those that comprise the three item-based factor scales, is provided in the on-line Supplement to this article.

Descriptive statistics for IRT-based estimates of facet scale scores for the full-form ESI and ESI–bf are presented in Table 2, by participant subgroup (students, prisoners) within the overall development sample of Krueger et al. (2007). For each participant subgroup, *M*s and *SD*s for trait estimates based on the ESI and ESI–bf were highly comparable for all facet scales. Expectedly, facet scale means for the prisoner subgroup were higher in the externalizing direction than means for the student subgroup. This held true for both the brief and full-length versions of the scales. In addition, for both the full-length and brief scales, *SD*s were somewhat higher in the prison sample than the student sample, perhaps reflecting greater variance and measurement error in the prison subgroup.

In practice, the subscales of the ESI–bf are likely to be scored as sums of item values, rather than as trait estimates computed using IRT or factor analysis methods. Given the multi-wave approach used to develop the ESI, items comprising the final version of the full-length ESI (and in turn, the ESI–bf) were administered *in toto* to only the third wave of development sample participants. Table 3 presents descriptive statistics for scores on the full-length ESI and ESI–bf facet scales, using data from this wave. Mean endorsements of items comprising the full-length and brief facet scales were quite comparable. Also shown in Table 1 (right-most two columns) are correlations between full-length and brief facet scale scores for participants in Wave 3; these cross-version *r*s were uniformly high, ranging from .91 to .98 for ML estimates and.89 to .98 for summed scale scores.

The precision of measurement for a set of items using IRT psychometric techniques is reflected in the TIF. Figure 1 (left) depicts the TIFs for full-length ESI scales (per Krueger et al., 2007, but rendered in *Mplus*) and brief form scales, plotted on the same axes for comparison purposes. For each scale, the morphology and peak-location of the curves for the two item sets (full-length, brief) are quite comparable. In each case, the height of the curve for the brief version is lower than for the full-length version because net information is determined by the number of items in the set as well as by the precision of measurement for items. Figure 1 (right) also depicts the relative efficiency of measurement for each of the brief facet scales, reflecting the proportion of information provided by each brief scale relative to its full-length counterpart across trait levels θ.

Structural Modeling of ESI Facet Scales

Regardless of whether confirmatory models used facet-level scores for the ESI, the ESI–bf, or the factor scales of the ESI–bf as indicators, the two-subfactor hierarchical (bifactor) model exhibited better fit than the one-factor model or the two-subfactor higher order model, as evidenced by lower AIC and BIC values (Table 3). RMSEA values for the bifactor model exhibited less than adequate fit for facet scales of the full-form ESI (value = .114; 90% confidence interval [CI] = .111 - .116), marginal fit for facets of the brief ESI (.091; CI = .088 - .094), and adequate to good fit (.064; CI = .061 - .067) for facets of the item-based factor scales. Inspection of modification indices for the full-form ESI model revealed two sources of less-than-adequate fit in particular: one reflecting unaccounted-for covariation between *Alcohol Use* and *Alcohol Problems* facet scores, and the other unaccounted-for covariation between *Alienation* and *Blame Externalization* facet scores. Inclusion of correlated residual terms for these two scale pairings improved the value of RMSEA to .096 (CI = .094 - .099) for the full-form ESI model, and to .078 (CI =.075 - .081) for the ESI–bf model.

The finding of superior fit for the bifactor model relative to other models tested (as reported by Krueger et al., 2007) indicates that a broad, general factor saturates each indicator of the domain, with two mutually uncorrelated factors specified as separate from the general factor accounting for proportions of remaining variance in specific facet scales. Parameter estimates for the best-fitting bifactor models are presented in Table 4. The loadings for ESI and ESI–bf facet scale indicators were quite comparable. Congruency coefficients between loading vectors for the general disinhibition factor, callous-aggression subfactor, and substance abuse subfactor were 1.00, .99., and .99, respectively. The loadings for facets represented by items of the ESI–bf item-based factor scales were also comparable to those for the full-length scales (corresponding congruency coefficients = .98, .96, and .99).

Properties of Item-based Factor Scales of the ESI-bf

Another goal in developing the ESI–bf was to formulate item-based scales for indexing the factors of the ESI. Descriptive statistics for scores on these scales are shown in Table 5. Although designed to measure distinguishable broad constructs, the ESI factor scales were nonetheless expectably correlated given that their items were drawn from content scales that all function as indicators of a common disinhibition factor. As shown in Table 6 (unbolded coefficients, right side), the ESI_{AGG} and ESI_{SUB} factor scales each showed appreciable correlations with ESI_{DIS} (*r*s = .52 and .74, respectively), and were correlated moderately with one another (*r* = .42). In evaluating relations of the item-based factor scales with model-estimated factors of the ESI and ESI–bf, regression analysis was used to isolate variance in the callous aggression and substance abuse factor scales distinct from the disinhibition scale (cf. Venables & Patrick, 2012). Table 6 depicts how residual variances in item-based ESI_{AGG} and ESI_{SUB} scales (i.e., after accounting for ESI_{DIS}) correlate with factor scores derived from the bifactor model of ESI scales (full-length and brief versions) using maximum likelihood estimation. It can be seen that ESI_{AGG} and ESI_{SUB} residual scores exhibit very high (>.8) correlations with scores for corresponding factors from the structural model (see bolded coefficients on lower left of Table 6), but negligible associations with scores for non-corresponding factors (see unbolded coefficients in Table 6, lower left). This

residual-variance approach can be used in analytic contexts where the goal is to quantify distinct predictive relations of the three higher-order ESI factors with criterion variables of interest (Venables & Patrick, 2012).

ESI Disinhibition—The ESI_{DIS} scale consists of 20 items, 4 from the *Problematic Impulsivity* and *Theft* scales, 3 from the *Irresponsibility* scale, 2 from the *Impatient Urgency* and *Dependability* scales, and 1 item from each of the *Fraud*, *Alienation*, and *Boredom Proneness* scales. IRT-based estimates of scores on the disinhibition factor derived from these items were correlated very highly with scores on the general factor of the full-form ESI model (r = .97), and negligibly with scores on the subfactors of the model (Table 6). The test information function for these scale items (Figure 2) evidences precise measurement over a broad range of the underlying trait, with maximal information provided just above the latent mean.

ESI Callous-Aggression—The ESI_{AGG} scale comprises 19 items, 10 from the *Empathy* scale, 4 from the *Relational Aggression* scale, 2 from the *Excitement Seeking* scale, and 1 from each of the *Physical Aggression*, *Destructive Aggression*, and *Honesty* scales. IRT-based maximum likelihood estimates of scores on callous-aggression factor computed from the items of the ESI_{AGG} scale correlated .74 with scores on this factor derived from the full-form ESI model, increasing to .84 after removal of variance associated with ESI_{DIS}. The TIF for this scale (Figure 2) shows somewhat better measurement at the high callous-aggression end of the continuum than at the lower end of the trait.

ESI Substance Abuse—The ESI_{SUB} scale contains 18 items, 3 from each of the substance-related facet scales (*Marijuana Use*, *Marijuana Problems*, *Drug Use*, *Drug Problems*, *Alcohol Problems*, *Alcohol Use*). In general, items from these scales show prominent cross-correlations with the general disinhibition factor of the ESI model. Bivariate associations between ESI_{SUB} and the general disinhibition factor, callous-aggression subfactor, and substance abuse subfactor of the ESI were r = .76, p<.001, r = .03, ns, and r = .69, p< .001 (Table 6). As a function of this, scores on the ESI_{SUB} scale correlated at similar levels with model-estimated scores on the general disinhibition factor and the substance abuse subfactor (rs = .76 and .69, respectively; see Table 6), albeit negligibly with model-estimated scores on the callous-aggression subfactor (r = .03). After removing variance in common with ESI_{DIS}, ESI_{SUB} showed a correlation of .85 with model-estimated scores on the substance abuse subfactor, and a negligible association with scores on the general disinhibition factor (r = .07). The TIF for this factor scale (Figure 2) reveals a narrower band of information coverage than for the other item-based factor scales, with a peak slightly below the latent mean.

Notably, the ESI_{SUB} scale comprises items reflecting experimentation, general use, and problems of lesser severity with substances (cf. article Supplement). Items indicative of more severe substance problems showed strong relations with the general factor, necessitating their omission from this factor scale (i.e., to improve separation from ESI_{DIS}). The strong convergence of scores on ESI_{SUB} with scores on the substance subfactor of the

ESI model indicates that the residual variance in this factor scale reflects utilization of substances for reasons other than general disinhibition proneness.

Criterion-Related Validity of ESI-bf Scores: Relations with Traits and Broad Factors of the MPQ

Table 7 shows, for the Wave 2 subset of the ESI development sample which included the MPQ, correlations for maximum likelihood estimated factor scores derived from the ESI (columns 1 – 3) and ESI–bf (columns 4 – 6) confirmatory models with MPQ score variables. Also shown are *r*s for scores on the general disinhibition factor estimated from the items of the ESI_{DIS} scale (column 7), and for scores on the two ESI subfactors estimated from the ESI_{AGG} and ESI_{SUB} scales after removing variance associated with ESI_{DIS} (columns 8 – 9). Comparison of the magnitudes of *r* between MPQ primary trait scores and ESI, ESI–bf, and ESI item-based factor scores reveals a high degree of similarity for each of the general disinhibition factor and callous aggression and substance abuse subfactors of the domain. Congruency coefficients between MPQ primary trait scale correlation vectors of ESI general factor scores and ESI–bf general factor scores, and between ESI general factor scores and ESI_{DIS}, both exceeded $r = .99$. Congruency coefficients between MPQ primary trait scale correlation vectors of ESI callous-aggression factor scores and ESI–bf callous-aggression factor scores, and between ESI callous-aggression factor scores and residual variance in ESI_{AGG}, were also both greater than.99. Congruency coefficients between MPQ primary trait scale correlation vectors of ESI substance abuse factor scores and ESI–bf substance abuse factor scores, and between ESI substance abuse factor scores and residual variance in ESI_{SUB}, were .92 and.95, respectively. These results demonstrate comparable associations for factor scores derived from these differing item sets (ESI, ESI–bf, ESI-bf factor scales) with normal range personality traits as indexed by the MPQ.

Discussion

Quantitative-structural models of adult mood- and anxiety-related problems, and affiliated measurement instruments, have existed in the literature for some time (e.g., Brown et al., 1998; Clark & Watson, 1991; Mineka et al., 1998; Watson et al., 1995). A quantitative-structural model of adult disinhibitory (externalizing) problems and traits was introduced more recently (Krueger et al., 2002). The ESI (Krueger et al., 2007) was developed to operationalize this model in the domain of self-report. As a follow-up to this work, the current study was undertaken to establish, through use of quantitative modeling methods including IRT and confirmatory factor analysis, a shorter-length version of the ESI with optimal measurement properties. Our efforts resulted in a 160-item brief form (ESI–bf) that faithfully indexes the inventory's 23 lower-order facet constructs and that provides for effective measurement of the ESI's three higher-order factors, as latent dimensions and through item-based scales. Facet scales of the ESI–bf range in length from 3 to 11 items, as compared to between 9 and 31 items for their full-length counterparts. Despite this marked reduction in scale length, internal consistency reliabilities remained high, with α values exceeding .85 for all scales but one (i.e., Alienation, for which only 3 of 9 items were retained; $\alpha = .74$).

Similarity of Brief and Full Length Forms

Comparability of measurement between the brief and full-length facet scales was demonstrated by similarity of IRT-based trait estimates (θ) for the two versions in distinct participant subsamples consisting of college students and prisoners, with trait-level differences for prisoners versus students highly similar across the two versions of each scale. In addition, mean item endorsements for the brief ESI facet scales mirrored means for their full-length counterparts. Correlations between brief and full-length scale scores computed as item sums were likewise very high (range = .89 - .98). Comparability at the facet scale level was also evidenced by similarity of test information functions (TIFs) for brief as compared to full-length scale versions. Although TIFs for the brief scales were expectably less elevated than TIFs for their full-length counterparts, reflecting the loss of some test information due to item deletion, the shapes and locations of TIF information peaks for all scales were highly similar across the two versions. That is, for each scale, the relative degree of information captured by the brief item set across differing levels of the relevant trait (θ) closely mirrored that for the full-length item set.

Comparability of the brief and full-length versions of the ESI was also evident at the higher-order structural level. For both forms of the inventory, the best-fitting model was a hierarchical (bifactor) model specifying a common general factor on which all facet scales loaded, along with two subsidiary factors (subfactors) on which residual variances of particular scales (i.e., portions of variance not accounted for by the general factor) exhibited loadings. The loadings of individual brief and full-length facet scales on the factors of the model were highly similar across the two versions of the model, as evidenced by near-perfect congruence coefficients between loading vectors for corresponding factors of the two models.

Item-Based Factor Scales

A further objective in developing the ESI–bf was to establish item-based scales for indexing the three higher-order factors of the ESI as manifest variables. A recent study by Venables and Patrick (2012) provided evidence for the validity of scores on these three factors, computed as composites of ESI facet scales associated preferentially with each, in relation to an array of interview-based diagnostic and self-report based personality criteria. The item-based factor scales devised in the current work provide an efficient and effective means for indexing the three ESI factors in future studies directed at investigating general externalizing (disinhibition) proneness and distinguishable callous-aggressive and substance-oriented expressions of disinhibition proneness.

Scores on the 20-item general disinhibition (ESI_{DIS}) factor scale correlated .97 with maximum-likelihood estimated scores on the general factor specified in the structural model of the full-length ESI facet scales (Krueger et al., 2007). Consistent with the findings of Venables and Patrick (2012), relations between the item-based callous-aggression (ESI_{AGG}) and substance abuse (ESI_{SUB}) factor scales (19 items and 18 items, respectively) and corresponding factors of the full-form ESI model emerged most clearly (rs = .84 and .85, respectively) after variance in common with the general disinhibition scale (ESI_{DIS}) was removed from these scales. The reason is that, within the full-form ESI model, the callous-

aggression and substance abuse factors are parameterized to be independent of the general factor; consequently, scores on the item-based ESI_{AGG} and ESI_{SUB} scales cohered most closely with estimated scores on counterpart factors from the full-form model when variance associated with ESI_{DIS} was removed from each.

Some notable features of these item-based factor scales warrant mention. The ESI_{DIS} scale includes no alcohol or drug-related items and no aggression-related items and thus can be conceptualized as a measure of general externalizing proneness free of content pertaining directly to substance abuse/dependence or aggressive behavior. As such, the scale can be used as a predictor variable in studies focusing on risk for substance-related problems or violent/aggressive outcomes, without concern for criterion contamination. The MPQ personality correlates of this scale closely resembled those of maximum likelihood estimated scores on the general factor from the full-form ESI model, and are consistent with extensive prior work showing traits in the domains of negative emotionality (encompassing neuroticism and antagonism-agreeableness in the Five Factor Model [FFM]; Costa & McCrae, 1992) and constraint/impulsivity (encompassing conscientiousness from the FFM) to be associated with externalizing proneness (e.g., Krueger, 1999b; Krueger et al., 1996; Lynam et al., 2003; Sher & Trull, 1994). The two lower-order trait scales of the MPQ that were related most strongly to scores on the disinhibition factor of the ESI (whether estimated from the full-form ESI model or derived from the item-based ESI_{DIS} scale) were Control (−) and Alienation (+).

The callous-aggression subfactor, captured by the item-based ESI_{AGG} scale, appears to reflect an aggressive-dominant interpersonal style distinguishable from general disinhibitory proneness. In relation to the MPQ, ESI_{AGG} showed its strongest association with the trait of Aggression, and also showed robust relations with Social Potency, and Harm Avoidance and Traditionalism facets of CON. These results indicate that ESI_{AGG} combines forceful-aggressive tendencies with nonconformity and tolerance (or preference) for risk/danger—propensities considered central to the diagnosis of psychopathy (Frick & White, 2008; Lynam & Derefinko, 2006; Zuckerman, 1992). Consistent with this, Venables and Patrick (2012) showed that scores on ESI callous-aggression (after controlling for general disinhibition) correlate robustly with affective-interpersonal symptoms of PCL-R psychopathy and with exploitativeness, entitlement, and exhibitionism facets of narcissism. The implication is that ESI_{AGG} may serve as an index of core aspects of psychopathy that are distinct from externalizing proneness--in particular, what investigators in the psychopathy area have termed callous-unemotionality (Frick & White, 2008) or meanness (Patrick, Fowles, & Krueger, 2009).

The Substance Abuse subfactor (ESI_{SUB}), as parameterized in the ESI bifactor model, reflects shared residual variance in scales indexing alcohol, marijuana, and drug use and problems--that is, covariance among these scales not accounted for by general disinhibition (ESI_{DIS}). This subfactor may reflect proneness to excessive use of substances with lesser risk for escalation to severe problems, dependency, and adverse consequences. However, when coupled with disinhibitory propensities reflected in the general factor, individuals with high ESI_{SUB} scores are prone to continue use despite outcomes such as problems with work and family, and legal trouble. This may in part account for why items reflecting chemical

dependency problems and antisocial behaviors causally or consequentially associated with addiction were more strongly associated with ESI_{DIS} than with ESI_{SUB} scores. However, longitudinal research will be required to formally evaluate this hypothesis.

Observed MPQ score correlates were also consistent with the hypothesis that ESI_{SUB} reflects tendencies toward alcohol and substance use distinct from general externalizing proneness. Following removal of variance associated with ESI_{DIS}, scores on ESI_{SUB} showed associations with traits reflecting stimulation-seeking and nonconformity (i.e., low Harm Avoidance, low Traditionalism) from the domain of CON. This result is consistent with evidence for a prominent role of traits of novelty- (Bardo, Donohew, & Harrington, 1996; Cloninger, 1987) and sensation-seeking (Earleywine et al., 1990) in alcohol and substance abuse. Evidence that novelty- and sensation-seeking may be dissociable from impulsivity (Depue & Collins, 1999; Flory et al., 2006; Whiteside & Lynam, 1999), though not synonymous with general Disinhibition, may also be consistent with the view that variation in ESI_{SUB} reflects the use and abuse of substances for reasons of experience-seeking rather than deficient behavioral or emotional control. Research utilizing the ESI_{SUB} scale may serve to elucidate these possibilities and better delineate, in conjunction with administration of the ESI_{DIS} scale, involvement in substances that occurs for reasons other than general externalizing proneness.

Limitations and Future Directions

Some potential limitations of the current work warrant mention. One is that current analyses entailed estimation of bifactor model parameters using conventional CFA, as opposed to semi-parametric methods used in modeling the original, full-length ESI scales (Krueger et al., 2007). We used this approach to enable us to apply a consistent modeling approach to differing versions of the ESI scales (i.e., full-length and brief versions, and items from the factor scales reflecting facets), with units of analysis in each case comprising IRT-based ML estimates of scale scores. However, the fact that parameters for the full-form bifactor model here were highly similar to those reported by Krueger et al. indicates that the model was robust to analytic approach. A second point is that the process of selecting items to represent each facet scale relied on data for the original ESI development sample, with all available item-level data used to identify items that provided information across a broad range of the underlying traits. Given the process of scale development in which new items were added in each wave of data collection, parameter estimates for items administered only in latter waves may have been less stable. A third point is that scores for full-length and brief facet scales were derived from a common administration, likely resulting in some inflation of correlations between the two (i.e., since brief scales are subsets of full-length scales). Considering these two latter points, it will be valuable to collect data for the two versions of the inventory in new samples to further evaluate their comparability. In addition, it will be valuable in future work to undertake analyses to evaluate the comparability of classification of individuals for levels of externalizing proneness based on the brief form of the ESI versus the full version (cf. Gass & Gonzalez, 2003).

Notwithstanding these limitations, the current work establishes the ESI–bf as an efficient tool for assessing diverse problems and traits in the domain of deficient impulse control, as

well as higher order factors corresponding to broad propensities in this domain. Given growing research interest in externalizing proneness (e.g., Endres et al., 2011; Hicks et al., 2004; Iacono et al., 1999, 2003; Latendresse et al., 2011), the inventory as a whole and its general disinhibition factor can serve as referents for ongoing work along this line—including research directed at clarifying the biological basis of externalizing problems (e.g., Dick, 2007; Hicks et al., 2007; Patrick et al., 2012). The availability of an ESI version that provides for comprehensive but efficient assessment at the facet level can also serve as a basis for profile-based analyses of individuals with externalizing problems in correctional or clinic samples. In addition, constructs indexed by the callous-aggression and substance abuse subfactors of the ESI can serve as targets, respectively, for research on similarities and differences between psychopathy and externalizing proneness, and on factors contributing to general risk for substance-related problems aside from externalizing proneness.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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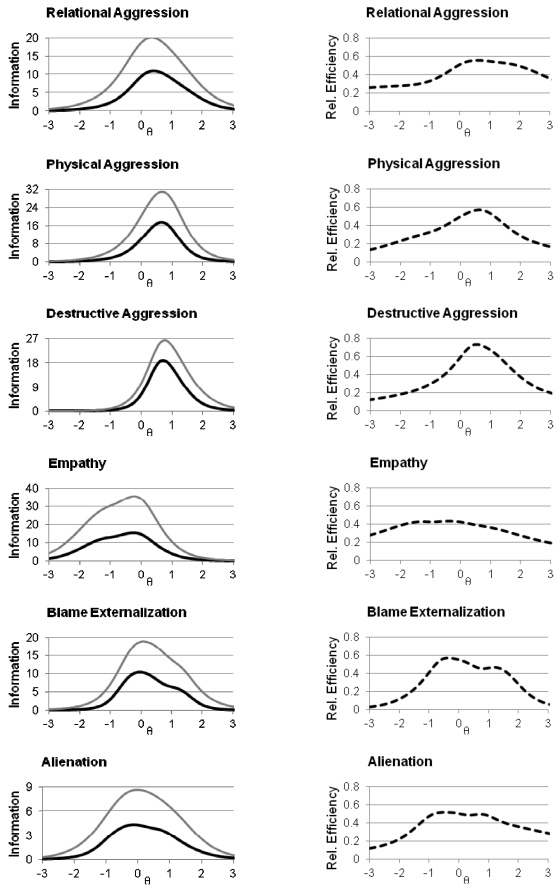

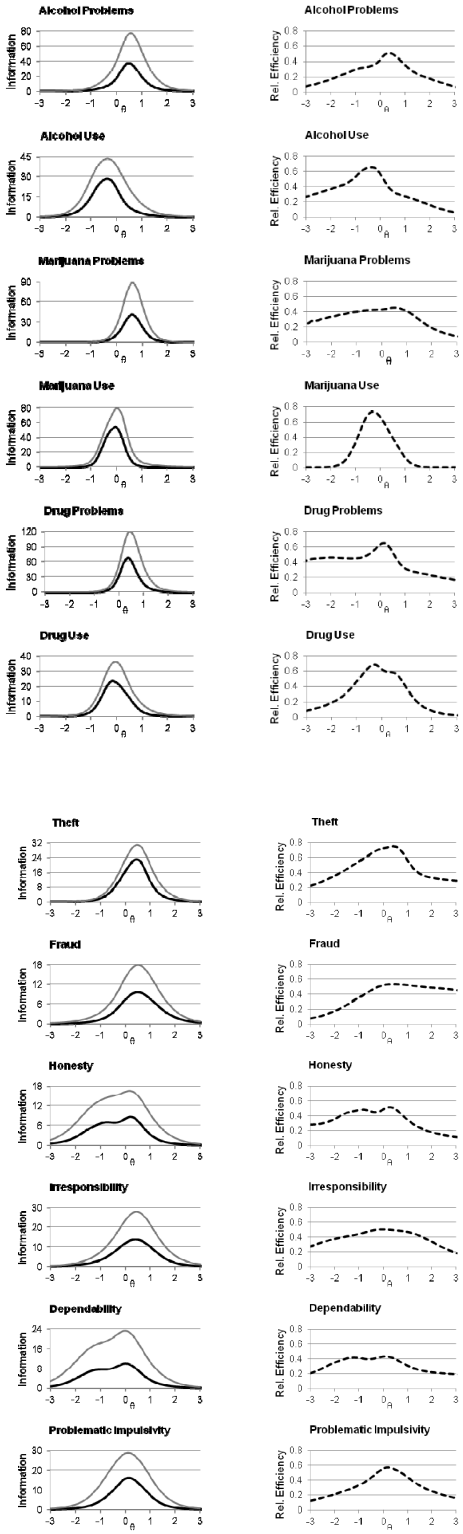

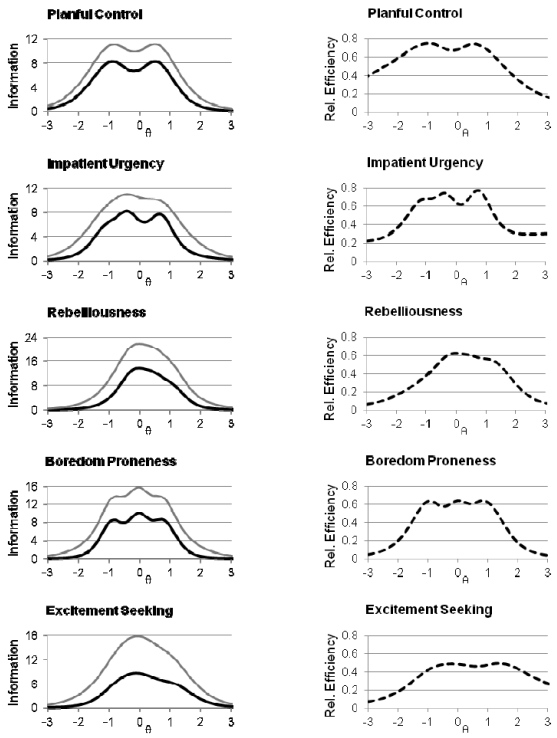

Figure 1.

Test information function for full-length and brief facet scales (left side) and relative efficiency for brief and scales (right side), where relative efficiency = proportion of information provided by brief scale relative to its full-length counterpart across trait levels θ.

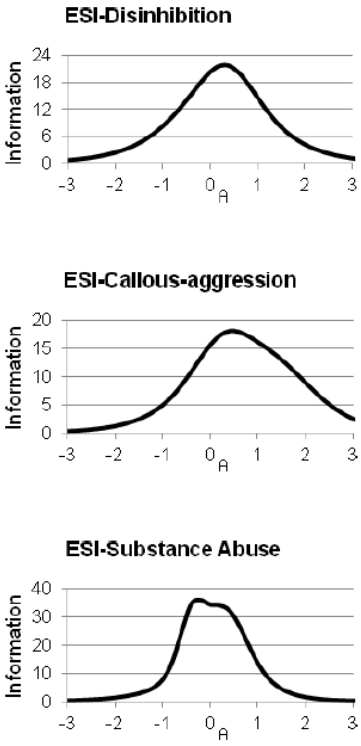

Figure 2.
Test information functions for item-based factor scales.

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Table 1

Descriptive Statistics for Endorsement of Facet Scale Items (M, SD), Scale Score Reliabilities (α), and Correlations (r) Between Scores for Full-Length and Brief Form Scales (Wave 3 Sample; n = 599)

	ESI				*ESI-bf*				*r*	
Externalizing Facet	***Items***	***M***	***SD***	**α**	***Items***	***M***	***SD***	**α**	***θ***	E_M
Problematic Impulsivity	20	1.46	0.89	.96	7	1.38	1.04	.93	.97	.98
Irresponsibility	25	1.10	0.86	.96	10	1.15	0.98	.92	.97	.97
Theft	15	0.98	0.99	.95	8	1.04	1.06	.92	.98	.98
Fraud	14	1.00	0.83	.92	6	0.88	0.88	.85	.95	.96
Impatient Urgency	12	1.60	0.70	.90	5	1.64	0.80	.85	.94	.92
Planful Control	11	1.95	0.66	.91	6	2.02	0.72	.89	.97	.96
Dependability	23	2.16	0.61	.95	7	2.18	0.70	.88	.95	.96
Alienation	9	1.47	0.73	.85	3	1.47	0.84	.74	.91	.89
Boredom Proneness	12	1.49	0.75	.92	4	1.53	0.93	.92	.97	.94
Blame Extemalization	14	1.11	0.74	.93	4	1.15	0.92	.91	.96	.94
Honesty	15	2.06	0.63	.93	5	2.10	0.71	.85	.95	.95
Rebelliousness	15	1.24	0.80	.90	6	1.18	0.97	.93	.97	.97
Physical Aggression	21	1.01	0.85	.95	8	1.02	0.96	.91	.96	.97
Destructive Aggression	15	0.59	0.76	.94	7	0.60	0.87	.92	.93	.96
Relational Aggression	19	1.09	0.71	.93	8	0.96	0.75	.87	.95	.96
Empathy	31	2.32	0.56	.96	11	2.30	0.62	.92	.96	.97
Excitement Seeking	18	1.43	0.73	.93	6	1.23	0.81	.87	.96	.94
Marijuana Use	17	1.55	1.15	.97	7	1.66	1.27	.96	.95	.98
Marijuana Problems	18	0.85	1.04	.97	7	0.88	1.09	.94	.97	.98
Drug Use	13	1.43	1.07	.95	6	1.51	1.18	.92	.97	.98
Drug Problems	25	1.01	1.09	.98	11	1.05	1.15	.96	.97	.99
Alcohol Use	23	1.74	0.92	.96	9	1.88	0.98	.92	.97	.97
Alcohol Problems	30	0.90	0.92	.97	9	0.95	1.03	.94	.97	.98

Note. Wave 3 data are presented because these participants were administered the final complete items set developed across the three waves. *M* and *SD* values for item endorsements reflect a 4-point response format, with scores for all items coded such that 0 = low and 3 = high, respectively, on the underlying trait. α = Cronbach's alpha for constituent items (range = 3-11) of each facet scale. θ = facet scale scores computed using item-response theory based maximum likelihood estimation; E_m = facet scale scores computed as mean item endorsement values.

Table 2

Full and Brief Form Externalizing Spectrum Inventory (ESI) Scale Means and Standard Deviations in Student and Prisoner Subgroups of Overall ESI Development Sample (ns = 871 and 916)

	Student (M, SD)		Prisoner (M, SD)	
Externalizing Facet	**ESI**	**ESI–bf**	**ESI**	**ESI–bf**
Problematic Impulsivity	−.72 (.61)	−.70 (.58)	.68 (.74)	.67 (.71)
Irresponsibility	−.72 (.58)	−.69 (.55)	.68 (.71)	.66 (.70)
Theft	−.67 (.58)	−.62 (.55)	.64 (.77)	.59 (.81)
Fraud	−.56 (.61)	−.54 (.53)	.54 (.89)	.51 (.87)
Impatient Urgency	−.42 (.72)	−.36 (.72)	.40 (.96)	.35 (.95)
Planful Control	.38 (.74)	.31 (.70)	−.37 (.93)	−.30 (.83)
Dependability	.34 (.71)	.35 (.70)	−.33 (.88)	−.33 (.86)
Alienation	−.48 (.80)	−.45 (.73)	.44 (.83)	.41 (.82)
Boredom Proneness	−.34 (.74)	−.32 (.77)	.32 (1.0)	.30 (.95)
Blame Extemalization	−.39 (.79)	−.33 (.76)	.36 (.92)	.31 (.92)
Honesty	.20 (.67)	.25 (.77)	−.20 (.87)	−.23 (.99)
Rebelliousness	−.49 (.73)	−.48 (.69)	.47 (.89)	.46 (.89)
Physical Aggression	−.53 (.67)	−.53 (.60)	.50 (.92)	.51 (.88)
Destructive Aggression	−.33 (.69)	−.33 (.62)	.32 (.98)	.31 (.95)
Relational Aggression	−.26 (.74)	−.23 (.76)	.25 (1.1)	.22 (1.01)
Empathy	.26 (.76)	.24 (.70)	−.24 (.96)	−.23 (.94)
Excitement Seeking	−.21 (.78)	−.13 (.76)	.20 (1.1)	,12 (1.06)
Marijuana Use	−.57 (.78)	−.54 (.78)	.53 (.73)	.49 (.67)
Marijuana Problems	−.52 (.62)	−.49 (.54)	.50 (.85)	.47 (.87)
Drug Use	−.62 (.71)	−.57 (.64)	.59 (.71)	.54 (.70)
Drug Problems	−.67 (.54)	−.65 (.45)	.68 (.71)	.62 (.73)
Alcohol Use	−.20 (1.00)	−.20 (.93)	.19 (.85)	.19 (.80)
Alcohol Problems	−.44 (.72)	−.44 (.64)	.41 (.97)	.42 (.96)

Note. Externalizing facet scales were estimated using maximum likelihood item response theory based scoring with means and standard deviations parameterized as zero and one in the overall sample, respectively.

Table 3

Fit Statistics for Confirmatory Factor Models (Overall ESI Development Sample; N = 1,787)

Models	K	ln(L)	AIC	BIC	CFI	TLI	RMSEA	SRMR
ESI Models								
One General Factor	69	−41099	82337	82715	.71	.68	.150	.079
Higher-Order Two-Subfactor	70	−40015	80170	80554	.77	.75	.135	.072
Hierarchical Two-Subfactor	92	−38434	77052	77557	.85	.82	.114	.052
with modification	**94**	**−37668**	**75524**	**76040**	**.90**	**.87**	**.096**	**.042**
ESI-bf Models								
One General Factor	69	−39637	79413	79791	.75	.72	.125	.079
Higher-Order Two-Subfactor	70	−38759	77657	78041	.81	.78	.110	.071
Hierarchical Two-Subfactor	92	−37607	75398	75903	.88	.85	.091	.052
with modification	**94**	**−37149**	**74486**	**75002**	**.91**	**.89**	**.078**	**.045**
Factor Scale Item Models								
One General Factor	63	−27387	54899	55245	.76	.74	.104	.081
Higher-Order Two-Subfactor	64	−27139	54406	54758	.79	.76	.098	.079
Hierarchical Two-Subfactor	**84**	**−26030**	**52227**	**52688**	**.92**	**.90**	**.064**	**.042**

Note. k = number of free parameters; ln(L) = natural log likelihood; AIC = Akaike's information criterion; BIC = Bayesian information criterion; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. Lower criterion values indicate better fit; best-fitting model for each ESI version is highlighted in bold.

Table 4

Full and Brief Form Hierarchical Model Parameter Estimates (Overall ESI Development Sample; N = 1,787)

	ESI				*ESI–bf*				*Subfactor Scales*			
Externalizing Facet	λ_1	λ_2	λ_3	Θ	λ_1	λ_2	λ_3	Θ	λ_1	λ_2	λ_3	Θ
Problematic Impulsivity	.92 (.01)	.00	.01 (.02)	.15	.90 (.01)	.00	.04 (.02)	.19	.83 (.01)	.00	.05 (.02)	.30
Irresponsibility	.92 (.01)	.00	.06 (.02)	.16	.90 (.01)	.00	.10 (.03)	.19	.85 (.01)	.00	.08 (.03)	.27
Theft	.85 (.01)	.00	.20 (.02)	.25	.82 (.01)	.00	.17 (.02)	.30	.82 (.01)	.00	.15 (.02)	.30
Fraud	.86 (.01)	.25 (.01)	.00	.20	.83 (.01)	.23 (.02)	.00	.26	.79 (.01)	.06 (.02)	.00	.37
Impatient Urgency	.74 (.01)	.17 (.02)	.00	.43	.63 (.02)	.22 (.02)	.00	.56	.60 (.02)	.02 (.03)	.00	.64
Planfiil Control	−.68 (.01)	−.02 (.02)	.00	.54	−.60 (.02)	−.05 (.02)	.00	.64	−.56 (.03)	.02 (.05)	.00	.68
Dependability	−.66 (.01)	−.12 (.02)	.00	.55	−.65 (.02)	−.12(.03)	.00	.57	−.67 (.02)	.03 (.03)	.00	.55
Alienation	.60 (.02)	−.02 (.01)	.00	.64	.53 (.02)	−.01 (.04)	.00	.72	.46 (.03)	−.09 (.03)	.00	.78
Boredom Proneness	.60 (.02)	.25 (.02)	.00	.58	.53 (.02)	.21 (.03)	.00	.67	.52 (.03)	.08 (.04)	.00	.72
Blame Extemalization	.52 (.02)	.21 (.02)	.00	.69	.43 (.02)	.17 (.03)	.00	.78	--	--	--	--
Honesty	−.54 (.02)	−.27 (.02)	.00	.63	−.51 (.03)	−.33 (.05)	.00	.63	−.20 (.04)	−.41 (.05)	.00	.80
Rebelliousness	.79 (.01)	.29 (.02)	.00	.30	.77(.01)	.30 (.02)	.00	.31	--	--	--	--
Physical Aggression	.72 (.01)	.42 (.02)	.00	.31	.70 (.02)	.34 (.02)	.00	.40	.49 (.02)	.48 (.02)	.00	.53
Destructive Aggression	.63 (.02)	.56 (.02)	.00	.29	.62 (.02)	.53 (.02)	.00	.34	.39 (.02)	.50 (.02)	.00	.60
Relational Aggression	.61 (.02)	.64 (.02)	.00	.22	.56 (.02)	.67 (.02)	.00	.24	.49 (.02)	.63 (.02)	.00	.37
Empathy	−.47 (.02)	−.55 (.02)	.00	.48	−.45 (.02)	−.53 (.02)	.00	.52	−.46 (.02)	−.55 (.02)	.00	.48
Excitement Seeking	.55 (.02))	.45 (.02)	.00	.50	.46 (.02)	.49 (.03)	.00	.55	.31 (.02)	.45 (.02)	.00	.71
Marijuana Use	.67 (.02)	.00	.64 (.02)	.14	.63 (.02)	.00	.61 (.02)	.23	.52 (.02)	.00	.65 (.02)	.31
Marijuana Problems	.70 (.01)	.00	.54 (.02)	.23	.70 (.02)	.00	.44 (.02)	.31	.65 (.02)	.00	.47 (.02)	.35
Drug Use	.74 (.01)	.00	.54 (.02)	.16	.71 (.02)	.00	.56 (.03)	.18	.59 (.02)	.00	.53 (.03)	.38
Drug Problems	.82(.01)	.00	.39 (.02)	.17	.81 (.01)	.00	.40 (.03)	.19	.73 (.02)	.00	.36 (.03)	.33
Alcohol Use	.44 (.01)	.00	.36 (.02)	.68	.41 (.02)	.00	.35 (.03)	.71	.28 (.02)	.00	.47 (.03)	.70
Alcohol Problems	.66(.01)	.00	.30 (.02)	.48	.66 (.02)	.00	.27 (.03)	.50	.53 (.02)	.00	.38 (.03)	.58

Note. General externalizing factor loadings and loadings for the two subfactors are labeled by λ_1, λ_2, and λ_3, respectively; standard errors are shown in parentheses next to loadings. Residual variances are in the columns labeled Θ. Values of .00 were fixed and not estimated, and -- denotes missing scale loadings for facets not included in item-based factor scales.

Table 5

Descriptive Statistics for Mean Endorsement of Factor Scale Items (Wave Three; n = 599)

Item-based Factor Scale	*Items*	*M*	*SD*	α
ESI_{DIS}	20	1.26	0.83	.94
ESI_{AGG}	19	1.46	0.96	.92
ESI_{SUB}	18	0.77	0.57	.95

Note. α = Cronbach's alpha for constituent items of each factor scale.

Table 6

Correlations between Full and Brief Externalizing Spectrum Inventory Factor Scores and Mean Item Endorsements for Item-based Factor Scales (Wave Three Sample; n = 599)

	ESI			ESI–bf			Factor Scales		
	Gen	**Agg**	**Sub**	**Gen**	**Agg**	**Sub**	**ESI_{DIS}**	**ESI_{AGG}**	**ESI_{SUB}**
ESI_{DIS}	**.97**	.05	.16	**.98**	.02	.14	--		
ESI_{AGG}	.55	**.74**	.08	.54	**.75**	.03	.52	--	
ESI_{SUB}	.76	.03	**.69**	.76	.00	**.69**	.74	.42	--
ESI_{AGG} Θ	.05	**.84**	.00	.04	**.87**	−.05	.00	**.85**	.03
ESI_{SUB} Θ	.07	−.02	**.85**	.06	−.02	**.87**	.00	.04	**.67**

Note. General externalizing (Gen), aggression (Agg), and substance (Sub) factor scores were estimated using maximum likelihood based on parameters of the two-subfactor hierarchical (bifactor) model. ESI_{DIS} = general disinhibition, ESI_{AGG} = callous-aggression, and ESI_{sub} = substance abuse item-based factor scale scores. ESI_{AGG} Θ and ESI_{SUB} Θ denote residual variance in factor scale scores after accounting for variance associated with ESI_{DIS} Correlations reflecting associations between alternative scores indices of the same factor are bolded.

Table 7

Relations between Externalizing Spectrum Inventory (ESI) Factors and Multidimensional Personality Questionnaire Scores (Wave Two Sample; n = 613)

	ESI			ESI–bf			Factor Subscales		
MPQ Scores	**Gen**	**Agg**	**Sub**	**Gen**	**Agg**	**Sub**	**ESI_{DIS}**	**ESI_{AGG} Θ**	**ESI_{SUB} Θ**
Primary Traits									
Well-being	**−.20**	.04	.00	**−.20**	.08	.00	**−.18**	.03	.00
Social Potency	−.03	**.27**	.01	−.02	**.27**	.00	−.04	**.25**	.03
Achievement	**−.16**	−.12	−.07	**−.16**	−.10	−.03	**−.15**	−.09	.00
Social Closeness	**−.37**	−.04	.07	**−.36**	−.05	.03	**−.36**	−.05	.10
Stress Reaction	**.47**	.09	−.12	**.44**	**.12**	−.06	**.45**	.05	−.06
Alienation	**.62**	.08	−.05	**.60**	.09	−.01	**.60**	.03	−.06
Aggression	**.59**	**.62**	.05	**.60**	**.63**	.03	**.58**	**.60**	−.05
Control	**−.65**	**−.16**	−.06	**−.63**	**−.19**	−.08	**−.59**	**−.19**	−.09
Harm Avoidance	−.05	**−.28**	**−.16**	−.03	**−.29**	**−.15**	−.03	**−.35**	**−.19**
Traditionalism	**−.13**	**−.25**	**−.17**	**−.14**	**−.23**	**−.12**	−.10	**−.25**	**−.15**
Broad Factors									
PEM: overall	**−.23**	.08	.02	**−.23**	.10	.01	**−.22**	.07	.06
PEM: agentic	−.20	.04	−.04	−.20	.07	−.03	−.19	.05	.00
PEM: communal	**−.29**	.06	.06	**−.28**	.06	.03	**−.28**	.04	.09
NEM	**.71**	**.31**	−.05	**.70**	**.33**	−.02	**.69**	**.27**	−.03
CON	**−.43**	**−.31**	**−.18**	**−.42**	**−.32**	**−.17**	**−.38**	**−.35**	**−.20**

Note. Bold-faced entries are significant at the $p<.001$ level. General externalizing (gen), aggression (agg), and substance (sub) factor scores were estimated using maximum likelihood based on parameters of the two-subfactor hierarchical (bifactor) model. ESI_{DIS} = item-based general externalizing (disinhibition) factor score. ESI_{AGG} Θ and ESI_{SUB} Θ denote residual variance in item-based factor subscale scores after accounting for variance associated with IRT-based maximum likelihood estimates of ESI_{DIS}. PEM = positive emotionality; NEM = negative emotionality; CON = constraint